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OBITUARY



Dr. J. C. Sharma (1929-1982)

The Editorial Board of the 'HAU Journal of Research' lost one of its distinguished members in the death of Dr. J. C. Sharma in the early hours of 28th February, 1982.

Dr. Sharma was the founder Director of Extension Education of the Haryana Agricultural University, Hissar. He dedicated the best part of his life to the cause of extension education in Haryana. Dr. Sharma is credited with numerous extension innovations he introduced. He developed the concept of Krishi Gyan Kendras at every district headquarters, introduced the concept of calendars of operations, prepared the first Job Book in India for subject matter extension specialists. He also initiated the extension publications programme in the University.

Dr. Sharma was a very active member of the Editorial Board of the Journal of Research since its very inception. We always looked to him for valuable suggestions and guidance which flowed from him readily.

A scholar of eminence, Dr. Sharma was a man of wide human sympathies and will always be remembered with love and respect.

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Department of Animal Production Physiology
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Before preparing the manuscript, the authors are requested to follow strictly the style of the articles published. Deviations from the accepted style may cause considerable delay in publication.

LIST OF ABBREVIATIONS

acre	=ac	milli	=m (e. g. mm, mg, ml)
ampere	=A		
approximately	=approx.	minimum	=min
aqueous	=aq.	minute	=min.
average	=av. (*mean* preferred)	mole	=mol.
		months of the year	=use first three letters, e. g. Jan
centigrade	=°C		
centimetre	=cm	numbers	=no.
chlorophyll	=chl	page, pages	=p., pp.
concentration	=concn	quintal	=q
cultivar	=cv.	relative humidity	=r. h.
day	=d	second	=s
dry weight	=d. wt	species	=sp., plural spp.
figure	=fig.	square	=sq. (but with units, e. g. square metre m^2)
fresh weight	=f. wt		
gram	=g		
hectare	=ha	standard deviation mean	=s. d. m.
height	=ht		
hour	=h	standard error mean	=s. e. m.
kilo	=k (e.g. kg, km)	temperature	=temp.
leaf area ratio	=LAR	tonne	=t
litre	=l	variety	=var.
maximum	=max.	volume	=vol.
metre	=m	weight	=wt
micro	=μ		

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EFFECT OF DIETARY PROTEIN LEVELS ON GROWTH, FEED EFFICIENCY AND CARCASS QUALITY OF PIGS

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ABSTRACT

Eighteen Middle White Yorkshire pigs were randomly allotted to three groups of six pigs each and were fed 18, 16, 14 and 16, 14, 12% crude protein (CP) diets during the growing and finishing phases of life cycle, respectively.

The average daily gain (ADG) of pigs fed 18% (0.71% lysine) and 16% (0.63% lysine) crude protein diets during the growing period was similar but was significantly higher than those fed 14% CP. Thus, lysine requirement of pigs during growing phase may be 0.63%. The maximum ADG for the finishing phase was for pigs fed 14% crude protein followed by those fed 16 and 12% crude protein diet. The ADG of pigs fed 16% (0.63% lysine) and 14% (0.56% lysine) crude protein diets was similar though it was more than those fed 12% crude protein. The requirement for lysine, thus, during the finishing phase may be 0.56%. The pigs fed 18 → 16% CP diet produced leaner carcasses than those fed 16 → 14 and 14 → 12% CP diets.

Abernathy *et al.* (1958) reported significant faster gains in pigs fed diets containing 18% protein than those fed diets containing 14% during the growing period (804 vs 735 g/day). No additional advantage was obtained by feeding 18% during the finishing period. Similar results were reported by Seymon *et al.* (1964) and Jurgens *et al.* (1967). Lynch *et al.* (1972) observed no advantage in terms of body weight gain by feeding higher protein though backfat thickness was reduced by increased protein in the diet.

The present study was conducted to assess the effect of protein level sequence in the diet on the performance and carcass quality of Middle White Yorkshire pigs.

MATERIAL AND METHODS

Eighteen Middle White Yorkshire pigs averaging 14 kg body weight were randomly allotted to three dietary treatments and housed in pens measuring 8.45 × 3.20 m. Feed and water were offered *ad lib.* The percentage composition of diets is presented in Table 1. The dietary treatments consisted of the following :

A = 18% → 16% CP
(maize — GNC — FM diet)

TABLE 1

Percentage composition of experimental diets

Ingredients	Diet identification			
	A 18% P	B 16% P	C 14% P	D 12% P
Maize	74.5	80.2	86.2	90.5
Groundnut cake	17.0	11.3	5.3	1.0
Fish meal	6.0	6.0	6.0	6.0
Mindif 'pigs'[a]	0.5	0.5	0.5	0.5
Lime stone	1.0	1.0	1 0	1.0
Steamed bone meal	1.0	1.0	1.0	1.0
Rovimix [b]	15g	15g	15g	15g
Rovibe[c]	25g	25g	25g	25g
C. F. (%)	3.00	2.50	2.45	2.98
Lysine (%)	0.71	0.63	0.56	0.50
DE (Kcal/kg diet)	3163	3166	3169	3167

[a]Mindif 'pig' contained : 25% calcium, 9% phosphorus, 30% sodium chloride, 0.5% iodine, 0.08% copper, 0.1% manganese, 0.15% cobalt and 0.15% sulphur.

[b]Rovimix contained vitamin B_1 4 mg, vitamin B_6 8 mg, vitamin B_{12} 40 mg, niacin 16 mg, calcium pantothenate 40 mg, and vitamin E 40 mg per g supplement.

B=16%→14% CP
(maize—GNC—FM diet)

C=14%→12% CP
(maize—GNC—FM diet)

The feed ingredients used in the study were analysed by the methods described by AOAC (1970). The pigs were fed the grower diets (18, 16 and 14%) till they attained the weight of 25 kg. Thereafter, they were switched over to finisher diets (16, 14 and 12%), which contained maize as the source of energy and groundnut cake (GNC) and fish meal (FM) as protein supplements. Weekly liveweights and daily feed consumed were recorded. The pigs were slaughtered when they attained the market weight of 70-75 kg. The slaughtering procedure was same as described by Sharda and Pradhan (1976). The data were analysed using the variance method as outlined by Steel and Torrie (1960).

RESULTS AND DISCUSSION

The effect of different protein levels in the diet on the performance of pigs is presented in Table 2. The average daily gain (ADG) of pigs fed diets A, B and C was 591, 570 and 510 g, respectively, during the growing period. Though the ADG of pigs fed 18% CP was more than those fed 16%, the differences among the treatments were not found to be statistically significant. The ADG of pigs fed 18 and 16% CP was significantly higher than those fed 14% CP. It may, thus, be deduced that diet having 14% protein was not optimum for desired muscle development in pigs during the growing period. Since the

TABLE 2

Effect of dietary protein levels on the performance of exotic pigs

Items	Diet identification			CD
	A	B	C	(P <.05)
	Growing period			
Average daily gain (g)	591	570	510	22.0
Feed/gain ratio	3.44	3.43	3.77	0.20
	Finishing period			
Average daily gain (g)	623	667	498	86.0
Feed/gain ratio	4.64	4.30	4.92	0.70
	Combined periods			
Average daily gain (g)	594	601	488	30.0
Feed/gain ratio	3.92	3 78	4.08	0.30

diets A and C contained 0.71 and 0.56% of lysine, respectively and there was no significant difference in daily gain between diets A and B with 0.71 and 0.63% of lysine, it may be concluded that lysine requirement may be about 0.63% in the diet.

During the finishing period, pigs fed 14% CP showed the maximum ADG (667 g) followed by those fed 16% (623 g) and 12% (498 g). Thus, 12% CP during the finishing phase was not adequate for optimum growth and no additional advantage was obtained by feeding 16% CP. Diets B, C and D contained .63, .56 and .50% L-lysine. Thus, the lysine requirement for finishing pigs may be 0.56%. The feed/gain (F/G) ratio of pigs fed 18 and 16% CP during the growing period was better than those fed 14% CP in diet ($P<.05$), but it was not different for pigs fed .18 and 16% CP. During the finishing period F/G was similar for the different groups of pigs. For the combined periods this trait was better for pigs fed 14% CP as compared to those fed 12% though not different for pigs fed 16 and 14% CP in the diet. These results are contrary to the findings of Seerley *et al.* (1964) who reported faster ADG of pigs fed protein levels higher than 16% and in agreement with those reported by Lynch *et al.* (1972).

The effects of different dietary protein levels on carcass traits and organ weights are presented in Table 3. The back fat thickness was smaller for pigs fed diet C(3.46 cm) as compared to those fed diets B(3.97 cm) and A(3.68 cm). The differences among the treatment means were, however, not found to be statistically significant. The lean and primal cut per cents were larger for the pigs fed the higher level of protein than those fed the lower levels ($P <.05$). The carcass length and dressing per cent, however, were not different for pigs on different diets. The present findings that higher protein level (18%) produced leaner

TABLE 3

Effect of dietary protein level on carcass traits and organ development of exotic pigs

Items	Diet identification			CD
	A	B	C	(P <.05)
Kill weight (kg)	71.7	70.6	66.9	4.4
Carcass length (cm)	65.3	66.9	66.6	3.6
Dressing per cent	68.9	68.4	68.7	5.3
Average back fat thickness (cm)	3.68	3.97	3.46	0.52
Lean cut (%)	64.5	60.4	60.9	2.83
Primal cut (%)	72.0	68.1	67.8	2.44
(Per cent of kill weight)				
Liver	1.95	1.66	1.64	0.35
Heart	0.28	0.27	0.27	0.03
Kidneys	0.34	0.33	0.29	0.04
Spleen	0.15	0.15	0.15	0.03
Lungs+Bronchi	0.91	0.83	0.96	0.17

carcasses agreed with the findings of most of the workers.

Data on organ weights did not reveal any difference among pigs fed three dietary protein levels.

The study revealed that in terms of growth and feed efficiency, diet having 16 → 14% crude protein was adequate but in terms of carcass leanness, pigs needed 18 → 16% crude protein in the diet.

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STUDIES ON COMPONENTS OF CALVING INTERVAL OF MURRAH BUFFALOES

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ABSTRACT

Average calving interval, service period, gestation period, dry period and lactation length were 476±102, 161±90, 309±2, 178±43 and 294±43 days, respectively. Significant coefficients of correlations of calving interval with service period (0.576), dry period (0.339) and lactation length (0.667) were observed. Calving interval, service period and dry period were longest (564, 265 and 214 days, respectively) for buffaloes calving during winter months and shortest (447, 134 and 169 days, respectively) for buffaloes calving during hot humid months. There was considerable year to year variation in the above traits. Contrary to common belief and earlier reports 36% of buffaloes on this farm calved during summer months. Calving interval of summer calvers was moderately short (484 days). This is attributable to the efficient summer managemental practices.

The water buffalo is a late maturing animal and has long calving interval (Tomar and Tomar, 1960; Singh and Dutt, 1964). This results in shorter productive life. The main factor contributing to prolonged calving interval is their seasonal breeding tendency. Understanding the factors contributing to this tendency of longer inter-calving period in buffaloes is essential before measures aimed at improving the situation can be derived. The present study is in this direction.

MATERIAL AND METHODS

Data pertaining to Murrah buffalo herd of the Department of Livestock Production and Management from 1969 to 1978 were utilized for this study. This herd was established in February, 1969 by purchasing 40 young freshly calved and in-calf buffaloes.

On this farm, since 1970 water sprinkling on buffaloes during hot part of the summer days was started as a regular practice. Bull parades during early morning and late evening were being used to locate and breed the buffaloes in oestrus during summer season. The animals were housed in a loose house which facilitated unhindered movement of animals under the shade during the day time and into the open during night time at their own will and necessity.

The practice of weaning calves at birth was started during the year 1972, which resulted in abrupt end of lactation in some buffaloes. Hence, it was dis-

continued. The practice was again started on farm-born first-calvers. Weaning was only partly successful this time and lactations of 30% of first-calvers too were lost. Hence the number of calvings included in this study (174) were 67% of total (265) calvings that occurred on the farm during the period under report. Lactations less than 150 days were not considered in this study. Simple and partial coefficients of correlations between different traits were calculated. Analysis of variance was carried out for data on these characters.

RESULTS AND DISCUSSION

The average overall values of calving interval, its components and lactation yield of buffaloes are presented in Table 1, which are generally in agreement with reports of other workers (Krishna Rao and Murari, 1956; Kohli and Malik, 1960; Bhatnagar *et al.*, 1961; Whyte and Mathur, 1966; Amble *et al.*, 1970).

Calving Interval

The average value of calving interval observed was 476±102 days. Coefficient of variation was about 30 per cent. Calving interval of 60% buffaloes fell within the range of 351 and 500 days and values below and above these ranges were rare. Nearly 28% of buffaloes had a calving interval of around 375 days. Substantial number of buffaloes (35%) calved during the hot and dry months of April, May and June (Table 2). This is contrary to the common belief and earlier reports (Kohli and Malik, 1960; Tomar and Tomar, 1960; Bhatnagar *et al.*, 1961; Goswamy and Nair, 1964; Rai, 1966; Sharma and Sarkar, 1968). Another 21% of buffaloes calved during the hot-humid months of July and August (Table 2). The calving intervals of buffaloes that calved during the above two seasons were 484 and 447 days, respectively, which was also contrary to the earlier reports.

In fact the shortest calving interval for whole of the year was observed in case of buffaloes that calved during the hot-humid seasons, while the longest calving interval (565 days) was for buffaloes that calved during the cold months of November, December and January, the seasonal differences being statistically significant. This proves that buffaloes can be made to calve during the so called 'off season', provided proper managemental practices are followed as is being done on this farm.

TABLE 1

Average calving interval and its components and lactation yield of buffaloes

Characters	Number	Average in days	S. E.	Coefficient of variation
Calving interval	174	476.39	102.05	29.97
Service period	174	160.66	89.60	77.72
Gestation period	174	309.09	0.15	1.64
Dry period	174	177.82	42.48	48.35
Lactation length	174	294.39	42.47	29.20
Lactation yield (kg)	174	1491.59	112.60	29.68

TABLE 2

Average calving interval, its components and lactation yield of Murrah buffaloes calving in different seasons

Parameters	Cold (Nov., Dec., Jan.)	Mild-cold (Feb., Mar.)	Hot-dry (Apr., May, June)	Hot-humid (July, Aug.)	Mild-hot (Sep., Oct.)
Number	11	29	63	36	35
Percentage	6.32	16.66	36.22	20.69	20.11
Calving interval (days)	565.4±53.6	451.4±14.3	484.0±18.0	446.8±18.0	486.0±26.6
Service period (days)	265.2±52.9	141.3±13.4	162.0±15.5	133.7±17.2	169.2±25.4
Gestation period (days)	304.9±10.6	309.2±0.8	309.3±0.6	308.1±0.7	310.9±0.9
Dry period (days)	214.3±31.0	157.1±9.0	172.5±10.5	169.0±12.9	202.2±18.6
Lactation length (days)	358.3±35.2	293.6±12.5	304.5±11.8	278.6±11.0	272.9±14.4
Lactation yield (kg)	1768.1±86.7	2228.7±64.1	1497.2±59.2	1430.8±54.1	1363.5±90.3

The managemental practices followed on this farm provide not only protection to buffaloes against thermal stress but also help in proper detection of heat during summer months. Further, because of assured irrigation facilities on this farm **rabi** legumes like berseem and lucerne are generally available right upto the month of June. Perhaps this helps inconditioning the open buffaloes for summer breeding. Such effect of level of feeding on fertility of buffaloes was suggested by Raizada *et al.* (1969), Netke *et al.* (1970), Buvanendran *et al.* (1971) and Sastry and Georgie (1978).

Significant differences were also observed in calving interval of buffaloes between different calender years, which may be due to variation in feed management and climate between different years.

Service Period

The average service period was 161 ± 90 days with a coefficient of variation of 78 per cent. The trend of service period during different seasons and years followed, obviously, the same pattern as that of calving interval, since the former determines the magnitude of the latter. It is worthwhile to ponder over the reasons for maximum calvings occurring on this farm during the 'off season', and shorter calving interval and service period for 'off season' calvers.

Buffaloes calving in the hot-humid months of July and August conceived during September and October months of the previous year. These months are reasonably cool. But buffaloes calving during summer months (April, May and June) conceived during the months of June, July and August of the previous year, which are appreciably hot and humid in this region. This ought to hav caused greater thermal stress on the buffaloes. Such conditions are considered to be not conducive to higher rates of fertility in this species (Kohli and Malik, 1960; Tomar and Tomar, 1960; Goswamy and Nair, 1964). The contrary trend observed on this farm may be due to better summer management practices as described above.

Gestation Period

The average duration of gestation period was 309 days with a low coefficient of variation (1.64%). Neither the season of calving nor the years of calving had any affect on this trait. This is so because gestation period is a character of the species and extraneous factors have very little affect on it (Arunachalam *et al.*, 1952).

Dry Period

The average dry period observed in this study was 178 ± 43 days. As evident from Table 2, buffaloes calving during the months of February to August had shorter dry period (157–173 days) than those calving during the months of September to January (202–214 days). The general trend of dry period over the years is akin to that of service period. This is so because longer service period is associated with longer dry period (Kale, 1963; Goswamy and Nair, 1964). Such a relationship was also observed in the present study between these two traits (r = 0.402). However, differences in length of dry period between seasons and years of calving were not statistically significant.

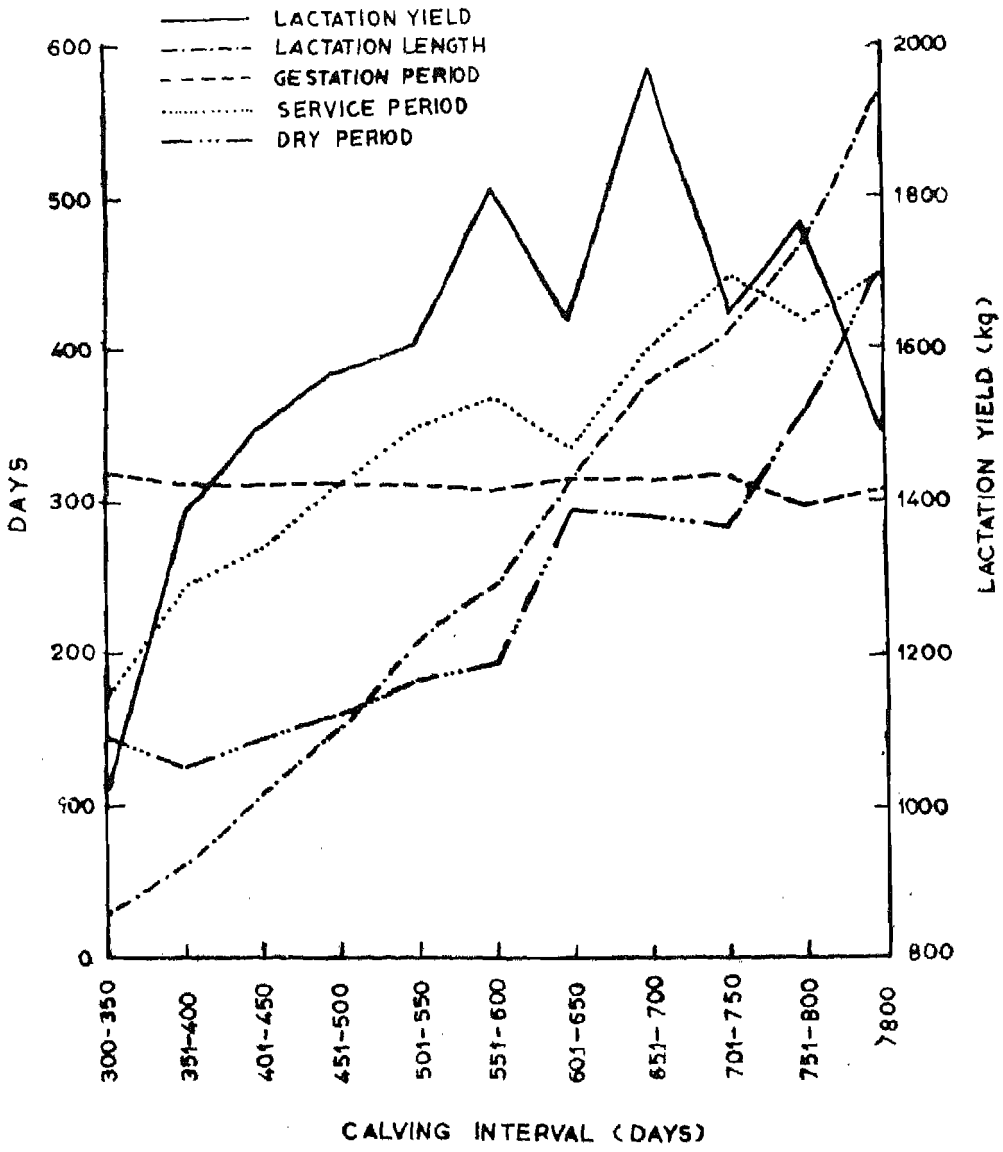


Fig. 1. Effect of duration of calving interval on gestation period, service period, dry period, lactation length and lactation yield of Murrah buffaloes.

Lactation Length

The average lactation length of buffaloes of this herd was 294±43 days with a moderate degree of variation (CV= 29%). It is evident from Table 2 that buffaloes calving in the hottest months of April, May and June (305 days) and coldest months of November, December and January (358 days) had statistically ($P<0.05$) longer lactation length in comparison to those calving during other months (273 to 294 days). Shorter lactations of animals calving during the months of July to October are rather difficult to explain, may be the ascending phase their lactations were adversely affected by shortage of green fodder (both quantity-wise and quality-wise). Generally, only over-ripe **kharif** fodders like jowar are available during this period as **rabi** crops (oats and berseem) appear from middle of November onwards. Whereas, for buffaloes calving from November upto June there is no such fodder shortage, because of winter and early summer (cowpeas and maize chiefly) fodder crops. The lactation length of buffaloes varied greatly from year to year which is probably due to variation in the fodder availability and climatic conditions (Bhatnagar *et al.*, 1961; Amble *et al.*, 1970).

Inter-relationships between Traits

The coefficients of correlation of calving interval with service period (0.58), dry period (0.34) and lactation length (0.67) were statistically significant, while that with gestation period (0.12) was not significant. The behaviour of each trait in relation to each of the other traits is depicted in Fig. 1.

Since calving interval and its chief components—service period and dry period, have generally low repeatabilities and heritabilities (Mason, 1974), their duration can be shortened only by appropriate feeding and management practices. The importance of such practices in improving the economic value of the buffalo can be judged from Fig. 1. If only the duration of service period can be shortened, it will have beneficial effect on all other traits and so on the life time production of the buffalo as she will be in milk for more number of days in her life. Further, experience on this farm clearly proves that though buffaloes calve more during the autumn and early winter months, it is quite possible to spread the calvings around the year by taking suitable measures during summer aimed at thermal protection, oestrus detection and breeding of buffaloes.

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ESTRADIOL AND PROGESTERONE LEVELS IN COWS DURING ESTROUS CYCLE AND EARLY PREGNANCY

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ABSTRACT

The 17 β estradiol and progesterone levels in plasma of seven Holstein-Friesian cows adapted to Rumanian conditions were studied throughout the estrous cycle and early pregnancy. Peak estradiol values of 8.9 pg/ml were observed on day 19th of the cycle. The lowest plasma progesterone level of 1 ng/ml was observed on the day of estrous. The highest plasma progesterone level on day 13th of the cycle was corresponding to the lowest estradiol levels. The significance of the findings in early pregnancy diagnosis has been discussed.

Estrus and ovulation in cattle are under hypothalamic control, mediated through an inverse feed back mechanism by the ovarian steroids. Consequently the levels of these ovarian steroids are of considerable importance in regulating the estrous cycle in these animals. Variations in the progesterone levels at different stages of estrous cycle have been the subject of uniform opinion, whereas divergent views have been expressed about the estradiol levels (Wettman *et al.*, 1972; Dobson and Dean, 1974; Smith *et al.*, 1975). The only study in Rumanian cattle (Ilinca, 1972), using classical bioassay methods, has been on estradiol levels alone in the peripheral plasma. Thus, the present study was designed to study the plasma steroid hormone concentrations in Holstein-Friesian cattle, adopted to Rumanian conditions.

MATERIAL AND METHODS

Seven Holstein-Friesian cows were bled by jugular veni puncture on day 0 (day of estrous) and 1, 3, 5, 7, 9, 11, 13, 16, 19 and 21 days after insemination. The plasma was immediately separated and stored at -20°C till assayed. Three of the seven animals returned to estrus subsequently and the remaining four were diagnosed pregnant, 45 days after insemination.

Hormone assay. The 17 β estradiol and progesterone concentrations were estimated by Radio-immunoassay using kits CEA-IRE-SORINO*. The methods were based on the procedures described by Abraham *et al.* (1971) and Abraham (1975).

Sensitivity. The sensitivity for standard curve for estradiol determined

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by variation of the reaction at zero dose level was 3 pg/ml. The sensitivity of progesterone assay as defined by Etkin (1970) was 0.05 ng/ml at 95% confidence limits. For practical purposes, taking into consideration the plasma volume, the sensitivity was 0.25 ng/ml plasma.

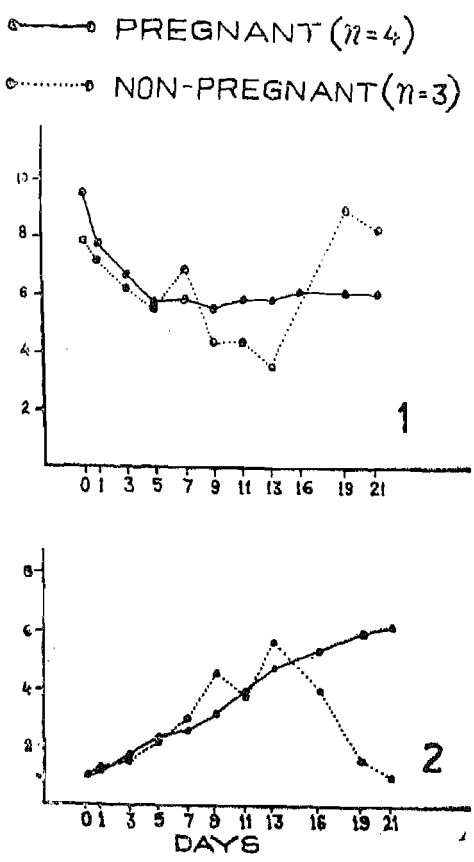
Specificity. Since chromatography was not included in the progesterone determination, it is possible that some degree of specificity may have been sacrificed. However, Robertson (1972) has shown that substances which interfere in the determination of progesterone at different stages of reproduction in cattle are not significant and the specificity of endogenous progesterone is at least 90 per cent.

The antiserum used for 17 β estradiol determination had 3% cross reactivity with estrone and 0.04% with estriol. Therefore, the results are specific for 17 β estradiol.

Precision. The assay precision was studied by recovery studies. 10, 20 and 50 pg of 17 β estradiol and 0.5, 1.0 and 2.0 ng of progesterone were added to 1 ml samples of plasma and recovery assay were made. The percentage of recovery for estradiol at different dose levels was 74, 73 and 75, respectively, whereas the percentage of recovery for progesterone was 94, 105 and 88, respectively. The statistical analysis was done according to Snedecor (1961).

RESULTS AND DISCUSSION

The estradiol and progesterone concentrations in different stages of estrous cycle are presented in Figs. 1-2. The peak estradiol levels were obtained at estrus, followed by a decrease and a small rise on day 7 of the cycle. Thereafter the plasma estradiol concentrations registered a steady decline till day 13 of the cycle; when they started rising again, reaching peak concentration of 8.9 pg/ml plasma on day 19 of the cycle. A com-



Figs. 1-2. Plasma estradiol levels (pg/ml) (Fig. 1) and plasma progesterone levels (ng/ml) (Fig. 2) in cows during estrous cycle and early pregnancy.

parison of these values with those of the animals which were subsequently diagnosed pregnant, showed a decline in post estrous values followed by a stabilization of the estradiol levels from day 7 onwards around 6 pg/ml plasma.

The plasma progesterone concentrations were lowest at 1 ng/ml on day 0 in all the animals. These values increased significantly in the post estrous period upto day 13 of the cycle, at which stage the values started falling in the non-pregnant animals, whereas in those that conceived the values were either stabilised and maintained or were still rising.

The plasma estradiol levels in non-pregnant cows showed two peaks, with the most characteristic peak around day 19 of the cycle. The other smaller peak observed at day 7 of the cycle corresponded to the development of the mid cycle follicles in cows (Rajakoski, 1960). The most important source of estrogens in the plasma is the ovarian follicles, whereas 17 β estradiol is the principal estrogenic steroid in the follicular fluid (Short, 1962) and in the whole follicle (Lunnas, 1964). Marion and Gier (1971) opined that although ovarian follicular growth continues independent of the estrous cycle stage, yet the number of follicles larger than 8 mm is more during 7 to 10th day of the cycle.

The progesterone levels in non-pregnant cows showed a sharp decline 4 days before the next estrus. The highest plasma progesterone concentrations of 5.7 ng/ml were obtained on day 13 of the cycle, which corresponds with the lowest estradiol levels obtained on any day of the cycle.

Generally the peripheral plasma progesterone levels are an indication of the corpus luteum function during the estrous cycle. Concannon (1972) observed that increased estrogen concentrations in the mid cycle may lead to or hasten the luteolytic processes.

A few studies are available on the hormonal status of cows in early gestation. The estradiol values in the present study showed a significant decrease by day 5 of the cycle, after which the values were stable. Similar results have been reported by Wettman and Haffs (1973). Shamesh *et al.* (1973) suggested that animals with peripheral plasma progesterone levels higher than 2.5 ng/ml on day 22 is suggestive of early pregnancy. In the present study the progesterone values of 6.8 ng/ml plasma are highly significant compared to values obtained on day 0; and pregnancy in these animals was confirmed by rectal palpation 45 days post insemination.

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UTILIZATION OF AGRO-INDUSTRIAL BYPRODUCTS BY LIVESTOCK AND POULTRY. V. REPLACEMENT OF MAIZE WITH HOMINY FEED IN BROILER RATION

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ABSTRACT

Replacement of maize with hominy feed upto a level of 66⅔% did not show any significant ($P<0.05$) effect on growth, however, inclusion of hominy feed resulted in a higher FCR. No significant differences were observed in dressing percentage and the chemical composition of thigh muscle due to inclusion of hominy feed which however, resulted in lowering the feed cost. Replacing groundnut cake with maize gluten meal resulted in a significant ($P<0.05$) decrease in the growth and feed efficiency.

Hominy feed, a byproduct of maize meal industry, is produced during manufacture of maize meal for human use. It consists of maize germ, maize bran and some starchy portion of maize kernals. In western countries, it is regularly produced for use in feed formula industry (Pfost, 1976). However, in India its potentiality as livestock feed has not been exploited so far. Paliwal *et al.* (1980) reported that hominy feed contained 13.21% DCP and 70.52% TDN on dry matter basis for cattle. Present investigation was, therefore, undertaken to study the effect of replacing maize with hominy feed in broiler rations.

MATERIAL AND METHODS

One hundred fifteen days-old Arbor Acre commercial broiler chicks, vaccinated against fowl pox and Marek's disease, were distributed into five comparable groups of twelve each and five comparable groups af eleven birds each on the basis of their body weight after wing banding. Each treatment was randomly allotted to one of the groups having 12 birds and another one of the groups having eleven birds each, thus, each treatment had two replicates.

The treatments consisted of five test diets prepared by the use of hominy feed replacing maize at different levels from the control diet (Table 1). The control (T_1) diet was based on 45.0% maize, while hominy feed was used to replace 33⅓, 66⅔ and 100.0% maize in the diets under treatments T_2, T_3 and T_4, respectively. Effort was also made to replace groundnut oil cake with maize gluten meal (T_5), keeping the energy-protein ratio same to that of control. The detailed per cent ingredient composition alongwith calculated crude protein (%), meta-

TABLE 1

Per cent ingredient composition of experimental diets (1-8 weeks)

Ingredients	Treatments*				
	T_1	T_2	T_3	T_4	T_5
Maize	45.0	30.0	15.0	—	—
Hominy feed	—	15.0	30.0	45.0	45.0
Groundnut oil cake	25.0	25.0	25.0	25.0	—
Maize gluten meal	—	—	—	—	22.5
Fish meal	8.0	8.0	8.0	8.0	8.0
Rice bran	18.5	18.5	18.5	18.5	21.5
Poultry mindif	2.5	2.5	2.5	2.5	2.5
Lime stone	1.0	1.0	1.0	1.0	1.0
Calculated					
C. P. (%)	22.0	22.3	22.5	22.8	22.2
M. E. (Kcal/kg)	2860	2773	2684	2613	2795
Energy to protein ratio	130 : 1	125 : 1	119 : 1	115 : 1	128 : 1
Cost of feed/kg (Rs.)	1.45	1.38	1.31	1.25	1.18

*Viteblend (Glaxo) was added to supplement Vit. A, B_2 and D_3 @ 25 g and Bifuran @ 40 g used as a coccidiostat per 100 kg diet.

bolizable energy (Mcal/kg) and energy to protein ratio of the different treatments has been depicted in Table 1.

The experimental period was of 8 weeks during which records were maintained for weekly feed intake and body weights of the chicks. Feed and water were made available *ad lib.* All the birds were sacrificed for carcass evaluation at the age of 8 weeks. The feed was withdrawn 24 h prior to killing, but a free supply of drinking water was available. Each bird was weighed (empty live weight), killed, dressed and eviscerated. Both dressed and eviscerated weights were recorded. Thigh muscle samples from four birds, selected randomly from each treatment, were also collected and were analysed for various proximate principles (AOAC, 1970) to ascertain the effects of different diets on its composition. The statistical analysis of the data was performed according to Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

The average body weight gain, feed consumption, feed efficiency, cost of feed/kg and feed cost/kg gain have been presented in Table 2. Highest body weight gain was observed in case of chicks reared on control (T_1) diet, followed by treatments T_3, T_2, T_4 and T_5, respectively. The statistical analysis of the data revealed that replacement of maize upto the extent of 66.0% (T_2) did not amount to a significant change in live weight gains, however, complete rep-

TABLE 2

Average body weight gain, feed consumption and conversion index and cost of feed of 8 weeks old broiler chicks

Parameters	Treatments				
	T_1	T_2	T_3	T_4	T_5
Average body weight gain (g)	1466.08 ± 37.32^{a}	1385.65 ± 46.50^{ab}	1462.55 ± 42.19^{ab}	1327.83 ± 28.50^{b}	992.77 ± 27.26^{c}
Average feed in take (g)	3884.18^{a}	4065.04^{ab}	4700.72^{c}	4849.24^{c}	$4295\ 46^{b}$
Feed conversion ratio (FCR)	2.64^{a}	2.93^{a}	3.21^{ab}	3.65^{b}	4.32^{c}
FCR index	100	111.40	121.59	138.26	163.63
Feed cost/kg gain (Rs.)	3.82	4.05	4.23	4.57	5.09

^{a}, ^{ab}, ^{b}, ^{c} = The figures having different superscripts are significantly different ($P < 0.05$) from each other.

TABLE 3

Average carcass yield, dressing percentage and feed cost per kg dressed carcasses

Parameters	Treatments				
	T_1	T_2	T_3	T_4	T_5
Empty live weight (g)	1369.54±30.52	1289.56±46.81	1370.80±36.70	1292.17±25.96	973.64±26.91
Dressed weight (g)	990.80±23.37[a]	933.48±33.67[a]	980.00±27.00[a]	944.34±16.91[a]	634.09±18.11[b]
Eviscerated weight (g)	823.18±18.87[a]	777.39±28.14[ab]	823.00±24.39[a]	756.08±13.49[b]	559.09±14.68[c]
Dressing percentage	72.34	72.39	71.49	73.08	70.26
Feed cost/kg dressed carcass (Rs.)	5.68	6.00	6.28	6.41	7.40

[a], [ab], [b], [c]=The figures having different superscripts are significantly different ($P<0.05$) from each other.

lacement of maize with hominy feed (T_4) significantly ($P<0.05$) depressed the live weight gains by chicks. Significantly lower body weight gain was also recorded in case of chicks reared under treatment T_5.

Significantly ($P<0.05$) higher feed was consumed by the chicks reared under treatments T_3, T_4 and T_5 in comparison to the chicks fed control diet (T_1). The difference in feed intake between the chicks under treatments T_1 and T_2 was insignificant. When the feed conversion ratio (FCR) was calculated it was found that the chicks reared on conventional maize-groundnut cake-fish meal diet (T_1) consumed lowest quantity of feed (2.64 kg) per kg gain. Significantly, higher ($P<0.05$) quantity of feed/kg gain was consumed by chicks reared under treatments T_4 and T_5 in comparison to chicks under treatment T_1 while the difference between treatments T_3 and T_4 were insignificant. These observations indicated that inclusion of hominy feed beyond 30 parts in broiler diet increased the feed intake required for one kg gain in body weight. This effect might be ascribed to the narrower energy protein ratio as the hominy feed contained higher protein and less energy in comparison to maize.

Data pertaining to carcass yield, dressing percentage and feed cost/kg dressed carcasses have been presented in Table 3. It was found that carcass yield was highest in chicks fed control diet followed by treatments T_3, T_4, T_2 and T_5, respectively. Similar trend was maintained in eviscerated weights. Statistical analysis of the data revealed that treatments T_1, T_2, T_3 and T_4 did not differ amongst each other, while significantly ($P<0.05$) lower dressed carcass weights were recorded in treatment T_5. It was further observed that treatments T_1, T_2 and T_3 did not differ significantly amongst each other with regard to eviscerated weights, but significant ($P<0.05$) differences were observed in treatments T_4 and T_5. Inspite of significant difference in dressed carcass yield, the dressing percentage was practically the same in all the treatments. Chemical composition of thigh muscles (Table 4) expressed on fresh basis did not reveal any change due to inclusion of hominy feed on any of the proximate principles. However, the fat content of thigh muscles gradually declined as the level of hominy feed increased which is apparently due to low ME content of hominy feed.

TABLE 4

Per cent chemical composition of thigh muscle (fresh basis)

Parameters	Treatments				
	T_1	T_2	T_3	T_4	T_5
Dry matter	29.80	29.84	27.80	25.78	26.16
Crude protein	20.50	19.71	21.46	20.44	22.34
Ether extract	7.93	8.57	5.05	4.20	2.60
Total ash	1.37	1.20	1.29	1.14	1.22

Replacement of maize with hominy feed resulted in decreased feed cost per kg diet but the feed cost/kg gain and per kg/dressed carcass increased with the increased level of replacement. This was mainly due to higher feed consumption by chicks reared on hominy feed diets containing less energy in comparison to control. Increasing the energy concentration of the diet with the help of maize gluten meal resulted in reduced feed intake coupled with significantly lower body weight gains. Thus, it indicates that diets containing hominy feed must be supplemented with some other protein supplement. Krishnappa *et al.* (1979) used hominy feed in the rations of broiler breeders and indicated that hominy feed could be satisfactorily substituted for maize if the diets are made iso-caloric and iso-nitrogenous. Hanumantha Goud *et al.* (1979) suggested that hominy feed could be incorporated upto 45% totally replacing maize, with highly satisfactory growth response, although feed efficiency slightly declined beyond 15% level in the diet.

These observations indicated that hominy feed could successfully be used to replace $66\frac{2}{3}$% of maize from a conventional maize, groundnut cake, fish meal diet for broilers without affecting growth and feed efficiency upto an age of 8 weeks.

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A NOTE ON THE MOST SUITABLE WEIGHT FOR SLAUGHTER OF PIGS ON THE FARM

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Pigs are becoming a part of the mixed farming system in India. Not much work has been done in India on the slaughter weight of pigs. The U.S.D.A. (1970) has recommended the slaughter at 100 kg of body weight.

A study was undertaken to find a suitable weight for slaughter of exotic pigs under Indian conditions One hundred eighty Middle White Yorkshire pigs, fed 16% protein in diet during the growing period and 14% during the finishing period, were slaughtered during different periods of the year at different weights. The growth, efficiency of feed conversion and carcass traits of these pigs were studied. The data of pigs were divided into the following categories for the purpose of this study :

The performance and carcass traits of pigs slaughtered at different weights are presented in Table 1. The average daily gain (ADG) of pigs slaughtered at 70 kg and above body weight was significantly larger than the pigs slaughtered at lower weights ($P < .05$). There was, however, no difference in ADG of pigs slaughtered at 50-59 kg and 60-69 kg body weights ($P > .05$). The feed/gain ratio (F/G) was not different for the pigs slaughtered from 40 kg and above body weight. This ratio, however, was significantly lower for pigs slaughtered at 39 kg and below body weight, as compared to pigs slaughtered at higher body weights ($P < .05$).

The average back fat thickness (ABF) increased with the increase in slaughter

Category	Per cent of pigs in the category (Per cent of the total)
Slaughtered at 70 kg body weight and above	26.11
Slaughtered at 60–69 kg body weight	32.22
Slaughtered at 50–59 kg body weight	16.67
Slaughtered at 40–49 kg body weight	13.89
Slaughtered at 39 kg body weight and below	11.11

TABLE 1

Performance and carcass traits of pigs slaughtered at different weights

	Weight groups (kg)					CD
	70 & above	60-69	50-59	40-49	39 & below	(P <.05)
ADG (g)	472	428	423	374	304	21
F/G ratio	3.45	3.92	3.86	3.81	4.42	0.59
Dressing per cent	68.40	67.40	64.20	66.20	67.20	1.82
Carcass length (cm)	70.20	66.10	61.50	57.80	52.50	2.14
ABF (cm)	3.85	3.23	2.76	2.43	2.08	0.22
Lean cut (%)	63.50	66.40	64.80	63.70	65.00	1.98
Primal cut (%)	71.90	77.40	75.40	73.20	72.40	2.27
H+L (%)	47.30	49.20	48.60	44.60	44.70	2.45
Organ weights (% KW)						
G. I. tract	11.76	12.67	14.42	14.30	15.24	0.94
Liver	2.13	2.32	2.26	2.50	2.52	0.22
Heart	0.28	0.29	0.30	0.33	0.33	0.03
Kidney	0.31	0.31	0.30	0.36	0.35	0.04
Spleen	0.17	0.16	0.18	0.18	0.18	0.03

weight of pigs It ranged from 3.85 cm in pigs slaughtered at 70 kg and above to 2.08 cm in those slaughtered at 39 kg and below. ABF was significantly more for pigs slaughtered at 70 kg and above than those slaughtered at 60-69 kg body weight (P <.05). The lean cut per cent, the primal cut per cent and ham+loin per cent were larger in the pigs slaughtered at 60-69 kg body weight than those slaughtered at higher weights (P <.05). The dressing per cent was not influenced by the kill weight of pigs. The carcass length was larger in pigs slaughtered at body weights of 70 kg and above probably due to larger body size of these pigs at the time of slaughter. The weight of G. I. tract and other organs as a per cent of the kill weight went on decreasing with the increase in the slaughter weights of pigs.

It is apparent from the above data that the best weight of slaughtering pigs is from 60-69 kg body weight in terms of the efficiency of body weight gains and carcass quality (there is a demand for leaner carcasses in the market). The above findings do not agree with those reported by Rai *et al.* (1974).

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EFFECT OF TRYPSIN TREATMENT ON PIGEONPOX VIRUS

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ABSTRACT

Tissue culture adapted pigeonpox virus when treated with 0.125% (W/V) of trypsin increased cytopathic effect in chick embryo cell culture, gave rise to well developed individual pox lesions on chorioallantoic membrane and showed increased infectivity to chick embryos. Electron microscopy confirmed the dispersive effect of trypsin on the virus.

Effects of several proteolytic enzymes on pox viruses and reoviruses have been reported. Galasso and Sharp (1962) observed by electron microscopy that 60-90% of vaccinia viruses were in aggregates. They found sonication, treatment with trypsin and chymotrypsin mixture, repeated freezing and thawing and repeated pipetting dispersed the virus aggregates and increased the plaque forming units (PFU). Kim *et al.* (1969) found a 5-100 fold increase in PFU in case of rabbitpox virus, when it was treated with 0.13% trypsin for 30 min. Tanka and Hatamo (1973) found considerable increase in surface S-antigen in several cell lines infected with cowpox virus when treated with trypsin. In the present report, the effect of trypsin on the pigeonpox virus (PPV) was studied in chick embryo cell (CEC) culture and chorioallantoic membrane (CAM) of chick embryo.

MATERIAL AND METHODS

Virus

CEC culture adapted PPV was used in this study. The virus had undergone 12 passages in CEC cultures. Viral suspension was prepared by centrifuging the infected culture fluid at 1500 rpm for 5 min which was earlier subjected to three cycles of freezing and thawing. The supernatant was used as the source of virus and it had a titre of $10^{6.5}$ $TCID_{50}$/ml.

Trypsin Treatment

Equal quantities of the virus and 0.25% (W/V) trypsin were mixed, kept for 30 min at 37°C, and the action of trypsin was inhibited by the addition of bovine serum. The effect of trypsin on PPV was studied by its growth on CEC cultures and on the CAM of chick embryos :

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(a) **On CEC monolayers.** Both trypsinised and non-trypsinised virus were used for infecting confluent chick embryo fibroblast (CEF) monolayers separately, using five bottles for each. The infected monolayers were observed for cytopathic effect (CPE) at 12 h intervals upto 72 h.

(b) **On chick embryos.** Each of the five 11-12 days old chick embryos inoculated by CAM route with 0.1 ml of 10^{-2} dilution of trypsinised as well as non-trypsinised virus separately and all were incubated at 37.5°C. After 120 h incubation, the CAMs of the infected embryos were harvested and examined for the nature and number of pock lesions.

Embryo infectivity titrations of both trypsinised and non-trypsinised virus were carried out by inoculating 0.1 ml of serial 10-fold dilutions of the virus into each of three embryonated eggs by CAM route and examining them for pock lesions after 120 h of incubation. The EID_{50} was calculated by Reed and Muench (1938) method.

Electron Microscopy

Both trypsinised and non-trypsinised virus were subjected to electron microscopy. After the initial centrifugation to remove cell debris, the supernatant was centrifuged at 16,000 rpm at 4°C in a Servall RC_2 refrigerated centrifuge (Beckman, USA) for 60 min to sediment the virus. The sedimented virus was suspended in triple distilled water, negative stained with phosphotungstic acid (PTA) as per the method described by Dawes (1973). PTA stained virus suspensions were sprayed on plastic emulsion coated copper grids, dried under vacuum and examined in Hitachi HU 11F electron microscope.

RESULTS AND DISCUSSION

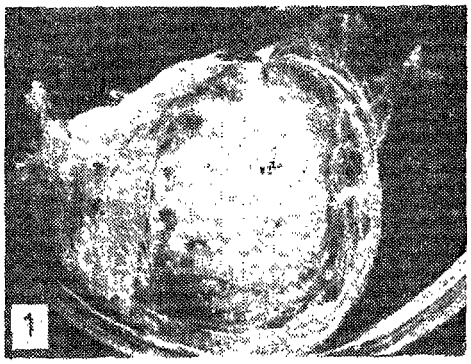
The CPE produced by trypsinised PPV was more extensive than that produced by non-trypsinised virus. When CEC monolayers were infected with trypsinised virus appreciable CPE was produced by 24 h after infection and was pronounced by 36 h. By 48 h there was complete destruction of cells and the monolayer peeled off from glass surface. Non-trypsinised virus produced considerably less CPE.

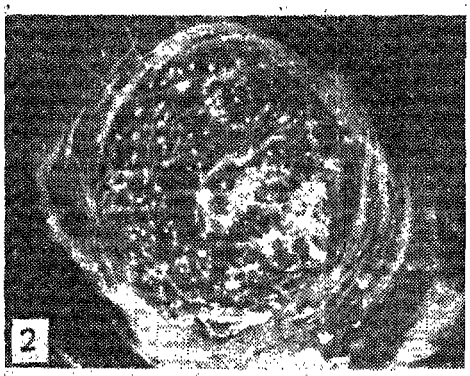
There was difference in the type of lesions produced by trypsinised virus and non-trypsinised virus when inoculated on the CAM of 11-12 days old chick embryos. The non-trypsinised virus produced confluent focal lesions on the CAM (Fig. 1) and no individual lesion was seen. In the case of trypsinised virus discrete individual pock lesions scattered all over the CAM were seen (Fig. 2).

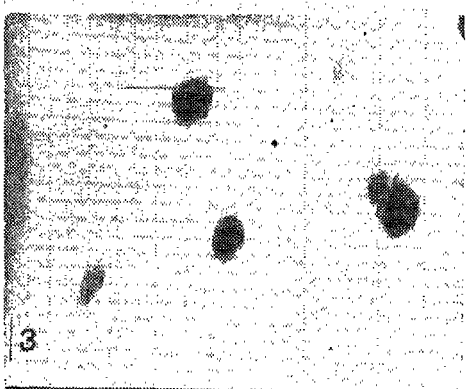
When trypsinised and non-trypsinised virus were titrated on CAM of chick embryos, the following titres were obtained :

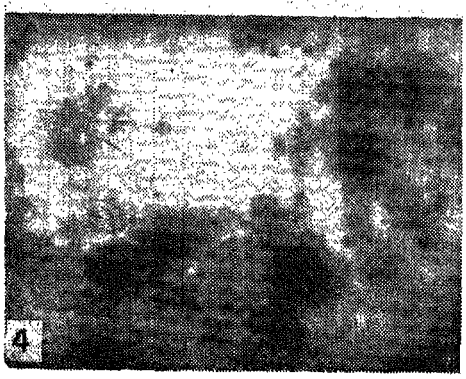
EID_{50}/ml of trypsinised virus $10^{9.24}$
EID_{50}/ml of non-trypsinised virus $10^{8.5}$

When observed in electron microscope, trypsinised virus sample showed virus particles scattered individually (Fig. 3), whereas in the case of non-trypsinised sample most of the virus particles were seen in clumps (Fig. 4).









It was reported by Galasso and Sharp (1962) that 60–90% of vaccinia virus particles were found in aggregates by electron microscopic examination. PPV when inoculated on the CAM of chick embryo has been shown to produce only focal lesions while the fowlpox virus gave rise to discrete and metastatic type of lesions (Cunningham, 1972).

In the present study, the dispersive effect of trypsin on PPV was seen by treating the virus suspension for 30 min with 0.125% (W/V) trypsin. The non-trypsinised virus produced only focal lesion on the infected CAM, whereas the trypsinised virus was responsible for the production of individual pock lesions which were well distributed on the infected CAM. The infectivity of the trypsinised virus on the CAM was increased by 89.9% over that of non-trypsinised virus. Appearance of CPE with trypsinised PPV in CEC culture was more extensive than with non-trypsinised virus. In order to ascertain that the trypsin actually has a dispersive effect on the virus, it was subjected to electron microscopy before and after trypsinisation. The electron micrographs revealed that the viral particles were more scattered in trypsinised virus suspension while the non-trypsinised

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Fig. 1. Pock lesions on the chorioallantoic membrane of chick embryo infected with pigeonpox virus.

Fig. 2. Pock lesions on the chorioallantoic membrane infected with trypsinised pigeonpox virus.

Fig. 3. Electron micrograph of trypsinised pigeonpox virus. PTA stain 34,000 x.

Fig. 4. Electron micrograph of non-trypsinised pigeonpox virus. PTA stain 34,000 x.

viral suspension contained more of the viral aggregates. Galasso and Sharp(1962) also observed similar scattering of viral particles when *vaccinia virus was treated* with trypsin-chymotrypsin mixture and was viewed under electron microscope. Kim *et al.* (1969) also reported 5-100 fold increase in the PFU when rabbitpox virus was treated with 0.13% trypsin for 30 min, the increased yield being due to the disruption of the aggregates by trypsin.

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SELENIUM ESTIMATES IN TISSUES OF CLINICAL CASES OF DEGNALA DISEASE

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ABSTRACT

The Degnala disease is prevalent among buffaloes and cattle in the rice growing areas. The condition is sporadic, seasonal and regional in character with a tendency to confine itself to a particular herd or field. In order to examine the possibility of chronic selenium toxicity as a causative factor of this condition, selenium contents in the tissues from natural as well as experimental cases that died of Degnala disease were estimated and found to be very low. These values were similar to those observed in healthy animals. On the other hand, in the experimentally produced cases of chronic selenium toxicity, the selenium levels were markedly high.

Degnala disease, a syndrome simulating chronic ergotism, has been reported to occur since early thirties among buffaloes and cattle in the rice growing areas of the Indian sub-continent. Earlier workers (Kalra *et al.*, 1972, 1973, 1977a; Kwatra and Singh, 1971, 1973; Rajan *et al.*, 1977) on the basis of their studies, considered this condition to be mycotoxicosis. However, Arora *et al.* (1975) suspected this disease to be caused by chronic selenium toxicity. In the present study, the estimation of selenium levels in the tissues of clinical cases of Degnala disease (natural and experimental) and its comparison with the selenium contents in the healthy animals and experimental cases of chronic selenium toxicity have been attempted in order to see if there was some relation between the selenium levels and occurrence of Degnala disease.

MATERIAL AND METHODS

On the receipt of reports of Degnala disease outbreaks, the affected areas were visited and the herds involved were examined. The epizootiological information associated with the occurrence of the disease was collected.

Besides collection of pertinent data, clinical natural cases of Degnala disease along with toxic rice straw were procured for further studies.

Four such clinical cases of Degnala disease in buffaloes (average age 2 years) exhibiting typical signs of the disease were studied. These were kept under observation and were fed the same toxic rice straw (as was being fed to these animals in the field), procured from the owners of the animals.

Experimental production of Degnala disease. The Degnala disease was reproduced experimentally in 5 apparently healthy male buffalo calves of non-descript breed, 6-12 months of age, procured from the unaffected areas (where the disease had not been reported to occur). Besides giving water, these animals were fed the same toxic rice straw, which was fed to the natural cases. No other feed or fodder was given to these animals.

Induction of chronic selenium toxicity. The objective of this experiment was to have a positive control for comparing selenium contents with natural and experimental cases of Degnala disease and healthy animals. The chronic selenium toxicity was induced by administering orally @ 30 ppm sod. selenite of feed (greens and wheat bhusa) to two apparently healthy male buffalo calves of non-descript breed (6-12 months age) daily, until they died.

Control animals. An identical set (similar age, sex and health status as compared to the above groups) comprising of 3 buffalo calves was kept as control group. These animals were fed *ad lib.* non-toxic rice straw collected from the University farm (unaffected area, where no disease has been reported to occur). No other feed/fodder was given to buffalo calves in the control group.

After the death of experimental/natural clinical cases of the disease, as well as cases of chronic selenium toxicity and sacrificing the control animals, tissue pieces, weighing 10 to 15 g, from liver, spleen, kidney and skin (close to the hooves), were collected in polythene bags at the time of post-mortem examination. These tissues were preserved at −20°C in deep freeze, until tested for selenium estimation as per the method of Cummins *et al.* (1965).

RESULTS AND DISCUSSION

On the basis of epizootiological study on 141 diseased and 73 unaffected herds (from 92 different villages), it was inferred that the outbreaks of Degnala disease were associated with the feeding of rice straw and occurred during the winter season. The disease restricted itself to rice growing areas. It affected buffaloes as well as cattle and remained confined to a particular herd or field. The respective per cent morbidity and mortality rates in buffaloes were 57.94 and 6.85 as compared to 13.53 and 2.13 in cattle. No sex and age difference was noticed.

The disease could be reproduced clinically (simulating natural cases) in buffalo calves by feeding the toxic rice straw. The signs of the disease developed within 5 to 12 days and death occurred within 16 to 20 days of feeding of the toxic rice straw. The experimentally induced cases of chronic selenium toxicity developed weakness, emaciation and alopecia. No signs or lesions such as necrosis or gangrene of extremities as observed in Degnala disease developed in these animals and they died on 35th and 55th day of the commencement of the experiment.

No signs of the disease could be observed in control animals besides varying degree of emaciation. The control calves were slaughtered 90th

day post feeding of the non-toxic rice straw.

The selenium levels, in different tissues/organs of animals in various groups, i. e., natural and experimental clinical cases of Degnala disease, healthy animals and experimental cases of chronic selenium toxicity, were studied. No significant variation existed between selenium levels in the tissues/organs of clinical cases of Degnala disease (both natural and experimental) and those of healthy control animals. The respective average selenium values in the liver, spleen, kidney, and skin were 0.287, 0.226, 0.80, and 0.019 ppm in natural cases, and 0.82, 1.116, 1.32 and 0.213 ppm in experimentally reproduced clinical cases. These values in the unaffected healthy control animals were 0.567, 0.000, 0.666 and 0.245 ppm, respectively. On the other hand, selenium levels in the tissues of experimental cases of chronic selenium toxicity were fairly high, i.e., 49.15, 1.57, 5.10 and 5.50 ppm in the liver, spleen, kidney and skin, respectively.

The low levels of selenium in the tissues of natural and experimentally induced cases of Degnala disease, as well as of apparently healthy animals do not suggest the possibility of selenium toxicity, to be associated with the causation of Degnala disease. The selenium content in the different tissues/organs of experimental cases of chronic selenium toxicity was found to be appreciably high. Rosenfeld and Beath (1964) have also reported high levels of selenium in the internal organs and skin in the cases of chronic selenium toxicity (alkali disease).

The epizootiological data of the disease also do not support the possibility of selenium toxicity as an etiological factor. The selenium toxicity occurs in all species of animals and does not restrict itself to the buffaloes and cattle (Radeleff, 1964; Rosenfeld and Beath, 1964; Maynard and Loosli, 1969; Clarke and Clarke, 1977), as is the case with Degnala disease. No cases simulating Degnala disease have been observed or reported in species other than buffaloes and cattle. The tendency of the disease to limit itself to a particular herd or field without affecting the neighbouring herds or fields also indicate factors other than selenium to be involved in this condition. Besides, seleniferous soils are arid and semi-arid in nature (Radeleff, 1964; Smith *et al.*, 1972) and have low rainfall (Rosenfeld and Beath, 1964; Clarke and Clarke, 1977) also do not support the possibility of selenium toxicity in this condition, especially when the disease has been recorded in areas other than arid/semi-arid regions. The areas from which the disease has been reported are well known rice growing regions and have higher rainfalls.

The toxic selenium level in feed/fodder has been reported to be above 5 ppm by Clarke and Clarke (1977), 8.5 ppm by Maynard and Loosli (1969), 25 ppm by Hungerford (1967), 5-40 ppm by Yates (1962), 5-50 ppm by Olson (1978), 10-30ppm by Rosenfeld and Beath (1964) and McDonald *et al.* (1977). Arora *et al.* (1975) suggested Degnala disease to be due to selenium toxicity. They derived this conclusion on the basis of satisfac-

tory treatment results, following the administration of preparation, 'Degcure' which is believed to contain an antidote of selenium. The selenium levels of the fodder samples (berseem, paddy straw, lucerne, maize-green, oat fodder), which they incriminated as the cause of this disease, were found to range between 0.9 to 6.7 ppm. Because of low selenium levels (0.11 to 0.72 ppm) in the toxic rice straw and short incubation period of the disease in the experimental cases, Kwatra and Singh (1973) and Kwatra (1980) ruled out the possibility of selenium toxicity as the cause of this condition. Kalra *et al.* (1977b) also reported low levels of selenium contents (0.1 to 0.75 ppm) in toxic rice straw. In the present studies, it was also possible to experimentally reproduce the Degnala disease by feeding toxic rice straw to the buffalo calves within a short period of 5 to 12 days. The low levels of selenium contents observed in the tissues of affected animals at death and rice straw (Kwatra and Singh, 1973; Kalra *et al*, 1977b; Kwatra, 1980) coupled with the epizootiological data, negates the possibility of selenium toxicity to be associated with the causation of Degnala disease.

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STRUCTURE OF THE DIAPHRAGM IN NORMAL AND RETICULAR HERNIA SUFFERING BUFFALOES

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ABSTRACT

Myoarchitecture and tendo-architecture of diaphragm of normal buffaloes and those suffering from the reticular hernia were studied following maceration of the diaphragm in 5% hydrochloric acid. The muscular architecture was little affected due to herniation. The tendinous part of the diaphragm, however, showed a thickening around the hernial ring. In two cases, development of bone in the hernial ring was recorded. Studies revealed the absence of any weak spot in the diaphragm. Hence, it is proposed that the innate weakness in the buffalo diaphragm as suggested by earlier authors cannot be regarded as a probable etiological factors of reticular hernia in these animals. Instead, a poor managemental practice and trauma in the organ added with increased abdominal pressure may be considered as possible reasons of the disease.

The reticular hernia is a serious disease affecting mostly the high milking buffaloes at the prime of their production; thus, causing a huge loss to the farmer's income. The hernia commonly occurs in the ventral part of the musculotendinous junction slightly right to the median plane, although, a shift towards midline or slightly to the left of the mid plane was also possible (Stober, 1967; Prasad *et al.*, 1977; Krishnamurthy *et al.*, 1980a). Prasad *et al.* (1977) and Singh *et al.* (1980) have reported a weak spot in the diaphragm of buffalo, and stated it to be the cause of malady in these animals. Further informations on the structure of the diaphragm of buffalo are not available. The present paper is primarily intended to record the regional texture and structure of the diaphragm in healthy buffaloes and in those suffering from the reticular hernia in order to confirm if there is any inherent weakness in this part of the diaphragm where the hernia occurs so commonly and also to record the anatomical changes in the organ which happen during the disease.

MATERIAL AND METHODS

Ten adult female buffaloes were used in this study. Five buffaloes were declared cases of diaphragmatic hernia with poor surgical risk and five were unproductive otherwise normal buffaloes. The animals were anaesthetised and exsanguinated through the right common carotid artery and the thorax was laid open. The diaphragm was dissected out from the cadavers, washed in running

tap water and then was put into dilute hydrochloric acid solution (5% v/v) for maceration. In cases of hernia, after noting the contents of hernia, the whole diaphragm along with the herniated portion of reticulum were subjected to maceration. The organ was examined daily for optimum maceration. The pleura and peritoneum were slowly peeled off and then the muscular and tendon fibers were teased and separated layer-wise and observations recorded for each animal separately.

RESULTS

Structure of the Normal Diaphragm

The diaphragm was composed of the serous membranes, skeletal muscle, tendinous tissue, blood vessels, nerves, lymphatics and the connective tissue. The diaphragmatic pleura, a reflection of the parietal plura, formed a close investment over the thoracic surface. Similarly the abdominal surface was lined by the diaphragmatic part of the parietal peritoneum. The two membranes were found in direct contact with each other in the lumbocostal arch in most of the cases. But in three other cases a triangular area of the diaphragm (muscular rim) was found deficient between the 11th and 12th intercostal spaces leaving the two serosa in contact. The line of reflection of the mediastinal pleura over the pericardium were evident on either side of mid plane in the ventral part of the diaphragm. On abdominal side, the reflections were absent, however, in two cases there was complete adhesion between the fibrous capsule of the liver and the diaphragmatic peritoneum through the fibrous tissue.

The diaphragm was pierced by three formina : dorsally the aortic hiatus bounded by the two muscular crurae, ventrally in the right hemitendon, the foramen venae cavae and in the ventral part of the right muscular crus the oesophageal hiatus. At the two hiati the diaphragm did not contribute any muscular or tendinous fibers over the structures passing through them. But at the foramen venae cavae tendinous fibers from the surrounding centrum tendineum continued over the adventitia of the venae cavae and, thus, the latter was fixed in the diaphragm. It was further anchored to it by means of the merging pleura of the plica venae cavae and the accessory fold of the right phrenic nerve over the diaphragmatic pleura.

Myo-architecture

The muscular tissue (skeletal muscle) formed the peripheral rim and the crura of the diaphragm (Fig. 1). The musculature of the crura were thick and heavy, particularly that of the right crus. These muscle fibers extended cranio-ventrally towards the central tendon and exhibited bipinnate type of muscle fiber arrangement with a central cord of fibrous inter muscular connective tissue. The heavy musculature of the right crus corresponded with its long tendon along the body of the lumbar vartebrae. The short musculature of the left crus might be due to a large rumen occupying major part of left abdominal cavity and short tendon of insertion.

The peripheral muscular tissues were radially arranged and converged along the periphery of the centrum tendineum. They had several slips between the inter

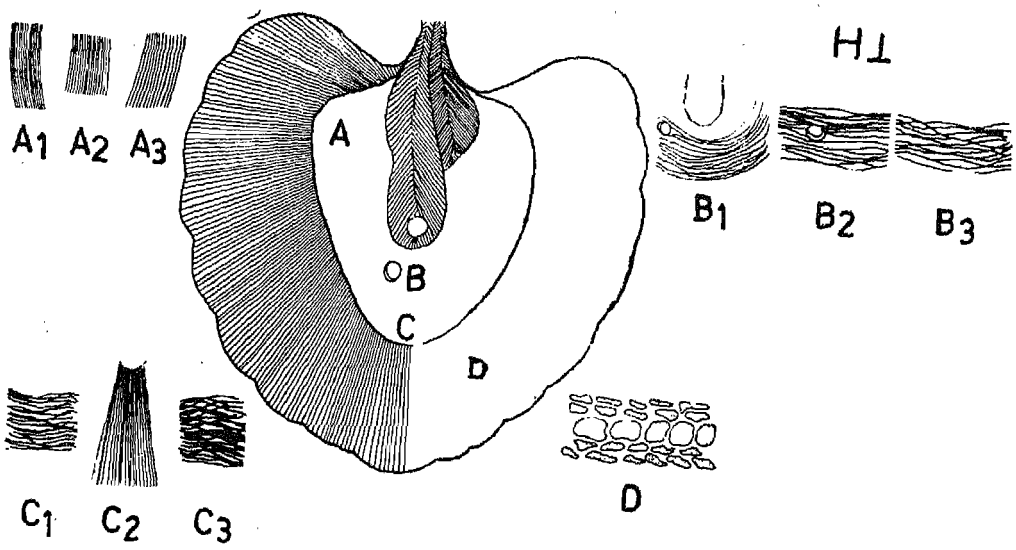


Fig. 1. Diagrammatic sketch of diaphragm indicating directional planes of the muscle fibers and tendon fibres in different regions. The muscle fibers as observed from the thoracic side in the crus, sternal and costal parts of the muscular rim have been shown.

A_1, A_2, A_3 – indicate the first, second and third layers of the tendon fibres in the dorsal aspect of the hemitendon (A) from thoracic to abdominal side.

B_1, B_2, B_3 – indicate the first, second and third layers of the tendon fibers in the area of foramen venae cavae (B).

C_1, C_2, C_3 – indicate the first, second and third layers of the tendon fibers in the ventral aspect of the himitendon (C).

D – cross section of the muscle fibers indicating composition of different layers.

costal spaces for their insertion with the ribs. These insertion marks were clearly visible from the thoracic surface of the diaphragm. The muscles were variably developed in the sternal and the costal parts of the diaphragm. When pleura and peritoneum were peeled off, it was found to be composed of 5 layers of muscular fascicles of different sizes. The central (deep) fascicles were thick and ovoid in crus section, whereas on either side of these (thoracic and abdominal surface) the muscular fascicles comprised of two layers of thin and flat muscle bundles. Towards the centrum tendineum they gradually transformed into typical tendinous structure with a distinct myo-tendinous junction. The tendon fibers formed the centrum tendineum.

Tendo-architecture

The tendon consisted of three grossly dissectable layers of the tendon fibers composed of collagenous (white fibrous) tissue as evident by their swelling during the process of maceration in the dilute acid solution and shining appearance.

The superficial layer of the tendon fibers were fused with the peritoneal and pleural fibrous layers in the area of centrum tendineum. This layer consisted of thick bundles of collagenous sheet forming flat annular rings around the ventral end of the muscular crurae which interrupted the centrum tendineum dorsally (Fig. 1). The fibrous bundles branched and anastomosed among themselves and with the deep layer of the tendon. Quite a few, thin, spindle shaped spaces were entrapped between these anastomotic channels. The fibrous arrangement was like a dense irregular connective tissue sheet. On abdominal side also, nearly similar arrangement of the fibrous elements was seen. The bundles, however, appeared much broader and thicker on this surface than on the thoracic surface.

The collagenous bundles of deep layer consisted of the actual tendon fibers of the diaphragm which were the direct continuation of the muscle fibers of the peripheral muscular rim and the muscular crurae. These fibers ran a straight course and appeared converging from the peripheral rim towards the foramen venae cavae and adjacent part of the crura. The tendon fibers appeared descending from the right and left dorsal parts of the tendon ventrally. In the left and right ventral parts, they appeared coursing horizontally across the foramen venae cavae forming a bridge over it. In the ventral and central part of the tendon, the fibers showed ascending course. The deep tendon fibers appeared to have the collagenic arrangement as in regular dense connective tissue sheet.

The ventral part of the tendon (along the cardiac contact area of the diaphragm) appeared relatively thicker than the dorsal part on either side of the hemitendon. The left and right dorsal parts of the hemitendon did not differ in gross thickness. The annular (superficial) fibers were well developed in the ventral part of the centrum tendineum particularly between the lines of mediastinal septum and hence the tendon appeared slightly thicker in this part.

Structure of the Diaphragm in cases of Reticular Hernia

The hernia mostly occurred in the ventral part of tendon or at musculotendinous junction. Most commonly the hernial ring involved the ventral part of the tendon (3/4th part) of the sternal musculature (1/4th part) of the diaphragm. The muscular architecture was little affected. The tendinous part, however, showed a thickening around the rent (hernial ring) through which migrated the reticulum. Among the fibrous components of the centrum tendineum the straight fibers of deep part remained relatively unaffected and showed normal central convergent course. The superficial annular fibers were, however, hypertrophied (thickened). The fibers were displaced peripherally as the diaphragm gave way to the reticulum in the thorax. The tendon fibers were condensed around the ring during displacement and the spindle shaped meshes among the superficial fibers disappeared. The condensation was thickest at the margin of the ring where it formed a strong band like structure and receded as traced away (Fig. 2). It appeared like a thick band of collagen between the rent and the

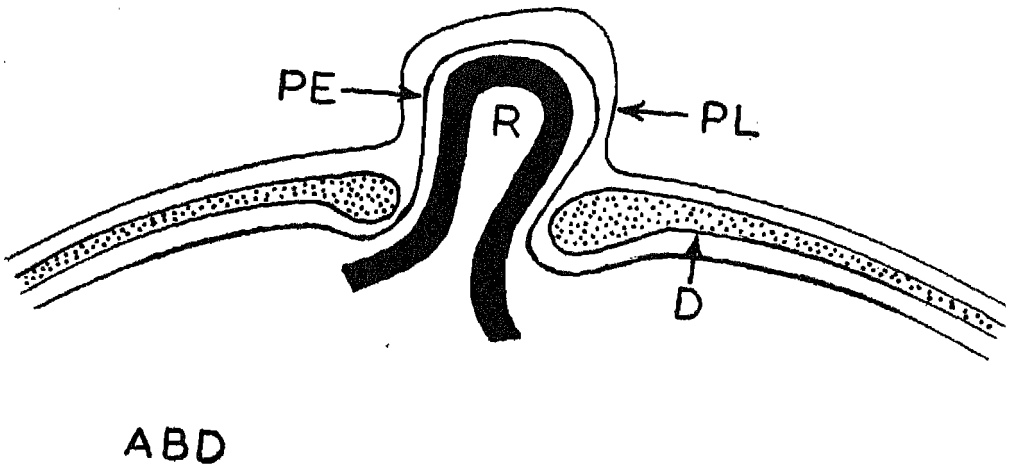


Fig. 2. Diagrammatic sketch of the diaphragmatic rent showing the herniated reticulum (R) covered by diaphragmatic peritoneum (PE) entering the thorax (TH) by making its way through diaphragm (D) and coming in contact with diaphragmatic pleura (PL).

ABD – Abdominal cavity.

foramen venae cavae. Sometimes it became so much condensed and hard that it gave a feeling of cartilagenous texture. In two cases a semi lumar shaped bone was also observed forming the right margin of the ring. There was no tear in the peritoneum and the pleura. The two serosae came in contact with each other at the margin of the ring and became continuous over the herniated reticulum (Fig.2). The right and left dorsal parts of the centrum tendineum remained normal.

DISCUSSION

Diaphragmatic hernia have been reported to occur dorsal to xiphoid either slightly to the right or to the left of the midline of the diaphragm (Diesem *et al.*, 1954; Prasad *et al.*, 1977; Krishnamurthy *et al.*, 1980a). Singh *et al.* (1980) reported a weak spot in the diaphragm of buffalo and stated that this innate weakness in the diaphragm was responsible for herniation in buffaloes. The present results, however, revealed that the ventral part of the centrum tendineum was relatively thicker, well knitted and as such was no less stronger than the dorsal part, the latter is, however, not predisposed to herniation as revealed in the perusal literature. The possibility of existence of a permanent weak spot in the diaphragm or innate weakness responsible for the malady in the buffaloes, therefore, does not seem to be entirely convincing. Obviously the extraneous factors like trauma (Blood *et al.*, 1979) associated with increased abdominal pressure along the ventral part of musculotendinous junction may be considered as possible etiological factors of the disease. Blood *et al.* (1979) reported

rare occurrence of the disease in farm animals. Hutchins *et al.* (1957) also reported a high incidence of the disease in local cattle population than in the well organised sectors. Hence, it appears that the poor managemental practices followed by local country fellows may act as a predisposing factor, because no cases of diaphragmatic hernia were reported from well organised dairy farms in Indian conditions too (Krishnamurthy *et al.*, 1980b).

During the process of herniation there was not much alteration in the muscular tissue and the dorsal parts of the tendon. There was, however, a condensation of the collagenous fibers particularly in the ventral part of diaphragm, i.e., between foramen venae cavae and ventral myotendinous junction. A thickening and hypertrophy of the tendon fibers constituted a thick and strong hernial ring. A chronic nature of the disease might have led to calcification and ossification of the ring as observed in the two cases. Osseous tissues developing in the muscular tissues due to scars resulting from single or repeated traumas have been reported in the literature (Cohrs, 1968; Krishnamurthy and Tyagi, 1974).

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ESTIMATION TECHNIQUE FOR MIXTURE OF TWO POISSON DISTRIBUTIONS

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ABSTRACT

Situations, where traditionally simple poisson distributions are fitted, have been identified but the situation demands that a more complex distribution viz., two poisson distributions which are mixed in a given proportion is more appropriate. The estimation technique for such a distribution has been developed under different conditions. The technique is also illustrated by applying it to some data from Beall and Rescia (1953).

The statistical theory of mixture of distributions plays an important role in agricultural research. At times, characters like germination percentage, yield, etc. are not explained by simple models, but these characters have more appropriately complex distributions such as compound distributions or mixture distributions. Consequently decision making in these situations will need appropriate estimation of the parameters involved. To illustrate let us consider two different varieties of wheat which though give the same yield in normal conditions are resistant to two different diseases one each (through reduction in number of ears). The disease reduces the yield and to control the risk it may be desirable to mix seeds of different varieties in a predetermined proportion from sowing and it may be necessary to maintain this proportion from generation to generation. The plants are indistinguishable as to the variety of seed these are coming from. In this situation it becomes necessary to estimate the proportion of infestation by observing some random variable say number of ears in a plant.

Earlier works regarding the problem of mixture of various types of distributions (discrete as well as continuous) are due to Rider (1961), Blischke (1962, 1964), Cohen (1967), and Dick and Bowden (1973). All these works are confined to mixture of exponential distributions, mixture of binomial distributions or mixture of normal distributions. It has been observed by earlier workers that for such situations maximum likelihood method gives complex equations and, therefore, it becomes imperative to use the method of moments. In the present study, estimators of parameters were derived in case of mixture of two poisson distributions and various properties of these estimators were studied. Throughout the paper m'_r denotes the rth sample moment and μ'_r denotes the rth population

moment (r=1, 2, 3.....). An illustration of the technique, derived in this paper, is given in Appendix I.

MIXTURE OF TWO POISSON DISTRIBUTIONS

A random variable 'x' is said to be distributed as mixure of two poisson if its probability function is given by,

$$f(x) = \alpha f_1(x) + (1-\alpha) f_2(x) \qquad (1.1)$$

where $f_i(x) = e^{-\lambda_i} \lambda_i^x / x_i$ $\quad x=0, 1, 2.....$ $\quad i=1, 2.....$

To know the structure of the population completely, our problem is to estimate, on the basis of sample observations, various unknown parameters α, λ_1, λ_2 involved in the mixed population. Of course, if $\lambda_1=\lambda_2=\lambda$ the problem reduces to the classical estimation for which minimum variance unbiased estimator is well known. The maximum likelihood method for the estimation of these parameters as usual, gives highly interactable equations which are not easily solvable. Therefore, the method of moments was used to estimate various parameters involved in the probability function (1.1)

Any rth order population moment of the distribution (1.1) is given by,

$$\mu'_r = E(x^r) = \alpha \sum_{x=0}^{\infty} x^r f_1(x) + (1-\alpha) \sum_{x=0}^{\infty} x^r f_2(x) \qquad (1.2)$$

therefore,

$$\begin{aligned}
\mu'_1 &= \alpha\lambda_1 + (1-\alpha)\lambda_2 \\
\mu'_2 &= \alpha(\lambda^2_1 + \lambda_1) + (1-\alpha)(\lambda^2_2 + \lambda_2) \\
\mu'_3 &= \alpha(\lambda^3_1 + 3\lambda^2_1 + \lambda_1) + (1-\alpha)(\lambda^3_2 + 3\lambda^2_2 + \lambda_2)
\end{aligned} \qquad (1.3)$$

The estimators of the three parameters α, λ_1 and λ_2 are found by the three estimating equations as follows :

$$\begin{aligned}
\alpha'\lambda'_1 + (1-\alpha')\lambda'_2 &= m'_1 \\
\alpha'\lambda'^2_1 + (1-\alpha')\lambda'^2_2 &= m'_2 - m'_1 \\
\alpha'\lambda'^3_1 + (1-\alpha')\lambda'^3_2 &= m'_3 - 3m'_2 + 2m'_1
\end{aligned} \qquad (1.4)$$

Where α', λ_1', and λ'_2 denote the estimates of parameters α, λ_1 and λ_2, respectively. Particular cases which arise in estimation problem are as follows :

λ_1, λ_2 known and α unknown. This model occurs in practical situations when it is definitely known that two populations have been superimposed and the interest is only in the estimation of the proportion. To cite an example, consider the situation when through past experience or through independent experiments it is known that a blood sample is infected by two types of indistinguishable

parasites and one would expect that the count at hoemocytometer for separate parasites follow distributions with parameters λ_1 and λ_2. One may be interested in estimating the proportion of each type of parasites in the sample. Similar examples are obtained in crop sciences when two identical but different types of insects attack a crop. The number of insects per plant is known to be distributed like poisson with known parameters in each case.

Under this situation, an estimator α' is given by

$$\alpha' = (m'_1 - \lambda_2)/(\lambda_1 - \lambda_2) \qquad (1.1.1)$$

Expected value and variance of α'. As α' is given by (1.1.1), therefore,

$$\begin{aligned} E(\alpha') &= (E(m'_1) - \lambda_2)/(\lambda_1 - \lambda_2) \\ &= [\alpha\lambda_1 + (1-\alpha)\lambda_2 - \lambda_2]/(\lambda_1 - \lambda_2) \\ &= \alpha \quad [\text{as } E(m'_1) = \alpha\lambda_1 + (1-\alpha)\lambda_2] \end{aligned} \qquad (1.1.2)$$

Thus, α' is an unbiased estimator of α.

Variance of α' is given by,

$$V(\alpha') = V(m'_1)/(\lambda_1 - \lambda_2)^2$$

But $V(m'_1) = V(x)/n = [\{\alpha(1-\alpha)\}\{(\lambda_1 - \lambda_2)^2\} + \alpha\lambda_1 + (1-\alpha)\lambda_2]/n$

hence,

$$V(\alpha') = \alpha(1-\alpha)/n + \alpha/(\lambda_1 - \lambda_2)n + \lambda_2/n(\lambda_1 - \lambda_2)^2 \qquad (1.1.3)$$

As n, the sample size $\to \infty$, $V(\alpha') \to 0$, so α' is a consistent estimator of α. An estimator of the V (α') is given by,

$$V'(\alpha') = \frac{m'_1(\lambda_1 + \lambda_2 + 1 - m'_1) - \lambda_1\lambda_2}{n(\lambda_1 - \lambda_2)^2} \qquad (1.1.4)$$

Since for large value of the sample size n, the estimator $\frac{m'_1 - \lambda_2}{\lambda_1 - \lambda_2}$ is distributed as N (α', V' (α')); a confidence interval for α' may be obtained.

λ_1 or λ_2 is known and α unknown. As we have two unknowns α and λ_2, therefore, first two equations of (1.4) are solved simultaneously for α' and λ'_2. Thus,

$$\alpha' = (m'_1 - \lambda'_2)/(\lambda_1 - \lambda'_2) \qquad (1.2.1)$$

and $$\lambda'_2 = (m'_2 - m'_1 - m'_1\lambda_1)/(m'_1 - \lambda_1) \qquad (1.2.2)$$

Using (1.2.2), (1.2.1) may also be written as,

$$\alpha' = (m'^2_1 - m'_2 + m'_1)/(2m'_1\lambda_1 - \lambda^2_1 - m'_2 + m'_1) \qquad (1.2.3)$$

Expected value and variance of λ'_2. The derivation of the expectation and variance of these estimators become difficult. Therefore, only asymptotic results have been derived through the following well known result (Cramer, 1946).

Theorem : If $H(m_u, m_s)$ is a function of two arguments m_u and m_s and the following conditions are satisfied :

(i) In some neighbourhood of the point $m_u=\mu_u$ and $m_s=\mu_s$, the function 'H' is continuous and has continuous derivatives of the first and second order with respect to the arguments m_u and m_s.

(ii) For all possible values of x_i, we have $|H| < cn^p$, where 'c' and 'p' are non-negative constants.

The mean and asymptotic variance of random variable $H(m_u, m_s)$ is given by,

$$E(H)=H_0+o(1/n) \tag{1.2.4}$$

$$\text{Var}(H)=\mu_2(m_u)\,H^2_1+2\mu_{11}(m_u, m_s)\,H_1H_2+\mu_2(m_s)\,H^2_2+o(1/n^{3/2}) \tag{1.2.5}$$

where H_0, H_1 and H_2 denote the values assumed by the function $H(m_u, m_s)$ and its partial derivatives at the point $m_u=\mu_u$, $m_s=\mu_s$.

$\mu_2(m_u)$, $\mu_2(m_s)$ and $\mu_{11}(m_u, m_s)$ are computed as in Weatherburn (1961) and is given by,

$$\text{Var}(m'_r)=\mu_2(m'_r)=(\mu'_{2r}-\mu'^2_r)/n$$

$$\text{Cov}(m'_q, m'_r)=\mu_{11}(m'_q, m'_r)=(\mu'_{q+r}-\mu'_q\mu'_r)/n \tag{1.2.6}$$

From (1.2.6), the expressions for expected value and asymptotic variance of $\lambda'_2=(m'_2-m'^2_1-m'_1\lambda_1)/(m'_1-\lambda_1)$ may be obtained which is a continuous function of m'_1 and m'_2. Therefore,

$$E(\lambda'_2)=H_0=H(\mu'_1, \mu'_2)=(\mu'_2-\mu'^2_1-\mu'_1\lambda_1)/(\mu'_1-\lambda_1) \tag{1.2.7}$$

Putting the values of μ'_1 and μ'_2 from (1.3), we get,

$E(\lambda'_2)=\lambda_2$ which proves the unbiasedness of λ_2.

The asymptotic variance of λ'_2 is given by,

$$\text{Var}(\lambda'_2)=\mu_2(m'_1)[(\partial\lambda'_2/\partial m'_1)^2]_{\mu'_1, \mu'_2}+2\mu_{11}(m'_1, m'_2)\,(\partial\lambda'_2/\partial m'_1)_{\mu'_1, \mu'_2}$$

$$(\partial\lambda'_2/\partial m'_2)_{\mu'_1, \mu'_2}+\mu_2(m'_2)\,(\partial\lambda'_2/\partial m'_2)^2_{\mu'_1, \mu'_2} \tag{1.2.8}$$

From (1.2.2) we note that

$$(\partial\lambda'_2/\partial m'_1)_{\mu'_1, \mu'_2}=(\lambda_1+\lambda^2_1-\mu'_2)/(\mu'_1-\lambda_1)^2$$

$$(\partial\lambda'_2/\partial m'_2)_{\mu'_1,\,\mu'_2} = 1/(\mu'_1 - \lambda_1) \tag{1.2.9}$$

and again taking r=1 and 2 in (1.2.6) we get

$$\left.\begin{aligned} \mu_2(m'_1) &= (\mu'_2 - \mu'^2_1)/n \\ \mu_2(m'_2) &= (\mu'_4 - \mu'^2_2)/n \\ \mu_{11}(m'_1, m'_2) &= (\mu'_3 - \mu'_1\mu'_2)/n \end{aligned}\right\} \tag{1.2.10}$$

and subsequently,

$$\begin{aligned} \text{Var}\,(\lambda'_2) = {} & [(\mu'_2 - \mu'^2_1)/n]\,[(\lambda_1 + \lambda^2_1 - \mu'_2)/(\mu'_1 - \lambda_1)^2]^2 \\ & + [(\mu'_3 - \mu'_1\mu'_2)/n]\,[(\lambda_1 + \lambda^3_1 - \mu'_2)/(\mu'_1 - \lambda_1)^2]\,[1/(\mu'_1 - \lambda_1)] \\ & + [(\mu'_4 - \mu'^2_2)/n]\,[1/(\mu'_1 - \lambda_1)^2] \end{aligned} \tag{1.2.11}$$

It is immediate that $\lim_{n\to\infty} \text{Var}\,(\lambda'_2) = 0$, hence λ'_2 is a consistent estimator of λ_2.

When all parameters α, λ_1 and λ_2 are unknown. In case all the three parameters are unknown, the three estimating equations of (1.4) are solved simultaneously for α', λ'_1 and λ'_2 and we get

$$\alpha' = (m'_1 - \lambda'_2)/(\lambda'_1 - \lambda'_2) \tag{1.3.1}$$

$$\left.\begin{aligned} \lambda'_1 &= (m'_2 - m'_1 - m'_1\lambda'_2)/(m'_1 - \lambda'_2) \\ \text{or}\quad \lambda'_2 &= (m'_2 - m'_1 - m'_1\lambda'_1)/(m'_1 - \lambda'_1) \end{aligned}\right\} \tag{1.3.2}$$

Solving the third equation of (1.4) after putting the values of α' and λ'_1 from (1.3.1) and (1.3.2), and on simplifying the terms we have,

$$\begin{aligned} & \lambda'^2_2(m'_1 - m'_2 + m'^2_1) + \lambda'_2(m'_3 - 3m'_2 + m'^2_1 + 2m'_1 - m'_1m'_2) \\ & + (m'^2_2 - m'^2_1 + m'_1m'_2 - m'_1m'_3) = 0 \end{aligned} \tag{1.3.3}$$

which is quadratic in λ'_2 and can be solved. It is also to be noted that the two roots of (1.3.3) directly gives the values of λ'_2 and λ'_1. Once λ'_1 and λ'_2 are obtained, α may be estimated from equation (1.3.1). Equation (1.3.3) may be written in a more convenient form as

$$a\lambda'^2_2 + b\lambda'_2 + c = 0 \tag{1.3.4}$$

where 'a', 'b' and 'c' are random variables and are function of first three sample moments about origin, given by,

$$\left.\begin{aligned} a &= m'_1 - m'_2 + m'^2_1 \\ b &= m'_3 - 3m'_2 + m'^2_1 + 2m'_1 - m'_1m'_2 \\ c &= m'^2_2 - m'^2_1 + m'_1m'_2 - m'_1m'_3 \end{aligned}\right\} \tag{1.3.5}$$

Expected value and variance of λ'_2, λ'_1 and α'. As we have seen that the coefficients 'a', 'b' and 'c' of quadratic equation (1.3.4) are functions of first three sample moments, so estimators λ'_1 and λ'_2 will also be functions of the

three sample moments m'_1, m'_2 and m'_3. Therefore, the expected values and asymptotic variances of λ'_2 and λ'_1 may be found by simply extending the results proved by Cramer (1946) for the function of the three sample moments. Further from (1.3.4), we have

$$\lambda'_2=(-b+\sqrt{b^2-4ac})/2a$$

$$=H(m'_1, m'_2, m'_3) \qquad \text{(say)}$$

therefore, $E(\lambda'_2)=(-B+\sqrt{B^2-4AC})/2A$ (1.3.6)

where $A=\mu'_1-\mu'_3+\mu'^2_1=-\alpha(1-\alpha)\ (\lambda_1-\lambda_2)^2$

$B=\mu'_3-3\mu'_2+\mu'^2_1+2\mu'_1-\mu'_1\mu'_2=\alpha(1-\alpha)\ (\lambda_1-\lambda)\ (\lambda^2_1-\lambda^2_2)$

$C=\mu'^2_2-\mu'^2_1+\mu'_1\mu'_2-\mu'_1\mu'_3=-\alpha(1-\alpha)\ \lambda_1\ \lambda_2\ (\lambda_1-\lambda_2)^2$

Putting the values of A, B, C in (1.3.6) we have

$$E(\lambda_2)=\lambda_2 \qquad (1.3.7)$$

So λ'_2 is an unbiased estimator of λ_2. Asymptotic variance of λ'_2 is given by,

$$\text{Var}\ (\lambda'_2)=\mu_2(m'_1)\ (\partial'\lambda_2/\partial m'_1)^2_{\mu'_1, \mu'_2, \mu'_3}+\mu_2(m'_1)\ (\partial\lambda'_2/\partial m'_2)^2_{\mu'_1, \mu'_2, \mu'_3}$$

$$+\mu_2(m'_3)\ (\partial\lambda'_2/\partial m'_3)^2_{\mu'_1, \mu'_2, \mu'_3}+2\mu_{11}(m'_1, m'_3)\ (\partial\lambda'_2/\partial m'_1)_{\mu'_1, \mu'_2, \mu'_3}$$

$$(\partial\lambda'_2/\partial m'_3)_{\mu'_1, \mu'_2, \mu'_3}+2\mu_{11}(m'_1, m'_3)\ (\partial\lambda'_2/\partial m'_1)_{\mu'_1, \mu'_2, \mu'_3}$$

$$(\partial\lambda'_2/\partial m'_3)_{\mu'_1, \mu'_2, \mu'_3}+2\mu_{11}(m'_2, m'_3)\ (\partial\lambda'_2/\partial m'_2)_{\mu'_1, \mu'_2, \mu'_3}(\partial\lambda'_2/\partial m'_3)_{\mu'_1, \mu'_2, \mu'_3} \qquad (1.3.8)$$

Since $\lambda'_2=(-b+\sqrt{b^2-4ac})/2a$, therefore,

$$(\partial\lambda'_2/\partial m_1')=[2a\ \{(-\partial b/\partial m'_1)+\phi_1/2\delta\}-\{2(\partial a/\partial m'_1)\ (-b+\delta)\}]/4a^2 \qquad (1.3.9)$$

where $\delta=\sqrt{b^2-4ac}$

and $\phi_1=2b(\partial b/\partial m'_1)-4a(\partial c/\partial m_1')-4c(\partial a/\partial m'_1) \quad i=1, 2, 3$ (1.3.10)

Variance and covariance of any order sample moments may be found out by the application of (1.2.5), substituting in (1.3.8) the asymptotic variance of λ'_2 may be found out. Similarly by taking $\lambda'_1=(-b-\sqrt{b^2-4ac})/2a$ the expected value of λ'_1 is given by,

$$E(\lambda'_1)=(-B-\sqrt{B^2-4AC})/2A$$

$$=\lambda_1 \text{ (by putting the values of A, B, C as given above and solving).}$$

So λ'_1 is an unbiased estimator of λ_1 and the asymptotic variance of λ'_1 may be found out in a similar fashion as that λ'_2 by using (1.3.9) by changing λ'_2 to λ'_1 and defining,

$$(\partial\lambda'_1/\partial m'_1)=2a\{(-\partial b/\partial m'_1)-\phi_1/2\delta\}-\{2(\partial a/\partial m'_1)(-b-\delta)\}]/4a^2 \qquad i=1, 2, 3 \qquad (1.3.11)$$

where δ and ϕ_1 (i=1, 2, 3) are as defined in (1.3.10)

It should be noted here that λ'_1 and λ'_2 are consistent estimators of λ_1 and λ_2, respectively. Therefore, to find the expected value and asymptotic variance of α', we may substitute λ_1 and λ_2 in place of λ'_1 and λ'_2. Thus from (1.3.1) we have,

$$E(\alpha')=[E(m'_1)-\lambda_2]/(\lambda_1-\lambda_2)=\alpha \qquad (1.3.12)$$

and $$\text{Var}(\alpha')=V(m'_1)/(\lambda_1-\lambda_2)^2$$

$$=\alpha(1-\alpha)/n+\alpha/(\lambda_1-\lambda_2)n+\lambda_2/n(\lambda_1-\lambda_2)^2 \qquad (1.3.13)$$

we can easily prove the consistency of α'.

APPENDIX I

To illustrate the results of this paper, a sample of the number of European corn-borers, *Pyrausta nubilalis* Hubn. on small unit areas of a field as observed in 1957 (Table 1), was selected from Beall and Rascia (1953).

Similarly a sample of number of European corn-borer larvae was selected from two field areas (Tables 2 and 3) by McGuire *et al.* (1957). Though the three data are similar in nature, yet three different models, viz., complete poisson, truncated poisson, Neyman type A, B and C had been used to explain the data. It can be shown that if a mixture of distribution model is used, the latter fits all the three data, thus, showing appropriateness of the model for the situations. Detailed calculations are given in the following tables. The values of χ^2 show the goodness of fit.

Note : α', λ'_1, λ'_2 and $v'(\alpha')$ denote the estimates of parameters α, λ_1, λ_2 and $v(\alpha')$, espectively.

TABLE 1

Distribution of European corn-borer larvae *Pyrausta nubilalis*

No. of insects	Observed frequency	Expected frequency		
		Complete poisson	Truncated poisson	Mixture of two poissons
0	33	26.48(27)	33.0(33)	33.38(33)
1	12	19.86(20)	10.8(11)	11.42(12)
2	6	7.44(7)	7.4(7)	6.08(6)
3	3	1.86(2)	3.3(3)	3.20(3)
4	1	0.35(0)	1.1(1)	1.32(1)
5	1	0.05(0)	0.4(1)	0.45(1)
Total	56	56	56	56
	χ^2 (Calculated)	11.95	0.59	0.0
	χ^2 (Tabulated) at 5% level	7.815	5.99	

TABLE 2

Distribution of European corn-borer larvae *Pyrausta nubilalis*

No. of insects	Observed frequency	Expected frequency	
		Complete poisson	Mixture of two poissons
0	423	356.75(357)	432.08(432)
1	414	460.20(460)	403.08(403)
2	253	296.80(297)	245.31(245)
3	117	127.62(127)	127.03(127)
4	53	41.15(41)	56.95(57)
5	22	10.62(11)	21.75(22)
6	14	2.86(3)	9.72(10)
	χ^2 (Calculated)	78.95	3.41
	χ^2 (Tabulated) at 5% level	11.07	7.82

TABLE 3

Distribution of European corn-borer larvae *Pyrausta nubilalis*

No. of insects	Observed frequency	Expected frequency	
		Simple poisson	Mixture of two poissons
0	89	63.48(64)	93.18(93)
1	96	103.47(103)	86.81(87)
2	57	84.33(84)	81.84(82)
3	44	45.42(46)	40.84(41)
4	16	18.67(19)	23.45(23)
5	11	6.08(6)	11.26(11)
6	11	2.13(2)	6.14(6)
	χ^2 (Calculated)	64.15	6.14
	χ^2 (Tabulated) at 5% level	11.07	7.82

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CHEMICAL COMPOSITION OF WHEAT AND BARLEY LEAVES UNDER WATER STRESS

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ABSTRACT

Effect of water stress was studied on DNA, RNA, protein, lipid and chlorophyll contents of leaves of two different water requiring varieties of wheat and barley at tillering, ear emergence and grain filling stages. Water stress resulted in lower levels of all these constituents in both the crops; maximum effect being at grain filling stage. The effect of stress was more pronounced on more water requiring varieties of wheat, S-308 and barley, BG-25.

Water stress is one of the adverse conditions that a plant faces in its life cycle. Under conditions of water stress, growth of plants is inhibited (Cleland, 1967) and a variety of morphological and biochemical modifications are brought about (Hsiao, 1973), which ultimately affect economic yield. Leaf is one of the most important plant organ which makes maximum contribution to growth and yield. Though composition of leaves is known to alter under water stress, different plant species behave differentially. While Gates and Bonner (1959) observed a decrease, Kessler and Tishel (1962) reported an increase in protein and nucleic acid contents. Reduction in chlorophyll (Bourque and Naylor, 1971) and lipids (Lechevallier, 1977) is also known under water stress. Water stress is critical at specific stages of plant growth. In wheat and barley, these stages are tillering, ear emergence and grain filling. Therefore, changes in the composition of wheat and barley leaves under water stress at different growth stages were studied. Two varieties each of wheat, S-308 (less drought tolerant) and C-306 (more drought tolerant) and barley, BG-25 (less drought tolerant) and C-138 (more drought tolerant) were selected for this study.

MATERIAL AND METHODS

Wheat (*Triticum aestivum* var. S-308 and C-306) and barley (*Hordeum vulgare* var. BG-25 and C-138) were sown in the **rabi** season in plots lined with polythene sheets. Water stress was created by withholding irrigations at tillering, ear emergence and grain filling stages. Leaf water potential of stressed plants was measured with a thermocouple psychrometer (Boyer, 1969). Nucleic acids were extracted following the method of Cherry (1962) and DNA was estimated by diphenylamine (Burton,

TABLE 1

Leaf water potential of wheat and barley leaves under water stress (bar)

Crop	Cultivar	Tillering		Ear emergence		Grain filling	
		C	S	C	S	C	S
Wheat	S-308	−11.0±0.02	−27.0±0.09	−15.0±0.02	−28.0±0.04	−20.0±0.03	−30.0±0.09
	C-306	−15.5±0.06	−25.5±0.06	−18.0±0.03	−27.0±0.04	−21.0±0.06	−29.0±0.08
Barley	BG-25	−10.0±0.06	−23.0±0.08	−15.0±0.04	−27.0±0.08	−23.0±0.08	−32.0±0.06
	C-138	−14.0±0.04	−23.0±0.08	−20.0±0.06	−28.0±0.09	−25.0±0.09	−30.0±0.08

C = control; S = stress.

TABLE 2

Composition of wheat leaves under water stress (mg/g dry wt.)

Parameters	Tillering		Ear emergence		Grain filling	
	C	S	C	S	C	S
Cv. S-308						
DNA	8.0±0.50	6.8±0.04	7.4±0.04	5.4±0.04	6.5±0.04	4.2±0.02
RNA	175.0±2.30	148.0±3.20	159.0±4.70	94.7±2.10	109.0±2.90	52.5±0.09
Protein	290.0±4.10	210.0±4.90	212.0±4.90	148.0±2.40	180.0±2.80	104.0±1.80
Lipid	75.0±2.00	69.0±1.80	80.0±1.60	72.0±1.20	67.0±1.10	60.1±0.90
Chlorophyll	9.0±0.09	5.9±0.20	10.8±1.00	5.6±0.02	11.5±0.06	6.1±0.09
Cv. C-306						
DNA	6.2±0.08	5.5±0.04	6.1±0.04	5.2±0.06	5.8±0.02	4.6±0.08
RNA	168.0±3.90	140.9±2.40	162.0±2.80	122.4±3.80	138.3±2.90	102.3±1.08
Protein	250.0±4.60	196.0±3.90	207.0±2.20	169.0±4.50	180.0±4.30	140.0±3.50
Lipid	73.2±1.90	68.5±0.08	78.0±0.06	70.5±1.00	68.4±1.30	64.3±1.80
Chlorophyll	10.0±0.90	9.0±0.08	10.9±0.02	8.5±0.09	11.5±0.08	10.0±0.06

C = control; S = stress.

TABLE 3

Composition of barley leaves under water stress (mg/g dry wt.)

Parameters	Tillering		Ear emergence		Grain filling	
	C	S	C	S	C	S
Cv. BG-25						
DNA	11.3±0.08	9.6±0.02	10.5±0.08	8.4±0.30	7.5±0.06	5.7±0.05
RNA	186.2±2.40	160.0±1.40	137.0±2.80	110.0±3.60	106.4±1.80	81.3±0.08
Protein	270.0±3.80	236.0±4.20	198.0±3.60	155.0±3.20	170.0±3.20	130.0±2.10
Lipid	72.0±1.10	62.0±0.09	81.1±1.20	70.0±0.04	76.1±0.06	71.0±0.08
Chlorophyll	7.9±0.04	6.9±0.04	7.9±0.80	4.0±0.02	8.7±0.09	4.9±0.04
Cv. C-138						
DNA	10.3±0.04	5.5±0.02	10.1±0.60	8.9±0.04	8.8±0.04	7.0±0.03
RNA	172.0±1.90	152.0±4.60	111.0±2.60	92.0±1.80	108.0±1.90	86.0±0.90
Protein	280.0±4.90	250.0±4.30	192.0±2.90	170.0±2.60	170.0±3.20	150.0±2.50
Lipid	74.0±0.08	67.5±0.02	85.0±1.30	77.0±0.80	77.1±0.80	74.0±1.00
Chlorophyll	7.3±0.02	6.8±0.02	7.6±0.0	6.15±0.02	8.0±0.06	6.9±0.04

C = control; S = stress.

1968) and RNA with orcinol (Militzer, 1946) reagents. Total proteins were estimated by Nesslerisation (Thompson and Morrison, 1951) and chlorophyll was determined by the method of Arnon (1949). Total lipids were extracted and determined gravimetrically by drying under vacuum at 60°C (Fishwick and Wright, 1977).

RESULTS AND DISCUSSION

The creation of water stress at tillering, ear emergence and grain filling stages was indicated by a decrease in leaf water potential of stressed plants (Table 1). There was considerable reduction in leaf water potential of stressed wheat and barley leaves as compared to normal leaves. Water stress had resulted in a decrease in DNA, RNA and protein contents in both wheat and barley varieties. The maximum decrease was observed at grain filling stage. The effect of stress on DNA, RNA and protein contents was greater in wheat (Table 2) as compared to barley (Table 3) and in addition the degree of stress was more marked in high water requiring varieties, S-308 (wheat) and BG-25 (barley). Shah and Loomis (1965) also reported a decrease in DNA, RNA and protein contents in water stressed sugar beet leaves. Reduction in protein content in wheat leaves under water stress has also been reported by Stutte and Todd (1969).

Chlorophyll content also decreased in both the crops and the decrease was more with stress at ear emergence stage. This stress affected decrease was of higher magnitude in more water requiring varieties of wheat (S-308) and barley (BG-25). Under drought conditions, Bourque and Naylor (1971) observed significantly slower accumulation of chlorophyll in green leaves which resulted into yellowing of leaves.

Total lipid content decreased slightly under stress in both the crops. Changes in total lipid content are known in plants under a variety of stress conditions (Redshaw and Zalik, 1968) including

TABLE 4

Effect of water stress on grain yield of wheat and barley

	Wheat		Barley	
	S-308	C-306	BG-25	C-138
Weight of grain/ear (g)				
C	1 11	1.71	2.44	2.41
S_1	0.50	0.86	1.27	1.59
S_2	0.60	1.01	1.86	2.00
S_3	0.83	1.37	2.19	2.28
1000—grain weight (g)				
C	52.6	41.0	44.5	47.0
S_1	40.9	35.8	28.9	37.6
S_2	44.0	37.0	37.5	39.8
S_3	50.0	39.2	40.8	43 5

C=control; S_1, S_2 and S_3 = stress at tillering, ear emergence and grain filling stages, respectively.

water stress (Lechevallier, 1977). Changes in specific membrane lipid components also took place under water stress (Chetal *et al.*, 1980).

Proteins are under the control of nucleic acids and form basic structure of enzymes and membranes. Alterations in nucleic acids, proteins and lipids will affect various plant functions, while reduction in chlorophyll content will affect photosynthesis. Wheat and barley varieties showed differential effect of water stress. The effect of stress was more pronounced in irrigated varieties C-306 (wheat) and C-138 (barley) and further wheat was more affected as compared to barley. The stress effect at grain filling stage is detrimental, since the synthetic activities of plant at this stage directly contribute to yield. In fact, these alterations in chemical constituents have been reflected in grain yield (Table 4).

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GROUND WATER STUDIES AT A DRY LAND AGRICULTURAL FARM IN HARYANA

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ABSTRACT

The ground water studies in the vicinity of flood plains of Sahibi river over an area of 73 ha were carried out from December 1976 through December 1979. Rate of rise in water table during the period 1976-78 was observed to be higher than during 1979. An average annual rise of 32.05 cm was estimated by using flow net technique for subsurface flow, which was in close proximity to the observed rise during the period. Subsurface inflow from flood plains of Sahibi river was mainly responsible for the rise in water table while other components of water balance equation were in equilibrium with each other. The overall electrical conductivity of underground water was observed to be within 5 mmhos/cm.

The area for which the study has been reported is the Dry Farming Research Station of the Haryana Agricultural University and is located 14 km south of Rewari town on Rewari-Bawal Road, approximately 28°4'30"N latitude and 76°35'E longitude and 260 m above mean sea level (Ahuja *et al.*, 1977). The farm extends over an area of 73 ha. It is a part of the pre-cambrian, within the dissected valley, filled up by the recent alluvium brought down by the rivers flowing south to north after plistocen fluivoglacial manifestation (Garlapuri and Duggal, 1974). The average annual rainfall during the past 10 years (1968-1977) is 534 mm. The overall climate of the area is arid type.

METHODOLOGY

To analyse different factors contributing to the change in ground water behaviour, it is necessary to determine the ground water movement in the saturated strata. It was accomplished by setting up a ground water monitoring system, which consisted of 21 observation wells at an approximate grid of 110×200 m. Water levels were recorded periodically once in a month and water samples were also collected for complete chemical analysis.

RESULTS AND DISCUSSION

The average ground water contour map (Fig. 1) for the period of observation, December 1976 to December 1979 indicates that the subsurface flow entered the eastern part of the farm and flowed towards the north-western side of the area. There were small areas in the south-eastern and south-western parts of the farm which behaved as independent hydrological units.

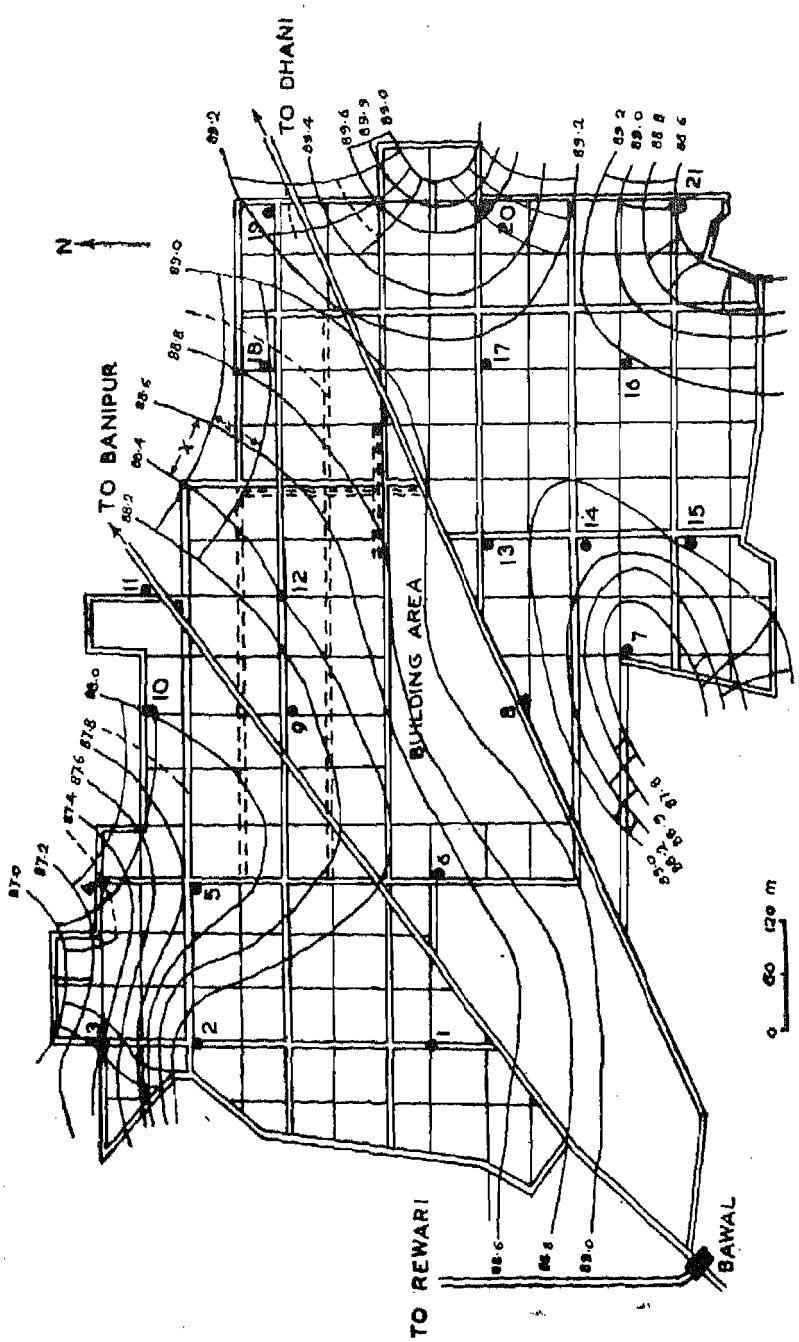


Fig. 1. Average ground water contour map (Dec. 1976-Dec. 1979) and flow net.

Fig. 1 has been used to estimate the rate of subsurface inflow and outflow through the boundaries of the area using flow net technique (Anonymous, 1974). Series of flow lines were drawn perpendicular to the system of equi-potential lines such that the squares were formed. The flow rate to any channel or path of flow between two adjacent flow lines was obtained from Darcy's law. Considering a width 'y' of unit thickness of the aquifer measured normal to the direction of flow, indicated by 'x' the Darcy's equation for this part of the aquifer is written as :

$$q = K \frac{dh}{dx} \cdot y \qquad (1)$$

Where

q = flow rate occurring between a pair of adjacent flow lines, m^3/day.

y = spacing of flow lines, m.

K = hydraulic conductivity, m/day, and

$\frac{dh}{dx}$ = slope of the water table.

If 'x' represents the spacing of equi-potential lines, $\triangle$ his the drop in hydraulic head between the equi-potential lines, 'n' is the number of squares and 'D' is the full saturated thickness of the aquifer, then equation (1) may be rewritten as follows :

$$Q = n.\triangle h.KD \qquad (2)$$

or $Q = n.\triangle h.T$

Where

Q = total flow in the entire saturated thickness 'D', m^3/day.

T = transmissivity of aquifer formation, m^2/day.

The aquifer transmissivity 'T' was estimated by conducting pumping tests at number of locations outside the farm. The tubewells of the neighbouring farmers were used for these tests. The 'T' value varied from 400-600 m^2/day. Along the eastern boundary of the farm. the average 'T' value was 400 m^2/day and along the north western side, it was 600 m^2/day.

From Fig 1, it can be seen that the total number of squares that were drawn towards the eastern part of the farm was 8, out of which 7 having a $\triangle h = 0.2$ m and 1 with a $\triangle h = 0.1$ m. Substituting in equation (2)

$$Qin = 7 \times 0.2 \times 600 + 0.1 \times 500$$
$$= 900 \text{ m}^3\text{/day}$$

Similarly, the subsurface outflow occurred in the north-western part of the farm. Following the above procedure

$$Qout = 4 \times 0.2 \times 400 + 0.1 \times 400$$
$$= 360 \text{ m}^3\text{/day}$$

Therefore, the net subsurface inflow into the ground water storage over an area of 61.5 ha (11.5 ha in under independent hydrological units) was worked out by using following equation :

$$Qnet = Qin - Qout \qquad (3)$$
$$= 900 - 360$$
$$= 540 \text{ m}^3\text{/day}$$

Average net subsurface inflow

$$= \frac{540 \times 10^3}{61.5 \times 10^4}$$

$$= 0.878 \text{ mm/day}$$

$$= 32.5 \text{ cm/year}$$

Table 1 shows the net rise observed during December 1976-December 1979. The average annual rise came out to be 39 cm. The observed annual rise and average net subsurface inflow are in close proximity which implies that the subsurface inflow from surrounding areas (flood plains of Sahibi river) is mainly responsible for the rise in water table while other components of ground water balance equation are in equilibrium with each other. Sahibi river flows from south towards north and passes through eastern border of the farm and is in conformity with the ground water movement (Fig. 1).

Variation of per cent area under different water table depth and quality ranges

Isobath or depth to water table and isoconductivity maps were drawn for each month from December 1976-December 1979 and per cent areas under different water table depth and E. C. ranges were measured and are reported in Tables 2 and 3, respectively.

The general water table depth varied from 11.4-13.5 m during December 1976 to 10.6-12.0 m during December 1979. During June 1977, whole of the area

TABLE 1

Observed rise in water table (Dec. 1976 to Dec. 1979)

Piezometer No.	Water table depth (m)		Rise/fall (m)
	Dec. 1976	Dec. 1979	
1.	12.55	11.35	1.20
2.	11.50	—	—
3.	13.53	11.58	1.95
4.	13.02	11.47	1.55
5.	12.76	10.97	1.78
6.	12.67	11.32	1.35
7.	12.10	10.90	1.20
8.	12.40	10.85	1.55
9.	12.92	11.07	1.85
10.	12.15	11.00	1.15
11.	12.23	11.28	0.95
12.	12.53	11.18	1.85
13.	12.72	10.90	1.82
14.	12.30	11.00	1.30
15.	11.40	10.92	0.48
16.	11.83	—	—
17.	11.90	10.98	0.92
18.	11.67	11.92	−0.25
19.	11.43	10.65	0.78
20.	11.48	10.70	0.78
21.	11.66	10.93	0.73

Annual average rise = 22.42/3 × 19 = 0.39 = 39 cm.

TABLE 2

Per cent area under different water table depths during different months

Month	Water table depths (m)								
	<10.0	10-10.4	10.4-10.8	10.8-11.2	11.2-11.6	11.6-12.0	12.0-12.4	12.4-12.8	>12.8
June 1977	—	—	—	—	—	—	18.60	30.40	51.0
Oct. 1977	—	1.54	10.60	8.21	14.01	23.94	38.61	3.09	—
March 1978	2.43	24.70	30.36	34.41	8.10	—	—	—	—
June 1978	—	3.46	22.88	55.00	18.85	—	—	—	—
Oct. 1978	11.83	27.48	48.85	11.83	—	—	—	—	—
Dec. 1978	30.40	28.00	32.80	8.80	—	—	—	—	—
June 1979	1.53	25.57	45.80	25.19	1.91	—	—	—	—
Oct. 1979	—	13.07	70.38	15.38	1.16	—	—	—	—
Dec. 1979	—	—	5.70	59.31	34.98	—	—	—	—

TABLE 3

Per cent area under different E. C. ranges during different months

Month	E. C. ranges (mmhos/cm)					
	<1	1-2	2-3	3-4	4-5	>5
June 1977	—	9.90	37.60	19.40	22.83	3.62
Jan. 1978	13.33	36.86	32.33	8.24	4.31	3.92
May 1978	10.69	17.18	28.63	17.56	13.36	12.60
March 1978	12.06	43.19	23.35	15.56	5.84	—
June 1979	11.98	35.94	43.78	8.29	—	—
Aug. 1979	13.51	40.54	35.59	6.76	2.70	0.93
Sep. 1979	17.67	33.02	38.14	6.98	3.26	0.93
Oct. 1979	17.59	29.17	40.28	6.48	3.70	2.78
Dec. 1979	17.21	32.09	38.60	6.98	3.26	1.86

was under more than 12 m water table and by the end of October 1977, 58.30% area came under less than 12 m depth range. The per cent area under lower water depth ranges kept increasing even after the end of monsoon. During October 1977, per cent area under less than 10.4 m was 1.54 which increased to 27.13 during March 1978. This rise in water table in the absence of rainfall and irrigation is mainly attributed to the subsurface inflow. During June 1978, per cent area under less than 10.4 m was 3.46 which increased to 39.31 at the end of October 1978 and further increased to 58.40 during December 1978. During June 1979, per cent area under less than 10.4 m was 27.10 which decreased to 13.07 during October 1979. By December 1979, no area was observed to be under the same water depth range. The years 1976-78 experienced above normal rain-

fall which resulted in the extension of flood plains of Sahibi river and thereby increasing the deep percolation over the surrounding areas of the farm. This seepage water contributed to the rise in water table at the farm through subsurface inflow. During 1979, the inflow into the farm from the surrounding areas was drastically reduced because of low rainfall in the catchment areas of Sahibi river.

Table 3 gives the per cent area under different E. C. ranges. During June 1977, per cent area under less than 2 mmhos/cm was 9.90 and increased to 50.19 during January 1978. During May 1978 per cent area under this range was 27.17 which increased to 55.15 by the end of November 1978. During June 1979, per cent area under this range was 47.92 and remained constant even after the end of monsoon period. During the years 1977–78 which experienced above normal rainfall, the improvement in ground water quality was observed during the post-monsoon. It was mainly due to good quality subsurface inflow from Sahibi river flood plains. But during the year 1979, no such phenomenon was observed because of reduction in subsurface inflow into the farm.

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CYTOGENETIC EFFECTS OF FOOD DYES IN *ALLIUM CEPA* ROOTS

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A majority of synthetic food colours are either azo dyes of triphenylmethane compounds containing sulphonic or carboxylic groups (Radomsky, 1974; Brown *et al.*, 1978). It is known that some of these dyes can cause genetic abnormalities in certain test systems (Kada *et al.*, 1972; Larson, 1975; Venitt and Bushell, 1976; Auletta *et al.*, 1977). Because of the potential hazards associated with such synthetic food colours, their unequivocal use without proper testing for cytogenetic effects should be discouraged. With this in mind, the present study was conducted to find out the cellular and subcellular changes induced by two popularly used food dyes, viz., amaranth ($C_{20}H_{11}O_{10}N_2S_3Na_3$) and azorubine (carmoisine, $C_{20}H_{12}N_2O_7S_2Na_2$) taking onion roots as the test material.

Twenty four hour old onion roots were allowed to grow for 5h in the dye solution ranging in concentration from 0.05 to 1.00 per cent. These roots were then fixed in 1 : 3 acetic alcohol and used for cytological preparations to score the mitotic index and chromosomal aberrations, if any. Respiratory rates of the treated and control roots were studied using a Warberg's Manometer. Root length was also recorded on the bulbs grown in the dye-solution for 48 h. A proper control was kept for each treatment.

In the present study, various types of chromosomal abnormalities were observed in the treated cells at relatively higher concentrations (Table 1). The effect was more pronounced in case of amaranth. The occurrence of chromosomal abnormalities in the treated cells suggests that the dyes or their metabolic products can cause chromosomal breaks at certain concentrations leading to the formation of bridges, fragments, gaps, etc. Havaland-Smith *et al.* (1979) found that one of the food dyes, Red 2G (C I. 18050) can cause repairable type of DNA damage in bacteria. In addition to the chromosomal aberrations a few treated cells also showed tripolar division and stickiness of the chromosomes. A remarkable reduction in the mitotic index was observed in higher concentrations of both the dyes (Table 2). This effect was further clear in the 48 h treated roots where a considerable reduction in the root length could be seen as com-

TABLE 1

Chromosomal aberrations (as % of the cells examined) in onion root cells resulting from exposure to aqueous solutions of the dyes, amaranth and azorubine

Concentration (%)	Breaks	Bridges	Stickiness	Total aberrations	Total cells scored
Amaranth					
1.00	3.30	1.50	0.80	5.60	1875
0.50	2.62	2.49	0.72	5.85	4414
0.25	1.80	1.00	0.52	3.32	3852
0.10	0.40	0.62	0.30	1.32	3100
0.05	0.33	0.35	0.39	1.07	4221
Azorubine					
1.00	2.80	1.18	1.00	4.98	1585
0.50	1.85	1.08	0.62	3.55	1348
0.25	0.88	0.82	0.40	2.00	1200
0.10	0.53	0.21	0.24	0.98	1300
0.05	0.40	0.20	0.20	0.80	2785
Control	0.42	0.30	0.23	0.95	1250

TABLE 2

Mitotic index of onion root cells when exposed to aqueous solutions of the dyes amaranth and azorubine

Concentration (%)	Dividing cells (%)	Total cells scored
Amaranth		
1.00	2.75	3858
0.50	2.60	3665
0.10	3.85	3300
0.05	4.73	3250
Azorubine		
1.00	2.86	3350
0.50	3.23	3820
0.10	4.30	3600
0.05	4.99	3150
Control	4.98	4000

pared to the control. The reduction in the mitotic index leading to retardation in growth of the treated roots could be either due to the chromosomal abnormalities leading to genetic damage at those concentrations or to physiological disturbances caused by the treatment conditions. In this context the respiratory rates of the treated roots were studied. None of the treatments gave significant difference in the rate of respiration as compared to the control. It suggests that there was no reduction in the energy output for growth but the

utilization of this energy might have been handicapped. However, at lower concentrations the effects were less marked and at 0.05 and 0.10 per cent the effects were not distinguishable from the respective controls.

Chromosomal abnormalities in addition to having direct effect on growth as seen in this study, can also have various other genetic implications. They can cause somatic mutations leading to mosaicism and if the changes are in the germ lines, can be carried over to the gametes and cause abnormalities in the offspring.

Thus, these observations suggest that the colouring materials which are under use currently should be put under rigorous genetic testing, using various test systems. In all cases safe doses in terms of the cytogenetic effects should be worked out which in the present study come out to be 0.05 and 0.10 per cent for amaranth and azorubine, respectively. It will also be advisable to standardise the methods for extrapolation of the information made available from various test systems to suggest about their potential hazards to human beings. However, it may not be possible to use extrapolation as a direct method of affixing safety norms.

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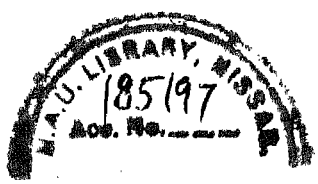
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EFFECT OF PRUNING, SPACING AND FERTILIZER LEVELS ON FLOWERING, FRUITING, YIELD AND QUALITY OF MUSKMELON

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ABSTRACT

In an experiment comprising of three plant spacings (30, 45 and 60 cm), two fertility levels, i. e , low (50 kg N_2 and 30 kg P_2O_5) and high (100 kg N_2 and 60 kg P_2O_5) fertility, and six treatments of pruning (no pruning, pruning to one, two, three, four or five fruits) were tried to see their effect on flowering, fruiting, yield and quality of muskmelon variety Hara Madhu. Pruning to one fruit was found to hasten fruit maturity by about 7 days as compared to control plants. Number of fruits per plant (except in case of pruning to one and two fruits) and average yield per hectare were significantly increased where pruning was done in comparison to control plants. However, effect of spacing and fertility levels on fruit maturity and number of fruits per plant could not be noticed. Yield per hectare was significantly reduced (151 80 q/ha) under wider plant spacing as compared to medium (226.2 q/ha) and closer spacing (333.6 q/ha).

Fruits harvested from pruned plants showed higher T.S.S , ascorbic acid, reducing sugers and better pulp thickness. Pruning did not help in increasing nitrogen content in plant tissues, though phosphorus content was improved in the pruned plants. Spacing and fertility status of soil did not show any remarkable effect on various quality characters except that nitrogen content of plant was improved in closer spacing and phosphorus content under higher fertility status of soil.

Role of pruning is well established. A significant increase in fruit yield by pruning the plants as compared to unpruned ones has been reported in tomato, muskmelon and cucumber (Mangal *et al*., 1979; Mangal and Pandita, 1980; Mangal and Yadava, 1980). Higher yield can also be obtained by maintaining optimum plant population and fertility status of soil (Padda *et al*., 1969; Godzhonov, 1972). However, the combined effect of these factors is not known. Therefore, a field experiment was conducted to investigate the effect of pruning, spacing and fertility on flowering, fruiting, yield and quality of muskmelon variety Hara Madhu.

MATERIAL AND METHODS

The experimental field was sandy loam with uniform fertility having pH

8.5, conductivity 0.78 mmhos/cm, organic carbon 0.48%, available P_2O_5 37.54 kg/ha and available K_2O 900.0 kg/ha. The experiment was laid out in a split plot design with six main plot treatments, comprising of three plant spacings (30, 45 and 60 cm) and two fertility levels, i. e., low (50 kg N_2 and 30kg P_2O_5 and high (100kg N_2 and 60 kg P_2O_5). The six sub-plot pruning treatments were no pruning, pruning to one, two, three, four or five fruits. The spacing between rows was maintained 1.5 m. Full dose of phosphorus in the form of single super phosphate (16% P_2O_5) and half dose of nitrogen as calcium ammonium nitrate (25% N) were applied as basal dose as per treatment. Remaining half dose of nitrogen was applied as top dressing after 35 days of seeding. Three seeds per hill were sown on one side of furrows on the edge of bed at desired spacing on 23rd February, 1978. When the germination was complete only one plant was allowed to develop per hill. Net plot size under each treatment was 4.8×1.5 m.

Hara Madhu variety of muskmelon is andromonoecious and male flowers are borne on main branches. The first hermaphrodite flower generally appears on 7th secondary branch. The secondary branches and regenerated growth upto 7th node were pinched off at their emergence and subsequent ones were allowed to develop. Perfect flowers arising from 8th branch onwards were allowed to set fruit. The desired number of fruits as per treatment were allowed to develop. The secondary branches were also detopped at two leaves after first perfect flower. The operation of pruning was done at three days interval and continued throughout the experiment. Field was irrigated, kept weed free and plant protection measures were taken as and when required.

Observations on various flowering, fruiting and yield characters like days taken for fruit maturity, position of fruit, number of fruits per plant, yield of fruits per plant and yield per hectare were recorded. T.S.S. of fruits was estimated with the help of Erma hand Refractometer (0-32 range), ascorbic acid by 2, 6 dichlorophenol indophenol titration method (AOAC, 1960) and reducing sugers by Fehling method.

Nitrogen and phosphorus contents in plant tissues were estimated by the method described by Jackson (1958).

RESULTS AND DISCUSSION

Fruit maturity was hastened by about 7 days where pruning was practiced to one fruit as compared to control plants (Table 1). Effect of spacing and fertility levels was not significant. First fruit was generally borne on 9th node where pruning was not exercised in comparison to 8th node where pruning was done to one fruit. Other pruning treatments did not differ significantly in this respect. However, spacing and fertility levels did not have any significant effect on the position of fruit. Highest number of fruits per plant were observed in treatments where pruning to three, four and five fruits was adopted. Number of fruits per plant were significantly reduced where pruning was done to one fruit in comparison to other treatments. Control plants and pruning to two fruits produced statistically similar number of fruits

TABLE 1

Effect of pruning, spacing and fertility levels on flowering, fruiting and yield of muskmelon variety Hara Madhu

Treatments	Days required for fruit maturity from the day of flower opening	Position of fruit	No. of fruits/plant	Weight of fruits/plant (g)	Yield/ha (q)
Pruning to number of fruits					
Control	37.69	9.27	1.75	1103.3	170.8
One	30.64	8.41	1.00	1481.3	240.2
Two	31.79	8.87	1.88	1531.4	242.9
Three	32.41	8.94	2.61	1166.3	268.4
Four	32.58	8.93	2.62	1407.2	225.1
Five	33.32	8.73	2.83	1714.0	277.8
C. D. at 5% level	0.68	0.37	0.38	299.9	59.0
Spacing (cm)					
30	30.06	8.73	2.08	1546.6	333.6
45	33.24	8.81	2.15	1495.9	226.2
60	32.92	9.05	2.11	1409.3	151.8
C. D. at 5% level	N. S.	0.23	N.S.	N.S.	68.9
Fertility levels (N and P_2O_5 kg/ha)					
Low (50-30)	32.77	8.91	2.14	1505.8	238.3
High (100-60)	33 37	8.81	2.09	1462.1	236.17
C. D. at 5% level	N.S.	N.S.	N.S.	N.S.	N.S.

per plant. Average weight of fruits per plant was also significantly better where pruning was practiced in comparison to control. Spacing ,and fertility levels of soil did not produce any significant effect on these characters.

It is likely that pruning helped in diverting the flow of nutrients towards apical growing point, increasing plant length with more number of leaves and ultimately assimilation of more carbohydrates and proteins. Greater production of plant food under these treatments appear to have increased the number of fruits per plant. Similar results have been obtained by Sambos and Sabina (1974), Mangal and Yadava (1980), and Mangal and Pandita (1980).

Yield was significantly influenced by pruning treatments and highest yield was obtained where pruning was practiced to five fruits (277.77 q/ha) and the lowest in unpruned (170.82 q/ha) treatment. Various pruning treatments did not differ significantly among themselves. However, the treatments where pruning was done to two to three fruits per plant were best as compared to other treatments because of early fruit maturity. Narrow plant spacings had marked influence on yield/ha as compared to wider plant spacing. It was interesting to note that fertility status of soil did not produce any significant effect on total yield of fruits. It may be because of poor response of this crop to higher fertility levels.

Higher yield due to pruning may be because of better vegetative growth (Mangal and Pandita, 1980), increased number, weight and size of fruit or may be that pruned plants were greatly exposed to light, leading to higher photosynthetic activity and greater production of food material and ultimately higher fruit yield. Similar results have been obtained by Mangal and Yadava (1980).

Plant spacing and fertility status of soil did not show any significant effect on fruit quality. Maximum T.S.S. and ascorbic acid contents were recorded where pruning was done to one fruit. All the pruning treatments gave significantly higher T.S.S., ascorbic acid and reducing sugars in comparison to the fruits harvested from control plants (Table 2).

The change in T.S.S. content with pruning is because of more availability of nutrients to the fruits due to their better exposure to sunlight. The trend of reducing sugars was almost similar to that of T.S.S. As sugars constitute a major component of T.S.S., the increase in T.S.S. may be due to increase in reducing sugars in the fruits harvested from pruned plants. The results are in conformity with the findings of Rates (1974) in cucumber fruits.

TABLE 2

Effect of pruning, spacing and fertility levels on fruit quality and mineral content in plant tissues of muskmelon variety Hara Madhu

Treatments	T.S.S. (%)	Ascorbic acid (mg/ 100 gm of edible part)	Reducing sugars(%)	Pulp thickness (cm)	Mineral content (%)	
					Nitrogen	Phosphorus
Pruning to number of fruits						
Control	10.16	31.95	3.71	2.35	1.64	0.26
One	12.15	41.30	4.39	2.68	1.50	0.26
Two	11.70	38.57	4.79	2.63	1.45	0.22
Three	11.50	38.46	4.45	2.57	1.50	0.20
Four	11.49	40.61	4.52	2.32	1.59	0.21
Five	11.57	38.58	4.47	2.58	1.44	0.20
C. D. at 5% level	0.38	2.90	0.29	0.09	N.S.	0.02
Spacing (cm)						
30	11.31	38.50	4.35	2.59	1.69	0.24
45	11.32	38.00	4.40	2.51	1.48	0.21
60	11.66	37.95	4.38	2.57	1.39	0.23
C. D. at 5% level	N.S.	N.S.	N.S.	N.S.	0.18	N.S.
Fertility levels (N and P_2O_5 kg/ha)						
Low (50-30)	11.41	37.76	4.51	2.51	2.03	0.20
High (100-60)	11.45	38.71	4.26	2.48	2.04	0.24
C. D. at 5% level	N.S.	N.S.	N.S.	N.S.	N.S.	0.03

Pruning had also significant effect on pulp thickness over control except to four fruits treatment. Pruning to one and two fruits produced significantly more pulpy fruits in comparison to other treatments. Similar results have been obtained by Sambos and Sabina (1974).

Pruning treatments and fertility levels of soil did not have any significant effect on nitrogen content in the plant tissues. However, the effect of spacing was found significant and plants grown under closer spacing (30 cm) had a maximum nitrogen content (1.69%), followed by medium (1.48%) and wider (1.39%) spacings (Table 2). Control and pruning to one fruit had significantly higher (0.26%) phosphorus content in plant tissues. Plant spacings did not have any effect on phosphorus content of plant tissues. However, higher fertility of soil increased the phosphorus content in plant tissues because of greater availability of P_2O_5 to the plants. Bradt and Cline (1970) also observed no marked difference in nutrient content in grape vine subjected to pruning.

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EFFECT OF GROWTH REGULATORS, WAX EMULSION AND LOW TEMPERATURE ON THE STORAGE BEHAVIOUR OF MUSKMELON

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ABSTRACT

Effect of seven treatments, viz., control, waxol-0 type 12%, GA 250 ppm, MH 1000 ppm, waxol+GA 250 ppm, waxol+MH 1000 ppm and low temperature (10±1°C) was studied on the shelf-life of muskmelon cv. Hara Madhu. Minimum loss in weight was recorded with waxol+MH 1000 ppm and the maximum weight loss in control at room temperature. The combination of waxol with GA 250 ppm did not give any additional benefit as compared to waxol treated fruits. The fruits thus treated maintained acceptable quality upto 9 days of storage. The treatments of waxol, waxol+MH 1000 ppm and waxol+GA 250 ppm were best in reducing microbial decay of fruits.

Low temperature (10±1°C and R. H. 65%) extended the shelf-life of fruits for 15 days without impairing the eating quality of the fruits. These stored fruits exhibited the minimum loss in weight as compared to all the treated fruits stored at room temperature.

Muskmelon *(Cucumis melo* L.*)* is one of the most popular delicious and juicy fruits, widely cultivated in Northern India. A large quantity of this fruit is lost every year while in storage and market before consumption. Post harvest application of certain growth regulators and waxing have extended the shelf-life of many fruits such as guava (Dutta and Mukherjee, 1967) and tomato (Dostal and Leopold, 1967). A little information is available about the storability of this fruit and possibility of extending its shelf-life with various growth regulators, waxing and low temperature conditions. Hence, present study was conducted to obtain information on these aspects.

MATERIAL AND METHODS

Muskmelon cv. Hara Madhu fruits of uniform size and colour were harvested at half slip stage. Effects of seven treatments, viz., control, Waxol-0 type 12%, GA 250 ppm, MH 1000 ppm, GA 250 ppm +waxing, MH 1000 ppm+waxing, and storage at low temperature (10±1°C and R. H. 65%) were studied. The growth regulators were given as dipping treatment for 30 min. Untreated (control) fruits were also dipped in distilled water for the same duration. After surface drying in shade, fruits were packed in carton, using paper cuttings as packing materials, and kept at room

temperature of 34±2°C and R. H. 20-30%. In low temperature treatment, fruits were stored at 10±1°C and R. H. 65%. Each treatment consisted of four replications. The changes in weight, T. S. S. and consumer acceptance rating were studied at 3 days interval. Per cent T. S. S. was determined with the help of Erma Hand Refractometer.

To determine the extent of losses due to microbial decays, the muskmelon fruits were examined at the time of opening of packings. Per cent fruit surface infection was calculated by measuring the diameter of lesions as suggested by Ogawa *et al.* (1963). Decaying fruits were taken out from each packing and organisms were isolated and purified by standard methods of Riker and Riker (1936).

Organoleptic ratings of fruits were also made by a panel of five judges on each date of observation. Fruits were assigned marks 10, 8, 6, 4, 2 and 0 for excellent, very good, fair, poor, very poor and badly deteriorated (non acceptable), respectively. The rating was based on the characters such as colour of skin, texture of skin and flesh, juiciness, sweetness, flavour and taste.

RESULTS AND DISCUSSION

Cumulative Loss in Weight

Loss in fresh weight of fruits increased gradually and progressively as the storage period increased (Table 1). Among the treated fruits (stored at room temperature), waxol-12%, and waxol+MH 1000 ppm reduced the per cent loss in weight significantly as compared to rest of the treatments including control. Both these treatments were at par. The maximum loss in weight was recorded in control (42.79%) and the minimum in waxol+MH 1000 ppm (12.46%) after 9 days of storage. It is also evident from the data that although GA and MH treatments were inferior than waxol, waxol+MH, and waxol+GA but compared to control these treatments reduced per cent loss in weight significantly after 9 days of storage. The highest per cent loss in weight in untreated (control) fruits was probably due to rapid vapour loss through evapotranspiration and high rate of respiration. Minimum loss in weight in waxol and waxol+MH treated fruits was due to presence of thin coating on fruit surface, which checked the loss of water from fruits. This coating may also have interrupted the gaseous exchange, which reduced the rate of respiration. Similar beneficial effects of waxing were also reported by Agnihotri and Ram (1970) in tomato, by Garg and Ram (1974) in guava, and by Singh *et al.* (1978) in okra. Similarly, MH application has also been shown to retard the rate of respiration in guava (Dutta and Mukherjee, 1967), in apple (Smock *et al.*, 1951) and in tomato (Southwick and Lachman, 1953). Similar beneficial effects were also observed when GA was combined with waxol. Dostal and Leopold (1967) reported that post-harvest application of GA delayed processes of ripening of fruits through preventing some of the changes triggered by ethylene action. Similar response of GA has also been observed by other workers (Abdel-Kader *et al.*, 1966; Lieberman *et al.*, 1977).

At low temperature, the weight loss was at a lower rate (Table 1). The loss

TABLE 1

Effect of growth regulators, waxol and low temperature on the storage behaviour of muskmelon cv. Hara Madhu

Treatments	*Per cent cumulative loss in weight* Storage life in days					*T. S. S. (%)* Storage life in days						*General appearance and ratings* Storage life in days					
	3	6	9	12	15	0	3	6	9	12	15	0	3	6	9	12	15
Control	8.88	24.18	42.79	—	—	10.0	12.6	12.0	8.9	—	—	8.0	6.5	3.0	2.0	—	—
Waxol-0-type 12%	3.66	10.62	14.12	—	—	10.0	11.8	12.0	12.4	—	—	8.0	7.0	7.0	5.0	—	—
GA 250 ppm	8.00	23.06	36.06	—	—	10.0	12.4	13.0	9.8	—	—	8.0	6.0	7.0	4.0	—	—
MH 1000 ppm	7.79	20.70	35.60	—	—	10.0	11.3	12.8	12.6	—	—	8.0	7.2	8.2	3.0	—	—
Waxol+GA 250 ppm	3.81	10.47	18.63	—	—	10.0	11.3	12.8	12.6	—	—	8.0	8.0	9.0	6.0	—	—
Waxol+MH 1000 ppm	3.43	8.65	12.46	—	—	10.0	11.7	13.6	12.0	—	—	8.0	8.0	9.0	6.0	—	—
Low temperature (10±1°C)	2.11	4.96	5.94	8.07	10.34	10.0	11.0	12.5	13.0	12.8	11.8	8.0	9.0	10.0	9.0	8.0	7.5
Mean	5.34	14.66	23.65	—	—	10.0	11.72	12.67	11.61	—	—	8.0	7.38	7.0	5.0	—	—
C. D. at 5% for treatment	2.26	4.33	2.27														

was only 5.94% at 9 days of storage at low temperature, whereas at room temperature the extent of loss was 42.79%. Thus, at low temperature the fruits can be successfully stored upto 15 days with maximum loss of 10.34% without any decay loss.

Total Soluble Solids

T. S. S. content increased gradually from the initial value of 10.0 to 12.8% during 6 days of storage. Later, it started declining and after 9 days of storage it was minimum (11.04%). Comparison of treatments revealed that maximum T. S. S (13.6%) was in the fruits treated with MH 1000 ppm+waxol and minimum (12.0%) in untreated and waxol coated fruits. Relatively lower content of T. S. S. in waxol coated fruits might be due to slow conversion of starch and other polysaccharides into soluble from of sugars. This might be because of slow rate of respiration, endogenous ethylene evolution and slow enzymatic activity delaying the ripening process. These results are in agreement with those of Das and Das (1968) in tomato. An initial increase in T. S. S. in untreated fruits may be due to conversion of starch and other polysaccharides into sugars, and loss in T. S. S. beyond that storage may be due to faster utilization of these sugars in respiration. Under low temperature conditions (10±1°C) the T. S. S. increased gradually due to slow conversion of insoluble to soluble form of sugars throughout storage period. The decrease in T. S. S. at later stages with slow rate was due to slower rate of catabolic activities.

General Appearance and Rating

Fruits retained acceptable appearance upto 9 days of storage with GA and MH alongwith waxing treatments, whereas in control this acceptability was only for 3 days. The better appearance and rating with these treatments might be due to reduced rate of water loss and respiration and, thus, these fruits maintained better appearance and taste. It is well known that GA acts as antisenescent agent and so increased the shelf-life of fruits.

At low temperature transpiration and respiration proceed at slower rate and that is why muskmelon fruits stored at 10±1°C had much longer storage life than the fruits at room temperature. Such stored fruits remained in quite acceptable conditions due to juiciness, good flavour and taste.

Microbial Decay and Microbes in the Pack

As evident from Table 2, among all post harvest treatments, waxol protected the fruits for longer period (9 days) with the minimum rotting of 4.44 per cent. Fruits treated with GA or MH tended to increase the loss significantly over control because incidence of decay organisms was much larger. When these treatments were subjected to waxing, the decay was significantly reduced. Thus, increase in storage life by treatments of waxol+MH or GA is mainly attributable to the effect of fungicide-sodium orthophenyl phenate (SOPP) which is one of the active ingredient of waxol (Singh and Gupta, 1979).

TABLE 2

Efficacy of different treatments on muskmelon fruits cv. Hara Madhu affecting decay loss (%) during storage at room and low temperature conditions

Treatments	Days of storage		
	3	6	9
Control	6.13(2.63)	35.08(5.96)	54.54(7.43)
Waxol-O-type 12%	0.0(1.00)	0.0(1.00)	4.44(2.30)
GA 250 ppm	9.10(3.17)	44.33(6.71)	100.00(10.00)
MH 250 ppm	7.56(2.89)	52.66(7.26)	81.98(9.05)
Waxol+GA 250 ppm	0.0(1.00)	1.64(1.62)	11.63(3.53)
Waxol+MH 1000 ppm	0.0(1.00)	0.50(1.19)	9.80(3.26)
Low temperature	0.0(1.00)	0.0(1.00)	0.00(1.00)
C. D. at 5%	0.52	1.10	1.05

Values in parentheses are transferred values $=\sqrt{n+1}$

Aspergillus niger was isolated more frequently in all the treatments during storage. The second group of microbes associated with muskmelon fruits, on the basis of frequency of occurrence, was *Fusarium roseium*, *Aspergillus flavus* and *Streptomyces* sp. The second group of microbes jointly caused a major decay in MH, GA and untreated fruits. The fruits stored at low temperature had no sign of decay upto 15 days of storage.

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EFFECT OF CYTOZYME ON GROWTH, YIELD AND QUALITY OF MUSKMELON

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ABSTRACT

Effects of cytozyme (seed treatment and crop+ foliar sprays) with regard to growth characters, fruit yield and quality in muskmelon variety Hara Madhu were studied during 1978 and 1979. Seed dip treatment in 5% solution of cytozyme for 8 h increased the length of vine, number of branches per plant, number of fruits per plant and yield. It also improved the T. S. S. content of fruits as compared to control and other cytozyme treatments.

A number of studies have been conducted on the effect of growth regulators in various crops. It has been reported that growth regulators are highly specific in nature. Recently a growth regulator—cytozyme has been marketed commercially. The product is available in two formulations, i. e., Seed Treat and Crop+ Spray, the former being used for treatment of seed and latter for the foliar spray. The product is reported to have cytokinin properties to which some micronutrients are also added. Beneficial effects of this product on several crops including some vegetables are reported (Pandita and Hooda, 1979). However, no systematic information is available regarding its use in enhancing crop productivity in vegetable crops. Keeping this in view the present investigation was undertaken to study the effect of cytozyme on growth, yield and quality of muskmelon *(Cucumis melo* L.) variety Hara Madhu.

MATERIAL AND METHODS

The experiments were carried out during 1978 and 1979. The soil of the experimental site was sandy-loam with pH 8.25, organic carbon 0.46%, available P 49 kg/ha, available K 550 kg/ha and ECe 0.51 mmhos/cm. Experiment was conducted with 16 treatment combinations of four levels of Seed Treat (0, 5, 7.5 and 10%) and four levels of Crop+ Spray (0, 0.75, 1.0 and 1.25% solution) in randomised block design in three replications. Seeds were sown on 23rd February and 4th March during 1978 and 1979, respectively. Seed dip treatments were given for 8 h one day before sowing. Two foliar sprays were given; first at 2-3 leaf stage and second 20 days after the first spray. Tween-20 (0.005%) was used as surfactant. Control plots were sprayed with canal water. The net plot size for each treatment was 4.8×2.5 m. There were eight plants per

treatment at a spacing of 60 cm. Three seeds were sown per hill on one side of the wide bed at a depth of 2-3 cm. After germination the plants were thinned to only one healthy and vigorous plant per hill. Well-rotton farm-yard manure was added to the field @ 15 tonnes/ha before sowing. All the treatment plots were given uniform dose of fertilizer (50 kg N, 25 kg P_2O_5 and 25 kg K_2O/ha) and irrigations. Plant protection measures were adopted uniformly in all the treatments as and when needed. The observations on growth characters were recorded at the time of final harvest, whereas T.S.S. content of fruits was recorded at every harvest with the help of Erma Hand Refractrometer and later on averaged.

RESULTS AND DISCUSSION

Growth Characters

Significant differences were observed in the length of vines due to various treatments during both the years (Table 1). Seed dip treatment for 8 h in 5% solution of cytozyme (Seed Treat) increased the length of vines during both the years. Similar results of increase in plant height by cytozyme were recorded in radish (Pandita *et al.*, 1980). Minimum vine length was obtained under 10% Seed Treat+1.0% Crop$^+$ Spray. The increase in vine length could be attributed to increased rates of photosynthetic activity, accelerated translocation and efficiency of utilizing photosynthetic products, thus, resulting in the cell elongation and rapid cell division in the growing portion (Sargent, 1965). Another reason for increased growth might be the stimulatory action of auxins which soften the cell wall by increasing its plasticity (Tagawa and Bonner, 1957).

The differences in the number of branches per plant due to various treatments were significant only during 1978 (Table 1). During both the seasons the max mum number of branches per plant were recorded from 5% seed dip treatment, whereas least number were in 1.0% Crop$^+$ Spray. The increase in the number of branches with 5% Seed Treat may be due to increase in vine length (Table 1) as a result of osmotic uptake of water under the influence of plant growth regulators which maintain swelling force by the softening of cell wall or due to the stimulus caused by these growth regulators in the absorption of available nutrients present in the soil (Kato, 1958).

Fruit Characters

The data on number of fruits per plant indicate significant differences due to various treatments during both the years (Table 1). Maximum number of fruits per plant were recorded under 5% Seed Treat followed by 5% Seed Treat +1.25% Crop$^+$ Spray and 7.5% Seed Treat +1.25% Crop$^+$ Spray during both the years. However, least number was obtained from 1.0% Crop$^+$ Spray in 1978 and from the control in 1979. The increase in the number of fruits per plant by Seed Treat (5%) may be due to the formation of higher number of branches per plant (Table 1) which resulted in more production of hermaphrodite flowers (Randhawa, 1969). Similar results were reported by Wittwer and Pryor (1946) in muskmelon and Singh and Randhawa (1969) in bottle gourd.

The differences in yield per plant due to various treatments were significant

TABLE 1

Effect of cytozyme on growth, yield and quality of muskmelon var. Hara Madhu during 1978 and 1979

S. No.	Treatments	Length of vine (cm)		No. of branches/ plant		No. of fruits/ plant		Yield/ plant (kg)		Yield/ha (q)		T. S. S. (%)	
		1978	1979	1978	1979	1978	1979	1978	1979	1978	1979	1978	1979
1.	Control	162.3	173.8	4.5	5.4	1.2	1.1	0.57	0.63	63.3	70.0	10.7	12.2
2.	0.75% Crop+ Spray	141.4	176.2	4.6	5.4	2.1	1.6	0.62	0.63	68.9	70.0	11.9	12.4
3.	1.0% Crop+ Spray	171.4	159.8	3.8	4.8	1.1	1.2	0.49	0.60	54.5	66.7	11.9	13.7
4.	1.25% Crop+ Spray	184.1	173.9	4.6	5.1	1.7	1.5	0.98	0.72	108.9	80.0	11.1	12.4
5.	5% Seed Treat (ST)	203.9	209.6	6.5	6.5	3.3	2.9	2.04	1.98	226.7	220.0	13.7	15.3
6.	5% ST+0.75% Crop+ Spray	148.4	189.0	4.0	5 0	1.2	2.0	0.58	1,28	64.4	142.4	11.1	12.5
7.	5% ST+1.0% Crop+ Spray	184.1	173.1	4.6	5.4	1.6	2.3	0.63	1.31	70.0	145.6	11.4	13.5
8.	5% ST+1.25% Crop+ Spray	190.8	202.2	5.0	5.6	2.5	2.7	1.50	1.79	166.7	198.9	11.2	14.5
9.	7.5% Seed Treat (ST)	156.6	157.9	4.3	5.4	1.6	2.5	0.62	1.17	68.9	130.0	13 1	13.2
10.	7.5% ST+0.75 Crop+ Spray	179.9	181.8	4.7	5.9	1.5	1.9	0.89	0.98	98.9	108.9	10.3	11.9
11.	7.5% ST+1.0% Crop+ Spray	169.9	152.8	5.2	5.2	1.2	1.4	0.47	0.58	52.2	64.4	12.4	11.5
12.	7.5% ST+1.25% Crop+ Spray	189.2	192.4	4.2	5.0	2.4	2.6	1.15	1.32	127.8	146.7	9.7	12.4
13.	10% Seed Treat (ST)	185.4	184.4	4.5	5.6	1.6	1.4	0.97	0.94	107.8	104.4	11.2	12.5
14.	10% ST+0.5% Crop+ Spray	188.4	209.1	4.6	5.4	1.7	1.8	0.81	0.97	90.0	107.8	11.9	13.9
15.	10% ST+1.0% Crop+ Spray	133.7	164.5	4.9	5.7	1.2	1.6	0.47	0.67	52.2	77.4	11.8	12.5
16.	10% ST+1.25% Crop+ Spray	194.1	172.2	5.0	5.7	1.2	2.2	0.59	1.10	65.6	122.2	12.1	12.7
	C. D. at 5% level	21.6	23.1	1.0	NS	0.5	0.9	0.40	0.71	44.4	62.5	1.0	1.8

during both the years. Maximum fruit yield per plant was obtained under 5% Seed Treat followed by 5% Seed Treat +1.25% Crop+ Spray during both the years, whereas minimum yield per plant was recorded in 7.5% Seed Treat+1.0% Crop+ Spray and 10% Seed Treat+1.0% Crop+ Spray during 1978 and from 7.5% Seed Treat+1.0% Crop+ Spray during 1979. The most probable reason for increased fruit yield with 5% cytozyme Seed Treat may be the increased translocation of organic material in the treated plants (Shindy and Weaver, 1967). The mobilization or movement of nutrients into flowers and fruits by cytozyme application might improve the yield in muskmelon (Weaver, 1973). The other possible reason for better fruiting with cytozyme Seed Treat and foliar sprays may be that external application of cytozyme increased the endogenous auxin content of flowers which improved fruit yield (Virzilov and Mihteleva, 1968). Another reason for increased fruit yield may be that plants remained physiologically more active to build up sufficient food stock for the developing flowers and fruits, ultimately leading to higher yield.

The trend in yield/ha was similar to that of yield per plant. There were significant differences in the yield due to various treatments (Table 1). Maximum yield (226.7 q in 1978 and 220 q in 1979) was recorded from 5% Seed Treat followed by 5% Seed Treat+1.25% Crop+ Spray (166.77 q in 1978 and 198.9 q in 1979) during both the years, whereas 7.5% Seed Treat+1.0% Crop+ Spray gave least yield (58.3 q) followed by 1.0% Crop+ Spray (60.6 q).

Significant differences in total soluble solids(%) due to various treatments were observed during both the years (Table 1). Maximum T.S.S. was recorded from fruits treated with 5% Seed Treat during both the years while least in fruits treated with 7.5% Seed Treat+1.25% Crop+ Spray during 1978 and 7.5% Seed Treat+1.0% Crop+ Spray during 1979.

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STABILITY FOR OIL CONTENT IN SUNFLOWER (*HELIANTHUS ANNUUS* L.)

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ABSTRACT

Thirty six genotypes of sunflower were selected and planted during rabi and kharif (1975-77) in 7 different environments in a randomized block design in order to identify the high oil containing genotype and to assess the magnitude and nature of G×E interaction. Joint regression analysis revealed the differences among genotypes and environments. Both linear and non-linear portions of genotype × environment interaction were found to be significant. However, the magnitude of linear portion was higher which suggested the possibility of prediction across the environments.

Genotypes EC 68414, Romsun Record, EC 69874 and EC 68415 were stable and hence these could be exploited in future breeding programmes.

In a breeding programme, it is necessary to select stable genotypes which could be used as parents to develop stable and high yielding lines. The role of G×E interaction has been emphasized by Allard and Bradshaw (1964), for the purposeful management of genetic variability. It is necessary to have basic information on the extent and nature of G×E interaction in sunflower, an important oil yielding crop. However, very scanty information is available on the above aspect in this crop. Therefore, an attempt was made to spot out the stable genotypes, utilising the techniques of stability analysis.

MATERIAL AND METHODS

Thirty six varieties were planted in a randomized block design with three replications during **rabi** and **kharif** (1975-77) in 7 different environments. These environments (Table 1) were created by different dates of sowing with manipulation of irrigations. The spacing for each genotype was 60 and 30 cm between rows and plants, respectively.

Oil analysis was done as per AOAC (1960). The data were subjected to stability analysis as per methods of Eberhart and Russell (1966) and Perkins and Jinks (1968).

RESULTS AND DISCUSSION

The estimation of environmental additive effects (I_j) in all the environments for oil content has been presented in Table 1 which indicated that E_5 was most favourable environment followed by E_6,

TABLE 1

Description of the environments provided

Environments	Location	Date of sowing	Irrigation	Environmental index (Oil content)
E_1	Hissar A	7-12-1975	Irrigated	—0.91
E_2	Hissar B	24-7-1976	Irrigated	—2.25
E_3	Hissar B	24-7-1976	Unirrigated	—0.18
E_4	Hissar C	20-11-1976	Irrigated	0.16
E_5	Hissar C	20-11-1976	Unirrigated	1.51
E_6	Hissar D	10-12-1976	Irrigated	0.97
E_7	Hissar D	10-12-1976	Unirrigated	0.71

Fertilizer dose (40 : 60 kg N and P per hectare) was same in all the environments.

TABLE 2

Joint regression analysis for oil content

Source of variation	Mean squares	
	Eberhart and Russell (1966)	Perkins and Jinks (1968)
Genotypes (G)	18.15*++	18.14**
Environment+Genotype×Env. (L)	6.94**+	—
Environment (L)	350.10	—
Genotype×Env. (L)	9.99*++	9.99*++
Environment	—	58.35**
G×E	—	5.47++
Pooled deviation/remainder	4.44	4.57**
Pooled error	0.19	0.19

For Eberhart and Russell (1966) model

**Significant mean square against pooled error $P<0.01$

*Significant mean square against pooled error $P<0.05$

++Significant mean square against pooled deviation $P<0.01$

+Significant mean square against pooled deviation $P<0.05$

For Perkins and Jinks (1968) model

**Significant at 1% level of significance

*++Heterogeneity between regression significant against error M. S. as well as against remainder M. S.

E_7 and E_4, whereas E_2, E_1 and E_3 were characterized as unfavourable environments for this trait.

Joint regression analysis (Table 2) showed the differences between genotypes and environments when tested against G×E interaction. This revealed that average performance of different strains tested varied significantly in different environments. The mean squares due to variety×environment (linear) were significant (Table 2) when tested against pooled deviation, which showed a significant portion of genotype×environment interaction to be of linear type. The non-linear portion of G×E interaction was also significant. However, the magnitude of linear portion was found to be higher, which suggested the possibility of prediction across the environments.

Estimates of stability parameters $\mu + d_i$, β_i and S^2d_i for individual genotype are given in Table 3 and Fig. 1. In Fig. 1 the horizontal lines are two standard deviation below and above the average response and vertical lines are two standard deviations above and below the grand mean. However, the genotypes were plotted by numbers, i. e. 1, 2..... 36. The identification of these numbers

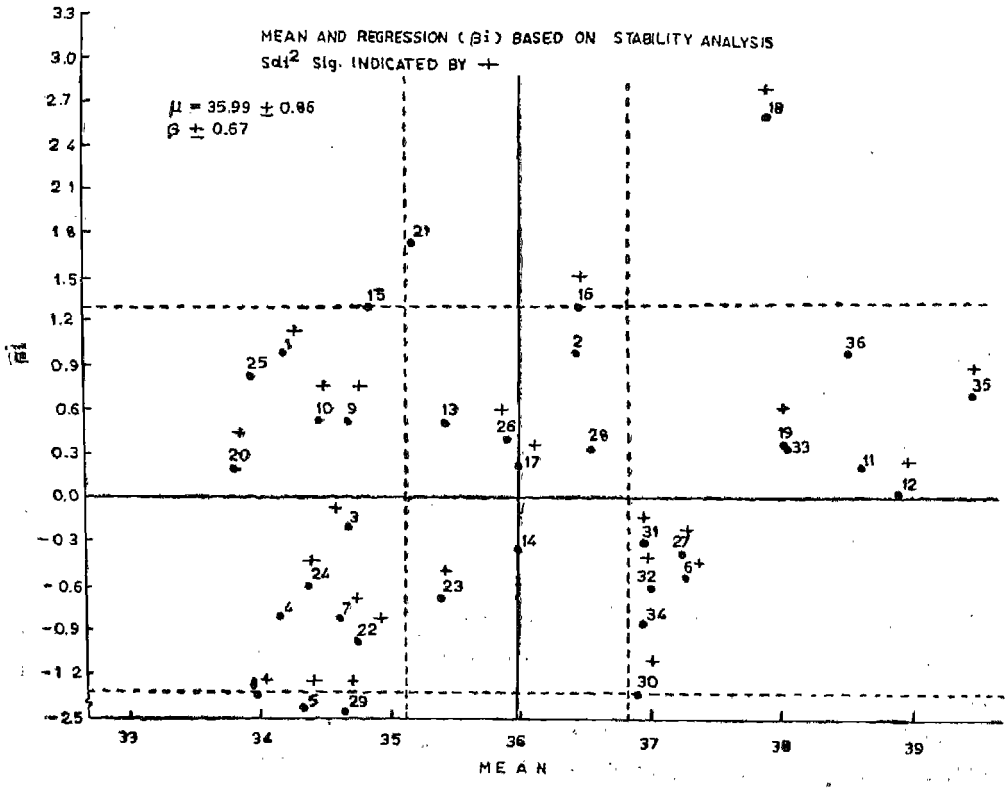


Fig. 1. Oil content (per cent).

TABLE 3

Estimate of stability parameters of individual genotypes for oil content (per cent)

Genotypes	Genotype identification	$\mu+d_i$	β_i	$1+\beta_i$	S^2d_i
1	EC 16751	34.18	0.99*+	1.99	9.02**
2	EC 21991	36.44	0.97*++	1.97	1.07
3	EC 21992	34.63	−0.20*+	0.80	1.91*
4	EC 21993	34.13	−0.82*+	0.18	0.76
5	EC 27290	34.33	−2.15*+	−0.15	3.54*
6	EC 27424	37.25	−0.57*+	0.43	8.30**
7	EC 27621	34.60	−0.86*+	0.14	4.72**
8	EC 27628	33.96	−1.53*+	−0.53	10.65**
9	EC 27993	34.66	0.56*+	1.56	2.67*
10	EC 66002	34.45	0.52*	1.52	9.20**
11	EC 68414	38.58	0.23	1.23	0.48
12	EC 75229	38.87	0.02	1.02	2.35*
13	EC 75273	35.45	0.51*+	1.51	0.24
14	EC 77194	35.98	−0.37*+	0.63	0.88
15	EC 89150	34.84	1.36*+	2.36	1.03
16	EC 82819-1	36.43	1.35*+	2.35	3.75**
17	EC 83096	36.01	0.22	1.22	1.27*
18	EC 85815	37.91	2.53*+	3.53	5.22**
19	EC 85818	38.03	0.32*+	1.32	2.01*
20	EC 85820	33.79	0.24	1.24	1.58*
21	EC 85820-M	35.16	1.07*+	2.07	0.51
22	EC 89093-1	34.75	−0.98*+	0.02	2.88*
23	EC 89100	35.41	−0.68*+	0.32	4.95**
24	EC 97916	34.38	−0.59*+	0.41	13.87**
25	EC 100103	33.92	0.72*+	1.72	0.73
26	EC 101492	35.89	0.45	1.45	3.49*
27	EC 101495	37.25	−0.48*+	0.52	18.22**
28	EC 101497	36.53	0.34*+	1.34	0.05
29	EC 61039	34.65	−2.26*+	−1.26	4.25*
30	CM 312	36.89	−1.32*+	−0.32	2.85*
31	CM 338	36.96	−0.30*+	0.70	11.33*
32	CM 361	36.99	−0.60*+	0.40	1.27
33	R. Record	38.04	0.37*+	1.37	0.88
34	EC 68415	36.94	−0.85*+	0.15	1.25
35	EC 93613	39.40	0.77*+	1.77	3.47*
36	EC 69874	38.47	0.94*+	1.94	0.60

$\mu=35.99$ S.E. $(\beta)=\pm0.6763$

S.E. $(\mu)=\pm0.8610$

*Significant at 5% level

**Significant at 1% level

*+Regression M. S. significant against error M. S.

*++Regression M. S. significant against error M. S. and against remainder M. S.

has been given in Table 3. These 36 genotypes were classified into different groups by considering the stability parameters β_1 and S^2d_1 of the individual genotype which showed the absence of G×E interaction for only one genotype. The presence of only linear portion was indicated by eleven genotypes as only β_1 values were significant for these genotypes. This showed that response could be predicted across the environments. Twenty one genotypes had both β_1 and S^2d_1 significant, which revealed the presence of linear and non-linear components of G×E interaction. Three genotypes had only S^2d_1 significant revealing thereby, the presence of non-linear portion of G×E interaction (Table 3).

Graphical summary (Fig. 1) indicated that genotype 35 (EC 93613) followed by genotype 12 (EC 75229) had highest oil content, average response and exhibited poor stability ($S^2d_1 \pm 0$). Other genotypes having high oil content were : 36 (EC 69874), 33 (Romsun Record), 11 (EC 68414) and 34 (EC 68415). These genotypes had average response and were stable which indicated their suitability to all kinds of environments. Genotype 18 (EC 85815) had above average mean performance, above average response to environmental changes but showed poor stability, whereas genotype 30 (CM-312) had above average mean performance, below average response and was unstable.

Genotype 21 (EC 85820-M) had average oil content, above average response and was stable which was characterized as suitable for only better yielding environments. The genotypes 16, 2, 28, 17, 13, 14, 26 and 23 had average oil content, average response with good stability except for genotypes 17, 16, 26 and 23 which had poor stability.

Genotype 20 (EC 85820) had the lowest oil content, with average response and poor stability. Other genotypes 25, 1, 10, 9, 3, 24, 4, 8, 7 and 22 were spotted out with below average oil content, average response to environment and with poor stability as evidenced from significant values for S^2d_1 except genotypes 25 and 4 which had good stability.

From the above, it is clear that the genotypes EC 69874, EC 68414, Romsun Record and EC 68415 could effectively be utilized in future breeding programmes as they possessed the high mean oil content, unity regression coefficient ($\beta_1=1$) and least deviation from regression ($S^2d_1=0$) which are the characteristics of an ideal variety.

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STUDIES ON THE UPTAKE AND UTILIZATION OF FERTILIZER PHOSPHORUS (P^{32}) BY WHEAT AS INFLUENCED BY TWO IONIC FORMS OF N

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ABSTRACT

In a pot culture experiment, the dry matter yield and uptake and percentage utilization of fertilizer P were highest when N in NH_4 form was applied in combination with P. The lowest values were obtained when NO_3—N and phosphate were applied separately to split roots. Application of both ammonical and nitrate—N gave intermediatory results.

Lower efficiency of applied P is a matter of great concern in the use of fertilizers in agriculture. Various ways and means have been suggested to enhance the efficiency of applied P. One of such methods is the incorporation of N for increasing the efficiency of P. Forms of N differ in their behaviour in affecting availability and utilization of added P by crops. According to Riley and Barber (1971) NH_4^+ increased the efficiency of P. Evidences are not lacking when NO_3—N has also been found to induce the uptake of P in plants (Subramonia *et al.*, 1973).

The present investigation was undertaken to isolate the effect of NH_4^+—N and NO_3^-—N on the fertilizer P uptake and its utilization by wheat (*Triticum aestivum* L.) with a split root technique in Typic Torripsament soil.

MATERIAL AND METHODS

For this study a loamy sand soil, very low in P(2 ppm), organic carbon 0.12%, pH 8.2, and E. C. 0.13 mmhos/cm was used. Plastic pots of 10 cm diameter and 8 cm depth were taken and each pot was divided into two equal halves with a plexi-glass sheet, which was firmly fixed with an adhesive (Fig. 1). In all, 500 g of soil was used in two halves of

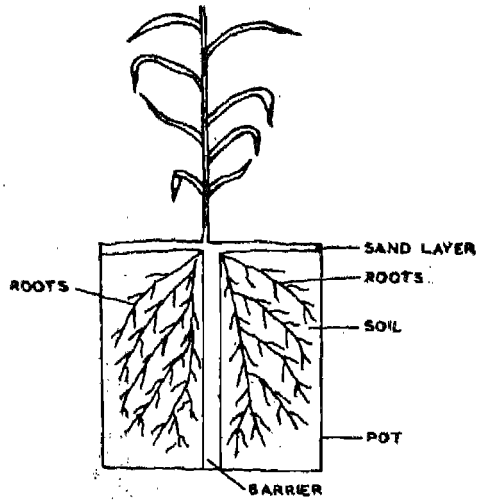


Fig. 1. Diagrammatic representation of pot used in split root experiment.

the pot and ^{32}P as monocalcium phosphate (tagged @ 0.2 mC/g P_2O_5) was applied at the rate of 50 ppm P. Nitrogen in two ionic forms from NH_4Cl and $NaNO_3$ at the rate of 200 ppm N was applied along with P in solution form at the transplanting time. A basal dose of 100 ppm K and 5 ppm Zn was applied in all the pots. The treatment details are given in Table 1.

The lay-out of the experiment was completely randomized, with three replications. Three seedlings of 30 days old wheat variety Kalyan Sona were transplanted over the central edge of the barrier, dividing the roots in two equal halves. The upper surface of the pots was covered with sand washed with acid to give support to the plants. The plants were harvested after 42 days of transplanting for the estimation of total and fertilizer P. Phosphorus in plant was determined by yellow colour method of Koenig and Johnson (1942). The radioactive assay was carried out by using end window G. M. tube and the fertilizer use efficiency was calculated by the method given by Mac-Kenzie and Dean (1948).

RESULTS AND DISCUSSION

Dry Matter Yield

The dry matter yield of wheat was increased by 0.24 g/pot with an application of 50 ppm P in the absence of N (Table 2). It was because of the fact that the original status of the soil for N was very low which did not increase the utilization of added P without the application of N. Such results are also reported by Shukla and Bhardwaj (1976), Tomar *et al.* (1977) and Dass and Singh (1979). It is also apparent that application of NH_4^+—N increased the yield of wheat by 1.47 g/pot, whereas the corresponding increase by NO_3^-—N was only 0.21 g/pot. The higher yield by the application of NH_4^+—N is due to enhanced availability of the native P which is also evident from the total

TABLE 1

Details of the experiment for the study of NH_4 and NO_3—N interaction on P uptake

Treatment	First half of the pot	Second half of the pot
1	Control	Control
2	Control	P
3	P	P
4	NH_4^+—N	Control
5	NH_4^+—N	NH_4^+—N
6	NO_3^-—N	Control
7	NO_3^-—N	NO_3^-—N
8	NH_4^+—N+NO_3^-—N	NH_4^+—N+NO_3^-—N
9	NH_4^+—N	P
10	NH_4^+—N+P	NH_4^+—N+P
11	NO_3^-—N	P
12	NO_3^-—N+P	NO_3^-—N+P
13	NH_4^+ -N+NO_3^-—N+P	NH_4^+—N+NO_3^-—N+P

TABLE 2

Effect of two ionic forms of N on the yield, concentration and uptake of P by wheat

Treatment	Yield (g/pot)	P concentration (ppm)	P uptake (mg/pot)
1	1.11	650	0.72
2	1.35	2083	2.83
3	1.18	3458	3.87
4	2.58	1146	1.96
5	2.65	1458	3.84
6	1.32	1000	1.32
7	1.43	892	1.23
8	2.64	879	2.36
9	3.55	3167	10.94
10	3.87	4250	16.41
11	2.58	2375	6.04
12	3.48	1479	5.08
13	3.96	2458	9.70
C.D. at 5%	0.74	434.6	1.34

uptake of P in these treatments (Table 2).

NH_4^+—N applied on one side and P on the other side of the pot, increased the yield by 0.97 g/pot over NH_4^+—N alone applied to one side as well as over the treatment in which NO_3^-—N was applied to one side and P to other side of the pot. The magnitude of response was 37 per cent.

Mixed application of NH_4^+—N and P on both sides of the pot gave an extra yield of 0.39 g/pot over NO_3^-—N and P applied together. But the differences were statistically non-significant. Maximum yield of 3.96 g/pot was obtained when $NH_4^+ + NO_3^- + P$ were applied on both sides of the plants. Statistically yield differences among three treatments, viz., splitting of NH_4^+ and P, mixing of NH_4^+ and P, and mixing of $NH_4^+ + NO_3^-$—N+P, were non-significant.

Phosphorus Concentration

Perusal of data in Table 2 indicates that higher concentration of P was observed when NH_4—N and P were mixed and applied on both sides of the pot. It was followed by treatment where equal amount of P was applied on both sides of the pot. The differences were of the order of 792 ppm and were significant. It was interesting to note that the yield differences between these treatments were highly significant, mixed application of NO_3—N and P on both sides of the pot significantly decreased the concentration of P over separate application of NO_3—N and P. Phosphorus concentration differences between NH_4—N and P, and NO_3—N and P were significant (792 ppm).

Similar observations were made by Riley and Barber (1971) in soybeans. The possible reason may be the decrease in pH in the vicinity of root zone by

NH_4—N thereby keeping the P available for longer period of growth. It may also be due to cationic effect of NH_4—N which would favour anionic absorption of H_2PO_4 (Arnon, 1939).

Another observation is the significant decrease (1792 ppm) in the concentration of P when NO_3—N was incorporated on both sides of the pot in the NH_4+P treatment even though the yield of NH_4+NO_3+P was little higher than the NH_4+P. This clearly indicates the role of NH_4—N in enhancing the absorption of P.

Uptake of Phosphorus

The total uptake of P almost followed the trend similar to P concentration in plants, being highest where NH_4—N+P were mixed and applied on both sides of the plants followed by its split application. Rennie and Soper (1958) also indicated similar trend and concluded that NH_4^+ indirectly influences the plants' ability to uptake P, rather than altering in any way the availability of applied P.

Mixing of NO_3—N with NH_4—N+P further decreased the uptake of P over separate application of NH_4 and P by 1.24 mg/pot. Combined application of NO_3—N+P on either side was not conducive to the greater P uptake than its split application on both the sides. Application of NH_4 alone on one side or both sides of the pots significantly increased the uptake of P over NO_3—N on one side or both sides of the pot.

Fertilizer P in Plant and its Utilization

It is evident from Table 3 that the percentage of fertilizer P in plant was highest when both NO_3—N and P were applied together to either sides of the plant. It was followed by the mixed application of NH_4+NO_3+P on both sides of the plants. The treatments like separate application of NH_4 and P, NO_3 and P and combined application of NH_4 and P on both sides were statistically at par as regards to percentage fertilizer P in plant.

The utilization of added P was maximum (25.7%) when NH_4—N and P were mixed together and applied on both sides of the pot. This method of application was superior to all other treatments

TABLE 3
Effect of two ionic forms of N on fertilizer P and its utilization by wheat plant

Treatment	Fertilizer P in plant (%)	Utilization (%)
2	43.6	4.9
3	42.1	6.5
9	36.2	15.9
10	39.3	25.7
11	39.3	9.3
12	58.9	11.9
13	51.4	19.8
C.D. at 5%	7.12	2.71

studied under the present investigation. Utilization was fairly good when both the ionic forms of N were mixed with P and applied on either side.

Subramonia *et al.* (1974), based on uptake studies on intact plants and excised roots of maize, reported that there was inducement in the uptake and transport of ^{32}P due to direct supply of NH_4—N. The inducement was about 20-30% more than that obtained due to NO_3—N supply. Percentage utilization in the present study due to separate application of NH_4—N and P and NO_3—N and P was 15.9 and 9.3, respectively.

Another interesting observation is that the percentage utilization is not significantly affected whether P is applied to one side or both sides of plants. This assumption is supported by the findings of Ohlrogge *et al.* (1957). It may be concluded that availability of P is significantly influenced by the ionic forms of N and NH_4—N is conducive to higher uptake of P and percentage utilization of added P when it is applied in close proximity with P fertilizer.

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EFFECT OF SPROUTED SEED TUBERS ON EARLINESS OF THE POTATO CROP

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ABSTRACT

In a field experiment, carried out in rabi season of 1972-73, it was found that plant emergence, growth, tuberization and bulking of potato tubers hastened in plants from sprouted seed tubers. Four weeks sprouting resulted in more tuber yield compared with sprouting for two weeks or unsprouting treatment upto 11 weeks growth stage after which the trend reversed and it was observed that the produce of each grade tuber was fairly high in plants from unsprouted seed tubers. While varieties Kufri Chandramukhi and Kufri Chamatkar behaved similarly in producing each grade tubers, Kufri Sindhuri outyielded and resulted in high proportion of ware but less seed tubers.

The practice of planting sprouted potato seed tubers is popular among early potato growers in many parts of the world. In India, the merits of planting sprouted seed tubers are not well realised and the practice is, therefore, not widely adopted by the farmers. Emergence, tuber initiation and bulking of tubers are enhanced and maturity is hastened as a result of sprouting (Headford, 1962; Sinha, 1962, 1968, 1969; Pushkarnath *et al.*, 1963; Roztropowicz, 1964; Hazdu, 1968; Balandina and Fillipov, 1969; Davies and Allaby, 1971). In problem areas where frost or late blight is a limiting factor for growth of plant, sprouting seed tubers can promise a bright prospect. In multiple cropping programme a farmer can better realise the value of sprouting seed tubers when he intends to take two **rabi** crops in one season, e. g., wheat following potato. In an earlier work (Sinha, 1974), it was observed that sprouting over four weeks reduced the yield of potatoes mainly due to shrinkage of seed tubers suggesting that the period of sprouting could further be curtailed. The immediate advantage of sprouting is that the cooling plant of cold storage would then stop working atleast a fortnight or even a month earlier than the scheduled time which means a saving of huge amount of energy. The apparent need for more definite information on the scope of sprouting by Indian potato growers suggested to work on this problem.

MATERIAL AND METHODS

The experiment was carried out in sandy loam soil during **rabi** season of 1972-73 in a randomized block design having three levels of sprouting and

three varieties. There were, thus, nine treatment combinations which were replicated five times. The plot size was 3.6 × 2.4 m and each plot consisted of six rows at 60 cm apart. Seed tubers were planted on October 7 at a distance of 20 cm within the row. The average seed weight was 31 g per tuber. A basal application of N, P and K at the rate of 135, 44 and 83 kg/ha was made through urea, super phosphate and muriate of potash, respectively.

Plant emergence was recorded at regular intervals from ten days onwards. Similarly, plant samples were taken from five weeks onward in order to study the growth and development of tubers.

RESULTS AND DISCUSSION

Plant Emergence

The frequency of plant emergence at various intervals as influenced by period of sprouting and varieties is illustrated in Fig. 1. Seed tubers sprouted for four or two weeks gave consistent rise in plant emergence compared with plants from unsprouted tubers; the four-week sprouting showing the superiority over two-week sprouting.

Varieties Kufri Chandramukhi and Kufri Chamatkar behaved more or less similarly in plant emergence, while Kufri Sindhuri showed fairly late emergence due to varietal characteristics.

Dry Weight of Tubers

The mean dry weight of tubers per hill as influenced by the period of sprouting and varieties on different dates of plant sampling has been shown in Table 1. At 5-week growth stage, plants from tubers sprouted for four and two weeks showed some visible tubers, while the plants from unsprouted tubers did not give any sign of tuberization.

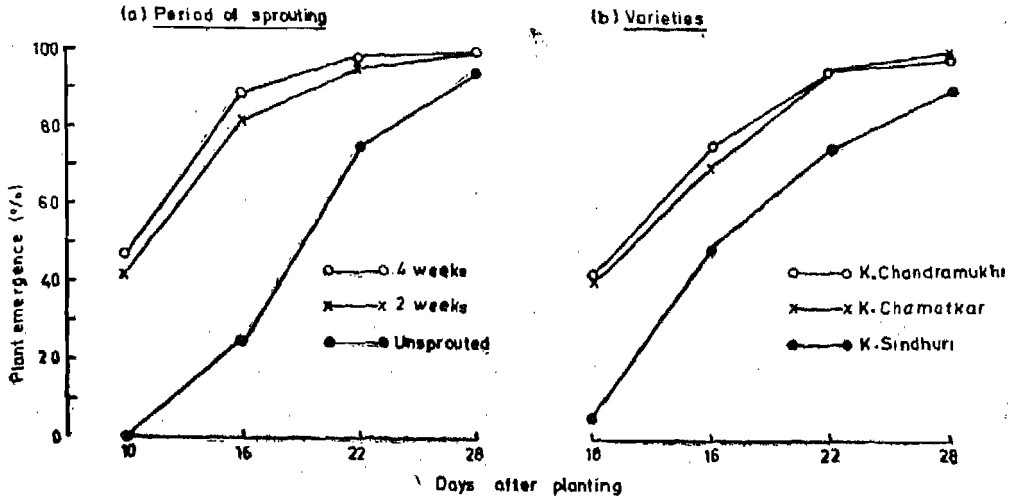


Fig. 1. Effect of period of sprouting and varieties on plant emergence.

At 8-week growth stage and onwards, the differences in the dry weight of tubers due to the period of sprouting were highly significant. At 8 and 11 weeks after planting, sprouting for four weeks gave significantly higher dry weight of tubers (8.9 g/hill) against 7.8 and 6.9 g per hill from sprouting for two weeks and no sprouting treatments, respectively. If a frost or late blight occurs at this growth stage or before 14-week growth and all the plants succumb to die, the potato yield from plants of sprouted tubers would naturally supersede that from unsprouted seed tubers. From 14 weeks and onwards, the trend of increase in dry weight of tubers reversed and the unsprouted seed tubers gave significantly higher dry weight than that from sprouting for two or four weeks which did not differ significantly. Such results have also been reported by other workers (Bates, 1935; Toosey, 1962). This is mainly due to prolonged vegetative growth of plant in absence of any frost or late blight damages.

From 8 weeks and onwards, the three varieties differed significantly in dry weight of tubers. At 8 and 11 weeks, Kufri Chandramukhi produced significantly higher dry weight than Kufri Chamatkar and Kufri Sindhuri. At 8 weeks, Kufri Chamatkar gave significantly higher dry weight of tubers than Kufri Sindhuri but this trend reversed at 11 weeks and onwards. At 14 weeks, Kufri Chandramukhi and Kufri Sindhuri did not differ significantly but both of these proved significantly superior to Kufri Chamatkar. At 17 weeks, Kufri Sindhuri produced significantly more dry weight of tubers than other two varieties which did not differ significantly.

TABLE 1

Effect of period of sprouting and varieties on dry weight of tubers/hill (g)

		Period of sampling (weeks)			
	5	8	11	14	17
Period of sprouting (weeks)					
4	+++	8.9	30.1	43.8	52.3
2	++	7.8	29 4	45.4	55.3
0		6.9	25.4	52.3	71.2
S.Em±		0.2	0.4	0.6	3.0
C.D. at 5%		0.5	1.1	1.8	8.8
Varieties					
Kufri Chandramukhi		9.4	33.3	50.6	54.8
Kufri Chamatkar		7.9	24.4	41.7	57.0
Kufri Sindhuri		6.2	27.3	49.2	67.1
S.Em±		0.2	0.4	0.6	3.0
C.D. at 5%		0.5	1.1	1.8	8.8

+Tuber initiation.

TABLE 2

Effect of period of sprouting and varieties on yield and number of potato tubers

	Yield (q/ha)				Number (thousand/ha)			
	Ware	Seed	Chat	Total	Ware	Seed	Chat	Total
Period of sprouting (weeks)								
4	119	37	31	187	209	146	316	670
2	127	38	31	196	213	149	364	726
0	145	42	39	226	239	167	447	854
S.Em±	6	2	2	6	32	6	24	26
C. D. at 5%	18	N.S.	5	17	N.S.	17	70	74
Varieties								
Kufri Chandramukhi	104	40	38	182	192	164	469	824
Kufri Chamatkar	100	97	43	190	215	192	448	855
Kufri Sindhuri	188	28	21	237	255	106	210	571
S.Em±	6	2	2	6	32	6	24	26
C. D. at 5%	18	5	5	17	N.S.	17	70	74

Yield

The data on the final yield of various grade tubers have been presented in Table 2. Unsprouted seed tubers gave significantly higher yields of ware, chat and total tubers than that from sprouted tubers. This was partly attributed to longer growth period of plants from unsprouted tubers and partly due to shrinkage of sprouted seed tubers. The number of each grade potato tubers was similarly affected by the sprouting treatment. Some workers (Dyke, 1956; Krijthe, 1962; Ivins and Bremner, 1965), who reported higher yield of potatoes due to sprouting, observed that there was apparently not much loss of weight of sprouted seed tubers during sprouting period resulting high proportion of ware and less quantities of seed and chat tubers.

Variety Kufri Sindhuri gave significantly higher yield of total and ware tubers than Kufri Chandramukhi and Kufri Chamatkar, the latter two did not differ significantly. For the yield of seed size tubers, Kufri Chamatkar proved significantly superior to Kufri Chandramukhi and Kufri Sindhuri, the former gave significant increase over the other one. Kufri Chandramukhi and Kufri Chamatkar produced significantly higher number of seed tubers than Kufri Sindhuri, the former two did not differ significantly. Although, Kufri Chandramukhi and Kufri Chamatkar did not give significant differences in the yield and the number of chat tubers, they proved significantly superior to Kufri Sindhuri.

The present investigation suggests that a short duration variety coupled with sprouting would be still better which would ensure early harvest of potato and would make potato-wheat rotation practicable and more remunerative, which is of vital importance for north-west regions of the country.

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INFLUENCE OF SOIL MOISTURE LEVELS ON YIELD AND WATER USE EFFICIENCY OF WHEAT AND GRAM

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ABSTRACT

In a study on the effect of different moisture levels, in a loamy sand soil of Hissar, an increase of 6.43 q/ha in grain yield of wheat was obtained when 5 cm irrigation was supplemented, at ear emergence stage, over the initial 15 cm soil moisture per meter of soil depth. Such an increase in gram grain yield was 5.55 q/ha with 15 cm moisture level over 10 cm level maintained at the time of sowing. A supplement irrigation of 5 cm in gram at pod formation stage gave an extra yield by 2.31 q/ha while further increase was of the order of 2.89 q/ha when second irrigation of 5 cm was given at dough stage. Highly significant positive correlation between grain yield and soil moisture at germination in case of wheat was observed. However, most of the yield contributory factors of wheat and gram increased with increase in moisture levels. Highest water use efficiency of 13.77 and 7.53 kg grain/ha/mm was obtained under 10 and 15 cm moisture levels in wheat and gram, respectively.

Crop growth is associated with loss of soil moisture through transpiration by plants and evaporation from the soil surface. The potential rate of transfer of water from the soil to the atmosphere as vapour is governed by the concurrent meteorological conditions and capillary conductivity of the soil. The actual evapo-transpiration rate, however, is influenced by the availability of water in the soil, nature and growth of the crop and soil characteristics in addition to meteorological factors. A serious difficulty encountered in attempts to relate soil water plant response is the fact that the water content in plant root-zone varies both with time and space. From these facts, one can deduce the role of soil moisture for better plant growth and yield. Day and Intalap (1970) reported that the sensitive period for moisture in the growth of wheat was the jointing stage. Water stress at this stage reduced grain yield which was attributed to fewer heads per unit area and fewer seeds per head. Keeping this in view, the present study was undertaken to see the effect of water stress given to plant at its various stages, on the growth and yield of wheat and gram.

MATERIAL AND METHODS

The experiment was conducted in a field having water table 12 m deep, pH 8.2, E.C. 0.21 mmhos/cm, organic

carbon 0. 21% and available N, P and K 126, 6.3 and 605 kg/ha, respectively. The soil was loamy sand in texture with bulk density about 1.50 g/cc and having 5.0 cm available water in one meter soil profile. The experiment was laid out in a randomized block design with well levelled plots of 7 x 3 m. There were five moisture regimes which were replicated four times. The treatments were :

(i) Soil moisture abjusted to about 7.5 cm in upper one meter of soil profile.
(ii) Soil moisture adjusted to 10 cm.
(iii) Soil moisture adjusted to 15 cm.
(iv) As (iii) plus one additional application of 5 cm water at the time of ear emergence in wheat and at pod formation stage in gram.
(v) As (iv) plus one additional application of 5 cm water at the time of dough stage.

The adjustment of soil moisture was made by calculating the amount of water required for every treatment. The amount of water so desired was supplied by pump fitted with a water meter.

A basal dose of 120 kg N, 60 kg P_2O_5 and 30 kg K_2O/ha for wheat, and 20 kg N, 60 kg P_2O_5 and 30 kg K_2O/ha for gram was applied in the form of CAN, super phosphate (single) and muriate of potash respectively. Wheat (Kalyan-227) and gram (C-214) having fibrous and tap root system, respectively, were sown on 8th November as the test crops.

Moisture percentage of soil samples, taken from various depths at different stages of crop growth, was determined on dry weight basis. For dry matter studies, plants were cut close to soil surface and then oven dried to constant weight. Plant growth characters such as final height of plants, effective tillers in case of wheat and branches in case of gram were studied in the field by taking 20 plants of each crop.

Consumptive use of water for both wheat and gram was calculated by adding soil moisture used from the profile, effective rainfal and amount of irrigation applied during the growth period of crops. Moisture use efficiency was worked out using the following formula :

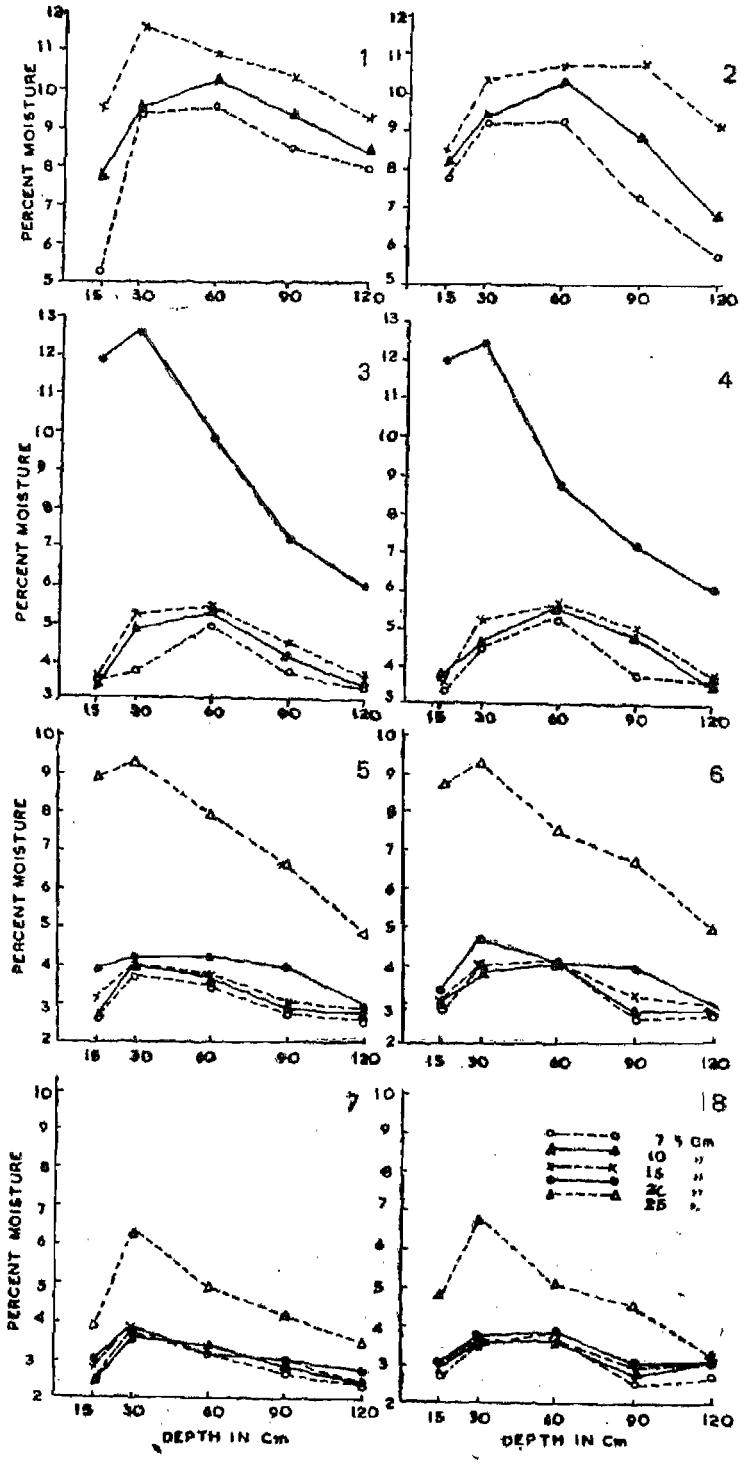
$$e = Y/U$$

where e = moisture use efficiency coefficient (unit of production per unit of water applied),
Y = grain yield (kg/ha),
U = consumptive use of water (m)

RESULTS AND DISCUSSION

Soil moisture content at various stages of crop growth, i. e., germination, tillering/branching, ear emergence/pod formation, dough stage and at the time of harvest for both crops has been shown in Figs. 1-8. The curves indicate that there were marked differences in moisture, upto the time of tillering (wheat) and

Figs. 1-8. Moisture percentage in soil at different depths at germination stage (Fig. 1) and tillering branching stage (Fig. 2) of wheat and gram, ear emergence stage of wheat (Fig. 3), pod formation stage of gram (Fig. 4), dough stage of wheat (Fig. 5) and gram (Fig. 6) and harvest stage of wheat (Fig. 7) and gram (Fig. 8). →


PERCENT MOISTURE
DEPTH IN Cm
1
2
3
4
5
6
7
8
7.5 Cm
10 "
15 "
20 "
25 "

branching (gram) among 7.5, 10 and 15 cm moisture levels (Fig. 2). At the time of ear emergence and pod formation, differences between 10 and 15 cm moisture levels almost levelled off (Figs. 3 and 4). At dough stage, the moisture percentage differences among 7.5, 10 and 15 cm treatments were negligible but 20 cm had slightly high while 25 cm had appreciably higher moisture percentage (Figs. 5 and 6). Interestingly, 20 cm moisture curve approached the curves of 7.5, 10 and 15 cm treatments while 25 cm curve still showed considerably higher moisture percentage even at harvest stage in both the crops (Figs. 7 and 8).

Dry matter yield increased from 7.38 to 14.80 g/plant in case of wheat and 9.08 to 17.47 g/plant in case of gram with the increase in moisture levels from 7.5 to 25 cm (Table 1). These results are in agreement with those of Rhoades and Nelson (1955) who reported the reduction in dry matter yield of corn when soil moisture was insufficient during the early growth period of crop. Higher dry matter yield in 25 cm moisture level showed that at all other moisture levels, either the plant roots could not proliferate or the availability of nutrients was curtailed at lower moisture levels. As evident from Table 1 all the growth characters, i. e., effective tillers in wheat and effective number of branches in case of gram, final height, dry matter yield, weight of 1000-grains and grain yield, both in wheat and gram, showed a positive trend with the increase in moisture levels.

The number of bearing tillers in wheat was lowest (1.73) in 7.5 cm moisture level because sufficient water was lost

TABLE 1

Effect of soil moisture levels on the growth characters of wheat and gram

Treatment (cm moisture)	Number of tillers	Final height (cm)	Final dry matter yield (g/plant)	Weight of 1000-grains (g)	Grain yield (q/ha)
			Wheat		
7.5	1.73	69.30	7.38	33.67	18.57
10.0	2.16	72.06	8.47	33.19	22.23
15.0	2.92	84.14	10.35	35.86	24.28
20.0	3.08	91.63	13.35	37.45	30.71
25.0	3.03	92.00	14.80	40.23	32.86
S. Em	±0.07	± 1.15	± 0.45	± 0.21	± 1.63
C. D. 5%	0.22	3.55	1.41	0.68	3.55
			Gram		
7.5	6.15	36.30	9.08	124.79	6.61
10.0	7.00	40.80	10.79	125.93	7.93
15.0	7.92	46.45	13.56	127.42	13.48
20.0	8.15	49.15	16.73	128.28	15.79
25.0	8.23	50.61	17.47	132.54	18.68
S. Em	±0.27	± 1.06	± 0.36	± 0.63	± 0.56
C. D. 5%	0.83	3.27	1.11	1.96	1.74

upto this stage due to surface evaporation as evident from lower water content in this soil profile (Fig. 2). In 15, 20 and 25 cm moisture levels, number of tillers was almost same because of equal amount of moisture in these three treatments at tillering stage. The minimum height of 69.30 cm of wheat plant was observed in 7.5 cm and maximum (92.00 cm) in 25 cm moisture level. Plant heights were statistically at par in 20 and 25 cm treatments, showing thereby, that application of irrigation water at dough stage did not contribute towards increase in plant height. A similar behaviour, with respect to effective number of branches and plant height, was observed in case of gram.

Weight of 1000-grains of wheat and gram increased with the increase in moisture levels (Table 1). The reduction in 1000-grain weight at lower levels of soil moisture may be due to the shrivelling of grains caused by soil moisture stress. At 25 cm moisture, the highest level maintained in the present study, the 1000-grains weight (40.23 g in wheat and 132.5 g in gram) was the highest. This indicates that water applied at dough stage has a role in mobilising the nutrients in making the grains bold. Patel *et al.* (1971) also observed that grain yield of wheat variety 'Kalyan Sona' was adversely affected by moisture stress at any of the stages of crop growth.

The increase in grain yield with the increase in moisture levels, may be explained on the basis of increase in the number of effective tillers, height and dry weight of plants and plumpiness of grains as evinced from 1000-grain weight. These observations are supported by the findings of Anaya and Stolzy (1972), but are contrary to the work of Partridge and Shaykewich (1972) who reported that low to moderate stress in soil moisture regimes had no significant influence on wheat grain yield. These differences are explainable by taking into consideration the time of stress given. In the present study, the stress was more or less a continuous phenomenon from tillering/branching onward while these workers gave stress for a particular period and that too at early stages of plant growth which affected only the vegetative growth and not the plant yield.

A sharp increase of 6.43 q/ha in grain yield of wheat in 20 cm as compared to 15 cm moisture level indicated that the irrigation at ear-emergence is very important. Horner and Mojtehdi (1970) and Robins and Domingo (1962) also reported that yield depressions were more pronounced when the moisture stress occurred during bloom and early maturity. In gram also a positive correlation was found between the yield and soil moisture levels. This relationship may be due to the increase in number of branches, height, dry weight, 1000-grains weight, number of pods and number of grains per pod (Table 1).

Consumptive use of water in both wheat and gram (Table 2) increased with the increase in moisture levels. Minimum consumptive use of water under lowest moisture level (7.5 cm) can be explained on the basis of very poor plant height, lesser number of tillers and green leaves, as all these growth characters have direct

TABLE 2

Effect of soil moisture levels on the total consumptive use of water by wheat and gram

Treatment (cm moisture)	Total moisture use (mm)	Effective rainfall (mm)	Amount of irrigation given (mm)	Total consumptive use (mm)
		Wheat		
7.5	102.6	45.00	0.0	147.6
10.0	116.4	45.00	0.0	161.4
15.0	135.5	45.00	0.0	180.5
20.0	132.4	45.00	50.00	227.4
25.0	110.0	45.00	50.00+ 50.00	255.0
		Gram		
7.5	99.6	45.00	0.0	144.6
10.0	114.1	45.00	0.0	159.1
15.0	133.9	45.00	0.0	178.9
20.0	131.3	45.00	50.00	226.3
25.0	106.7	45.00	50.00+ 50.00	251.7

TABLE 3

Effect of soil moisture levels on water use efficiency of crops

Treatment (cm moisture)	Total consumptive use (mm) U	Grain yield (q/ha) Y	Water use efficiency (kg/ha/mm) Y/U
	Wheat		
7.5	147.6	18.57	12.58
10.0	161.4	22.23	13.77
15.0	180.5	24.28	13.45
20.0	227.4	30.71	13.50
25.0	255.0	32.86	12 89
	Gram		
7.5	144.6	6.61	4.57
10.0	159.1	7.93	4.98
15.0	178.9	13.48	7.53
20.0	226.3	15.79	6.98
25.0	251.7	18.68	7.42

relationship with transpiration losses by crop plants. The lower consumptive use under low moisture levels can also be due to less availability of water for evapo-transpiration under these treatments.

Water use efficiency of both wheat and gram (Table 3) was found to differ markedly under different soil moisture levels. In wheat, lowest water use efficiency of 12.58 kg/ha/mm was observed in 7.5 cm treatment. The reason for this seems to be the overall water deficit which significantly lowered the grain yield. In 25 cm treatment, the water use efficiency was comparatively lower than that of 20 cm. This is because 5 cm water applied at dough stage, contributed little towards increase in grain yield. This shows that irrigation at ear emergence stage contributed more towards grain yield than that at dough stage.

In case of gram, highest water use efficiency of 7.53 kg/ha/mm was obtained under 15 cm treatment. This was because of less evaporation from the surface due to the self mulching on light soils, and it may be also because of low water requirement of gram. The increments in yield due to the subsequent irrigation were smaller thereby lowering the water use efficiency.

In case of wheat, the soil moisture at germination, tillering, ear emergence and dough stages gave a positive correlation with grain yield. A strong positive correlation ($r = 0.945$) was found between the soil moisture upto 30 cm at ear emergence stage and grain yield of wheat. In case of gram, such a relationship was observed at germination stage having correlation coefficient of $r=0.903$. Thus, it may be inferred that moisture level at germination is very important for gram, whereas for wheat such a stage seems to be ear emergence on loamy sands. This is in confirmity with the work of Horner and Mojtehdi (1970) and Lehane and Staple (1962).

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EFFECT OF NITROGEN AND IRRIGATION LEVELS ON THE NUTRIENT UPTAKE OF DWARF WHEAT

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ABSTRACT

A field experiment, conducted during rabi 1975-76 and 1976-77, to study the effect of 3 nitrogen levels (40, 80 and 120 kg/ha) and 5 irrigation levels (3 based on physiological growth stages and 2 based on pan evaporation) on the wheat plant, showed that the nitrogen content and nitrogen and phosphorus uptake significantly increased with each successive dose of nitrogen upto the highest dose of 120 kg N/ha. The nitrogen content and uptake, phosphorus content in grain and uptake significantly increased with the frequency of irrigations. Six irrigations irrespective of method of scheduling irrigation showed significantly higher concentration and total uptake of nitrogen and phosphorus in the plant.

Nitrogen and irrigation are the most important factors which govern the uptake of nutrients in wheat. Singh *et al.* (1973) found that the uptake of nitrogen and phosphorus in wheat increased significantly by the application of irrigation. They further observed that nitrogen in wheat was significantly higher with 80 and 120 kg N/ha application over 40 kg N/ha, and the application of 40 and 80 kg N/ha also significantly increased the phosphorus content in grain, straw and total produce. Similar observations were made by Grunes *et al.* (1958) and Grunes (1959). They also reported that nitrogen additions affect plant metabolism and might change the ability of a unit area of root surface to absorb more phosphorus. Singh and Anderson (1973) and Singh and Singh (1975) also observed that the application of fertilizer increased the uptake of nutrients. Most of the work on wheat irrigation has been restricted to its developmental stages of crop growth. Soil governs only the depth and frequency factors in irrigation, while the consumptive use of water is governed primarily by meteorological parameters. This necessitates a comparison between critical stage approach and soil moisture deficit in relation to evaporative demand of the atmosphere for developing guidelines for scheduling irrigation in wheat. The present investigation was, therefore, undertaken to find out the effect of rate of nitrogen and application of irrigation on nutrients concentration and their uptake in wheat.

MATERIAL AND METHODS

A field experiment was conducted during winter season of 1975-76 and 1976-77. The soil of the experimental

field was sandy loam, low in available nitrogen and high in phosphorus and potash, and having pH 7.8. There were fifteen treatment combinations comprising of three nitrogen levels (40, 80 and 120 kg N/ha) and five irrigation levels.

(a) **Irrigations based on physiological growth stages.** I_1–Four irrigations applied at crown root initiation (CRI), late tillering (LT), heading (H), and milk (M) stages; I_2–Five irrigations applied at CRI, LT, late jointing (LJ), flowering (F), and M stages; I_3–Six irrigations applied at CRI, LT, LJ, F, M, and dough (D) stages.

(b) **Irrigations based on pan evaporation demand.** I_4–6 cm water after 8.6 cm water cumulative pan evaporation from USWB class A pan–ID/CPE ratio of 0.70; I_5–6 cm water after 6.6 cm cumulative pan evaporation from USWB class A pan–ID/CPE ratio of 0.90. A measured quantity of water was applied at each irrigation of 6 cm depth.

The experiment was laid out in a randomized block design with four replications. The size of the gross and net plots were 10×1.61 m and 8×0.69 m, respectively. The details of the irrigation schedule are given in Table 1.

Half of the nitrogen as per treatment through urea and 60 kg P_2O_5/ha through single super phosphate were applied at sowing and the remaining nitrogen was top dressed after first irrigation. Wheat variety WH 147 was sown in rows of 23 cm apart at the rate of 100 kg seed/ha on 14th and 19th November in 1975–76 and 1976–77, respectively. At the time of sowing, 5% BHC at the rate of 25 kg/ha was dusted to prevent termites. One hand weeding was given after first irrigation to control weeds.

At harvest, uptake of nitrogen and phosphorus in total plant produce was computed from the concentration of nitrogen and phosphorus in grain and straw multiplied by the respective grain and straw yield values. The concentrations of N and P were determined with the colorimetric procedure (Linder, 1944).

RESULTS AND DISCUSSION

Nitrogen Content

Application of 120 kg N/ha significantly increased the N content over 40 kg N/ha in grain and straw in both the years (Table 2). The differences between two successive levels of nitrogen application were also significant in grain. The irrigation treatments did not influence the nitrogen content significantly in grain and straw in any of the season except in grains in 1976–77. The N concentration was significantly higher in I_1 and I_4 treatments receiving four irrigations as compared to I_3 and I_5 treatments receiving six irrigations irrespective of method of scheduling irrigation. The reduction in N concentration under higher soil moisture status would have been merely a dilution effect due to better growth and yield of wheat. Singh (1975) also reported similar results.

Phosphorus Content

Phosphorus content in grain and straw was not affected significantly by nitrogen application in both the years (Table 2). However, it increased signi-

TABLE 1

Details of irrigation schedule

Treatment	No. of irrigations	Total water added (cm)	Crop age at irrigation (days after sowing) 1975-76	1976-77
I_1	4	24	20, 50, 94, 121	20, 49, 94, 119
I_2	5	30	20, 50, 74, 102, 121	20, 49, 73, 100, 119
I_3	6	36	20, 50, 74, 102, 121, 135	20, 49, 73, 100, 119, 135
I_4	4	24	32, 74, 129, 135	33, 71, 104, 130
I_5	6	36	22, 50, 79, 106, 124, 135	22, 54, 82, 100, 115, 130

TABLE 2

Effect of levels of nitrogen and phosphorus content in grain and straw of wheat

Treatments	Nitrogen content (%)				Phosphorus content (%)			
	Grain		Straw		Grain		Straw	
	1975-76	1976-77	1975-76	1976-77	1975-76	1976-77	1975-76	1976-77
Nitrogen level (kg/ha)								
40	1.72	1.85	0.40	0.39	0.249	0.274	0.055	0.054
80	2.02	2.11	0.43	0.44	0.252	0.276	0.054	0.055
120	2.27	2.24	0.46	0.47	0.254	0.297	0.053	0.055
S. Em. ±	0.06	0.04	0.02	0.02	0.007	0.009	0.002	0.001
C. D. at 5%	0.17	0.11	0.05	0.06	N. S.	N. S.	N. S.	N. S.
Irrigation level								
I_1	2.12	2.17	0.42	0.45	0.247	0.253	0.055	0.054
I_2	2.28	2.06	0.44	0.43	0.264	0.278	0.054	0.054
I_3	2.31	1.96	0.44	0.41	0.277	0.298	0.053	0.055
I_4	2.09	2.19	0.42	0.45	0.241	0.254	0.055	0.054
I_5	2.30	1.94	0.44	0.41	0.276	0.294	0.053	0.055
S. Em. ±	0.08	0.05	0.02	0.02	0.008	0.011	0.002	0.001
C. D. at 5%	N.S.	0.14	N.S.	N.S.	0.022	0.027	N.S.	N.S.

N. S.=Non-significant.

ficantly in grain by the application of six irrigations (I_3 and I_5) over four irrigations (I_1 and I_4) irrespective of method. This was probably due to higher rate of mineralisation, more interception of soil by roots and consequently greater absorption of phosphorus under wet conditions. Similar findings were also reported by Sharma *et al.* (1972) and Singh (1975).

Total Nitrogen Uptake

The total uptake of N significantly increased with each successive dose of nitrogen upto the highest dose tried (120 kg N/ha). The increase in total nitrogen uptake owing to N application was because of additive effect of favourable influences recorded in the N content in grain and straw and their respective yields (Table 3). These findings are in

TABLE 3

Effect of levels of nitrogen and irrigation on nutrient uptake and yield of wheat

Treatment	Nitrogen uptake (kg/ha)		Phosphorus uptake (kg/ha)		Grain yield (q/ha)		Straw yield (q/ha)	
	1975-76	1976-77	1975-76	1976-77	1975-76	1976-77	1975-76	1976-77
Nitrogen level (kg/ha)								
40	98.1	72.6	12.63	10.71	37.5	29.9	58.8	45.3
80	119.2	94.0	15.08	12.30	43.3	34.1	69.9	51.2
120	138.7	106.7	17.16	13.55	47.1	36.8	77.2	54.2
S. Em. ±	3.1	1.6	0.66	0.21	0.7	0.6	1.1	1.8
C. D. at 5%	8.4	4.4	1.83	0.58	2.0	1.7	3.0	4.5
Irrigation level								
I_1	106.7	86.3	13.06	10.12	38.8	30.0	60.2	47.6
I_2	120.5	94.0	15.21	12.43	43.1	34.4	67.2	52.1
I_3	129.6	99.2	16.80	14.51	46.4	38.0	73.2	57.2
I_4	99.6	76.5	12.03	8.94	36.0	26.5	56.4	39.5
I_5	135.2	99.9	17.39	14.59	48.4	39.0	75.3	56.2
S. Em. ±	4.1	2.1	0.78	0.27	0.9	0.8	1.4	2.1
C. D. at 5%	11.6	5.8	2.16	0.76	2.5	2.3	3.9	5.9

agreement with those of Singh and Singh (1975) who reported that N application increased the N yield.

The total uptake of nitrogen was affected significantly due to different irrigation treatments (Table 3). Six irrigations irrespective of method (I_3 and I_5) increased N uptake significantly over rest of the irrigation treatments in both the years, however, the differences between I_3 (five irrigations) and I_3 or I_5 (six irrigations) were not significant for N uptake. The beneficial effects of irrigation could be due to its role in increasing yield attributes and ultimately the total dry matter. Singh (1975) also reported that application of irrigation increased the total N uptake in wheat.

Total Phosphorus Uptake

The total uptake of phosphorus significantly increased with the increased dose of nitrogen from 40 to 120 kg N/ha in both the years (Table 3). The percentage increase in phosphorus uptake over 40 kg N/ha at 80 and 120 kg N/ha was 19.4 and 35.9 per cent during 1975-76, and 14.8 and 26.5 per cent during 1976-77, respectively. The higher phosphorus yield obtained under higher levels of nitrogen was due to enhanced phosphorus concentration and significantly higher grain and straw yield (Table 3). Similar findings have been reported by Singh *et al.* (1973).

The treatments I_3 and I_5, both being at par, showed maximum total phosphorus uptake and were significantly superior to rest of the irrigation treatments in both the years except in 1975-76 when the I_3 and I_3 treatments did not differ significantly (Table 3). It may be attributed that as the soil moisture increases the total phosphorus uptake also increases.

Singh *et al.* (1973) and Singh (1975) have also reported an increase in total phosphorus yield with the increase in soil moisture availability in wheat.

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STABILITY AND ITS GENETIC BASIS WITH REGARD TO GRAIN SIZE IN PEARL MILLET

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ABSTRACT

One hundred five F_1's obtained from 15×15 diallel cross (excluding reciprocals), 15 parents alongwith a check HB-3 were grown in three different environments to study the stability and its genotypic basis for 1000-grain weight in pearl millet. Pooled regression analysis revealed that mean sum of squares due to linear and non-linear components of genotype×environment interaction were significant. However, the magnitude of linear component was high as compared to non-linear components, indicating thereby the possibility of prediction for this trait. The two components of genotype×environment interaction viz., responsiveness (b_i) and stability (S^2_{di}) for this trait appeared to be controlled by distinct genetic systems which were probably also independent.

Among the factors of major importance to the plant breeding in developing a variety are those involving genotype and environment interaction. These interactions bias the estimation of various genetic components of variance which further affects the rate of progress to be expected from given breeding programme. In recent years effective methods have been developed which could be used to provide reliable estimates of these interactions. These techniques provide two simple measures of the genotypic changes relative to environments, namely regression coefficient (b_i) and deviation from regression slope (s^2_{di}). Here, thus the question raises, as to whether these two parameters of stability are governed by some simple genetic system or by some complex genetic system, which lend a particular genotype to be responsive and stable. If these parameters are genetically governed, a primary evaluation could be planned to identify a stable genotype. Also, an understanding of the genetic basis of stability and the responsiveness at the genetic level will aid in the formulation of the breeding procedures. Accordingly, the results obtained for 1000-grain weight in the present investigation were utilized to draw inference about genetic control of two components viz., responsiveness (b_i) and stability of the individual genotype (s^2_{di}) in pearl millet.

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MATERIAL AND METHODS

In the present investigation 105 F_1's obtained from 15×15 diallel cross (excluding reciprocals), 15 parents alongwith a check HB-3 were grown in a simple lattice design consisting of four replications. Each genotype was represented by a single row of 4.5 m length and 45 cm apart from each other. The material was sown in three different environments viz., two different locations and two agronomic variables at the same location.

The data for 1000-grain weight were recorded on each of the five competitive plants under each environment and were subjected to stability analysis as per method suggested by Eberhart and Russell (1966).

RESULTS AND DISCUSSION

Pooled analysis of variance (Table 1) revealed that mean squares due to genotypes were significant when tested against pooled deviation and pooled error. This indicated the presence of high genetic variability in respect of progenies including parents and F_1's. The mean sum of squares due to linear portion of genotype×environment were significant, thus, showing that a significant portion of genotype×environment were of linear type. Further, the mean squares due to pooled deviation (non-linear component) were also found to be significant, which indicated the presence of high non-linear component of genotype×environment interaction. The magnitude of linear component was high as compared to non-linear component, showing thereby a linear relationship between genotypes and additive effects of environments and so the prediction for this trait would be possible. It has been suggested by some workers that prediction will depend upon the relative magnitude of linear and non-linear components, however, prediction will be more reliable when only former is tested against the latter (Breese, 1969; Samuel *et al.*, 1970).

Further, the results were utilized to draw inference about genetic control of the two components viz., responsiveness and stability of the individual genotype. The estimates of b_i and s^2_{di} of certain parents and their arrays are presented in Table 2. The parent IP-2087 was characterized by below average estimate of bi (—5.092), whereas the hybrids in this array exhibited above average response ranging from 1.139 to 11.413. The consistant estimate of b_i among the hybrids involving this parent thus revealed the presence of over-dominance type of gene action in favour of high responsiveness. On the contrary, the parent Senegal-8180 possessed the above average response (b_i=3.920) while hybrids within this array exhibited below average response. The two arrays, therefore, provided immediate contrast in respect of transmission of parental characteristics and represented complete reversal of dominance. In each case the parental attribute was recessive and the expression of the array confirmed to over-dominance. The results indicated the presence of distinct genetic control of the responsiveness in the present material.

TABLE 1

Pooled regression analysis of variance for phenotypic stability in respect of 1000-grain weight

Source →	Genotypes	Environment (L)	G×E (L)	Pooled deviation	Pooled error
d. f.	120	1	120		1080
M. S.	1.37*	9.15*	0.94*	0.42*	0.14

*Significant at P=0.05

TABLE 2

Estimates of regression coefficient (b_i) and deviation from regression (S^2_{di}) of 15 parents and some of the hybrids in respect of 1000-grain weight

Parent/ F_1 hybrid	b_i	S^2_{di}	Parent/ F_1 hybrid	b_i	S^2_{di}
H-38	—0.117	—0.045	H-19	—4.389*	1.070*
J-934	—2.904	0.946*	H-672	0.676	—0.039
J-104	2.819*	—0.504*	H-39	5.706*	0.166
H-745	3.415*	—0.122	H-150	0.293	—0.001
H-798	0.841*	—0.132	H-79	3.391*	0.106
H-815	4.146*	—0.063	H-93	1.836*	—0.138
H-789	—2.097*	0.366	Senegal 8180	3.920*	0.774*
IP-2087	—5.092*	0.078	H-38 × Senegal 8180	0.281	0.011
H-38 × IP2087	1.139*	0.011	Senegal 8180 × J-934	0.421	—0.099
IP-2087 × Senegal 8180	11.413*	0.404	× J-104	—1.621*	0.264
× J-934	5.374*	2.512*	× H-745	—0.539	0.311
× J-104	7.657*	3.337*	× H-798	—0.379*	—0.137
× H-745	10.665*	1.635*	× H-815	—1.465*	0.078
× H-798	5.911*	1.641*	× H-789	1.098*	—0.138
× H-815	5.383*	2.264*	× H-692	—0.031	—0.066
× H-789	9.900*	3.039*	× H-672	—0.306*	—0.106
× H-692	7.959*	1.138*	× H-39	—0.471*	—0.101
× H-672	10.074*	1.111*	× H-150	—2.385*	0.615
× H-39	7.482*	1.110*	× H-79	1.887	0.655*
× H-150	5.680*	3.734*	× H-93	—0.489*	—0.124
× H-79	7.062*	1.750*			
× H-93	3.115*	1.963*			

*Significant at P=0.05

As regards the stability (s^2_{di}), the hybrids in array IP-2087 with two exceptions, were found to exhibit significant estimates of s^2_{di}, i.e., these were unstable, whereas the parent itself was characterized as stable ($s^2_{di}=0$). It indicated that the expression of high stability was recessive in this array. Exactly the opposite results were observed for this attribute in array Senegal-8180, in which case the parent was highly unstable but its all hybrids again with two exceptions were highly stable ($s^2_{di}=0$). Thus, in this array high stability appeared to behave as dominant or resulted from over-dominance. The consistant performance of hybrids within these two arrays and the contrasting expression of over-dominance in them, indicate that perhaps the two stability parameters were not related and may, thus, be governed by different genetic systems. The results of Kapoor (1972) in pearl millet were in accordance who concluded that the two attributes of g×e interaction viz., (b_i and s^2_{di}) were governed by different genetic systems and are each subject to dominance/and over-dominance in either direction *vis-a-vis* the parents involved.

Further, the correlations of parental means ($\bar{Y}i$) and linear response (b_i) were computed in order to know whether these two attributes were governed by same genetic system or by two independent genetic systems. There was an apparent lack of correlation between the parental means and the linear response. This would also indicate that independent genetic systems were involved in governing responsiveness on one hand and stability on the other. Kapoor (1972) also reported a lack of correlation between these attributes. The available literature shows that while $\bar{Y}i$ and b_i may be correlated in some cases, the opposite is true in certain others (Perkins and Jinks, 1968; Breese, 1969; Hill and Perkins, 1969; Westerman and Lawrence, 1970; Paroda and Hayes, 1971). It is suggested that still more studies are required regarding genetic systems governing the different parameters of genotype×environment interaction before any precise conclusions can be drawn.

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EFFECT OF CROP REGULATION ON DROP, RIPENING, YIELD AND QUALITY OF BEAUTY SEEDLESS GRAPE VINES, TRAINED ON BOWER

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Beauty Seedless cultivar of grape is known for its high yield, earliness and wide adaptability to different training systems. Inspite of many points in favour of this cultivar its cultivation on commercial scale is confronted with some pressing problems such as uneven ripening, berry drop, shot berry and lower fruit quality. These problems are mainly related with heavy cropping. Crop regulation by thinning is an important technique for obtaining optimum yield and fruit quality. Hence, it was desirable to study the effect of crop regulation on Beauty Seedless grage.

Ten years old Beauty Seedless grapevines growing at the Experimental Vineyard of Haryana Agricultural University, Hissar were used. Vines were spaced at 3×3 m, bower trained and spur pruned. Experiment consisted of 5 crop regulation treatments, i. e., (i) no thinning, (ii) cluster thinned to 40 and (iii) 60 per vine, (iv) cluster thinned to 40+berry thinning, and (v) cluster thinned to 60 + berry thinning. Cluster and berry thinning were done after the berries had set. Level of berry thinning and technique used were followed as described by Singh *et al.* (1980). Each treatment consisted of single vine and was replicated four times in randomised block design.

Berry drop was recorded by counting the berries of two tagged clusters from each vine at berry set and then at harvest. Berries were considered ripen when TSS/acid ratio reached 20 and when berries were uniformly coloured. Bunch and berry weight were recorded by taking 10 bunches and 100 berries, respectively from each treatment. Normal and shot berries (less than 4 mm in diameter) were separated from four clusters at harvest and counted for calculating the percentage of shot berries. Colour intensity was measured by using the method of Kliewer (1970). Total soluble solids were determined by hand refractometer. Total acidity was determined by titrating the juice against 0.1 N NaOH using phenolphthalein as an indicator and expressed as tartaric acid in gram per 100 ml of juice.

The maximum reduction in berry drop was recorded in the case of cluster thinned to 40 per vine + berry thinning

(Table 1). Reduced competition for metabolites as a result of thinning may be one of the reasons for inhibition of berry drop.

Cluster+berry thinning treatments were more effective in advancing the ripening than cluster thinning treatments alone. Mechanical stimuli such as separation of organs (Abeles, 1973) stimulates ethylene production and ethylene is well known as a fruit ripening hormone, hence, possibility may seem that berry thinning induced ethylene production in remaining parts of the cluster which enhanced ripening.

Bunch weight was highest in cluster thinned to 40 per vine+berry thinning treatment (Fig. 1) but it did not differ significantly with cluster thinned to 60 per vine+berry thinning. Berry weight was also higher in these two treatments as compared with control. Reduced berry drop and shot berry and increased berry weight have contributed for higher bunch weight in these treatments. Total crop weight per vine was reduced by cluster and cluster+berry thinning treatments as compared to control. Similarly, reduction in total yield per vine was observed by cluster (Singh and Chundawat, 1980) and berry (Sharples *et al.*, 1961) thinning.

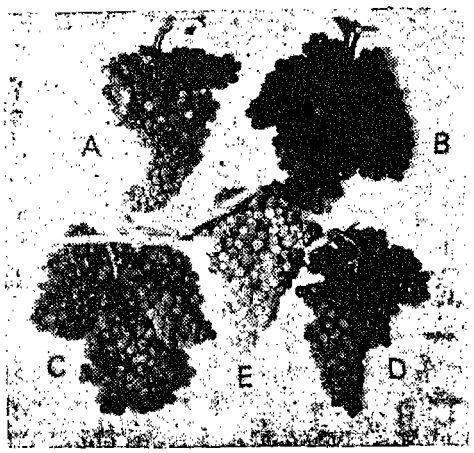


Fig. 1. Cluster and colour development in Beauty Seedless grape under crop regulation treatments. (A) cluster thinned to 60 per vine; (B) cluster thinned to 60 per vine+berry thinning; (C) cluster thinned to 40 per vine+berry thinning; (D) cluster thinned to 40 per vine; (E) no thinning (control).

Cluster thinned to 40 per vine+berry thinning showed the lowest percentage of shot berries (Table 1). However, it did not differ significantly with cluster thinned to 60 per vine+berry thinning treatment. The occurrence of shot berries in Beauty Seedless cultivars has been reported mostly near the apex of the cluster (Singh and Chauhan, 1980). Hence, apex removal in berry thinning treatments was mainly responsible for reducing the number of shot berries in a cluster.

Data recorded on quality components are presented in Table 2. The colour development in berries was maximum in cluster thinned to 40 per vine+berry thinning treatment. Berries were most attractive, uniform and have deep coloration under this treatment. The findings of Sharples *et al.* (1961) also support the contention that berry thinning increased colour intensity in grape berries.

Per cent of juice in grape berries was significantly increased under all crop regulation treatments as compared to control. Differences between berry and

TABLE 1

Effect of crop regulation treatments on berry drop, ripening, yield components and shot berries of Beauty Seedless grape

Crop regulation treatments	Berry drop (%)	Enhanced ripening (days)	Bunch weight (g)	Berry weight (g)	Yield/ vine (kg)	Shot berry (%)
No thinning (control)	48.10^{a}*	—	375.87^{e}	1.29^{b}	28.19^{a}	36.55^{a}
Cluster thinned to 40 per vine	28.52^{bc}	3	387.00^{bc}	1.36^{a}	15.48	25.28^{b}
Cluster thinned to 60 per vine	30.53^{b}	3	379.00^{c}	1.31^{b}	22.74^{c}	26.49^{b}
Cluster thinned to 40 per vine+berry thinning	25.53^{c}	7	399.90^{a}	1.36^{a}	16.00^{d}	20.50^{c}
Cluster thinned to 60 per vine+berry thinning	32.11^{b}	6	392.80^{ab}	1.35^{a}	23.56^{b}	22.39^{c}
C.D. at 5%	4.02	—	11.31	0.04	0.51	2.17

*Data followed by different superscripts within the column are significantly different at 5% level.

TABLE 2

Effect of crop regulation treatments on quality components of Beauty Seedless grape

Thinning treatments	Colour absorbance (at 530 nm)	Juice (%)	T.S.S. (%)	Acidity (%)	TSS/ acid ratio
No thinning (control)	0.41^{c}*	50.15^{b}	16.10^{b}	1.33^{a}	12.10^{c}
Cluster thinned to 40 per vine	0.61^{b}	61.70^{a}	16.97^{b}	0.86^{b}	19.73^{b}
Cluster thinned to 60 per vine	0.60^{b}	60.25^{a}	16.87^{b}	0.87^{b}	19.39^{b}
Cluster thinned to 40 per vine +berry thinning	0.69^{a}	64.80^{a}	19.82^{a}	0.83^{b}	23.70^{a}
Cluster thinned to 60 per vine +berry thinning	0.62^{b}	62.15^{a}	19.52^{a}	0.89^{b}	21.99^{a}
C.D. at 5%	0.03	5.65	1.19	0.08	1.80

*Data followed by different superscripts within the column are significantly different at 5% level.

cluster thinning treatments were not significant. Increased berry size in thinning treatments might be the possible reason for higher percentage of juice.

Cluster thinned to 40 per vine+berry thinning gave highest percentage of total soluble solids but it did not differ significantly with cluster thinned to 60 per vine+berry thinning treatment. Better ripening of the clusters in these treatments might be the consequence for increased total soluble solids.

Total acidity of grape juice was reduced by both cluster and cluster+berry thinning treatments. These results are in line with the results reported by Kondrya (1975) in other cultivars of grapes.

Cluster+berry thinning treatments were found most effective in increasing TSS/acid ratio. The findings of Sarowa and Bakshi (1972) in Perlette grape also support contention that thinning increased TSS/acid ratio.

Thus, it is clear that cluster+berry thinning treatments were very effective in reducing the berry drop and shot berries, enhancing ripening and improving fruit quality by increasing colour intensity and TSS/acid ratio. Total yield per vine was decreased considerably by cluster thinned to 40+berry thinning treatment. Hence, cluster thinned to 60 per vine+berry thinning was an ideal crop regulatory treatment for optimum yield and quality.

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RESEARCH NOTE

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STUDIES ON THE COMPATIBILITY AND PROFITABILITY OF DIFFERENT INTERCROPS IN PIGEON PEA

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Availability of short duration varieties of pulses like **moong, mash**, cowpeas, soybean, etc. has added a new era in intercropping systems in various long duration and tall growing crops including pigeon pea. Since the optimum row spacing for pigeon pea is 50 cm, a lot of space remains vacant in between the rows for a period of about 75-80 days due to its slow growth in the beginning. Therefore, it provides an opportunity to grow quick growing and short-statured pulses in between the pigeon pea rows with little competition.

In trials at IARI, New Delhi and Pantnagar it was observed that short duration grain legumes viz., **moong, mash** or cowpea could successfully be grown as intercrop in between two rows of pigeon pea and an additional yield of 5-7 q/ha of pulse grain can be obtained (IARI, 1971; Saxena and Yadav, 1973; Saraf *et al.*, 1975).

An experiment was conducted in **kharif** 1977 on sandy-loam soil, poor in organic carbon (0.29%), low in available phosphorus (17 kg P_2O_5/ha) and rich in available potash (418 kg K_2O/ha). The soil was alkaline in reaction (pH 8.5) with normal electrical conductivity (0.95 mmhos/cm at 25°C). The treatments comprised pure pigeon pea (Prabhat), pigeon pea+**moong** (Varsha), pigeon pea+**mash** (T-9), pigeon pea+**guara** (FS 277), pigeon pea+soybean (Bragg) and pigeon pea+**bajra** (BJ-104). The intercrops were planted in alternate rows of pigeon pea sown at 50 cm row distance. All the treatments were replicated four times in randomized block design. 40 kg P_2O_5/ha through single super phosphate was drilled through pora at a depth of about 10 cm at sowing. Nitrogen through urea at 50 kg N/ha was also applied alongwith the rows of **bajra** alone, one month after sowing.

Maximum grain yield of pigeon pea was obtained when it was grown without any intercrop being significantly higher over all the other intercropping treatments (Table 1). A drastic reduction in pigeon pea yield was recorded with **guara** and **bajra** intercropping to the extent of 9.7 and 8.1 q/ha, respectively. However, this reduction was of the order of about 1.3, 1.8 and 1.6 q/ha when pigeon pea was intercropped with **mash, moong** and soybean, respectively.

Among intercrops, **bajra** and **guara** yielded higher than grain legumes but

TABLE 1

Yield of pigeon pea, different intercrops and economics of intercropping

Treatments	Yield of pigeon pea (q/ha)		Yield of intercrops (q/ha)	Gross income (Rs./ha)	Profit over pure pigeon pea (Rs./ha)
	Grain	Stalk			
Pigeon pea	17.0	54.9	—	4407	—
Pigeon pea+moong	15.2	41.1	4.9	5324	917
Pigeon pea+mash	15.7	45.1	6.6	6045	1638
Pigeon pea+guara	7.3	28.6	7.0	2813	—1594
Pigeon pea+soybean	15.4	42.4	4.2	4850	443
Pigeon pea+bajra	8.9	31.9	10.7	3279	—1128
C. D. at 5%	1.1	4.3	—	365	

TABLE

Growth and yield parameters of pigeon pea with different intercrops

Plant characters	Pure pigeon pea	Crop combination with pigeon pea					C. D. at 5%
		Moong	Mash	Guara	Soybean	Bajra	
Plant height (cm)	163.0	163.8	163.6	168.4	164.4	168.1	2.3
Dry matter accumulation (g/plant)	46.6	40.4	44.0	24.0	41.2	26.0	5.6
Branches/plant	12.4	11.4	11.6	6.2	11.1	5.5	1.1
Pods/plant	76.3	61.9	66.2	36.0	65.2	38.9	8.1
1000-grain weight (g)	64.3	60.9	63.8	60.1	61.5	60.1	0.8

had an adverse effect on grain and straw yields of pigeon pea. The higher yields of guara and bajra might be due to their better competitive ability. Among the grain legumes, **mash** yielded higher followed by **moong** and soybean. Various workers have also advocated the successful growing of **moong, mash**, soybean and cowpea in between two rows of pigeon pea (Saxena and Yadav, 1970, 1973).

The plant height of pigeon pea remained unaffected due to **moong, mash** or soybean intercropping (Table 2). However, significantly greater height was observed when pigeon pea was intercropped with either **guara** or **bajra**. This may be attributed to competition for light offered by these crops. Consequently smoothering effect on pigeon pea was observed during major part of its growth and development which adversely affected the growth (branches and dry matter accumulation), yield parameters (pods/plant and 1000-grain weight) and grain yield of pigeon pea. Intercropping in pigeon pea also reduced the stalk yield

significantly as compared to pure pigeon pea. Reduction in stalk yield may be assigned to lesser branching and dry matter accumulation as a result of intercropping in pigeon pea. The dry matter of pigeon pea remained unaffected when intercropped with either **mash** or soybean. However, it was significantly lower with **moong** intercropping which may be due to higher leaf area of **moong** resulting in greater competition. Similarly, the branching in pigeon pea was not reduced in intercropping with grain legumes except soybean. The pods/plant and 1000-grain weight of pigeon pea were decreased significantly by all the intercrops except **mash** which recorded higher 1000-grain weight over other intercrops but was at par with pure pigeon pea.

The gross income was significantly higher when pigeon pea intercropped with either **moong, mash** or soybean over pure pigeon pea (Table 1). Intercropping with **mash** was most profitable fetching an additional profit of Rs. 1638/ha followed by **moong** (Rs. 917/ha) over pure crop of pigeon pea. The higher profit with these intercrops may be attributed to their grain yields which fetched higher market prices and also because of their comparatively less adverse effect on grain yield of pigeon pea. **Guara** and **bajra** proved to be the losing proposition as they reduced the grain yield of pigeon pea considerably on the one hand and had relatively lower market prices on the other hand. Kaul and Sekhon (1974) and Saraf *et al.* (1975) have also reported that intercropping of grain legumes viz., **moong, mash,** soybean and cowpea brought higher net profits over pigeon pea alone.

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STUDIES ON THE STABILITY OF PRODUCTIVE PLANT POPULATION FOR INCREASED CASTOR BEAN (*RICINUS COMMUNIS* L.) YIELD IN RAINFED CONDITIONS

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Castor bean *(Ricinus communis* L.*)* is an industrially important crop of rainfed regions of South India. It has indicated promise in rainfed regions of Hissar. Mehrotra (1975) observed that loss of plant population due to moisture stress vulnerability till 3-4 leaf stage could be compensated by gap-filling even after 14 days from seeding because the new comers compensate during growth cycle and share productivity.

Even when plant population was kept constant by maintaining 60×40 cm spacings in 6.6×7.6 sq m plot, the productive plants at maturity during 1972-73 and 1973-74 differed considerably. This necessitated the present study of phenotypic stability (Eberhart and Russell, 1966) because of highly significant positive correlation coefficient (r=0.98; Table 1) between plant population and seed yield. Out of four environments created by considering middle and border rows, the productive plant population data from the middle plots of 1973-74 were erratic and hence not considered for studying stability parameters.

The highly significant effects due to genotype (MS_1) and genotype×environment linear (MS_2) and considerable environment index differences suggest the desirability of creating environment by considering middle and border plots (Mehrotra *et al.*, 1980; Mehrotra and Chaudhary, 1981). The deviation from regression (s^2di) and linear regression (b_i), respectively indicate the stability and responsiveness of genotypes (Paroda and Mehrotra, 1976). Thus, negative values of s^2di (Table 1) indicate the effectiveness of gap-filling in stabilising productive plant population/unit area in rainfed conditions. Mehrotra *et al.* (1980) suggested that genotypes with $\mu+di$ estimates above population mean, b_i around unity and negative or low positive estimates of s^2di were desirable for rainfed conditions. With this criterion, genotypes 1-32 and 144 appear useful because of promise for productive plant population/unit area and productivity (Mehrotra, 1975). Further, the recommended variety Pb. Castor No. 1 was not only non-responsive for plant density but was also low yielder because of long vegetative phase (113 days)

TABLE 1

Stability parameters for productive plant population/ha in castor raised in rainfed conditions of Hissar

Genotypes	Plant population/ha				b_i	SE b_i	s^2di
	1972–73		1973–74	*Average*			
	Middle plot	Border plot	Border plot	$(\mu+di)$			
1–32	28950	33333	32308	31530	0.70*+	0.0118	−8519960
Aruna	24621	38333	35385	32780	2.00*+	0.1072	−8276697
144	24080	31666	28333	28026	1.13*	0.2599	−7074662
239	19481	35000	27692	27391	2.29*+	0.6067	−6306790
63–1–21	28410	25000	23333	25581	−0.67+	0.4204	−4732520
H 13 A	24351	33333	32308	29997	1.49*+	0.1906	−7744278
224	26245	30000	32308	29518	0.76	0.5440	−2176630
157 B	31115	31666	32308	31696	0.13+	0.1295	−8163226
Pb. Castor No. 1	26245	31666	32308	30073	0.46+	0.3336	−6136842
Population mean	25944	32222	30698	29622	r $(\mu+di, bi)$ = 0.7611		
C. D. 5%	4964	—	—	—	r $(\mu+di, s^2di)$ = −0.9270		
C. V. %	11.06	15.54	19.61	17.00	r (bi, s^2di) = −0.6455 (NS)		
					r (μ+di and seed yield q/ha) = 0.98		

* and + significantly different from 0 and 1, respectively at 1% level.

resulting in acute moisture stress at generative stages (Mehrotra, 1975). Thus early maturing genotypes with favourable partitioning between vegetative and generative periods appear desirable for rainfed conditions. On the other hand, another recommended variety Aruna being highly responsive (Table 1) requires favourable environments for maintaining adequate productive plant population under rainfed conditions.

The significant positive r estimates between $\mu+di$ and b_i logically suggested that with the increase in the plant density, the responsiveness would tend to increase. Interestingly, another trend with significant negative r estimate between $\mu+di$ and s^2di suggest that stability would tend to increase with the increase in population. It supports the view that the reasonable curb on plant density would be desirable in increasing castor bean productivity in rainfed conditions.

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RESEARCH NOTE

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MOBILITY OF PHOSPHORUS IN RELATION TO DIFFERENT METHODS OF ITS APPLICATION UNDER LOW LAND CONDITIONS

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Majority of the alluvial soils (69.24%) in Haryana, Punjab and Delhi are low to medium in available phosphorus (Sethi *et al.*, 1952). These soils respond well to the application of nitrogen but little or no response to phosphorus application is observed for paddy crop in alkaline arid soils. Due to introduction of high-yielding varieties of paddy, the need of phosphorus application has been felt. In submerged conditions, the mobility of phosphorus is also important. Lot of efforts have been made to determine the forms in which the added phosphorus is converted but the studies relating to its mobility in rice soils are lagging behind. This study was undertaken to know the mobility of applied phosphorus under waterlogged conditions with respect to different methods of its application.

A laboratory experiment was conducted on Coarse Loamy Typic Camborthids soil whose physico-chemical characteristics were : pH 8.2, E.C. 0.6 mmhos/cm, organic carbon 0.25%, $CaCO_3$ 0.41% and available phosphorus ($NaHCO_3$ extractable) 6 ppm. The soil was ground to pass through 2 mm sieve. The columns were packed with 20 kg of soil. Phosphorus was applied @ 100 ppm P through monocalcium phosphate which was tagged @ 0.25 mCi/g P. The methods used for application of phosphorus are given below.

Three replications were kept for each treatment. After the application of phosphorus, water was allowed to stand 2 cm above the soil surface throughout the experimental period. The column was cut vertically from the centre and the samples were collected in sections of 2 cm upto a depth of 14 cm after 1, 7, 21 and 42 days. The samples were dried, ground and 4 g soil was taken in

1. Surface application : The required amount of P was mixed with one cm soil uniformly.
2. Placement at 4 cm } The solution was spread uniformly after taking
3. Placement at 8 cm } out the soil upto 4 and 8 cm, respectively.
4. Mixing the phosphorus in 0-8 cm soil depth uniformly.

stainless planchet for radio-active counts using end window tube of G. M. counter. From the radio-active counts, the per cent phosphorus recovery was determined at different depths.

The per cent recovery of phosphate at various depths as affected by different methods of its application is given in Table 1. It is clear from the data that, after one day of application, about 98 to 99% of applied P was recovered at the site of phosphorus application when it was applied on surface, 4 and 8 cm deep. But when P was uniformly mixed in 0-8 cm depth, then P was distributed almost uniformly in this zone. Only 1.58, 1.18, 0.59 and 0.44 per cent of P was recovered at 2 cm below the placement zone in surface,

TABLE 1

Mobility of phosphorus as affected by different methods of its application under low land conditions (per cent P present at different depths)

Treatments	Depth (cm)	Interval (days)			
		1	7	21	42
Surface	0—2	98.01	95.42	89.12	85.68
	2—4	1.85	4.16	9.56	12.39
	4—6	0.04	0.42	1.00	1.41
	6—8	—	—	—	—
	8—10	—	—	—	—
	10—12	—	—	—	—
	12—14	—	—	—	—
Placement at 4 cm	0—2	—	—	—	—
	2—4	98.82	96.41	90.46	87.57
	4—6	1.18	3.50	8.72	11.25
	6—8	—	0.09	0.82	1.01
	8—10	—	—	—	—
	10—12	—	—	—	—
	12—14	—	—	—	—
Placement at 8 cm	0—2	—	—	—	—
	2—4	—	—	—	—
	4—6	—	0.13	0.15	0.18
	6—8	99.41	97.31	92.00	89.72
	8—10	0.59	1.99	6.75	8.60
	10—12	—	0.57	1.10	1.36
	12—14	—	—	—	0.14
Mixing with 8 cm layer	0—2	23.11	20.72	18.60	17.69
	2—4	24.23	22.19	21.31	18.84
	4—6	25.18	26.58	27.15	25.58
	6—8	26.04	29.37	29.78	30.72
	8—10	0.44	0.98	3.11	6.16
	10—12	—	0.16	0.79	0.93
	12—14	—	—	—	0.08

4, 8 and 0-8 cm applications, respectively. This shows that the movement of P is negligible at the initial time of application and it decreased as the depth of application increased.

A perusal of the data (Table 1) further reveal that the per cent recovery decreased in the applied zone by the increase in the time of application in all the treatments, whereas its mobility in lower depths increased with increasing time.

After 7 days of application of phosphorus, the movement of phosphorus was limited to only in 4 cm in all the treatments and the per cent recovery decreased as the depth of application increased. At this stage, the upward movement was also noticed when it was applied 8 cm below but the magnitude was negligible (0.13%) which can be due to the diffusion of phosphorus.

After 21 days of P application, the movement of P was also noticed in 6 to 8 cm layer under surface application, although the extent of mobility was very low (0.32 %), but in other treatments, the movement was not found beyond 6 cm depth. After 42 days, the movement of P further extended by 2 cm in all the methods of application and the minimum was when P was mixed in 0-8 cm soil depth (0.08%) except surface application where P was already detected after 21 days of application, but the extent was increased in that case.

Thus, it is clear from this study that the mobility of P is only 6 cm and, out of that, negligible amount was recovered in 4 to 6 cm under submerged conditions. The results corroborate the findings of Okuda and Kawasaki (1962), but contradict to those of Chaudhry (1971) who reported 2-4 cm movement of P under paddy soils; and Bray (1942) who reported lesser movement of nutrients like K, Ca, Mg and P as those are absorbed by clay or organic matter or have other conditions for their precipitation. These results indicate that surface application is equally efficient in paddy fields as the mobility beyond the root zone is not expected under submerged conditions.

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RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XII, No. 1, pp. 125– 127 (March 1982)

EFFECT OF AUXINS AND ASCORBIC ACID ON GROWTH, FLOWERING AND SEX EXPRESSION OF *CUCURBITA PEPO* L.

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Application of auxins is known to change the sex of flowers towards femaleness. This was shown in cucumber (Laibach and Kribben, 1950), ridge gourd (Satyanarayana and Rangaswamy, 1959) and watermelon (Rahman and Thompson, 1969). Auxin has also been shown to participate in endogenous regulation of sex expression in cucumber (Galun, 1959).

Application of ascorbic acid (AA) is reported to increase growth, flowering and yield of several crop plants. Endogenous content of ascorbic acid has been reported to increase markedly during germination, active vegetative growth and flowering (Chinoy, 1962). However, its role in sex expression is not known.

Plants of *Cucurbita pepo* L. were raised in earthen pots in 2:1:1 mixture of garden soil, sand and farm-yard manure under natural conditions in a net house. After the first primary leaf unfolded, the plants were sprayed with different concentrations of freshly prepared aqueous solutions of IAA, NAA, PCPA and ascorbic acid to run off along with a drop of Tween 80 as wetting agent. Altogether, the plants were treated thrice at weekly intervals. Periodical observations on growth and flowering were recorded for 60 days.

NAA, IAA and PCPA were used in the concentrations of 125, 250 and 500 mg/l each. All the plants treated with PCPA died after 2 weeks of the treatment. The height of plants after 60 days was lesser with NAA than control but IAA was not effective. Similar trends were noticed in the number of leaves (Table 1). The number of male buds decreased with auxin application. NAA was more effective than IAA in this respect. The number of male flowers also showed more or less similar trend. The number of female buds decreased with all the three concentrations of NAA but did not differ with IAA. On the other hand, the number of female flowers markedly decreased with all the concentrations of NAA and IAA. Ratio of female to male buds markedly increased with 500 mg/l of NAA but did not differ with other concentrations. The ratio slightly decreased with all the concentrations of IAA (Table 1).

The height of plants treated with upto 500 mg/l of ascorbic acid was more than the control (Table 1). Trends were more or less similar in the number of leaves

TABLE 1

Effect of naphthaleneacetic acid (NAA), indoleacetic acid (IAA) and ascorbic acid (AA) on growth, flowering and sex expression of *Cucurbita pepo*

Concentration (mg/l)	Height of main stem (cm)	Number of leaves	Number of male buds	Number of male flowers	Number of female buds	Number of female flowers	Ratio of female to male bud
Control	27.8±1.6	30.5±0.7	46.0±1.8	29.3±1.9	3.5±0.2	1.7±0.5	13.1
NAA 125	25.5±1.9	31.0±1.2	36.0±0.9	25.0±2.2	2.7±0.3	1.5±0.4	13.5
250	21.2±1.2	26.4±1.8	26.0±0.8	17.5±2.1	2.5±0.3	0.7±0.3	10.6
500	18.2±0.4	23.4±0.6	23.0±2.4	15.2±0.8	0.8±0.1	0.7±0.2	27.4
IAA 125	29.2±2.4	31.5±1.4	37.0±2.2	25.0±1.9	3.5±0.2	0.8±0.3	10.5
250	28.9±1.4	32.0±1.0	35.1±2.1	24.7±1.0	3.0±0.3	0.7±0.3	11.7
500	27.0±0.9	32.7±1.3	31.0±0.9	20.2±3.3	4.5±0.3	0.5±0.2	9.1
Control	17.0±1.4	16.0±0.9	23.2±1.9	3.8±0.5	3.6±1.2	0.5±0.2	6.4
AA 50	18.5±1.1	15.4±0.6	22.0±2.8	6.0±1.2	4.8±2.1	1.0±0.3	4.7
100	23.2±3.7	18.3±1.0	29.9±3.2	8.1±1.2	5.1±1.7	1.1±0.4	5.8
500	27.0±2.7	20.8±1.3	34.4±2.9	8.5±2.4	6.6±2.2	0.9±0.5	5.2
1000	18.5±2.2	17.3±0.7	24.5±3.1	3.5±1.0	5.3±1.5	0.9±0.4	4.6

produced. The number of male buds also increased with 100 and 500 mg/l of ascorbic acid, the latter being more effective. Trends were more or less similar in the number of flowers. Thus, the number of male flowers increased from 3.8 to 8.5 with 500 mg/l of AA but the effect decreased with higher concentration. The ratio of female to male buds also decreased with AA application.

These results are not in conformity with the reported promotion of femaleness with auxin in other plants (Galun, 1959; Chailakhyan and Khryanin, 1978).

Application of ascorbic acid on the other hand increased both vegetative growth and flowering of *Cucurbita pepo*. The number of both male and female buds increased. This is in conformity with the reported promotion of vegetative growth and reproductive development with AA in other plants (Chinoy, 1962). However, AA does not appear to influence the sex expression of flowers.

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RESEARCH NOTE

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RELATIVE SUSCEPTIBILITY OF PEA CULTIVARS AGAINST LEAF MINER, *MELANOGROMYZA CONAVISTAE* GREATHEAD (DIPTERA : AGROMYZIDAE)

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The leaf miner, *Melanogromyza conavistae* Greathead (Diptera : Agromyzidae) is one of the serious pests of pea crop. The insect mines the leaves and, thus, adversely affects the photosynthesis as well as grain yield. Reaction of eleven pea cultivars grown in a Coordinated Varietal Trial during 1977-78 to this pest

TABLE 1

Reaction of promising pea cultivars against *M. conavistae*

Cultivars	Per cent leaves attacked by the leaf miner (pooled data)	Mean number of insect tunnels per 5 infested leaves (pooled data)
G_c—195	25.8*(29.74)	9.5*(3.03)
87—1	29.0 (32.98)	9.7 (3.06)
88—2c	32.1 (31.72)	12.4 (3.19)
Arkel	20.3 (25.20)	7.4 (2.68)
Harabona-B	22.9 (27.27)	11.4 (3.26)
Multi freezer	21.5 (32.58)	12.3 (3.45)
Early giant	20.1 (26.13)	13.6 (3.60)
9 P3	31.3 (35.06)	10.8 (3.22)
P—23	30.9 (32.88)	10.2 (3.13)
Bonneville	33.6 (34.83)	10.3 (3.10)
G_c—141	33.0 (34.59)	10.4 (3.24)
Analysis of variance	N.S.	N.S.

*Each figure is based on 12 observations—3 replications on 4 different dates (27th January to 8th March, 1978)

Figures in parentheses are Arc sin $\sqrt{\text{percentage values}}$

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was, therefore, studied. These cultivars were sown in the research area of the Department of Entomology in a randomized block design with three replications and plot size of 4 metre row. In each row, four observations on percentage of leaves bearing mines as well as number of mines per five infested leaves were recorded at fortnightly intervals starting from 27th January, 1978. For assessing leaf infestation, 50 compound leaves per plot per observation were examined. For recording the number of tunnels per five infested leaves, 15 randomly selected leaves per plot were observed. The data for all these observations were pooled and subjected to analysis of variance.

The data in Table 1 reveal no significant differences among the cultivars so far as percentage and extent of incidence of this pest is concerned.

The insect was identified by the British Museum (Natural History), London.

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EFFECT OF ATONIK ON YIELD AND QUALITY OF MUSKMELON *(CUCUMIS MELO* L.) VARIETY HARA MADHU

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Plant growth regulators such as auxins, anti-auxin and gibberellin are known to modify the growth, sex-expression and yield in cucurbits (Bukovac and Wittwer, 1956; Randhawa, 1969; Singh and Randhawa, 1969). Atonik has been reported to have a good effect for improvement of growth, yield and quality in several crops including vegetable crops (Arora *et al.*, 1980, 1981). The main constituent of atonik is aromatic nitro compound which stimulates plant activity without causing malformation or toxicity to the plant itself. The foliar spray of atonik at fruit set stage was effective in enhancing maturity, and thus, improved early yield in tomato (Arora *et al.*, 1981), whereas both seed dip treatment and foliar spray improved yield in radish (Arora *et al.*, 1980) and palak (Pandita *et al.*, 1980).

The present investigation was undertaken during 1978-79 to study the effect of atonik on yield and quality of muskmelon variety Hara Madhu. The soil of the experimental site was sandy loam with pH 8-8.5. Experiment was conducted with 12 treatment combinations of four seed treatment durations (0, 8, 16 and 24 h) and three spray intervals (weekly, fortnightly and unsprayed control) with 0.05% solution of atonik. A total of seven foliar sprays were made in weekly spray treatment and four in fortnightly treatments. Spray was started 15 days after germination of seeds. The experiment was laid out in randomized block design with four replications. Seeds were sown on 23rd February and 4th March in 1978 and 1979, respectively. Tween-20 was used as surfactant @0.005%. The treatment plot measured 4.8×1.5 m. There were eight plants per treatment at a spacing of 60 cm. All the treatment plots were given uniform dose of fertilizer (50 kg N, 25 kg P_2O_5 and 25 kg K_2O per hectare). Observations were recorded on fruit yield and T.S.S. content of fruits.

The data presented in Table 1 indicated significant differences in the number and weight of fruits per plant due to various treatments during both the years. Based on the average of two years data, 8 h seed dip treatment+spray at weekly intervals gave maximum number and weight of fruits per plant (3.1, 2.79 kg, respectively), however, least number and weight of fruits (1.3, 0.93 kg, respectively), were harvested

TABLE 1

Effect of atonik on yield and quality of muskmelon var. Hara Madhu during 1978-79 and 1979-80

Treatment	Average number of fruits per plant			Yield (kg/plant)			Yield (q/ha)			T. S. S. (%)		
	78-79	79-80	Av.	78-79	79-80	Av.	78-79	79-80	Av.	78-79	79-80	Av.
Control	1.8	0.8	1.3	1.20	0.65	0.93	83.3	69.1	76.2	11.9	12.9	12.4
Spray at weekly interval	2.0	1.1	1.5	1.30	0.62	0.96	84.5	68.9	76.7	11.1	13.8	12.5
Spray at fortnightly interval	2.5	1.5	2.0	1.70	0.99	1.35	108.9	75.1	92.0	12.0	13.3	12.7
8 h seed dip treatment (SDT)	2.4	1.2	1.8	1.73	0.80	1.27	122.2	74.7	98.5	12.6	13.0	12.8
8 h SDT+weekly spray	4.2	2.0	3.1	3.29	2.29	2.79	205.6	188.5	197.1	11.9	13.3	12.6
8 h SDT+fortnightly spray	3.2	1.9	2.6	1.79	1.16	1.48	192.2	79.3	135.8	13.7	13.2	13.5
16 h seed dip treatment	2.8	1.4	2.1	2.12	0.79	1.46	146.7	94.5	120.6	12.1	13.9	13.0
16 h SDT+weekly spray	2.0	1.9	2.0	1.39	1.15	1.27	154.5	109.9	132.2	12.2	13.8	13.0
16 h SDT+fortnightly spray	2.1	1.9	2.0	2.09	1.53	1.81	202.2	103.7	153.0	13.0	12.7	12.9
24 h seed dip treatment	1.6	1.5	1.6	1.25	0.79	1.02	86.1	73.2	79.7	13.5	12.4	13.0
24 h SDT+weekly spray	2.3	1.3	1.8	1.96	0.84	1.40	117.8	61.4	89.6	13.6	12.3	13.0
24 h SDT+fortnightly spray	2.2	1.3	1.8	1.80	0.87	1.34	155.6	92.9	124.3	12.7	11.6	12.2
C. D. at 5% level	1.2	0.7		1.04	0.39		31.9	24.7		N. S.	N. S.	

from untreated control plants. The most probable reason for increased number of fruits with atonik application might be increased translocation of organic material to the treated portion of the plant (Shindy and Weaver, 1967) or increase in the endogenous auxin content of flower which improved fruit set and development (Randhawa and Thompson, 1949). The mobilization or movement of nutrients into flowers and fruits by atonik application might have improved fruit set.

The maximum total yield of muskmelon fruits with atonik (8 h seed dip treatment+weekly spray) was primarily because of increased fruit set (Table 1). Another possible reason for higher total yield may be auxin directed mobilization of nutrients into flowers and fruits by its application (Weaver, 1973) or may also be due to effect on multiplying the soil microorganism because atonik is expected to make the soil fertile indirectly through foliage of the plant by accelerating the decomposition of organic matter as reported by the manufacturers of this chemical. The yield responses were poor in all the treatments during 1979-80 primarily because of non-availability of sufficient canal water than any other climatic condition, mainly temperature (Wacquant, 1974) at the critical stages of flowering and fruit set, thus, muskmelon plants were subjected to moisture stress (Sutcliffe, 1966). During 1978-79 the plant experienced no moisture stress and the various physiological processes went on normally resulting in better uptake of nutrients (De Kock *et al.*, 1979), more conducive soil environment for better plant growth (Wilcox, 1973), increased number of hermaphrodite flowers, fruit set, fruit weight and number of fruits per plant (Chander, 1980) which are the attributes of yield per plant (Malinina, 1971).

There were no significant differences in the T.S.S. content of the fruits due to various treatment combinations during both the years (Table 1). However, maximum T.S.S. content of fruits was recorded from 8 h seed dip treatment+spray at fortnightly interval, while least from 24 h seed dip treatment+spray at fortnightly interval and untreated control.

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FARMING SYSTEMS IN RELATION TO SIZE OF LAND HOLDING—A CASE STUDY

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ABSTRACT

The study was undertaken to give a systematic account of different farming systems in relation to size of operational holdings. The occupational structure of families, cropping patterns and animal patterns were found to be influenced by the size of land holdings. It was observed that with the decrease in the size of holding from large to marginal led to a decline of the professional farable farmers and non-workers and increased the professionals in the dairying, service, carpenter, shop keeper and wages workers. With the decrease in the land holding size, area under bajra and gram was decreased but those under wheat, cotton, jowar and rabi fodders increased. The number of bullocks, buffaloes less than 2 years and dry buffaloes decreased but those of milch buffaloes, milch cows, sheep and goats increased as the size of holding decreased.

Meagre information is available on farming systems in relation to the size of an operational unit or a combination of such units and the constraints of socio-economic factors.

The present study represented a sample village Gangwa of district Hissar located 4 km in south of Hissar. The location survey was characterised by the advantage of nearness to a big city and of being situated on a metalled road. It is a village of peasant proprietors with agriculture as main occupation.

MATERIAL AND METHODS

The study is based on family-wise information regarding cropping patterns, animal patterns and occupational structure of the family including farming, service, dairying, wage workers, carpenter, shop keeper and non-workers. The heads and youths of the family were interviewed to collect data regarding crops, animals and family composition with the help of a well drawn questionnaire during December, 1979. The information about cropping patterns was collected for the period of **kharif** 1978 and **rabi** 1979. All the families were divided into five categories of operational holdings and data relating to each category were converted into percentage. The percentage of different crops, animals and family occupation in each category were arranged in the descending order and then deviation was computed with respect to data given in Table 1 so as to find out the given combinations

TABLE 1

Crop, animal and family occupation combination

Family occupational grouping	Per cent weightage attached
1	100.00
2	50.00
3	33.33
4	25.00
5	20.00
6	16.66

arising out of the parameters measured (Wearer, 1954). These values were later squared and summed up. The lowest value indicates the stages of crop, animal and family occupation combinations (Table 2) best suited in a category. Similar studies were made by Jasbir Singh (1976) and Negi (1978). The present study is in the nature of a case study and, thus, a micro-level method was used to examine the effect of land holdings on farming systems.

RESULTS AND DISCUSSION

The total number of families in village Gangwa was 367, having a population of 3952 (Table 2). The land holding with families coverage and category-wise details about occupational structure, cropping pattern, animal pattern and their combinations have been shown in Table 2.

Large Size of Land Holding

The main occupation of the people in large size of holdings was arable farming in which 44.9% of the total population was engaged. Non-workers were 10.4% of the total population. The dominant category was for bajra, gram, wheat and guara crops with coverage being 23.5, 22.9, 20.2 and 10.6 per cent, respectively. The intensity of cropping was 124.3 per cent. The population of buffaloes less than 2 years was 32.7%, bullocks 30.5%, buffaloes in milk 16.8 % and dry buffaloes 12.8 per cent. The existing type of farming in this category came under subsistence crop and livestock farming with coarse food-grain dominating the cropping pattern.

Medium Size of Land Holding

The cultivators formed 38.6% of the population. Arable farming was composed of wheat (24.5%), bajra (22.2%), gram (16.9%), cotton (8.9%), guara (8.5%), jowar (8.2%) and rabi-oilseeds (6.8%). The animal component comprised bullocks 28.9%, buffaloes in milk 21.0%, buffaloes less than 2 years 29.5% of the total animals. Cotton was the only commercial crop that ranked fourth in the cropping pattern. The farming practised in this category was subsistence crop and livestock farming with domination of food-grains having cotton as commercial crop in the crop associations.

TABLE 2

Occupational structure, cropping pattern, livestock pattern and their combination under different land holdings of village Gangwa (Hissar)

Parameter	Large	Medium	Small	Marginal	Landless	Village as a whole
1. Size of holding (acres)	>20.0	>10-≤20.0	>5.0≤10.0	≤5.0	—	—
2. Number of families	49	83	70	105	60	367
3. Total population	560	846	768	1043	735	3952
4. Occupational structure (percentage of the total population)						
(a) Farming	44.9	38.6	30.0	16.9	1.2	27.3
(b) Dairing	0.9	2.3	3.3	4.8	0.9	2.5
(c) Service	1.4	2.5	3.3	4.7	2.4	2.9
(d) Carpenter	—	0.5	2.9	5.1	5.4	2.8
(e) Shop keeper	1.4	2.6	2.8	4.5	4.8	3.2
(f) Wage worker	0.2	1.6	2.9	11.0	15.2	6.2
(g) Non-worker	10.4	8.5	7.0	6.6	11.9	8.9
(h) Children	40.5	42.8	46.4	45.2	53.4	45.0
(i) Others	0.3	0.6	1.4	1.2	4.8	1.2
Total	100.0	100.0	100.0	100.0	100.0	100.0
5. Total cultivated area (acres)	2111	606	216	77	—	3012
6. Intensity of cropping (percentage of total cultivated area)	124.3	138.4	151.2	164.9	—	144.7
7. Cropping pattern (percentage of the total cultivation)						
(a) Bajra	23.5	22.2	21.0	20.2	—	21.7
(b) Jowar	5.7	8.2	9.5	9.2	—	8.4
(c) Guar	10.6	8.5	5.8	7.6	—	8.1
(d) Cotton	8.5	8.9	11.1	11.2	—	9.7
(e) Wheat	20.2	24.5	25.0	25.9	—	24.2
(f) Gram	22.9	16.9	15.6	14.2	—	17.2
(g) Rabi fodder	2.2	4.0	6.2	7.6	—	5.7
(h) Rabi oil seeds	6.4	6.8	5.8	4.1	—	5.7

8. Total number of animals of each holding	475	470	321	293	300	1859
9. Pattern of livestock distribution (percentage of total number of animals)						
(a) Cattle 2 years	3.0	2.5	2.3	2.0	1.0	2.3
(b) Buffaloes <2 years	32.7	29.5	27.6	26.9	8.0	24.4
(c) Bullocks	30.5	28.9	22.5	12.8	—	24.4
(d) Cows in milk	2.9	3.5	4.5	5.4	1.3	3.1
(e) Cows in dry	1.0	1.4	1.9	2.2	0.5	1.0
(f) Buffaloes in milk	16.8	21.0	28.0	30.0	7.0	17.2
(g) Buffaloes in dry	12.8	10.5	8.1	7.6	1.0	9.1
(h) Goats	0.3	2.7	4.1	7.5	26.7	8.5
(i) Sheep	—	—	—	5.5	54.7	12.0
10. Crop combination	Bajra-gram-wheat-guar	Wheat-bajra-gram-cotton-guar	Wheat-bajra-gram-cotton-jowar	Wheat-bajra-gram-cotton-jowar	—	Wheat-bajra-gram-cotton-jowar
11. Livestock combination	Buffaloes<2 yr-bullocks-milch buffaloes	Buffaloes<2 yr-bullock-milch buffaloes	Milch buffaloes-buffaloes<2 yr-bullocks	Milch buffaloes-buffaloes<2 yr-bullocks	Sheep-goat	Buffaloes<2 yr-bullocks-milch buffaloes-sheep
12. Occupational combination	Farming-non-worker	Farming	Farming-non-worker-service-dairying	Farming-wage worker-non-worker-carpenter	Wage worker-non-worker-carpenter-shop keeper	Farming-non-worker-wage worker-shop keeper-service

Small Size of Land Holding

Farming accounts for only 30.0% of the total population, with dominant occupational combinations being : farming--non-workers--dairying--service. The intensity of cropping was high upto 151.2 per cent. The crop combination of this category was wheat-bajra-gram-jowar with proportion of different crops being, wheat 25.0%, bajra 21.0%, gram 15.6%, cotton 11.1% and jowar 9.5%. Milch buffaloes became more important in this category as these account for 29.0% of the total animals and these ranked first in the livestock associations. Buffaloes less than 2 years got second rank and bullocks third rank. Some differences were found into the combinations as compared to previous categories such as the introduction of dairying in occupational structure, jowar as a forage crop in the crop combination, and milch buffaloes as a first rank animal in the animal combinations. From this fact it is imperative that milk production becomes lucrative with small holders.

Marginal Size of Land Holding

The dominant occupational combination in this category was farming—wage worker and non-worker—carpenter and dairying. The intensity of cropping was 164.9 per cent. The crop and livestock combinations were same to that of small sized category. Wheat, bajra, gram, cotton, jowar and rabi fodder covered 25.9, 20.2, 14.2, 11.2, 9.2 and 7.6 per cent of the total cropped area of the category, respectively. The animal combinations were milch buffaloes 30.1%, buffaloes less than 2 years 26.9%, bullocks 12.8%, buffaloes dry 7.6%, goats 7.5 %, and sheep 5.5 per cent. The presence of sheep became noticeable in this category (Table 2). The existing farming in this category was also 'mixed farming'.

Landless

The occupational category of wage worker accounted for 15.2% of the total population. Farming disappeared from the occupational combination and the combination comprised wage worker—non-worker--carpenter--shop keeper. Only 1.2% of the total population was engaged in farming as tenants. Sheep and goats were most important livestocks of this category. Sheep accounted for 54.7 % of the total animals and goats 26.7 per cent. Due to disappearance of farming occupation, bullocks were also not reared. Thus, the farming system in this category was small animal rearing.

On the whole three types of farming systems were recognised in the present study in different sizes of holdings, viz., (i) 'subsistences crop and livestock farming' on large and medium size of holdings, (ii) 'mixed farming' on small and marginal farmers, and (iii) 'small animal rearing' practised by landless farmers. These studies could, thus, be used more advantageously for planning agricultural development programmes.

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ECONOMIC FEASIBILITY OF BER CULTIVATION IN HARYANA

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ABSTRACT

The study revealed that investment in ber orchard is a profitable proposition in the areas where irrigation water is scarce. Capital cost of ber orchard is recoverable in a period of six years and ber crop provides regular net income of Rs. 1500/- per hectare per annum. The benefit cost ratio showed that an investment of Re 1/- in ber orchard would fetch a return of Rs. 3.00. Ber cultivation will also stabilize the income of the dry belt farmers of the State, where occurrence of drought is expected after every 2 or 3 years. In the drought years, crops fail but ber crop will tolerate drought without severely affecting the production. Cultivation of ber will also check menance of desert expansion. Hence, farmers may be advised to plant ber orchards where irrigation water is scarce. However, there is need to develop proper marketing and processing facilities before its cultivation is popularised on a large scale.

Ber is one of the oldest and popular fruits grown in the country. Besides Vitamin C, it contains adequate quantity of Vitamins A and B and important minerals, particularly calcium and iron. It is grown under conditions where most other trees fail to grow. For its successful cultivation it favours a hot and dry climate, but requires light watering during the fruiting season. It withstands the conditions of extreme drought as well as water-logging. In addition, it requires very little care and hence very little expenditure is to be incurred on its cultivation. In India, it occupies about 10,000 hectares area, whereas in Haryana it occupies about 1,000 hectares. **Ber** is an important fruit crop of the dry areas of the State; mainly grown in Rohtak, Narnaul, Hissar, Sirsa and Gurgaon districts of the State. The land allocated to this crop is generally sandy and unirrigated.

The cost of cultivation of **ber** consists of two parts, viz., capital costs and recurring expenditure. The former consists of the expenditure on goods and services (excluding the value of land) required for the establishment of the orchard. Recurring costs include all non-capital expenses required for the annual maintenance of trees. It includes wages of labourers, cost of inputs such as fertilizers, pesticides, irrigation, maintenance and repair of capital items, etc.

In this study an attempt was made to appraise the economic feasibility of **ber** cultivation in the State.

METHODOLOGY

From all the districts where **ber** cultivation is done, 45 growers (5 from district Hissar, 9 from Narnaul, 6 from Gurgaon, 16 from Rohtak and 9 from Sirsa) were selected for this study. The data used related to year 1977-78.

For estimating the costs and returns, prices paid by the owners and amount received from the auction were considered. Harvesting charges were not included as orchards were auctioned by the owners. To examine the economic feasibility of **ber** cultivation three indicators were used, viz., cost-benefit ratio, internal rate of return, and recoupment or pay back period. For calculating the internal rate of return Bierman and Smidt (1975) tables were used.

RESULTS AND DISCUSSION

Economics of Ber Cultivation

Ber trees start bearing fruits in the third year and reach full bearing capacity of about 50 q/ha in fifth year and thereafter yields remain more or less constant. The bearing continues for about 50 years but reasonable rate of return can be expected till 30 years. It is evident from Table 1 that this crop generates an average net income of Rs. 1515.22 (Rs. 2876.83–Rs. 1361.61) per hectare per year in the fifth year and onwards. On an average 4614 kg of berries per hectare (about 42 kg/plant) were obtained. This yield is quite low compared to the yields of the improved varieties which vary from 73 to 112 kg/plant (Singh *et al.*, 1967). This indicates potential to increase **ber** production which is actually being obtained by growers through proper manuring, irrigation and pruning of the orchards.

Discounting Future Returns

Net return figures shown in Table 1 do not serve as true guide for making choice to go for **ber** orchard. This is mainly because the costs included and returns obtained from **ber** orchard over time are not comparable with other crops. This is due to the fact that returns from the investment in food grain crops can be obtained within a year, whereas three years must lapse after planting before any returns are obtained over recurring costs from **ber**. This shows the need to estimate the deferred returns by discounting future returns. Hence, it is necessary to estimate the net present value of future returns which can be determined by discounting both the costs as well as returns at the prevailing rate of interest. Future net returns were discounted to their net present value by using following formula :

$$NPV = \frac{R_1}{(1+r)^1} + \frac{R_2}{(1+r)^2} + \cdots\cdots + \frac{R_{n-1}}{(1+r)^{n-1}} + \frac{R_n}{(1+r)^n}$$

Where R_1, R_2,..... ....R_n are the net returns in period 1, 2,... ...n, respectively, n is the life span in years of the investment in the **ber** orchard, r is discount rate (rate of interest) and NPV is net present value of the returns (R_1, R_2.....R_n). The net returns thus obtained are shown in Table 2.

TABLE 1

Economics of *ber* cultivation per hectare in Haryana during 1977-78 (average stand=109)

Item	Year				
	I	II	III	IV	V and onwards
A. Establishment costs					
(i) Cleaning and levelling of field	182.04				
(ii) Digging and filling of pits	241.10				
(iii) Cost of plants (138 plants)	228.85				
(iv) Replacement of plants	—	3.61			
(v) Fencing	114.56	—			
Total	766.55	3.61	—	—	—
B. Recurring and maintenance costs					
(i) Manuring (Farmyard manure and fertilizers)	198.97	127.18	67.26	—	—
(ii) Interculture	—	113.37	66.00	58.96	58.96
(iii) Irrigation	138.79	157.68	149.56	115.40	115.40
(iv) Plant protection	12.69	88.48	—	—	—
(v) Pruning	—	27.64	108.24	93.71	93.71
(vi) Repair of fencing	—	52.34	54.22	59.01	59 01
(vii) Opportunity cost	1034.53	1034.53	1034.53	1034.53	1034.53
Total	1384.98	1601.22	1479.81	1361.61	1361.61
Total cost (A+B)	2151.53	1604.83	1479.81	1361.61	1361.61
C. Returns					
(i) Yield (q)			20.87	42.49	46.14
(ii) Gross returns (Rs.)			1301.24	2630.55	2876.83
(iii) Price received by the orchard owner (Rs./q)			62.35	62.35	62.35

TABLE 2

Net present value of one hectare **ber** orchard (discount rate 10%)

Year	Cost	Net returns	Discount coefficient 1/(1+r)	Present value	
				Cost (Rs.)	Returns (Rs.)
I	2161.53	—	0.9091	1955.96	—
II	1604.83	—	9.8264	1326.23	—
III	178.57	—	0.7313	130.59	—
IV	—	1268.84	0.6630	—	866.62
V and onwards	—	1515.22	6.2679	—	9496.49
Total	3934.93	2784.06	—	3412.78	10363.11

The discounted returns at 10% for the one hectare **ber** orchard came to Rs. 6950.33 (Rs. 10363.11–Rs. 3412.78) for the entire expected life of 30 years or on an average annual net return of Rs. 737.20 per hectare*. This represents constant annual net returns over the life of **ber** orchard.

Table 3 shows net present value(NPV) of returns from one hectare of competing crops with one hectare **ber** orchard. It is clear from Table 3 that **ber** cultivation is more paying than competing crops. Returns from a single crop were considered because where **ber** is grown, it is not possible to grow both **kharif** and **rabi** crops due to severe scarcity of irrigation water. **Ber** cultivation is comparatively less paying in partly irrigated areas where crops are grown. However, when the social benefits from the **ber** orchard such as afforestation resulting into improvement in ecological environment, use of **ber** leaves as fodder to goats and sheep, and wood for fuel are also considered, **ber** cultivation may prove more economical even than these crops.

Internal Rate of Return

One of the important indicators for evaluating the desirability of the investment with long gestation period is the internal rate of return. It is defined as the rate of discount (γ) or the earning power of the investment which equalises discounted benefits or returns (B) with the discounted cost C, i.e., the rate of discount which will satisfy the relationship, B—C=0. In estimating the internal rate of return, the investment costs and incremental gross returns for each year in the life of **ber** orchard are calculated. For each year expenditure is

*The average annual net return is determined by dividing total discounted net returns or net present value (NPV) by the present worth of an annuity of Re. 1.00 for the life of the ber orchard (30 years in the present case). Thus, at the discount rate of 10% present worth of one hectare of ber orchard was estimated to be Rs. 6950.33 for a life span of 30 years. The present worth of an annuity of Re. 1.00 for 30 years at 10% is Rs. 9.4269. Therefore, average annual net return is Rs. 6950.33÷9.4269=Rs. 737.20 per hectare.

TABLE 3

Net present value (NPV) of returns from one hectare of competing crops with **ber** orchard

Crop	Net returns* (Rs.)	NPV** of returns received in 30 years
Gram	543.74	5125.78
Mustard	418.28	3943.08
Guar	289.81	2732.01
Bajra (desi)	148.66	1401.03

*Source : Economics of Important Kharif and Rabi Crops in Haryana. Package of Practices Kharif and Rabi Crops 1977-78. Directorate of Extension Education, Haryana Agricultural University, Hissar.

** Net present value of Re. 1.00 received per year for a period of 30 years at the interest rate of 10% is Rs. 9.4269.

TABLE 4

Internal rate of return from one hectare **ber** orchard

Year	Cost	Annual gross return	Net cash flow		Present value coefficient	Corresponding present value	
			(−)	(+)	r=26%	(−)	(+)
I	2151.53	—	2151.53	—	0.7937	1707.67	—
II	1604.83	—	1604.83	—	0.6299	1010.88	—
III	1479.61	1301.24	178.57	—	0.4999	89.27	—
IV	1361.61	2630.55	—	1268.84	0.3968	—	503.48
V and onwards	1361.61	2876.83	—	1515.22	1.5222	—	2306.47
Total	—	—	3934.93	2784.06	—	2807.82	2809.95

substracted from gross return (Table 4). The result is a single value for each year. These single yearly values have negative and positive signs depending on the quantum of costs and benefits or returns in each year. Finally to find out a discounted rate iterative method is employed until the difference between the sums of discounted streams of positive and negative values is reduced either to zero or to a lowest minimum (Anonymous, 1973). The internal rate of return or earning power of one hectare **ber** orchard was found to be as high as 26 per cent.

Recoupment or Pay Back Period

It is the period within which the cost of the **ber** orchard is fully recovered from its own returns. In other words, it indicates the number of years by which the net return (R) equals to the cost of

TABLE 5

Sensitivity analysis : Internal rate of return (Rs./ha) from one hectare ber orchard when returns fall by 20 and 25 per cent

Year	Cost	Returns	Net cash flow		Present value coefficient	Corresponding present value	
			(—)	(+)		(—)	(+)
		When returns fall by 20 per cent (r=17 per cent)					
I	2151.33	—	2151.53		0.8547	1838.91	—
II	1604.83	—	1604.83		0.7305	1172.73	—
III	1479.61	1041.00	438.61		0.6244	273.87	—
IV	1361.61	2104.15	—	742.54	0.5337	—	396.29
V and onwards	1361.61	2301.44	—	939.85	3.0859	—	2900.28
Total	7959.19	5446.61	4194.67	1682.39	—	3285.11	3296.57
		When returns fall by 25 per cent (r=15 per cent)					
I	2151.53	—	2151.53		0.8696	1870.97	—
II	1604.83	—	1604.83		0.7561	1213.41	—
III	1479.61	975.93	499.68		0.6575	328.54	—
IV	1361.61	1972.79	—	611.18	0.5718	—	394.47
V and onwards	1361.61	2157.62	—	796.01	3.7110	—	2953.99
Total	7959.19	5106.34	4256.04	1407.19	—	3412.92	3303.46

the ber orchard (K). For this condition the following relationship must be satisfied. :

$$\sum_{i=1}^{n} R_i = K$$

As evident from Table 4, the net cost incurred during the first 3 years of the ber orchard is Rs. 3934.93. This cost would be more than fully recovered (Rs. 4299.28) during next three years, i. e., sixth year of the ber orchard. Thus, the pay back period of one hectare ber orchard is six years.

Benefit-Cost Ratio

This indicator (B) is ratio between the sum of discounted net benefits of returns (R) and the sum of discounted cost (K), i.e. $B = \frac{R}{K}$. When discounted rate is 10 per cent (i.e., interest paid on long term investment), B is found to be $\frac{10363.11}{3412.78} = 3.04$ (Table 2). It indicates that at the prevailing rate of interest of 10% per annum an investment of Re. 1.00 would fetch a return of Rs. 3.04 (both calculated at present value). Since this ratio is greater than one, the investment in ber orchard is considered to be economically justified. It may be noted from the analysis of internal rate of return given in Table 4 that even at an interest rate of 26% on the capital invested, the ratio would be unity.

Sensitivity Analysis

The rate of return from an investment is likely to be affected by changes in values of its basic parameters such as future yield, output prices and input costs, demand estimated and lags in output (Anonymous, 1973). In case of ber, unit prices and unit costs (unit costs change due to change in yield or input prices) are the sensitive parameters and they are likely to have greater impact on the rate of return. For the sensitivity analysis 20 and 25 per cent fall in returns either due to change in ber yield or prices, the discounted present value of future returns with negative (−) and positive (+) signs are found out as in case of internal rate of return. The final discount rate is that which will make the sum of discounted stream of positive and negative equal to either zero or any other possible minimum. The details are given in Table 5.

It is evident from Table 5 that the internal rate of return of ber orchard would go down to 17 per cent, i.e., 9% less when returns from ber orchards fell by 20% either due to fall in prices or yield. Internal rate of return would be about 15% when returns decline by 25 per cent. This rate of return sets the lower limit below which the farmers may not prefer to invest money in ber cultivation. Considering the results of three feasibility tests used in this study, it can be concluded that the cultivation of the ber is profitable in the areas of the State which are sandy and cropping is surely impeded by qualitative and quantitative water availability constraints.

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STUDY ON THE ASPIRATION OF RURAL PARENTS REGARDING THEIR CHILDREN'S EDUCATION

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ABSTRACT

The study undertaken in four villages of Hissar district revealed that rural parents had differential level of aspiration for the education of their sons and daughters. The parents aspiration for their children's education, occupation, their income and general contentment with present standard of living when correlated with type of family, family size, son's and daughter's age and father's education was found to be significantly related in most of the cases, whereas mother's education and child labour variables were found to be significantly but negatively related. The crucial factors found affecting the aspiration of rural parents were child labour utilized for field or household work, care and handling of sibling in absence of parents.

The role of rural parents in the acquisition of their children's future is well documented by the ways in which they operate as the source for the transmission of the old cherished values and unfavourable attitude towards education of their off-springs.

Education has tremendous role in transformation of one's behaviour, therefore, provision for education of children is the primary goal in any endeavour connected with the development of a nation. Therefore, at this juncture, it was felt necessary to find out the self-motivation or aspiration of parents towards their children's education. Muthaya (1971) observed that lack of parental orientation to education was merely because of their own illiteracy. He further (1972) substantiated that farmers had differential aspirations for their children's education, especially, in case of daughters it was of a lower level. Hence, aspiration of parents is a crucial determinant for launching formal or informal educational programme in Indian villages.

Preston and Bayton (1941) mentioned aspiration as goal statements concerning future level of achievement. Holler (1968) referred aspiration to a person's (or group of persons) orientation towards future goals, which may vary in nature of status of attributes, as income, occupation, education, etc. For the purpose of this study, aspiration has been operationally defined as a statement of respondents concerning their future level of achievement. High and low levels are relative aspiration of future specified goals.

METHODOLOGY

The sample respondents were drawn from four villages, viz., Dabra, Mayyar, Nayana and Satroad of Hissar Block I and II. One hundred rural parents having children in between 5 to 16 years of age constituted the sample. The data were collected personally with the help of a structured interview schedule. A projective technique was used for explaining the concepts of aspiration levels in the form of a ladder occupying positions from least satisfying to highly satisfying continuum. The respondents were asked to place themselves on the ladder as they feel they are at present. They were also asked to visualise themselves on the ladder in terms of their future achievements. The difference between the two was calculated to determine their aspiration level of future for their children's education, employment, parent's income and general contentment with present standard of living. The collected data were analysed and processed by applying coefficient of correlation.

RESULTS AND DISCUSSION

Rural Parents Socio-personal and Economic Profile

The study revealed that majority of the rural parents had individual type of family comprising 5 to 10 members (62%). The age of children particularly boys (69%) ranged between 13-16 years and that of girls between 9 to 12 years (58%). Majority of the parents (fathers 58% and mothers 94%) were illiterate. Only 14% of fathers had high school and above level of education. The child labour utilization was found to be highest in case of agriculture (34%) followed by animal husbandry (20%) and household activities (12%). However, nearly one-third of parents (34%) were interested in the education of their children and did not put them for any type of work which might supplement their family income.

Level of Aspiration of Rural Parents Regarding Education, Employment, Income and General Contentment in Life

Educational aspiration of rural parents for their children goes with parent's aspiration for their children's employment, their own income and general contentment in life.

The study established that a fairly large number of rural parents had moderately satisfying level of aspiration for their children's education, occupation, income and general contentment with their present standard of living, the corresponding figures being 46, 46, 47 and 56%, respectively (Table 1). These findings are in consonance with the study of Singh and Tripathi (1969), who reported that education and income were positively associated with the development of aspiration level.

The data in Table 1 indicate that parents' aspiration was to the extent of moderately satisfying level, for their sons' education (60%), whereas average level was recorded in case of daughters (47%). The study revealed that parents had differential aspiration levels for their sons and daughters which apparently had higher loading in case of sons. This might be due to the fact that girl's

TABLE 1

Aspiration level of rural parents regarding children's education, occupation, parent's income and general contentment with present standard of living

Aspiration level	Parent's aspiration					
	Children's education (%)		Children's occupation	Parents income	Present standard of	Mean scores
	Sons	Daughters	(%)	(%)	living (%)	
Highly satisfying	2	0	0	0	0	0.50
Moderately satisfying	60	32	46	47	56	48.75
Average	34	47	36	29	34	34.75
Less satisfying	3	19	16	19	7	13.25
Least satisfying	1	2	2	5	3	2.75

education was not getting required attention in rural communities. Higher educational aspiration for sons was obviously due to higher expectations in future from them as bread earner of the family.

Socio-personal Variables in Relation to Parents Aspiration

Socio-personal variables included type of family, family size, age of children, parents' education and child labour utilized for work. The data in Table 2 revealed that there was positive and significant correlation between parent's aspiration for their son's education and type of family, family size, boy's age and father's education. These findings are in agreement with Choudhary (1977). However, the girl's age was not found to be significantly related. Mother's eduacation and child labour were found

TABLE 2

Socio-personal variables in relation to parents aspiration for their children's education, occupation, income and general contentment with present standard of living

Socio-personal Characteristics	Parent's aspiration				
	Children's education		Children's occupation	Parent's income	Present standard of living
	Sons	Daughters			
Type of family	.2344*	.2660*	.2569*	.2590*	.2192*
Family size	.2649*	.8450*	.2883*	.2305*	.2780*
Children's age					
Sons	.2619*	.0137	.2144*	.2041*	.2551*
Daughters	.0108	−.2420*	−.0195	.0681	.2197*
Parents education					
Father	.9803*	.2314*	.2655*	.3750*	.2040*
Mother	−.2224	−.2759*	−.2433*	−.2257*	−.1071
Child labour	.2887	−.2182*	−.2257*	−.2179*	−.2204*

*Significant at 0.05 level ($r < 0.2$)

to be negatively and significantly correlated with their aspiration for their son's education.

So far parent's aspiration for their daughter's education was concerned, type of family, family size and father's education were found to be positively and significantly related. Solcum and Empey (1966) also reported their results on these lines. The study further established that daughter's age, mother's education and child labour were negatively and significantly related with the aspiration of parents. There was positive and significant relationship between parents aspiration and job placement of their children. These findings run counter to the results obtained by Rao (1964).

In case of aspiration level of parents regarding their income, all the variables taken into account were found to be positively and significantly related. These results were consistent with the findings of Caro and Pihilblad (1965). Mothers' education and child labour were negatively significant.

The aspiration level of parents for saving with their standard of living indicates that the type of family, family size, son's and daughter's age and father's education were positively related and child labour was negatively related with the parents standard of living.

The aspirations of parents for their children's education, occupation income and standard of living were significantly related to the type of family, family size, son's age and father's education. This appears justifiable since the educated fathers, having larger family size with grownup sons, provides greater scope for parents to aspire more for their future. The negative trend was observed in case of mothers education. Nevertheless the

TABLE 3

Factors affecting the aspiration of parents

S. No.	Factors	Mean scores	Ranking
1.	Child labour utilized for field/household work	3.80	I
2.	Care and handling of siblings in absence of parents	3.60	II
3.	Preference to male children in all spheres of life	3.18	III
4.	Unhealthy parents	3.08	IV
5.	Unfavourable attitude of parents or children	2.80	V
6.	Parent's non-progressive value of life	2.67	VI
7.	Death of either husband or wife	2.43	VII
8.	Low annual income	1.84	VIII
9.	Dissatisfaction with farming	1.76	IX
10.	Parents routine work and monotony	1.76	IX
11.	Heavy dependence on poor group for decision making	1.32	X
12.	Lack of mutual parental encouragement	1.32	X
13.	Economic insecurity or unsafety	0.99	XI

negative relationship could be explained in the light of higher aspiration of mothers to improve their standard of living inspite of their being uneducated.

Similarly, negative trend in case of parents aspiration in relation to daughters' education could be due to the fact that as the age of daughters advances, the parents would not aspire more for their education and might keep up the norms of the society. Moreover, the negative relationship between parents' aspiration with child labour could be explained in terms of continued involvement of the family in labour work, hence decreased level of aspiration for future.

Factors Affecting the Aspiration of Rural Parents for their Children's Education

The factors influencing the level of parents aspiration for their children's education have been shown in Table 3 in descending order of their importance.

The most important factors (mean scores ranging between 3.08 to 3.80) like child labour utilized for field/household work, care and handling of sibling in absence of parents, preference to male children in all spheres of life and unhealthy parents were found exerting their influence on the aspiration of rural parents.

The second set of factors (mean scores ranging between 2.43 to 2.80) were unfavourable attitude of parents for children, non-progressive value of life and death of either husband or wife. Rest of the factors had mean score less than 2.00. Therefore, it could be inferred from the data that in most of the cases these factors with mean scores less than 2.00 have insignificant bearing on the level of aspiration of parents for their children's education.

CONCLUSION

Rural parents need special orientation regarding their children's education, which would help them to get suitable employment opportunity, which will add to their income leading to better standard of living. The formal, informal and adult education programmes if geared up with clients' aspiration, would go a long way in uplifting rural economy. Adequate attention is required to control or manipulate the factors which are responsible to decrease the level of aspiration.

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NATURE AND EXTENT OF CHILD AND INFANT DISEASES IN RURAL HARYANA

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ABSTRACT

Nature and extent of child and infant diseases, in a typical Haryana village, were studied. Incidence of seriousness of 29 different diseases was assessed. The incidence of serious diseases like gastro-enteritis, malaria, whooping cough, and cold and cough was very high. The perception of seriousness of the diseases by rural women was correlated with those of medical professionals and found to be positively correlated.

A child is the future builder of a nation. About 42% of Indian population is in the age group of 0-14 years and 21% in the age group of 0-6 years (UNICEF, 1974). Thus, any neglect of their health would mean the negligence of health of almost half of the population. If we want to improve the health of our population, due attention to it should be paid right from childhood. The health problem is more acute in rural areas because of the indifferent attitude of the population towards personal hygiene and prevailing poor environmental conditions coupled with low socio-economic status (Achar, 1975). Considering the importance of the aspect, the present study was undertaken.

METHODOLOGY

A typical Haryana village in terms of number of families, caste and occupational conditions, socio-economic status of the families and availability of medical facilities was selected purposely. Slimgarh a medium-sized, multi-caste village in which farming was the main occupation of most of the families was selected. In all, there were 244 households in the village. The socio-economic status of all the families was measured by using the socio-economic status scale developed and standardised by Pareek and Trivedi (1963) for Delhi villages, as Delhi villages have cultural pattern similar to Haryana villages. The reliability and validity indices of the scale were .93 and .98, respectively.

Each factor in the socio-economic status scale was given a score. The minimum and maximum possible socio-economic status scores on this scale were 5 and 48, respectively. The whole range was divided into three groups viz., high, medium and low on the basis of weighted cumulative frequency of the scores.

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One hundred families were selected by simple random sampling. Fifty, 35 and 15 families were included from the low, medium and high socio-economic status groups, respectively. As many as 26 child and infant diseases were included in the study on the basis of observations of leading medical professionals in respect of importance of the different child diseases in the area. Women were presented with a list of 26 common child ailments and diseases. They were asked to mark against each whether they considered a particular disease of high, medium or low incidence. Similarly, they were asked to mark a disease as very serious, serious and non-serious.

RESULTS AND DISCUSSION

The socio-economic status scores for 244 families ranged from 6 to 40. The number of families falling under low, medium and high socio-economic status group is given in Table 1.

The first eight ailments and diseases were considered of high incidence as 90% of women respondents placed them in high incidence category. Malaria, simple fever, eye infection, cold and cough, gastroenteritis, ear discharge and prickly heat were considered of either high or medium incidence by the medical professionals (Table 2). Thus, from incidence point of view these eight diseases can be considered very important.

The diseases at serial numbers 10 to 16 were rated high by 7 to 62% and medium by 29 to 62% women, while all the medical professionals placed five of these either in high or in medium categories on the basis of incidence.

As high as 90% of the medical professionals rated tetanus as very serious while women respondents rated tetanus not serious (Table 3). The diseases at serial numbers 17 to 26 were reported to be of low incidence both by the medical professionals and the women. These were also not considered serious except the smallpox by the medical professionals. The latter was of nil incidence.

With the solitary case of ear discharge, none of the eight diseases falling under the category of high incidence were reported very serious by the women. Even gastroenteritis was not considered serious by women, while the medical professionals (90%) considered it either very serious or serious and 60% of them also considered malaria as a serious disease. Very serious and serious diseases of high incidence are, therefore, very likely to be dismissed as simple ailments. This phenomenon is, therefore, fought with dangers. This might be one of the reasons of high mortality rate due to gastroenteritis.

Some of the diseases of high incidence were not considered serious even by the medical professionals, e.g., cold and cough, and simple fever. These are not serious so far as immediate results are concerned but are likely to have long term effect on health of the children. These make the children highly susceptible to other diseases. These are definitely the major causes of high mortality rate. Therefore, there is a great need to educate women about these

TABLE 1

Distribution of families in different socio-economic status groups

Group	Class interval	Cummulative weighted frequency	No. of families
Low	6-20	6-1611	123
Medium	21-26	1612-3622	86
High	27-40	3623-4737	35
Total			244

TABLE 2

Frequencies of incidence of disease (n=100)

S. No.	Disease	Women			Medical professionals		
		High	Medium	Low	High	Medium	Low
1.	Malaria	100	—	—	100	—	—
2.	Simple fever	100	—	—	60	30	10
3.	Eye infection	100	—	—	30	60	10
4.	Cold and cough	99	1	—	100	—	—
5.	Gastroenteritis	98	—	2	—	40	60
6.	Tonsils	95	—	5	20	50	30
7.	Ear discharge	92	6	2	30	60	10
8.	Prickly heat	91	4	5	70	20	10
9.	Mumps	62	29	9	—	30	70
10.	Whooping cough	32	28	40	20	60	20
11.	Scabies	24	56	20	70	30	—
12.	Pneumonia	22	31	47	30	40	30
13.	Cholera	20	40	40	10	20	70
14.	Measles	19	49	32	40	30	30
15.	Typhoid	7	62	31	30	30	40
16.	Constipation	3	77	20	—	60	40
17.	Marasmus	1	15	84	—	60	40
18.	Kwashiorkor	—	1	99	—	—	100
19.	Tetanus	—	—	100	10	—	90
20.	Mirgi	—	—	100	—	20	80
21.	Poliomyelitis	—	—	100	20	20	60
22.	Heart disease	—	—	100	—	40	60
23.	Cord infection	—	—	100	20	10	70
24.	Small pox	—	—	100	—	—	—
25.	Rickets	—	—	100	—	20	80
26.	Chicken pox	—	—	100	—	30	70

TABLE 3

Frequencies of seriousness of disease (n=100)

S. No.	Disease	Women			Medical professionals		
		Very serious	Serious	Not serious	Very serious	Serious	Not serious
1.	Malaria	11	16	73	—	60	40
2.	Simple fever	—	4	96	10	20	70
3.	Eye infection	—	1	99	—	30	70
4.	Cold and cough	—	3	97	—	—	100
5.	Gastroenteritis	4	21	75	40	50	10
6.	Tonsils	—	5	95	—	30	70
7.	Ear discharge	7	89	4	—	30	70
8.	Prickly heat	—	—	100	10	—	90
9.	Mumps	—	—	100	10	40	50
10.	Whooping cough	50	13	37	—	60	40
11.	Scabies	71	12	17	10	10	80
12.	Pneumonia	36	26	38	30	60	10
13.	Cholera	14	48	38	60	30	10
14.	Measles	7	65	28	—	30	70
15.	Typhoid	15	60	25	10	60	30
16.	Constipation	—	—	100	—	20	80
17.	Marasmus	—	39	61	20	30	50
18.	Kwashiorkor	—	19	81	40	30	30
19.	Tetanus	—	21	79	90	—	10
20.	Mirgi	10	—	90	30	30	40
21.	Poliomyelitis	8	1	91	20	40	40
22.	Heart disease	6	—	94	70	30	—
23.	Cord infection	—	3	97	10	50	40
24.	Smallpox	1	1	98	100	—	—
25.	Rickets	1	—	99	20	10	70
26.	Chickenpox	—	—	100	—	30	70

diseases of high incidence and low seriousness. These diseases can be incorporated in a child health extension programme.

The incidence scores of all the diseases were calculated by assigning 3, 2 and 1 points to the respondents of high, medium or low incidences, respectively. The incidences of all the diseases according to the responses of the medical professionals and women were calculated. The correlation between these two sets of scores with respect to incidence of diseases was quite high and positive ($r=+0.571$).

Seriousness scores of all diseases based on the judgements of village women and of medical professionals were

also calculated by assigning 3, 2 and 1 points to very serious, serious and not serious, respectively.

The correlation between the two sets of scores with respect to seriousness of all the diseases was positive but very low ($r = +0.116$).

This clearly showed that the estimates of seriousness of diseases by village women were different from that of medical professionals. The degree of correlation, therefore, clearly suggests that village women either overestimated or underestimated the seriousness of the diseases presuming that the medical professionals rating was objective. A common man should know the seriousness of common diseases. Therefore, it becomes an important aspect in formulating any child health extension programme, specially for rural areas.

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AN INTEGRATED SYSTEM OF RAISING CALVES AND CHICKEN

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ABSTRACT

In an integrated mixed farming system involving poultry and buffaloes, birds were kept on hay which, later when enriched with poultry droppings and wasted feed, was fed to buffalo calves. Similarly dried calf dung was added to poultry ration at 3% level. Feeding of 1 kg per head per day of poultry litter from hay caused no significant increase in growth of buffalo calves, but there was a clear trend in favour of such feeding in all growth parameters. It did not pose any health problems of calves. Among birds, housing on hay and feeding 3% calf dung significantly reduced hen-housed-egg production, and feed efficiency. This was mainly due to a significant increase in mortality among birds in the treatment groups. However, it appears possible to increase profits provided mortality among birds on hay litters is checked by various methods. Adapting these systems had the potential to solve 100% of the pollution problem arising from poultry and 11% of that from cattle excreta in the country.

In India, enormous quantities of bovine and poultry waste material are produced annually (Ichhponani and Lodhi, 1976). In view of the looming pollution problem due to these wastes, unaffordable cost is involved in mechanical disposal and the proven nutritive value of animal wastes (Palafox and Rosenberg, 1951; Brugman *et al.*, 1964; Menawat and Sharma, 1973; Ichhponani and Lodhi, 1976; Cross *et al.*, 1978) recycling by feeding back to some of the animals seems to be the only logical answer. The animal wastes, if fully utilized, could supply feed energy equivalent to 4.3 million tonnes of cereals and protein equivalent to 4.2 million tonnes of oil seed cakes (Ichhponani and Lodhi, 1976). The experiment was, therefore, planned to integrate poultry and dairy keeping in a mixed farming system in which the waste products from either species were reciprocally fed.

MATERIAL AND METHODS

The experiment was carried out on 234 White Leghorn layers and 36 cockrels just above 1 year of age and 15 Murrah buffalo female calves between 4 months and 1 year of age. They were randomly divided within each class and assigned to three systems as follows :

System I, on the poultry side, consisted of 6 pens each housing 13 White Leghorn layers and 2 cockrels.

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They were housed in deep-litter pens on built-up litter of wood shavings and were fed layer mash. Out of 15 calves selected in triplets (members of each triplet being similar in age and body weight), 5 were grouped under system I randomly with one calf from each triplet. These calves were housed in individual calf-stalls fabricated inside a big shed. They were individually fed on *ad lib.* green berseem, and 100 g/head/day a of mixture of wheat bran, mineral and common salt in a proportion of 8 : 1 : 1.

System 2 was similar to system I except that the birds were housed on fresh oats hay litter and were fed a ration incorporating dried calf-dung meal at 3% level. The calves were fed daily 1 kg of poultry - droppings enriched - oats hay which was removed from the respective 6 pens at monthly intervals and replaced by fresh hay. This was fed in place of concentrates in addition to *ad lib.* green berseem.

System 3 was like system 2 except that lucerne hay was used in place of oats hay.

The experiment lasted for 145 days. The birds were under experiment for 105 days. Collection of litter for heifer feeding was started after 30 days and feeding of heifers with the litter material was started immediately. A 25-day preliminary feeding period was allowed to the heifers for adjustment after which they were on actual experiment for 90 days. Housing and management of birds were similar under the three systems as described under system 1. Observations with respect to feed intake and egg production by birds and feed intake and gain in body weight by calves were recorded and overall economics of the three systems evaluated.

RESULTS AND DISCUSSION

There were no significant differences in body weight gain due to the treatment (Table 1).

There was a trend towards better gain in body weight in the groups receiving poultry litter and among them, those receiving lucerne-hay-litter seemed to do better (Fig. 1). Many workers (Cuevas,

TABLE 1

Gain in body weight by 5 experimental buffalo calves in 90 days (kg) and hen housed average egg production (105 days) under 3 systems

Treatment	Gain in body weight in buffalo calves*	Hen-housed-average egg production
System 1 (control)	122.6±27.9	43.0±11.4Aa
System 2	124.4±39.0	36.0±7.0Bb
System 3	126.6±37.2	36.4±7.6ABb

*Differences were not significant at 5% level.

A,B=Values with different superscripts vary at 1% level.

a, b=Values with different superscripts vary at 5% level.

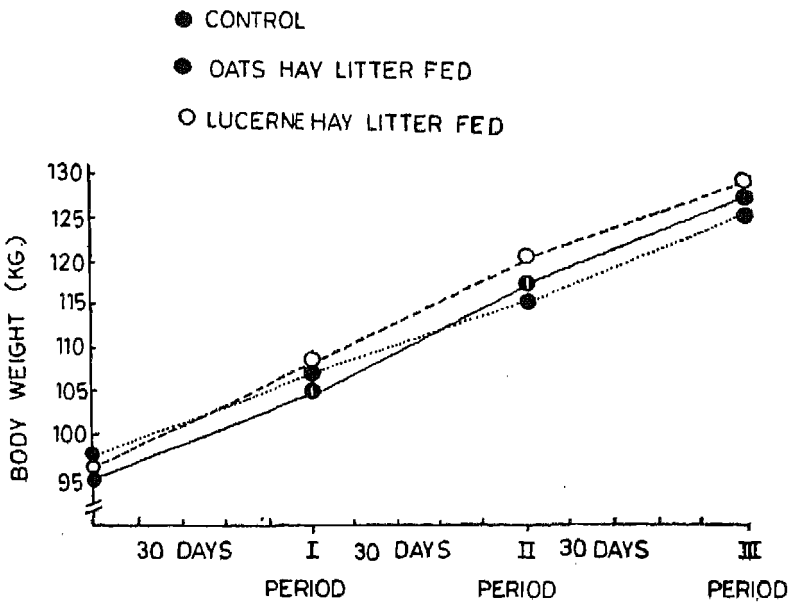


Fig. 1. Body weight gain in calves fed hay litter rations.

1969; Cross *et al.*, 1978) have observed that poultry litter can be a good source of nutrients and could replace protein supplements for bovines. In the present study, poultry litter was fed as a concentrate to provide additional nutrients for growth over and above those provided by good quality roughages. Chemical analysis showed that oats-hay-litter contained 26.2% and lucerne-hay-litter 32.7 per cent crude protein. The results of the experiment indicate that poultry excreta deposited on a good quality hay can be used, in place of expensive concentrates for growing buffalo calves.

Hen-Housed Egg Production by Birds

The egg production has been classified into three sub-periods, i. e., early, middle and late and analysed accordingly. The results show a significant ($P \leq 0.05$) reduction of hen-housed-average egg production in the two groups kept on hay-litter and fed ration incorporating calf dung at 3% level (Table 1) which was due to higher mortality in these groups. As against a mortality of five birds (1.8%) in the control group, 24 birds (9.7%) died in the oats-hay-litter group. The mortality was significantly higher in the groups with hay as litter material. This was attributed to increased heat stress on the birds due to additional heat load from fresh litter, and non-availability of some B-vitamins which would be present in built-up litter. Addition of B-vitamins to drinking water from period 2 onwards decreased mortality rates.

Feeding cost. Feed intake by birds in the three systems was 852.48 kg, 922.30 kg and 936.39 kg, respectively. The feeding cost for poultry during 105 days for the three groups came to

Rs. 1150.51, 1244.86 and 1267.78. Similarly, the feeding cost for the heifers during the trial (90 days) came to Rs. 183.90, 161.72 and 135.46, respectively under the three systems (Table 2).

Income. During the experiment, birds under systems 1, 2 and 3 produced 3522, 2784 and 2833 eggs, respectively. The value of eggs @ Rs. 0.35 came to Rs. 1238.70, 974.40 and 981.55 under the respective systems. Assuming the sale price of fully mature buffalo heifers as Rs. 1100/- (Sharma, 1979) the value of 1 kg of growth was roughly estimated to be Rs. 3.70. On that basis, the growth observed during the experiment had a value of Rs. 453.62, 460.28 and 468.42 in the three systems. Thus, the total income from egg production and growth of calves in the three systems came to Rs. 1686.32, 1434.68 and 1449.97, respectively.

Profits. The income in surplus of feeding cost has been calculated to be Rs. 351.91 in system 1, Rs. 28.10 in system 2 and Rs. 46 73 in system 3.

These figures apparently show that the system 2 incorporating raising of birds on litter out of good quality hay and feeding the same to growing buffalo heifers reduced the profitability. On further analysis it can be seen that the major reasons for less profitability rests on performance of the poultry components of these systems. Increased mortality and reduced feed efficiency under systems 2 and 3 were mainly responsible for the poor performance and profitability of these systems. The lowered feed efficiency may be due to less number of birds remaining under these systems because of higher mortality and thereby giving more chance to eat perhaps in excess of their needs of feed energy wasted in non-production exercise by the birds in rather large pens. If this hypothesis holds good, increased birds mortality is the only disadvantageous point in systems 2 and 3. By giving a B-vitamin supplement, shifting the period of egg production to cooler months and by using pullets to build up hay-litter on which they continue to re-

TABLE 2

Feed cost, income and income over feed cost under 3 systems

Items	System 1	System 2	System 3
Feed intake by White Leghorn (90 birds initially)	852.48	922.30	936.39
Cost of feed (Rs.)	1150.51	1244.86	1267.78
Feed cost/kg gain of buffalo heifers (Rs.)	1.50	1.30	1.07
Feed cost for 5 heifers during the experiment (Rs.)	183.90	161.72	135.46
Total feed cost (for birds and calves) (Rs.)	1334.41	1406.58	1403.24
Egg-production	3522	2784	2833
Value of eggs produced @ Rs. 0.35 per egg	1232.70	974.40	981.55
Value of growth in 5 buffalo heifers (Rs.)	453.62	460.28	468.42
Income over feed cost (Rs.)	351.91	28.10	46.73

main during their peak production stage, the problem of mortality may be checked.

Results of this experiment indicated that if mortality could be checked among birds, systems involving raising birds on high quality hay litter and feeding such litter to growing buffalo heifers should be profitable. Besides, this type of recycling of animal wastes will go a long way on solving the pollution problem.

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PROTEIN LEVELS FOR GROWING CROSSBRED SWINE

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ABSTRACT

Twenty eight crossbred pigs (Middle White Yorkshire females crossed with **desi** male pigs) were used to study the protein levels in rations of growing crossbred swine. The average daily gain was not influenced by increasing the protein in the diet from 16 per cent to 20, 22 and 24 per cent. Higher protein levels viz., 22 and 24 per cent had a detrimental effect on the feed conversion efficiency of pigs. The carcass quality was also not improved by increasing protein levels in the diet. Only 24% protein in the diet significantly affected the back fat thickness but the adverse effect of this treatment on F/G ratio counteracted this beneficial effect on the performance of pigs. Pigs on different dietary treatments produced acceptable carcasses.

Thus, no distinct beneficial effect of 20, 22 and 24 per cent protein levels in the diet over that of 16% was observed.

In one of the previous studies by Sharda and Yadav (pers. commun.) it was observed that crossbred pigs needed 18% protein in the diet for optimum performance during the growing period. A little information is available in India about the requirements of **desi** pigs crossed with exotic ones. The present study was, thus, undertaken to find the effect of feeding protein levels higher than 18% in the diet of these crossbred pigs.

MATERIAL AND METHODS

Twenty eight crossbred pigs (Middle White Yorkshire sows crossed with **desi** pigs) weaned at 56 days of age and weighing about 14 kg were divided into four groups of seven pigs each in a completely randomized design. The pigs were housed in pens which provided covered area for feeding in mangers and an open one for exercise and dunging. The pigs were dewormed and treated for external parasites before being fed the experimental diets. The composition of diets is given in Table 1. The ingredients were analysed by standard methods (AOAC, 1970) for computing the diets. The diets were again analysed for crude protein, crude fibre, calcium and phosphorus by the same method. The diets were balanced according to NRC (1968). The four groups of pigs were fed diets containing 16, 20, 22 and 24 per cent protein. The feed and water were allowed *ad lib.* The experimental pigs were slaughtered when they reached the weight of 50 kg. The slaughtering and cutting procedures were the same as described by Satya Parkash *et al.* (1976).

TABLE 1

Composition of experimental diets

Ingredients	A	B	C	D
	(Per cent protein)			
	16	20	22	24
Maize	80.2	69.0	63.2	57.6
Groundnut cake	11.3	22.5	28.3	33.9
Fish meal	6.0	6.0	6.0	6.0
Limestone	1.0	1.0	1.0	1.0
Bone meal	1.0	1.0	1.0	1.0
Mineral mixture[a]	0.5	0.5	0.5	0.5
Rovimix (g)[b]	15	15	15	15
Rovibe (g)[c]	25	25	25	25

[a]Mineral mixture contained 28% calcium, 5% phosphorus, 100 ppm copper, 50 ppm cobalt, 2000 ppm manganese, 13 ppm iodine, 3500 ppm iron, 1100 ppm zinc chloride, and 23% sodium chloride.

[b]Rovimix contained 40,000 I.U. vitamin A, 8 mg vitamin B_6 and 6000 I. U. vitamin D_3 per 9 supplement.

[c]Rovibe contained vitamins B_1 4 mg, B_6 8 mg, B_{12} 40 mg, niacin 60 mg, Cal. pantothenate 40 mg and E 40 mg per 9 supplement.

Quality scores from 1-5 were obtained for colour, firmness and marbling of the LD muscle at 10th rib section as described by Sharda *et al.* (1972). The data were analysed according to procedures laid down by Steel and Torrie (1960).

RESULTS AND DISCUSSION

The effects of feeding higher levels of protein to crossbred pigs on their performance, carcass traits and organ weights are presented in Tables 2 and 3.

The average daily gain of pigs fed 20, 22 and 24 per cent protein in the diet was not different from those fed 16% ($P>0.05$). The feed/gain ratio (F/G) was significantly higher for pigs fed 22 and 24 per cent protein as compared to those fed 16 and 20 per cent ($P<0.05$). The performance of pigs fed 16 and 20 per cent protein, however, was not different for this parameter. The dressing per cent was highest for the pigs fed 20% protein (61.6%) followed by those fed 22 (58.9%), 24 (57.6%) and 16 (57.8%) per cent protein in the diet. The pigs fed 20% protein had a significantly higher dressing per cent than those fed 24% ($P<.05$). A similar trend was observed for carcass length and *longissimen dorsi* muscle area.

The pigs fed 24% protein had a significantly smaller back fat thickness than those fed 16, 18 or 22 per cent protein in the diet ($P<.05$). However, lean cut per cent, primal cut per cent and loin+ham per cent were not influenced by the dietary treatments. When quality of carcasses as indicated by colour, marbling and firmness scores of LD muscles was studied, it was observed that the pigs

TABLE 2

Effect of high protein levels on the performance and carcass traits of pigs

Items	A	B	C	D	CD (P<.05)
	(Per cent protein)				
	16	20	22	24	
Initial body weight (kg)	14.6	14.3	14.4	14.7	2.1
Final body weight (kg)	52.0	52.0	50.9	51.5	1.3
ADG (g)	372	369	379	358	32
F/G ratio	3.69	3.52	4.00	4.05	0.32
Dressing per cent	63.0	65.3	64.3	62.1	2.60
Carcass length (cm)	57.8	61.6	58.9	57.6	2.75
Av. back fat thickness (cm)	2.90	2.88	3.00	2.42	0.37
LD area	23.8	29.4	25.6	24.5	3.86
Lean cut per cent	68.6	70.3	68.4	68.7	2.52
Primal cut per cent	81.3	82.3	80.3	82.4	2.39
Ham+loin per cent	53.3	52.0	48.4	51.1	2.56
Colour	2.8	2.4	2.6	2.5	0.41
Marbling	3.2	2.6	2.7	2.4	0.36
Firmness	3.0	2.5	2.5	2.3	0.34

TABLE 3

Effect of high protein levels on the organ weights of growing pigs

Organs	A	B	C	D	CD (P<.05)
	(Per cent protein)				
	16	20	22	24	
Liver	1.99	1.84	2.04	2.12	0.70
Heart	0.31	0.31	0.35	0.37	0.08
Kidney	0.34	0.32	0.36	0.34	0.10
Spleen	0.15	0.20	0.18	0.25	0.12

under different dietary regimes produced carcasses of acceptable quality. The weights of organs expressed as a per cent of the kill weight were not different for the pigs fed different protein levels in the diet. No information is available regarding the protein requirement of exotic pigs crossed with desi pigs. Sharda and Yadav (pers. commun.) indicated better performance of pigs fed levels of protein higher than 16% viz., 18 per cent. Tanksley (1970) observed better performance in pigs maintained on 16 and 19 per cent dietary protein.

The results indicated no distinct beneficial effects of protein levels above 16% in the diet on the performance and carcass quality of growing pigs. Diet with 16% protein may, thus, be considered optimum for exotic pigs crossed with Indian desi pigs.

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STUDIES ON THE EFFECT OF FREQUENCY OF FEEDING ON MILK PRODUCTION AND ITS COMPOSITION IN MURRAH BUFFALO

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ABSTRACT

Effect of frequency of feeding of mixed green and dry forage on dry matter and nutrient intake, dry matter digestibility, body weight changes, milk yield and milk composition of Murrah buffalo over a period of nine weeks was studied.

The average dry matter intake as percentage of body weight and $W^{.75}$ kg was 2.40 and 112.9, 2.64 and 123.6, and 2.75 and 129.7 g for 24, 12 and 6 hourly feeding schedules, respectively. The dry matter intake per 100 kg body weight differed between treatments ($P<0.01$). The dry matter digestibility of 54.63, 58.96 and 60.26% was observed for 24, 12 and 6 hourly schedules, respectively. Similar trend was observed for crude fibre digestibility.

The DCP and TDN intakes (kg/day/animal) were 0.799 and 6.084 for 24 hourly, 0.893 and 6.940 for 12 hourly and 0.831 and 7.071 for 6 hourly feeding. DCP intake appeared to be in excess of suggested requirements and TDN sufficient for 6 hourly feeding schedule only but was deficient in other treatments. All animals maintained their body weights during experiment. Difference between treatments for milk, FCM, SCM and fat and SNF yields were not significant.

The total feed cost/kg/FCM including labour cost in feeding was Re 0.89, 0.89 and 0.92 in 24, 12 and 6 hourly feeding schedule. No decline of milk yield or in body weight inspite of deficiency of TDN in 24 and 12 hourly feeding schedule was in evidence which indicates a possibility of lowering of TDN requirement.

One of the factors which may affect feed utilisation is the frequency of feeding. Information in this regard in case of buffaloes is scanty. However, work on dairy cows and growing animals revealed that there was greater dry matter intake, higher milk yield and more body weight gain with increasing frequency of feeding (Dawson and Kopland, 1949; Rakes *et al.*, 1957; Campbell and Merilan,

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1961; Hemminger and Kirchgessner, 1971; Martz *et al.*, 1971; Kaufmann *et al.*, 1975) though no significant effect was observed by Gordon and Tribe (1952), Mochrie *et al.* (1956), Stanley and Morita (1967), Renton and Forbes (1974), Guglya *et al.* (1975) and Thomas and Kelly (1976). The experiment has been planned to study the effect of frequent feeding on milk production and its composition.

MATERIAL AND METHODS

Nine lactating Murrah Buffalo calves of almost similar age, stage of lactation and average milk yield (5.71-6.10 kg) were used in 3×3 Latin square switch-over design with three treatments and three periods. In between two treatment periods, each of which were of 2 weeks duration, seven days were allowed as adjustment period. The trial was conducted for nine weeks between December 1978 and February 1979.

Preparation of forage. Green berseem *(Trifolium alexandrinum)*, grown in well fertilised and well irrigated plot of land, was received from the farm daily. Berseem was chaffed using power chaff-cutter and 40 kg of green chaffed berseem and 10 kg of wheat straw were mixed thoroughly before being fed to each experimental animal.

Feeding. In treatment A, total 50 kg of mixed chaffed berseem and wheat straw were offered daily at 4 p. m. to each animal. In treatment B, the total quantity was divided into two halves and one part was offered at 4 p. m. and the other half kept in gunny bag and given at 4 a. m. In treatment C, the total quantity was divided into four and one part of 12.5 kg was offered at 4 p. m. and remaining three parts were offered at 10 p. m., 4. a. m. and 10 a. m., respectively, to each animal.

The concentrate mixture containing 17.92% digestible crude protein and comprising maize 50 parts, barley 25 parts and groundnut cake 25 parts supplemented with 2 % mineral mixture and 1% common salt was prepared in one lot. This mixture was offered at the rate of 1.5 kg to each animal at milking time.

Housing and management. The experimental animals were kept in a byre having arrangements for individual feeding and milked at 3 a. m. and 3 p. m. The animals were let loose from 9 a. m. to 10 a. m. for exercise. Regular cleaning was done in byre as well as of animals for clean milk production.

Recording and sampling of milk. Daily milk yield in each milking was recorded to nearest 0.1 kg with the help of 20 kg spring balance. Individual milk samples of 100 g each in morning and evening were collected immediately after milking once in a week. The aliquots for morning and evening milk were composited for analysis of fat (Ghouse and Jain, 1973), total solid (TS) (ISI, 1972) and solid-not-fat (SNF). The solid corrected milk (SCM) was calculated by the method of Tyrrell and Reid (1965).

Sampling of feed. The feeds offered as well as refused were collected following morning twice a week during each period. The dry matter was determined after which these were milled and bulked

for each period for determination of proximate composition.

Digestibility trial. A conventional digestibility trial on all experimental animals with five day collection period was conducted at the end of the third period. The proximate composition of feed and faeces was determined as per AOAC (1970).

Weighing of animals. The animals were weighed at the beginning and end of each period in the morning before offering feed and water.

RESULTS AND DISCUSSION

Dry Matter Intake

The daily dry matter intake per 100 kg body weight under A, B and C treatments was 2.40, 2.64 and 2.75 kg, respectively. The corresponding figures were 112.9, 123.6 and 129.7 g when it was calculated as per metabolic body weight (W^0 kg^{75}) (Table 1).

Significant differences in dry matter intake per 100 kg body weight were observed between C and A, C and B and B and A treatments. Thus, greater dry matter intake accompanied increased frequency of feeding which is in agreement with reports of Dawson and Kopland (1949), Campbell and Merilan (1961), Hemminger and Kirchgessner (1971) and Rohr and Daenicke (1973) in cattle. The reason for higher dry matter intake by buffaloes may be due to supply of small quantity of fresh forage at short intervals which precludes deterioration before consumption. Another probable reason is that continuous availability of large quantity of forage in manger for a long time results in not only matting but in generation of heat which causes rise of temperature. This may be repulsive to buffalo and led to lowered dry matter intake (Table 1).

The dry matter crude fibre, ether extract, nitrogen free extract, total digestible nutrients and total ash contents of green forage during the entire experimental period ranged from 13.08–17.00, 18.75–19.65, 14.66–20.07, 3.28–3.43, 46.43–50.51 and 10.85–12.40%, respectively. There appears practically no loss of nutrients during the chaffing process.

The average dry matter digestibility coefficients are shown in Table 2.

TABLE 1

Average dry matter intake (kg)/100 kg body weight (BW) and metabolic body size (W^0 kg^{75})

Period	Treatment A		Treatment B		Treatment C	
	100 kg BW (kg)	W^0 kg^{75} (g)	100 kg BW (kg)	W^0 kg^{75} (g)	100 kg BW (kg)	W^0 kg^{75} (g)
I	2.33	110.0	2.73	127.0	2.83	133.0
II	2.46	115.6	2.60	122.0	2.96	139.0
III	2.43	113.3	2.60	122.0	2.46	117.6
Mean	2.40	112.9	2.64	123.6	2.75	129.7

TABLE 2

Nutrient digestibility coefficients (%)

Nutrients	Treatments		
	A	B	C
Dry matter	54.63	58.96	60.26
Crude protein	56.46	61.04	57.08
Ether extract	57.07	63.36	58.65
Crude fibre	51.86	52.14	52.33
Nitrogen free extract	63.36	67.03	67.45

Average of three estimates.

TABLE 3

Nutrient intake (DCP and TDN) compared to requirements as per Sen and Ray (1971)

	Treatment A	Treatment B	Treatment C
Body weight (kg)	479	481	480
Milk yield (kg)	6.8	6.7	6.9
Fat (%)	7.33	7.78	7.30
Total requirement :			
DCP	0.714	0.748	0.745
TDN	6.765	6.940	6.915
Total intake :			
DCP	0.799	0.893	0.831
TDN	6.087	6.944	7.071
Differences :			
DCP	0.086 (+)	0.145 (+)	0.074 (+)
TDN	0.610 (−)	0.006 (−)	0.177 (+)

Average of nine observations.

On the basis of digestibility coefficients observed the digestible crude protein (DCP) and total digestible nutrients (TDN) intakes were worked out. These intakes were compared with the requirements of each animal as per Sen and Ray (1971) standard. There was significant difference between C and A treatments on one hand and B and A on the other for both DCP and TDN intakes.

Better dry matter digestibility with increase in feeding frequency in buffalo may be due to less fluctuation of rumen pH and VFA production (Satter and Baumgardt, 1962). This presumably created suitable ruminal environment which in turn favoured better dry matter digestibility.

It is interesting to note that DCP and TDN were utilised more effectively as per increased feeding frequency in buffalo

(Table 3). It is also revealed that the wastage of DCP and TDN could be minimised (Pathak, 1979) by reducing the quantity of chaffed berseem and substituting the same with wheat straw in the ratio of 4 : 1 and adopting 6 hourly feeding schedule.

On the basis of these findings it may be suggested that 6 hourly feeding of protein-rich leguminous forage (chaffed berseem) mixed with wheat straw in the proportion of 4 : 1 along with 1.5 kg concentrate during milking time may be followed for the Murrah buffalo to maintain upto 9 kg of milk/day without any deleterious effect or causing deficiency of nutrients as per suggested requirements. It is also revealed that all the animals maintained their body weight and milk production under all treatments though there was some deficiency in TDN intake for once or twice a day feeding system.

Milk Yield and its Composition

The total milk yield of buffalo cows under A, B and C treatments was 863.4, 845.4 and 873.36 kg (47.93, 46.96 and 48.52)*, whereas FCM (6%) yield was 993.5, 1019.83 and 1038.67 kg (55.10, 56.65 and 57.70). When it was converted into total SCM (kg) the figures were 1286.64, 1335.62 and 1336.69 (71.90, 74.19 and 74.25). Weekly milk yield, FCM (6%) and SCM on the three treatments were similar. A trend for increased FCM (6%) and SCM production was observed with the feeding frequency progressive increase. Milk production in Murrah buffalo showed the same trend as observed by Dawson and Kopland (1949), Campbell and Merilan (1961) and Rohr and Daenicke (1973).

The weekly mean fat percentage was 7.33, 7.78 and 7.30 for A, B and C treatments, respectively. The corresponding figures for SNF were 10.15, 9.80 and 10.31%. The total fat and SNF production for entire experiment were 63.28, 65.76 and 63.75 kg and 87.57, 82.87 and 90.12 kg under different treatments. The total fat production was found to be highest on 12 hourly followed by 6 and 24 hourly feeding programme. The present investigation did not show significant difference in fat and SNF production between three feeding schedules. This is in agreement with the work of Thomas and Kelly (1976) in dairy cattle.

The daily feed costs including the cost of labour were Rs. 7.02, 7.27 and 7.58 under A, B and C treatments. Cost per kg FCM (6%) was calculated to be Re. 0.89, 0.89 and 0.92 under respective treatments. Additional labour on treatments B and C contributed to the higher costs of production. But these treatments were accompanied with higher milk production (FCM 6%) also. If the labour rendered by small and marginal farmers perhaps to the extent of 10 min in each feeding per animal is not taken into account, then the cost of feeding may be reduced from Re. 0.89 to 0.87 in 12 hourly and from Re. 0.92 to 0.86 in 6 hourly feeding schedule.

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*Figures in parentheses are yields in different weeks.

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PART-LACTATION YIELD AND ITS RELATIONSHIP WITH TOTAL MILK YIELD IN BEETAL AND ITS CROSSES WITH ALPINE AND ANGLO-NUBIAN

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ABSTRACT

Different part-lactation records revealed that there was linear trend of milk production throughout the lactation in all the genetic groups. Analysis of variance for milk production revealed that 60 and 90 days milk yield was affected significantly by genetic groups, whereas 30 days milk yield had no effect of genetic groups. All the estimates of correlation and regression between 30, 60 and 90 days and total milk production were very high and significant, which indicated that we could select the animals at an early stage of lactation. The total milk production can be accurately predicted from 60 days milk y el as compared to 30 and 90 days milk production.

The level of milk production measures the superiority of a dairy goat from economic angle either through complete lactation records or through part-lactation records. The part-records offer the advantage of shortening the generation interval besides reducing the cost of recording. Keeping this fact in view, the present investigation was undertaken to evaluate the part-lactation records to decide the selection criterion at an early stage of lactation.

MATERIAL AND METHODS

The breeding data used in this study relates to the experimental flock maintained in the Department of Animal Breeding under the scheme 'Evaluation of milk strain of goats through crossing Beetal goats with Alpine and Anglo-Nubian' over a period of 12 years from 1966 to 1977.

On the basis of maximum frequency of kidding, the two breeding seasons were categorised, viz., March to May and September to November. The duration of study was divided into two periods, viz., 1966-71 (first period) and 1971-77 (second period). Milk production was recorded daily with assumed lactation length of 150 days. The abnormal lactations and records of lactation length less than 60 days were not considered. The milk production of 30, 60 and 90 days and total milk production were used for predicting the lactation yield. The analysis of data was done using least squares technique (Harvey, 1966). Observations were recorded from the following genetic groups :

1. Beetal G_1
2. 75% Alpine+25% Beetal G_2
3. 50% Alpine+50% Beetal G_3
4. 25% Alpine+75% Beetal G_4
5. 75% Alpine-Nubian+25% Beetal G_5
6. 50% Alpine-Nubian+50% Beetal G_6

RESULTS AND DISCUSSION

The least square means of part-lactation yields of 30, 60 and 90 days and total milk production alongwith their S. E.'s genetic group-wise, lactation-wise, period and season-wise are presented in Table 1. The perusal of the means indicated that there was uniformity in terms of milk production from 0-90 days. Whereas the groups differed significantly in milk yield for 60 and 90 days and total milk yield, there were no differences in milk yield at 30 days. The highest yield upto 30, 60 and 90 days was obtained in G_4 (25% Alpine+75% Beetal), whereas the total highest milk yield was recorded in G_2 (75% Alpine+25% Beetal). These findings were suggestive of the fact that

TABLE 1

Least square means and per cent milk production in different genetic groups, lactations, periods and seasons

Characters	30 days	Per cent production	60 days	Per cent production	90 days	Per cent production	Total milk yield
G_1	22.94±0.64 (166)	23.34	41.52^c±1.49 (168)	42.25	59.43^c±2.42 (153)	60.48	98.26^c±3.76 (161)
G_2	23.40±2.01 (30)	20.26	45.52 ±1.80 (30)	39.42	65.26 ±4.20 (30)	56.52	115.46^a±4.98 (30)
G_3	23.40±2.10 (30)	21.77	46.20^a±1.67 (29)	42.99	64.31^b±5.12 (28)	59.85	107.45^b±5.78 (29)
G_4	24.03±1.95 (30)	23.13	48.45^b±1.08 (30)	46.34	70.26^a±5.06 (26)	67.62	103.89^b±5.61 (32)
G_6	23.51±1.50 (60)	21.65	46.84^a±2.05 (58)	43.14	67.64^b±3.76 (57)	62.30	108.57^b±5.61 (57)
L_1	21.49^a±0.78 (152)	22.65	40.80^a±1.51 (157)	43.00	58.54^a±2.46 (143)	61.70	94.87^a±3.88 (148)
L_2	25.44^b±0.79 (103)	22.95	46.79^b±1.63 (103)	42.21	60.10^b±2.67 (95)	54.22	110.83^b±3.40 (101)
L_3	23.88±1.43 (61)	21.46	46.89±2.93 (56)	42.13	69.35±3.79 (56)	62.35	111.28±5.86 (58)
P_1	22.98±0.91 (258)	22.66	43.45±1.14 (258)	42.85	62.65±1.67 (238)	61.78	101.40±2.59 (251)
P_2	24.41±1.56 (58)	21.91	45.53±2.86 (58)	40.85	64.69±3.81 (56)	58.06	111.41±5.88 (58)
S_1	23.28±0.80 (185)	22.70	44.37±1.16 (185)	43.27	63.54±2.12 (171)	61.96	102.54±3.44 (187)
S_2	23.04±0.88 (131)	22.08	43.05±1.71 (131)	41.27	62.34±2.57 (123)	59.76	104.31±4.01 (128)
Overall	23.24±0.59 (316)	22.50	43.83±1.01 (316)	42.43	63.04±1.42 (294)	61.03	103.28±2.69 (315)

Figures in parentheses are the number of observations.
Figures bearing different superscripts differ significantly ($P<0.05$).

the animals having 75% inheritance of Alpine were well suited for dairy goat production. Similar observations for total milk yield had been reported by Bhatnagar *et al.* (1976), Mishra *et al.* (1976) and Rao *et al.* (1976).

The comparison of means in three lactations revealed the highest yield in 3rd lactation which was in accordance with the expectation due to physiological maturity of the animals. Similar trend was observed by Parkash (1968) and Singh (1969). The period II was better in terms of production at all stages in comparison to the period I. This may be because better management was available during this period.

The seasonal means indicated no significant difference among themselves. The percentage of milk production upto 30, 60 and 90 days had been calculated on the basis of total milk production (Table 1). On overall milk production basis 22.50% of the milk was produced upto 30 days, 42.43% upto 60 days and 61.03% upto 90 days. In Beetal (G_1) milk production upto 30 days was 23.34%, a little higher than any other genetic group. Milk production upto 60 and 90 days was maximum (46.34 and 67.62 kg, respectively) in G_4 (25% Alpine+75% Beetal). Total milk production was higher in G_3 (75% Alpine+25% Beetal). It can be concluded that amount of milk production in different part-lactations is almost similar showing a linear milk production trend throughout the lactation.

The analysis of variances (Table 2) for the various effects like genetic groups, lactation, period and season revealed significant differences due to genetic groups for 60 and 90 days and total milk yield. The differences due to lactation were significant for 30 days milk yield and total milk yield only. These results were in close conformity with the findings of Parkash and Khanna (1972).

Whereas, the period effects were also found to be significant for total milk

TABLE 2

Analysis of variance for milk production

S. V.	Mean squares				
	D. F.	30 days	60 days	90 days	Total milk yield
Genetic group	4	9.88	1057.75**	1186.11*	2656.62*
Lactation	2	493.19**	1434.92	3008.21	10030.20**
Period	1	96.84	205.48	187.60	4727.21
Season	1	8.71	132.70	103.47	233.40
Error		59.64 (307)	202.73 (307)	361.75 (285)	1076.40 (300)

Figures in parentheses are the error degrees of freedom.
*Significant at 5% level.
**Significant at 1% level.

TABLE 3

Regression and correlation (milk production) coefficients

Period	30 days	60 days	90 days	Total milk production
30 days		1.605**	1.824**	2.415**
60 days	0.858**		1.188**	1.700**
90 days	0.688**	0.838**		1.035**
Total milk production	0.370**	0.488**	0.535**	

Above diagonal are the regression and below diagonal are the correlation coefficients.
**Significant at 1% level.

yield, the seasonal effects were not significant at different stages of lactation.

Correlation and Regression

The correlation and regression among part-lactation yields were estimated and are presented in Table 3. All the regression and correlation were significant between different part-lactations and total milk yields.

The prediction equations were also constructed for 30, 60 and 90 days milk yield which are as follows :

$y_1 = 43.30 + 2.42\ x_1$

$y_2 = 25.51 + 1.70\ x_2$

$y_3 = 33.99 + 1.04\ x_3$

where

x_1 = 30 days milk yield

x_2 = 60 days milk yield

x_3 = 90 days milk yield

and y's are total milk yield.

The coefficients of determination for these three equations were obtained as 13.61, 23.80 and 28.09, respectively. The values of coefficient revealed that the reliability of the prediction increases with the increase in lactation length.

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STUDIES TO ESTIMATE THE DRESSING YIELDS OF TURKEYS AT DIFFERENT AGES

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ABSTRACT

Eight turkeys (4 male and 4 female) were slaughtered from 8 to 30 weeks of age at biweekly intervals to study the effect of age and sex on dressing yields. The sex and hatch did not have significant effect on shrinkage due to pre-slaughter fasting, loss of blood, per cent dressed and eviscerated weights and weight of giblets and neck. However, all these traits were significantly affected by age of slaughter. The meat per unit bone was highest at 18 weeks age.

Sharma *et al.* (1981) estimated the cost of producing live turkeys at different ages and indicated that the optimum economical marketing age for turkeys was 16 weeks. In U. S. A., turkeys are generally marketed from 16 to 30 weeks of age. Therefore, it is important to estimate the effect of age on dressing yield. A number of reports have been published on the physical composition of chicken and the manner in which the composition is affected by different factors. However, this is the first report on turkey reared under India climatic conditions typical of northern India to present the dressing yields of male and female turkeys at 12 different ages.

MATERIAL AND METHODS

The birds used in this experiment were obtained from a flock of randomly mating crossbred population obtained by crossing Broad Breasted large White with Beltsville Small White turkeys maintained as a closed flock since last 8 years. Turkeys were processed beginning at eight weeks and progressively through each two weeks until the final sampling at 30 weeks of age. Four carcasses of each sex from two hatches were used as sample for estimating per cent yields and two out of these were used for estimating bone meat ratio at each age.

The birds after a 16 h fast for feed were slaughtered, bled, scalded and picked. The weight after picking was the dressed weight. The drawn weights (eviscerated weights) were the weights of the carcasses after removal of head, neck, feet (shanks) and giblets. The giblet weight included the weights of heart, liver and empty gizzard. Two carcasses were subjected to manual separation of bone and meat. The data were subjected to usual statistical analysis using analysis of variance.

RESULTS AND DISCUSSION

The average loss in weight due to fasting by sex and age has been presented in Table 1. The per cent loss due to pre-slaughter fasting at different ages varied between 2.60 to 7.40 in males, 3.14 to 7.49 in females and 2.94 to 7.40 on a combined sex basis. Marsden (1937) reported that the weight loss during overnight fasting of Bronze turkeys averaged 3.34 and was not affected significantly by sex or age. Except at 28 weeks of age when the differences in weight loss in male and female turkeys averaged 7.4 and 3.14, respectively the differences in shrinkage in the two sexes were rather small. No significant effect of sex was evident on shrinkage. A wide variation was observed in shrinkage at various ages for both the sexes and the effect of age was significant. This type of variation was contrary to the findings of Marsden (1937) and may be expected because of too few number of observations.

The loss in weight due to bleeding averaged 2.4 to 5 per cent (Table 2). The average loss due to blood and feathers averaged 13.2 to 20.8% in males, 12.1 to 20.7% in females and 13.1 to 20.7% in the birds on a combined sex basis. Winter and Funk (1960) have reported that there would be a loss of about 10% due to removal of blood and feathers from the turkey carcasses. Marsden (1937) reported a dressing shrinkage of 9.65, 9.55 and 9.62 per cent in males, females and combined turkeys. Rodionova (1975) studied the dressing percentage at 105, 120 and 150 day age in turkeys and reported a dressing percentage of 88.4, 89.1 and 88 2 in males and 88.1, 89.5 and 89.4 in females, respectively, for the three ages. The

TABLE 1

Average live weight, weight after fasting and per cent loss due to fasting at different ages

Age	Live weight (g)			Weight after fasting (g)			Per cent loss		
(weeks)	M	F	C	M	F	C	M	F	C
8	1570	1362	1466	1455	1260	1358	7.32	7.49	7.40
10	2408	1995	2201	2315	1908	2112	3.86	4.36	4.04
12	3287	2268	2778	3163	2194	2679	3.77	3.26	3 56
14	3850	2720	3285	3663	2556	3109	4.90	6.00	5.40
16	4458	3423	3941	4260	3258	3759	4.44	4.80	3.90
18	5438	4170	4804	5218	4013	4616	4.04	3.76	3.91
20	5888	4163	5026	5563	4003	4783	5.52	3.84	4.80
22	6555	4288	5422	6318	4153	5236	3.61	3.15	3.61
24	7167	4840	6004	6900	4626	5763	3.72	4.40	3.90
26	8400	4725	6563	8183	4558	6370	2.60	3.53	2.94
28	8750	4692	6721	8100	4417	6259	7.40	3.14	6.87
30	7600	4300	5950	7205	4110	5658	5.19	4.42	4.90

M—Male; F—Female; C—Combined sex.

TABLE 2

Percentage of weight after bleeding, dressed and eviscerated weights to live weight after fasting at different ages

Age (weeks)	Weight after bleeding (%)			Dressed weight (%)			Eviscerated weight (%)		
	M	F	C	M	F	C	M	F	C
8	96.9	96.7	96.8	83.2	83.9	83.6	67.7	66.8	67.3
10	95.5	95.9	95.7	79.2	79.3	79.3	64.8	65.9	65 4
12	96.7	95.6	96.2	82.7	83.0	82.8	67 2	66.5	66.9
14	95.6	94.9	95.3	84.1	82.8	83.4	68.2	66.2	67.2
16	97.3	97.3	97.3	86.8	87.1	86.9	70.8	70.8	70.6
18	96.5	96.9	96.7	85.3	85.7	85.5	65.4	70.3	67.9
20	96.5	96.9	96.7	84.8	87.9	86.3	70.1	73.1	71.6
22	96.5	96.4	96.4	85.4	85.7	85.6	71.4	73.0	72.2
24	97.5	97.6	97.5	86.0	87.6	86.8	68.4	72.3	70.4
26	96.5	96.7	96.6	83.4	82.2	82.8	67.0	69.2	68.1
28	96.8	96.9	96.8	85.6	85.2	85.4	67.1	65.5	66.3
30	96.6	96.5	96.6	85.1	85.4	85.3	65.8	68.6	67.2

weight after bleeding was significantly different for birds of different ages although sex did not have any significant effect on this trait.

The evisceration or ready to oven or ready to cook weight at various ages was 64.8 to 71.4% in males, 65.5 to 73.1% in females and 65.4 to 72.2% in birds on a combined sex basis. Fort and Kosar (1978) reported that the oven ready carcass weight as a percentage of slaughter weight ranged from 59.04 at 16 weeks to 66.90 at 28 weeks for males and from 59.74 at 12 weeks to 67.26 at 28 weeks of age for females. These workers observed that within sex, differences among age groups in percentage of meat in the carcass were mostly significant. The evisceration percentage at 16 weeks age (about 70-71%) was higher than the one at 26, 28 and 30 weeks of age indicating that it is economical to market these birds at 16 weeks of age. This information supports the earlier findings of Sharma *et al.* (1981). There was no particular trend indicating the effect of sex on evisceration percentage, however, the meat yields differed significantly at different ages.

The average weight of giblets and neck expressed as percentage of live weight at different ages has been presented in Table 3. It appeared that sex did not have an appreciable effect on giblet yields. The males yielded a higher percentage of neck meat compared to that of females at all ages of measurements. Age of slaughter had a significant effect on giblet weight.

TABLE 3

Average weight of giblets and neck expressed as per cent of live weight after fasting at different ages

Age	Weight of giblets (%)			Weight of neck (%)		
(weeks)	M	F	C	M	F	C
8	4.3	4.3	4.3	4.3	4.4	4.4
10	3.9	3.7	3.8	5.4	4.9	5.2
12	4.0	4.3	4.2	5.1	5 0	5.0
14	4.2	4.1	4.1	5.8	5.3	5.6
16	4.0	4.5	4.3	5.1	5.1	5.1
18	3.3	3.3	3.3	5.8	5.4	5.6
20	2.9	3.6	3.3	5.7	4.6	4.7
22	2.6	3.0	2.8	6.3	5.1	5.7
24	2.6	2.9	2.8	5.4	5.2	5.3
26	2.4	2.8	2.6	8.0	5.2	6.6
28	2.4	2.9	2.7	7.7	5.0	6.4
30	2.9	3.3	3.1	6.3	5.1	5.7

TABLE 4

Average weight of bones and meat per unit bone at different ages

Age	Weight of bones (g)			Weight of meat (g)			Meat per unit bone		
(weeks)	M	F	C	M	F	C	M	F	C
8	330	230	280	930	667	799	2.8	2.9	2.9
10	515	425	470	1100	985	1043	2.1	2 3	2.2
12	560	440	500	1680	1223	1452	3.0	2.8	2.9
14	675	400	538	1930	1375	1653	2.9	3.4	3.1
16	770	580	675	2845	2225	2535	3.7	3.8	3.8
18	820	600	710	3720	2570	3145	4.5	4.3	4.4
20	942	695	819	3320	2590	2955	3.5	3.7	3.6
22	1110	720	915	3595	2685	3140	3.3	3.7	3.4
24	1235	765	1000	4695	3110	3903	3.8	4.0	3.9
26	1375	900	1138	5150	3100	4125	3.7	3.4	3.6
28	1345	817	1081	4905	2737	3821	3.6	3.4	3.5
30	1130	785	958	4295	2185	3240	3.8	2.8	3.4

The weight of bones and meat in turkey carcasses of different ages has been presented in Table 4. The meat per unit bone was highest at 18 weeks of age.

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ANATOMICAL BASIS OF THE DIAPHRAGMATIC HERNIA IN BUFFALOES : A HISTOLOGICAL STUDY

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ABSTRACT

Detailed histological observations of 11 different regions of muscular and tendinous parts of the diaphragm of seven clinically normal buffaloes revealed no anatomical abnormality, responsible for the occurrence of the diaphragmatic hernia. However, the musculo-tendinous junction being a transitional zone might serve as a weak spot. It is presumed that primarily, the migrating foreign body causes *rupture in the organ, and subsequently increases abdominal pressure* (due to several reasons) and pushes the reticulum into the thorax.

The anatomical study of the diaphragm of buffalo has become significant because of the diaphragmatic hernia occurring mainly in the high yielding buffaloes. Diaphragmatic hernia is a form of internal hernia associated with the passage of viscera into the chest cavity through an opening acquired or congenital in the diaphragm. Enormous literature have accumulated on the corrective procedures of this disease (Jit Singh *et al.*, 1977; Krishnamurthy *et al.*, 1980a; Nigam *et al.*, 1980). However, the etiology of genesis of the disease and also the basic anatomical facts which may be responsible for the trouble are not well documented. It is, thus, imperative to investigate in detail the anatomical basis of the disease so that we can find out the etiology and radical method of cure or suggest some preventive measures for this condition.

The present paper incorporates the studies on the microscopic anatomy of the diaphragm of the adult normal she-buffaloes.

MATERIAL AND METHODS

Seven adult female clinically normal buffaloes were used in this study. Tissues from the 11 different parts of the diaphragm as shown in Fig. 1 were collected and fixed immediately in 10% formalin. Standard techniques involved in processing the tissues for light microscopic examination were adopted. The 5μ thin paraffin sections were stained with Harris hematoxylin and eosin stain Histomorphological and cyto-morphological studies on the various segments of the centrum tendineum and the musculature of the diaphragm were recorded for each region. The cyto-morphometry was done with a calibrated ocular micrometer. The fasciculo-interfascicular ratio of the tendon and muscles were computed with the help of the projection drawing prepared on an Ermascope with lanometer at 50 × magnifications.

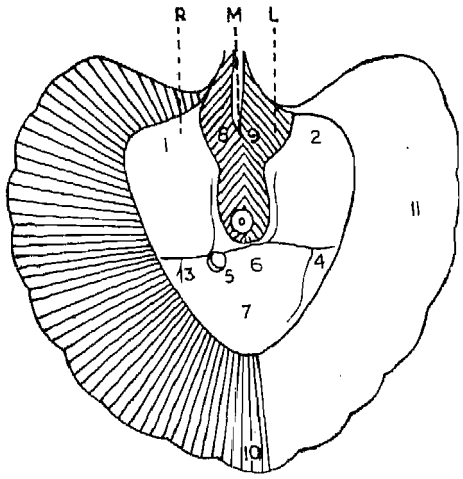


Fig. 1. Diagrammatic illustration of the diaphragm showing the various loci (1-11) from where the tissues were collected for the study.

R—Right side of the diaphragm; M—Mid line; and L—Left side of the diaphragm.

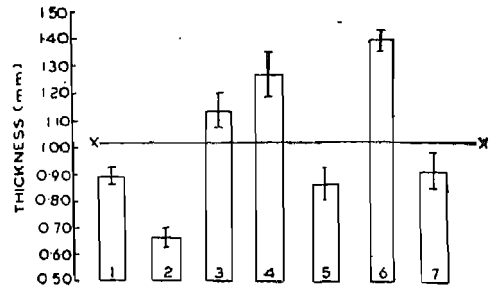


Fig. 2. Bar diagram showing the total thickness of the tendinous centre of the diaphragm at different points.

Right dorsal part of the tendon (1); Left dorsal part of the tendon (2); Right ventro-lateral part of the tendon (3); Left ventro-lateral part of the tendon (4); Right ventro medial part of the tendon (5); Left ventro-medial part of the tendon (6); Pericardiac part of the tendon (7).

X - X Mean thickness of the whole tendon.

RESULTS

The diaphragm of buffalo was composed of central tendinous area, the muscular crura and the peripheral muscular rim (sternal and costal parts).

The Central Tendon

The tendon on either side was covered by pleura and peritoneum with intact mesothelium. The total thickness of the tendon along with the serous membranes in different parts of the diaphragm has been shown in Fig. 2. The connective tissue and muscular/tendinous tissue ratio in different areas of the diaphragm has been shown in Fig. 3.

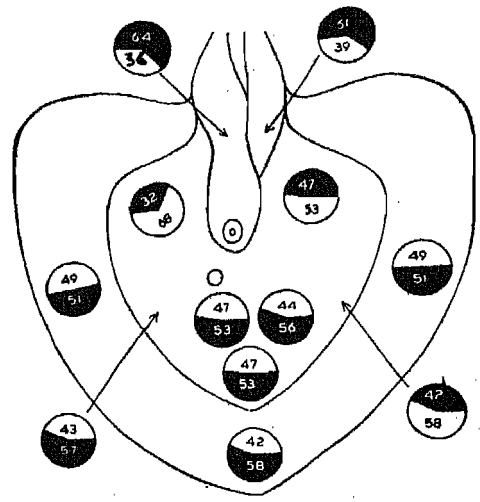


Fig. 3. Proportions of muscle/tendon and connective tissue in different regions of the diaphragm.

The serous membrane of the right dorsal part of the hemitendon was composed of the dense irregular connective

tissue. The peritoneum was thicker than the pleura and consisted of two layers of connective tissue fibers, the superficial layer being loose as compared to the deep layer. The latter was continuous with the tendinous fibers. Between the two layers there was an interrupted line of blood vessels extending upto the subepithelium. The tendon was also distinctly divisible into two layers, the fascicles of which ran in oblique direction to each other (Fig. 4). Blood vessels and lymphatics were observed between the two layers alongwith some fine bundles of collagen. Focal infiltration of mononuclear cells was found around some arterioles, commonly in the peritoneum than in the pleura. The sub serous layer consisted of a loose areolar connective tissue rich in adipose cells. The tendinous part had more connective tissue elements than the tendon fibers and maximum amongst all the components of the diaphragm (Fig. 3).

In the left dorsal portion of the diaphragm the serous membranes had more intimate association with the tendon. Lot of adipose tissue was observed in the subserous and inter fascicular tissues (Fig. 5). A distinctly thick sheet of connective tissue was identified in between the two major tendon fascicles of the right ventro-lateral hemitendon. A third but thin layer of tendon was also present in this area (Fig. 6). The inter tendinous connective tissue was poorly developed but had a very rich blood supply. The tendon fibers constituted the major portion of the tissue in this area and the interstitial connective tissue was much less (Fig. 3). In the right ventro-medial tendinous area of the diaphragm, three distinct layers of tendon fibers, besides serosal layers, were observed (Fig. 7). Total connective tissue was less in amount as compared to the tendon fascicles (Fig. 3). The tendon fibers were, however, very much intermingled. There was no lymphocytic infiltration but lot of dilated lymphatics were observed. This area was traversed by a fewer blood vessels.

The left ventro-medial tendinous portion of the diaphragm was the thickest amongst the whole centrum tendineum (Fig. 2). The tendon fibers were very much knitted and arranged in 4 to 5 layers (Fig. 8). The inter fascicular connective tissue was much less than the tendinous elements but was very rich in blood supply. The left ventro-lateral portion of the diaphragmatic tendon was also quite thick (Fig. 2) but was poorer in tendon content (Fig. 3). The connective tissue elements were more predominant. A thick sheet of adipose tissue containing large blood vessels was observed (Fig. 9).

In the ventral part of the centrum tendineum, three distinct layers of tendon fibers were present (Fig. 10). Tendon, connective tissue ratio was similar to right ventro-medial part of the centrum tendineum.

The Muscular Parts

The micrometric data on the individual fascicle and muscle fibres have been summarized in Table 1.

The crura of the diaphragm consisted of skeletal muscle fibers running in a longitudinal direction. Their myo-fibrils

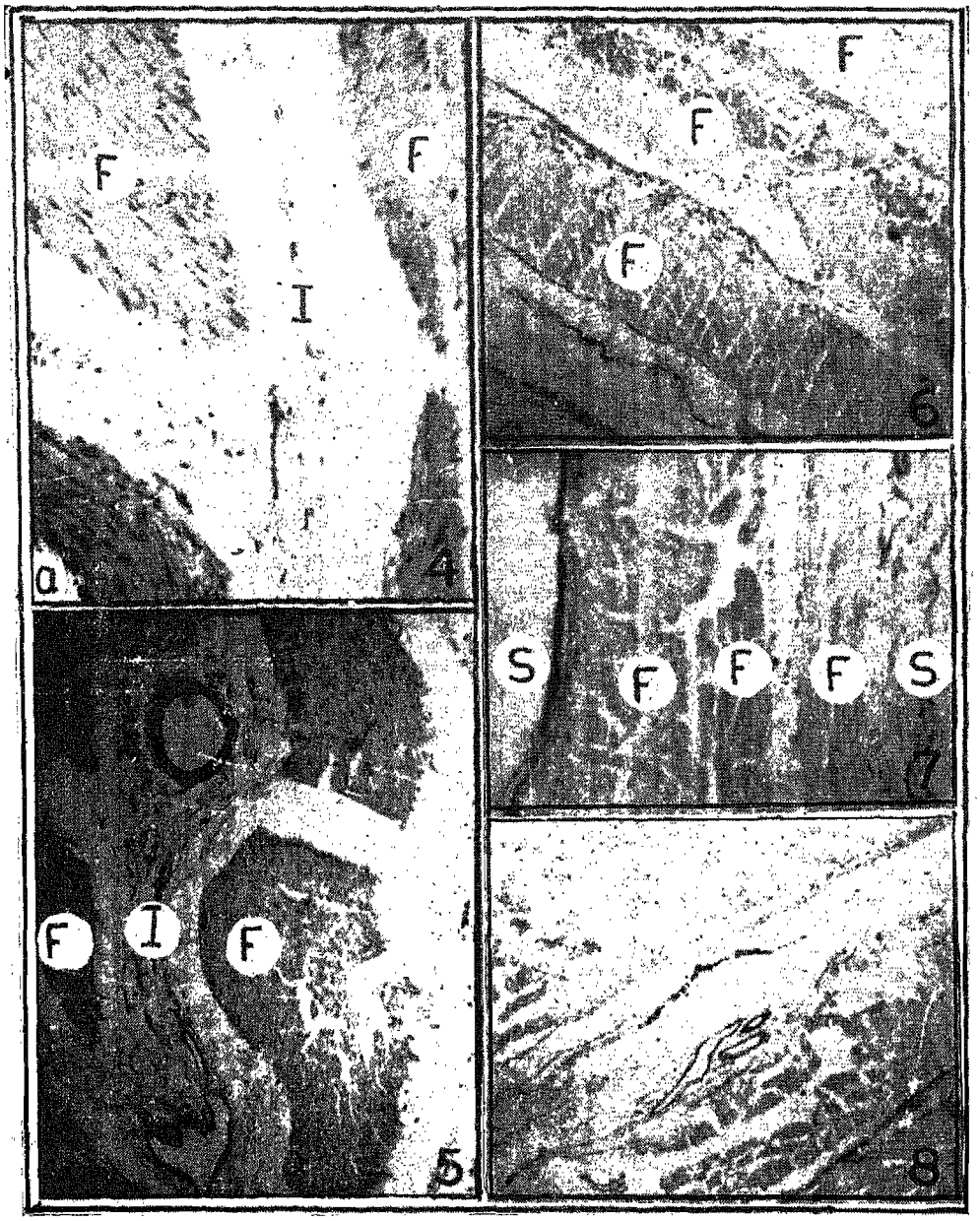

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TABLE 1

Micrometric data on the skeletal muscle of the diaphragm of adult female buffalo

Part of diaphragm	Fascicular size (μ^2)		Size of individual muscle fiber (μ)	
	Range	Mean	Range	Mean
Right crus	620-2070	1392	45-60	50
Left crus	340-2450	1532	45-58	50
Sternal	110-1680	611	37-45	40
Costal	80-1880	493	18-22	20

were uniformly distributed with no distinct Cohnheim's areas. Occasional cells showed the aggregation of myo-fibrils with a crescentric or circular clear sub-sarcoplasm. Inter fascicular connective tissue contained fat cells. The fascicles (Figs. 11, 12) were larger in left crus than in the right (Table 1). The muscle was composed of both the red and white fibers. The red fibers were fewer in number as compared to white fibers in the left crus. The red muscle fibers were more in number as compared to white fibers.

Muscular fascicles of different sizes mostly small bundles with a lot of inter muscular connective tissue rich in blood vessels and fat was observed in the sternal part of the diaphragm (Fig. 13). Muscular fascicles of the costal part of the diaphragm were very small with thin myofibers (Table 1). They had distinctly developed Cohnheim's areas. This part was, however, less vascular as compared to the sternal region and had a very little fat in the intermuscular connective tissue (Fig. 14).

DISCUSSION

The study revealed that different areas of the diaphragm varied in their thickness and composition. Among the seven

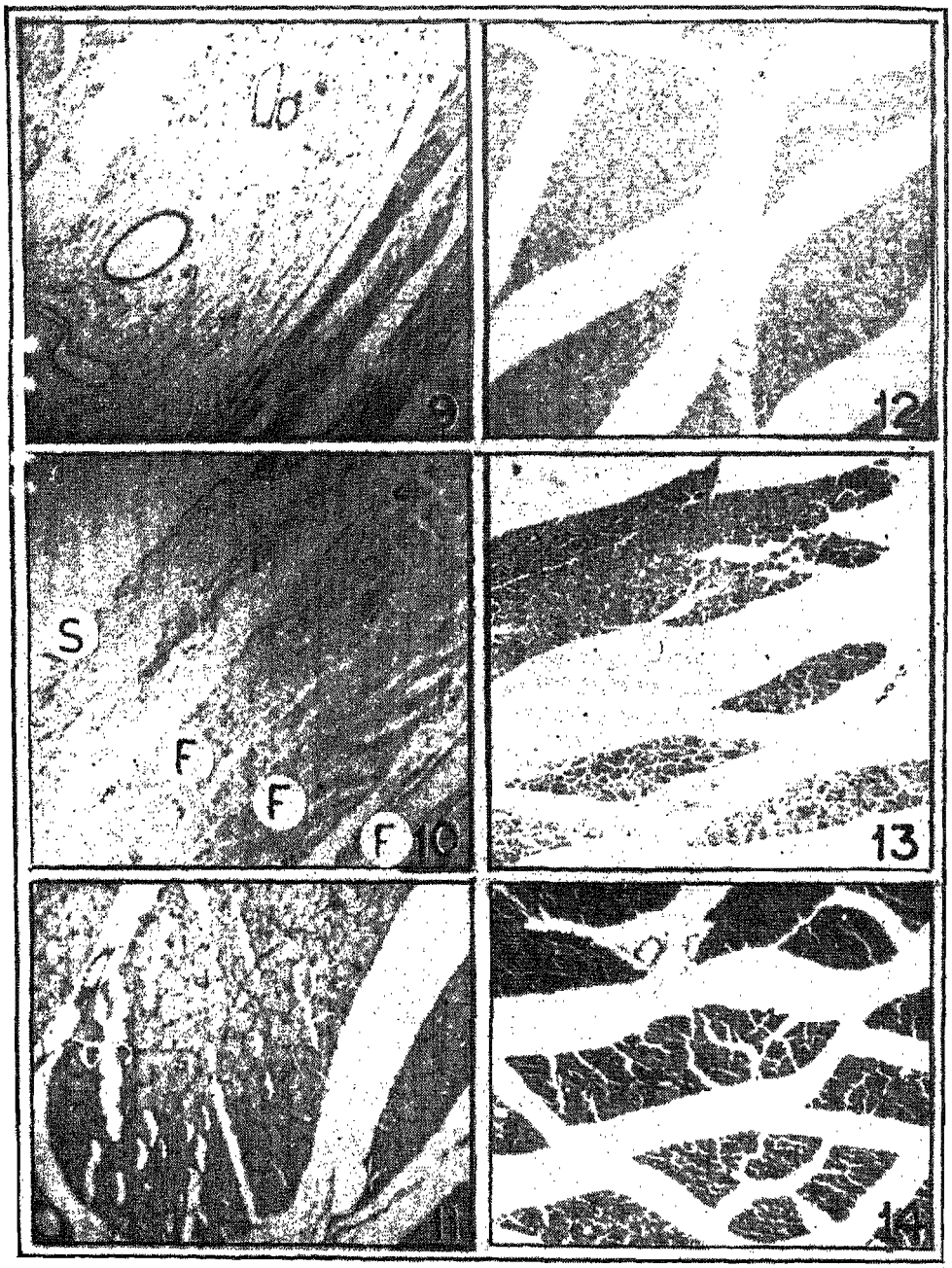
Fig. 4. Photomicrograph showing the composition of right dorsal part of the diaphragmatic tendon. Two layers of tendon fascicles (F) are running in oblique directions, separated by intertendinous tissue (I). An arteriole (a) is seen along the left ventral margin of the figure. H & E×100.

Fig. 5. Photomicrograph showing the composition of left dorsal part of the diaphragmatic tendon. The tendon fascicles (F) are separated by connective tissue (c) rich in adipose cells and blood vessels. H & E×100.

Fig. 6. Photomicrograph showing the cross section of right ventro-lateral part of the diaphragmatic tendon, composed of three distinct layers of the tendon fascicles (F). H & E×40.

Fig. 7. Photomicrograph of the right ventro-medial part of the diaphragmatic tendon, showing three distinct layers of the fascicles (F) covered by serosa (S) on either side. H & E×40.

Fig. 8. Photomicrograph of the ventro-medial part of the diaphragmatic tendon showing its complex nature. The tendon fascicles are arranged in many layers. H & E×40.


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regions observed from the centrum tendineum the thinnest was the left dorsal part and the thickest was the left ventro-medial part.

The right ventro-medial, right dorsal and ventral-central parts were of intermediate type in this increasing order. The hernia has been reported to occur frequently in the right ventro-medial (83%), left ventro-medial (10%) and the ventral (7%) part of the centrum tendineum (Krishnamurthy *et al.*, 1980b) but never in the dorsal parts which are much thinner than the right ventro-medial part of the diaphragmatic tendon.

Since the muscle/tendon fibers form the frame work of the diaphragm and provide the strength to this organ, the percentage ratio of these fibers was calculated in different segments of the diaphragm in relation to their connective tissue content. It was found that the right dorsal and left ventro-lateral parts of the tendon were the poorest in tendon content and hence appeared the weakest. But no incidence of diaphragmatic hernia has been reported in these two regions. The right ventro-medial part of the centrum tendineum where many cases of hernia have been reported (Krishnamurthy *et al.*, 1980b) contained much higher percentage of the tendon fibers than the interstitial connective tissue, and thus do not appear weak. Similar evaluations were done on the muscular regions of the diaphragm too. The musculature of the crura were heaviest particularly that of the right as reported earlier (Krishnamurthy *et al.*, 1982). The costal musculature was thinnest and hence may be weaker. But their reinforcement with ribs prevent the hernia. The sternal musculature was of intermediate type. However, its involvement in the disease is common (Krishnamurthy *et al.*, 1980b). Thus, there appears to be no morphological evidence of the weakness in the diaphragm responsible for the hernia. The disease occurred commonly at musculotendinous junction goes in conformity with the observation of Anderson (1969). This may be due to a transitional nature of this zone as reported earlier (Krishnamurthy *et al.*, 1980b). Right ventro-

Fig. 9. Photomicrograph showing the tendon fascicles of the left ventro-lateral part of the diaphragmatic tendon separated by means of a thick sheet of vascular connective tissue rich in adipose cells. H & E×40.

Fig. 10. Photomicrograph of the central part of the diaphragmatic tendon composed of three layers of the tendon fascicles (F) separated by little connective tissue elements and covered by a thick serosa. H & E×40.

Fig. 11. Photomicrograph of the cross section of the left crus of diaphragm showing large muscular fascicles separated by moderate amount of inter muscular tissue. H & E×40.

Fig. 12. Photomicrograph of the cross section of the right crus of diaphragm showing smaller muscle fascicles than the left crus (Fig. 11). H & E×40.

Fig. 13. Photomicrograph of the musculature of sternal part of the diaphragm showing varying sizes of myofascicles and large intermuscular tissue (space). H & E×40.

Fig. 14. Photomicrograph showing the small sized myofascicles separated by means of inter muscular tissue (spaces) in the costal part of the diaphragm. H & E×40.

medial tendinous part had a relatively poor blood supply. This is in agreement with the earlier roent-genographic (Krishnamurthy *et al.*, 1980b) and gross anatomical studies of the phrenic arteries of buffalo, where pericardiophrenic arteries are absent (Sharma *et al.*, 1980). On the other hand the sternal part (muscles) of the diaphragm had the richest blood supply.

Thus, it appears that the diaphragmatic rupture is sequelae of the trauma through metallic objects found in the cases of traumatic reticulitis. The condition is further aggravated by the increased abdominal pressure in cases of tympany, pregnancy and straining at the time of parturition. Tympany has been observed in 99% cases of the hernia (Krishnamurthy *et al.* 1980d). The increased abdominal pressure may while aggravate the condition secondarily as stated above it may also serve as a primary factor by causing vascular stasis and occlusion through pressure on the diaphragmatic vessels (Krishnamurthy *et al.*, 1980c; Sharma *et al.*, 1980). Vasovagal reflexes have also been reported to be the contributory factors to the diaphragmatic hernia in man (Anderson, 1969).

Thus, the intrinsic weakness of the diaphragm at the musculo-tendinous junction, and poor vascularity of the reticular area of the diaphragm, the paroxysmal increase in the intra-abdominal pressure causing vascular stasis in the sternal part, etc. may act as the predisposing factors while the actual rupture is caused by the migrating metallic objects in the cases of traumatic reticulitis. The traumatic reticulitis particularly occurs due to the poor managemental practices (Hutchins *et al.*, 1957; Krishnamurthy *et al.*, 1980d). It is, thus possible to limit the occurrence of the disease through good management practices in the dairy husbandry.

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HISTOMORPHOLOGY AND HISTOCHEMISTRY OF THE SCROTAL APOCRINE GLANDS OF BUFFALO IN RELATION TO TESTICULAR HOMEOTHERMY

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ABSTRACT

Morphologically and histochemically active apocrine sweat glands were found on the scrotal skin, which were generally more in dimensions but less in population than of the cattle. Their size increased but the frequency decreased with the advancing age. Thin population of the sweat glands in the buffalo scrotal skin provides an inefficient mechanism for the testicular cooling and this is probably compensated by the various morphological adaptations of the testicular vessels reported earlier as a characteristic of this species.

The role of a good buffalo bull in dairy husbandry is highlighted by the wellknown old proverb "The sire is half of the herd". The quality and production of semen are greatly influenced by the temperature, both inside and outside the testicular envelope. Defective sperm production in cases of raised scrotal temperature and infertility due to high summer temperature have been reported by a number of workers in different domestic animals (Gunn *et al.*, 1942; Waites, 1970; Ortavant *et al.*, 1977; Setchell, 1977). The vascular architecture of the testis plays a vital role in the local thermoregulation of the organ (Waites and Moule, 1961; Setchell and Waites, 1969; Waites, 1970). The scrotum also provides a suitable thermal insulation for normal spermatogenesis (Bishop and Walton, 1960). While the vascular adaptations of the testis and epididymis of buffalo have been described (Borthakur and Dhingra, 1978; Dhingra, 1978; Dhingra, 1980), the detailed information on the histology and histochemistry of the scrotal sweat glands is sparse (Dhingra and Sharma, 1980a). The present paper describes the distribution pattern and histological and histochemical structure of these glands at various ages of postnatal development. Their correlation with the various vascular adaptations and role in the local thermoregulation of the testis are also discussed.

MATERIAL AND METHODS

Scrotal tissues from 10 different regions as detailed in an earlier communication (Dhingra and Sharma, 1980a) were collected from 10 buffalo bulls (3 neonatal, 3 prepubertal and 4 adult) and stored in 10% neutral formalin, chilled

alcohol and Zenker's fixatives. Tissues were processed through routine alcohol-benzene schedule for paraffin embedding. The sections were cut at 5-10 μ thickness and stained with hematoxylin and eosin for general fibrocellular elements aldehyde fuchsin for elastin, Vangieson's for collagen, and Gomori's for reticulum, McManus periodic acid Schiff (PAS) and Best's carmine for glycogen, alcian blue at different pH for acid mucopolysaccharides (AMPS), Feulgen and Methyl green-pyronin Y for nucleic acids (Luna, 1968), mercury bromophenol blue for proteins (Pearse, 1961), calcium cobalt method for alkaline phosphatase and lead method for acid phosphatase (Thompson, 1966). Cryosections were stained with Chiffelle and Putt's method of Sudan black-B for fats (Luna, 1968), Dunnigan's nile blue sulphate for phospholipids (Dunnigan, 1968) and Zeil Nelson's method for acid fast lipids (Pearse, 1961). Paraffin sections and pyridine extracted sections were also run simultaneously for comparison. Cytomorphometry was done through the callibrated ocular micrometer on the lines suggested by Jenkinson and Nay (1968).

RESULTS AND DISCUSSION

Histomorphology

The sweat glands of the scrotal skin were of apocrine type (Fig. 5) as reported earlier in different body regions of buffalo (Yamane and Ono, 1936; Hafez *et al.*, 1955; Prusty, 1971; Dhingra *et al.*, 1978; Dhingra and Sharma, 1980b). They were distributed over whole surface of the scrotum in young calves but only in the neck and body of the scrotum in adult buffalo bulls. The young animals' scrota represented higher density of the sweat glands per unit area when compared to adult ones. They were particularly more numerous in anterior raphe area of the body. They were simple tubular glands with moderately coiled secretory part lying deep into the dermis (Fig. 1), and always below the level of sebaceous glands and hair follicle in adults and at the level of root of the hair in young calves. They were placed deeply at the junction of the papillary and the reticular parts of the dermis (Fig. 2) as reported in cows (Nay and Hayman, 1956) and buffaloes (Prusty, 1973; Dhingra and Sharma, 1980a). The glands were mostly sausage shaped or sac like (Fig. 3) in appearance as reported by earlier workers (Nay and Hayman, 1956; Walker, 1960; Prusty, 1971; Singh *et al.*, 1973) in cattle and buffaloes. Baggy type of glands have also been found as reported in Zebus (Walker, 1960) and European cattle (Findlay and Yang, 1951). Their shape (L/D ratio) varied between 1.26-2.74 (Table 1) in left lateral and anterior raphe area of the body regions. Nay and Jenkinson (1964) reported a much higher L/D value of 5 9-10.2 in different breeds of European cattle. The maximum gland diameter (133μ) reported by them for cattle accounts for the lowest value (133.30μ) of the present investigation. The minimum (209.25μ) and maximum (424.7μ) lengths of the glands were also in the same parts of the scrotum where the lowest and highest values of shape index were observed. Hence, it is possible that the length of the gland determined its shape. Similarly the most voluminous glands (10.7×10^6 μ^3) were observed in the right side of the neck of the scrotum, where maximum diameter of the gland (208.35 μ) was also recorded, and the least volume of the glands

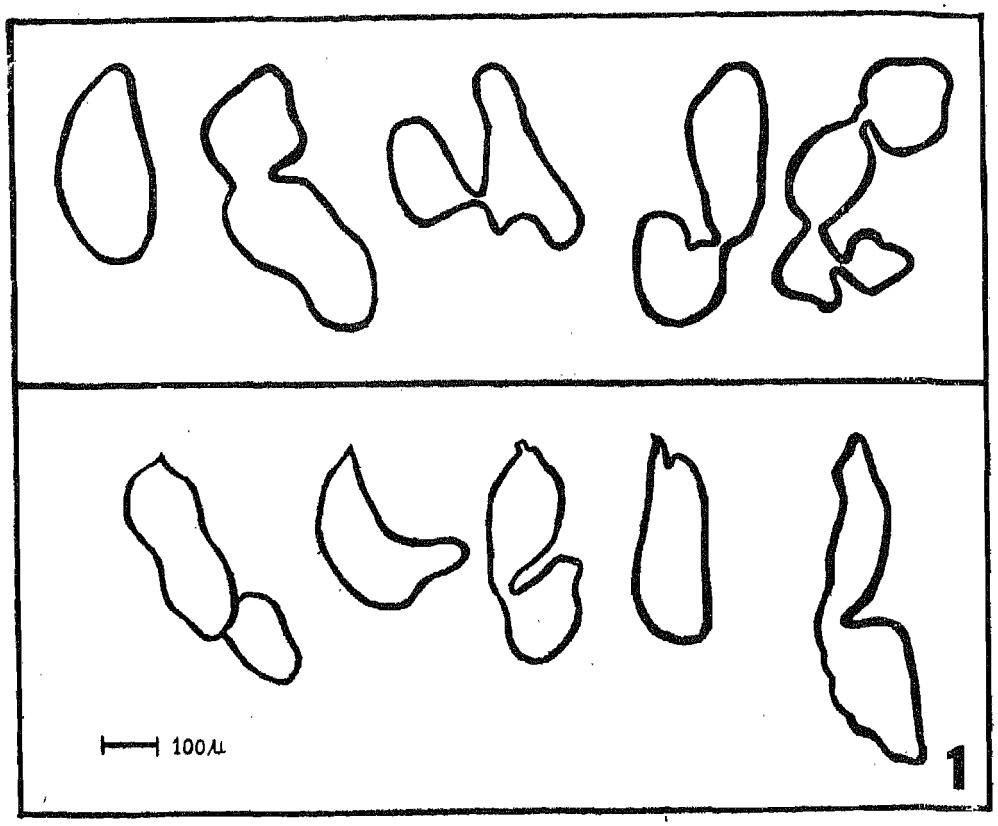


Fig. 1. Projection drawings of the sweat glands showing their different shapes.

TABLE 1

Micrometry of the sweat glands in different parts of the scrotum of adult buffalo bull

Scrotal segment	Length (μ)	Diameter (μ)	Shape	Volume ($\times 10^6 \mu^3$)	Circumferential area (μ^2)
Neck lateral left side	248.00	144.15	1.72	4.05	720
Neck lateral right side	315.00	208.35	1.51	10.71	360
Neck raphe anterior side	330.00	155.00	1.59	3.87	560
Neck raphe posterior side	235.60	133.30	1.77	3.29	340
Body raphe anterior side	424.70	155.00	2.74	8.01	280
Body raphe posterior side	271.25	189.10	1.43	7.61	334
Body lateral right side	209.25	165.75	1.26	5.45	190

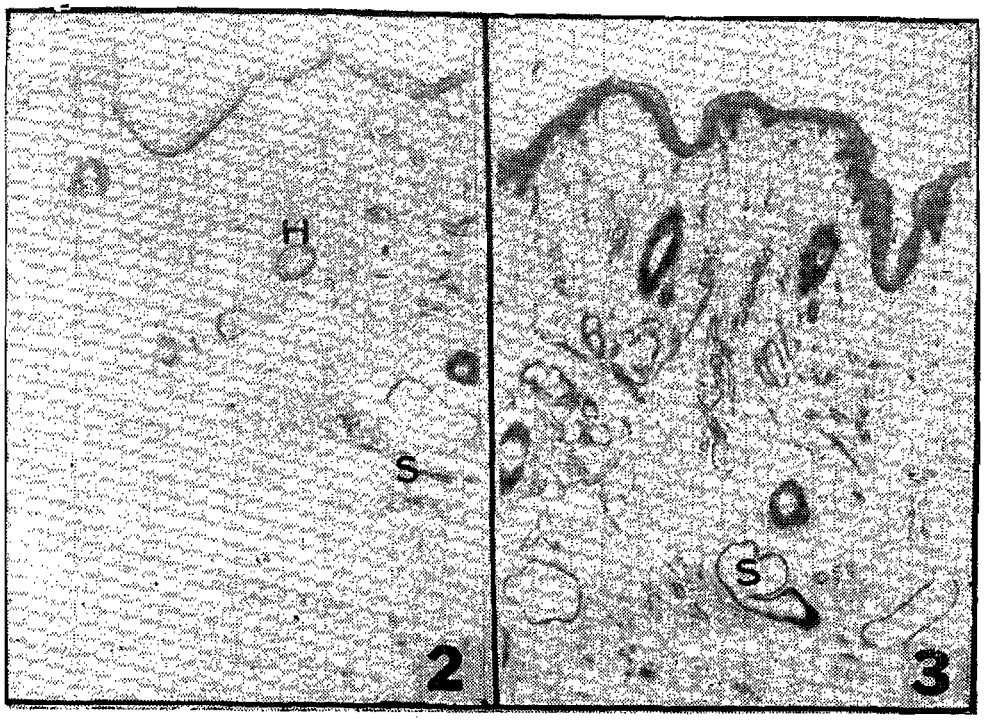


Fig. 2. Photomicrograph of the scrotal skin showing association of hair follicle (H) and the sweat gland (S). There is no sebaceous gland associated with any of the hair follicle in this field. H & E, ×40.

Fig. 3. Photomicrograph of the scrotal skin showing the sebaceous follicle located in the vicinity of the ordinary hair follicle. Deeply located sweat glands (S) are dilated sac like structures. Their ducts course upward along the hair follicle to open on the surface. The arrector pili muscles are seen around the hair follicle as well as the duct of the sweat glands. H & E, ×40.

(3.29×10^6 μ^3) was observed in posterior part of the raphe of the neck where the diameter too was the lowest (133.30 μ). It is possible that the volume of the gland is determined by the diameter of the gland. The sweat glands of Zebu cattle are one and a half times larger than that of the European cattle (Fahimuddin, 1975). In different European breeds Nay and Jenkinson (1964) recorded sweat gland volumes varying between $8.1 \times 10^6 \mu^3 - 14.3 \times 10^6 \mu^3$. The present studies revealed even smaller sweat glands in buffaloes. Hence, the heat load shedding through sweat evaporation mechanism is very poor in Murrah buffaloes. Asker *et al.* (1952) also reported least heat resistance in Egyptian buffaloes as compared to different cattle of Egyptian and European origin. The values reported for length, area and volume of sweat glands by Fahimuddin (1975) fell within the range of the values recorded

in the present study. On an average the biggest cross sections of the glands (720 μ^2) were observed in left lateral wall of the neck and the smallest in the left lateral part of the body (Table 1) of the scrotum. The cross-sections of the sweat glands were mostly elongated oval or sausage shaped (Figs. 1, 2, 4) as reported in cattle (Walker, 1960).

The secretory portion of the gland was lined with simple columnar to low cuboidal type of epithelium resting on a typical argyrophilic, PAS reactive basement membrane (Figs. 4-6). The varying heights of the epithelia probably were indicative of the different states of functional activity of the glandular cells as suggested by Montagna and Parakkal (1974) and Calhoun and Stinson (1976). Some times a single gland cross section showed cells of different heights in its different parts, indicating that all the cells of one gland are not in the same

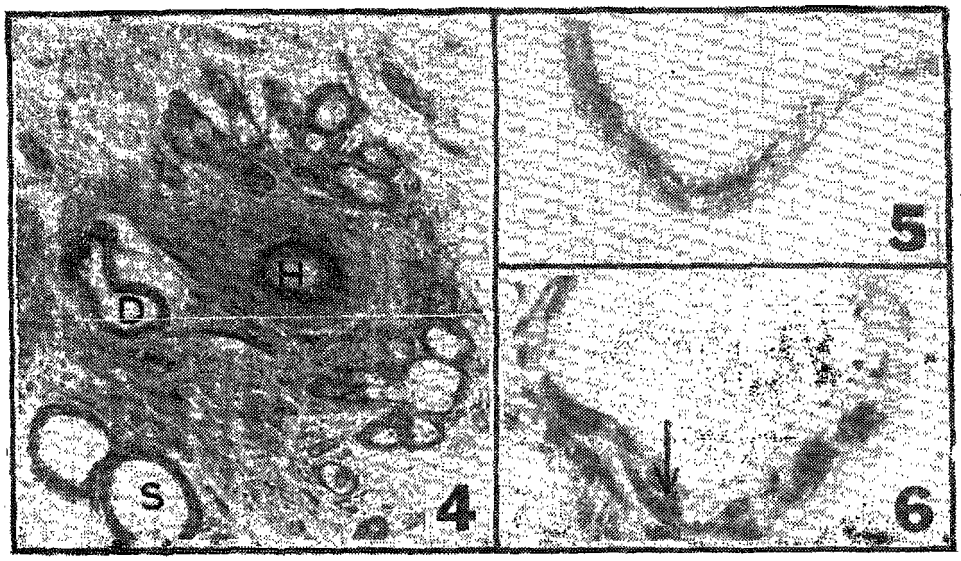


Fig. 4. Photomicrograph of the scrotal skin showing a typical pilosebaceous unit. The hair follicle is surrounded by the sebaceous glands on either side. The arrector pilorum muscle lies between the sweat gland duct (D) and the hair follicle (H). The gland (S) lies farther away from the unit. H & E, ×100.

Fig. 5. Photomicrograph of the scrotal skin showing a large apocrine sweat gland. Its active secretory nature can be appreciated because of the deposition of variable amount of carminophilic blebs on the secretory border of the cells. Best's carmine × 400.

Fig. 6. Photomicrograph of the scrotal skin showing apocrine sweat glands lined with simple cuboidal epithelium. Their cytoplasm is PAS reactive. The secretion droplets are seen along the apical border of the cells. The myoepithelial cells (arrow) are sandwitched between the sudoriferous epithelium and the basement membrane. Mc Manus PAS × 400.

stage of activity at the same time. Their cytoplasm was generally eosinophilic but some times lightly basophilic supra nuclear region was also observed. It was PAS positive (Fig. 6), orthochromatic and very strongly aldehyde fuchsin reactive. It was further observed that some of the secretory cells had a clear area in perinuclear and some in supra nuclear parts, while some appeared foamy and still others, were completely homogeneously laden with finely granular cytoplasm. Their basal border and sometimes apical border too showed lightly basophilic striated appearance. The nuclei which were generally single but sometimes double, were round (7-15μ diameter) or elliptical (20-25 μ long × 7-15 μ wide) in shape and stained deeply with hematoxylin and methylene blue stains. The glandular lumen was rarely completely empty. Mostly it contained acidophilic fibrinous or orthochromatic PAS positive colloid material. Occasionally resorption vacuoles were also seen in colloid mass. All these morphological characters clearly indicate their actively secretory nature. Secretory nature of the sweat glands have also been proposed by Calhoun and Stinson (1976) in other domestic animals. However, Prusty (1973) stated that they are non-functional and atrophic glands and play no part in heat regulation.

Wedged between the basement membrane and the secretory cells, lay crescentric shaped myoepithelial cells (Fig. 6), which were aligned parallel to the basement lamina as reported in human beings (Montagna and Parakkal, 1974) and buffalo (Hafez *et al.*, 1955; Majeed *et al.*, 1975; Dhingra *et al.*, 1978; Dhingra and Sharma, 1980a). Their spindle shaped argyrophilic nuclei were darkly stained with hematoxylin and flatly placed in the cell. Their basophilic cytoplasm was orthochromatic. Outside the basement membrane lay a homogenous 2-4 μ thickacidophilic line of collagen or connective tissue cells (3-5 μ).

The excretory ducts of these glands were not coiled. This is in contrary to the observations of Prusty (1971) who reported a serpentine course of the ducts in buffalo. Calhoun and Stinson (1976) reported a reasonably straight course of sudoriferous ducts in ruminants. In buffalo they ran straight and formed a very acute angle with the pilary canal and poured their secretions into the pilosebaceous system opening under the sebaceous ducts. Trautmann and Fiebiger (1957) reported that the sweat glands always open above the sebaceous glands in the skin of other domestic animals. The cross sections of the ducts were always round measuring 100-130 μ in diameter, and were always less than the diameter of even the smallest cross section of the secretory portion of the gland (Fig. 2). Calhoun and Stinson (1976) reported that in ruminants the excretory ducts were dilated giving them appearance of large saccules. They were lined with simple low cuboidal epithelium (cell height 7-15 μ) which near their termination, became stratified cuboidal (height 15-30 μ) epithelium resting on a regular PAS and silver reactive basement lamina. The myoepithelial cells were also observed in some cases between the lining cells and the basement membrane. Occasionally a glossy type homogenous 3-5 μ thick eosinophilic and alcianophilic, amorphous line was observed around them. A number of fine

capillaries were also found in the connective tissue around the ducts. Their lumen some times contained strongly acidophilic but PAS reactive homogenous colloid. The ductal cells showed certain secretory blebs and also some showed striated appearance at their distal border. These points indicated a secreting nature of these ducts too.

Histochemistry

PAS positive and Best's carmine reactive, diastase labile granules were observed in the cell cytoplasm, particularly concentrated along their apical border (Figs. 5, 6). Such PAS positive, non-pigmented, acidophilic granules of human apocrine glands have been regarded to be the mitochondria (Montagna *et al.*, 1953; Montes *et al.*, 1960) or Golgi apparatus with phospholipids, glycoproteins or mucopolysaccharides (Montagna andParakkal,1974). Glycogen, lipid or pigment granules may occur in the cytoplasm of other domestic animals too (Calhoun and Stinson, 1976). Sweat glands of cattle, however, do not respond to the glycogen stains (Yang, 1952). The intra glandular colloid also showed homogenous red reaction. Methylene blue revealed orthochromasia. Aldehyde fuchsin staining revealed carboxylated group of the carbohydrates. Acid mucopolysaccharide staining revealed its greater concentration at the secretory border of the cells. Myoepithelial cells were altogether negative for all the carbohydrate stains. A hyaline amorphous material around the duct also showed an affinity for the alcian blue stains.

Lipid stains revealed homogenous sudanophilia in the glandular cell cytoplasm which remained unaltered in paraffin sections. Montagna and Parakkal (1974) have reported similar nature of the human apocrine glands. Yang (1952), however, reported absence of fats, fatty acids, cholesterol and phospholipids in the sweat glands of European cattle. The Nile Blue Sulphate (Dunnigan's) staining demonstrated the presence of acidic type of lipids but there were no phospholipids. Zeihl Nelson's staining confirmed the acid fast nature of the lipids.

Mercury bromophenol blue staining for protein showed its absence in the glandular secretory portions. Yang (1952) has reported arginine and xanthoprotein concentration in the myoepithelial cells and secretions of sweat glands of European cattle. In the ducts, where it was lined with stratified type of epithelium the superficial cells showed a positive reaction while the deep layer remained non-reactive for the proteins.

Nucleic acid stains revealed finely granular RNA distributed throughout the cell cytoplasm, with a tendency of greater accumulation in the supra nuclear and perinuclear area. The nucleolar RNA was either found touching the nuclear membrane or in split form. The DNA was observed in a coarse granular form, mildly reactive and regularly distributed throughout the nucleoplasm. Myoepithelial cells were mildly reactive for both the nucleic acid stains. Sweat glands of cattle while show RNA activity, they do not take up DNA stains (Yang, 1952). Alkaline phosphatase enzyme was observed in the cytoplasm of the lining cells of the glands and their ducts, in moderate concentration. The nuclear membrane of the

myoepithelial cells was also reactive. Similar distribution of the phosphatase enzyme has been reported in the sweat glands of human beings (Montagna and Parakkal, 1974) and cattle (Yang, 1952).

Thermoregulatory role of the sweat glands have been reported in cattle (Ferguson and Dowling, 1955; Beakley and Findlay, 1955), buffalo (Dhingra and Sharma, 1980a) and sheep (Brook and Short, 1960; Waites, 1961, 1962). The histological and histochemical observations on the buffalo scrotal skin, thus, conducted confirmed the presence of the actively secreting apocrine type sweat glands. However, their frequency and sweating area had been much less than that of the cattle (Yamane and Ono, 1936; Hafez *et al.*, 1955). Dhingra and Sharma (1980a) have further reported larger sweat glands in Murrah buffaloes than those of the Pakistani Nili Ravi (Majeed *et al.*, 1973). Similar differences have been reported among the sweat glands of Egyptian buffalo and cattle (Hafez *et al.*, 1955). These observations confirmed the statements of Findlay and Yang (1951) whereby they stated that where the glands were more numerous per unit area, there was a tendency for these to be smaller in circumference and to have a smaller area of secreting surface.

The poor population of the sweat glands of buffalo scrotum may be responsible for its poor heat adaptability for proper spermatogenesis in the testis than in the cattle. This inefficiency of the cooling mechanism of the buffalo scrotum (through sweat evaporation) might have been compensated by the various morphological adaptations of the intratesticular vessels as reported by Godinho *et al.* (1973) and Dhingra (1980). They observed a more tortuous and coiled course of the centripetal arteries on their way to mediastimum testis in buffaloes as compared to other ruminants (Godinho *et al.*, 1973; Dhingra and Sharma, 1980b). Waites (1970) stated that the effectiveness of the vascular counter current heat exchange depends on the thermoregulatory mechanism of the scrotum in rats. In buffalo, however, the latter appears to play a minor role and the major cooling effect is probably brought about by the vascular adaptations as suggested by Setchell (1970, 1977).

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SEROLOGIC EVIDENCE OF *COXIELLA BURNETII* INFECTION IN BLACK BENGAL GOATS

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Q fever (*Coxiella burnetii* infection) is an ubiquitous rickettsial zoonoses of public health significance which often goes unnoticed in animals. Wide seroprevalence of this infection has been reported in different animal species from various parts of the country (Kalra and Taneja, 1953, 1954; Pathak and Tanwani, 1969; Choudhury *et al.*, 1971; Randhawa *et al.*, 1972; Kulshreshtha *et al.*, 1974; Ghosh *et al.*, 1976; Shukla and Negi, 1978). This communication reports seroprevalence of antibodies to *Coxiella burnetii* in apparently healthy Black Bengal goats commonly found in West Bengal.

Coloured antigen was obtained from National Institute of Allergy and Infectious Diseases, Rocky Mountain Laboratory, Hamilton, Montana, U.S.A. One hundred and ninety five serum samples were collected in sterile test tubes from Black Bengal goats of 1.5-2.5 years of age during Jan.-Feb. 1980. These goats were imported from Murshidabad and surrounding areas of West Bengal State. The serum samples were preserved in 1 : 10000 merthiolate and stored at −20°C until used. The serum samples were subjected to capillary agglutination test (CAT) as described by Luoto (1953). Appropriate positive and negative controls were included in each test.

Out of 195 serum samples tested 63 sera were observed to be positive for antibodies to *Coxiella burnetii* recording an incidence of 32.31 per cent. Domestic animals have well been recognised as reservoirs of Q fever. However, the relative status of goats among various animal species with regard to incidence of Q fever is not clear. In the present study, capillary agglutination test was employed for serological studies because of its efficacy and quick results. The serologic prevalence of Q fever in goats was found to be 32.31% which is much higher as compared to the observations of other workers (Table 1) in different parts of the country. Such a high seroprevalence perhaps be because of a younger age group, winter season and a specific breed ofgoats, while the data presented in Table 1 is computed

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TABLE 1

Serologic evidences for the prevalence of antibodies to *Coxiella burnetii* in goats at different places

Area	Total sera tested	No. of positive serum	Per cent positive	Reference
Delhi and surrounding areas	52	1	1.92	Choudhury *et al.* (1971)
Bareilly and surrounding areas	176	17	10.35	Ghosh *et al.* (1976)
Throughout India	90	4	4.4	Kalra and Taneja (1953)
Madhya Pradesh	520	65	12.5	Pathak and Tanwani (1969)
Bihar, Lucknow, Hissar, Kasauli, Mukteshwar and Poona	90	3	3.3	Kalra and Taneja (1954)
Haryana and Panjab	503	40	7.9	Randhawa *et al.* (1972)
Murshidabad and surrounding areas	195	63	32.31	Present study

irrespective of such factors. It would be worthwhile to study the impact of introduction of these goats possessing higher evidence of antibodies to *C. burnetii* in other breeds of goats, other animal species kept at the farm and human beings coming in contact with them frequently. The seroprevalence of Q fever in Panjab and Haryana has been recorded as 7.9% in goats (Randhawa *et al.*, 1972), and 20.5% in buffaloes and 4.0% in pigs (Kulshreshtha *et al.*, 1974). It would be interesting to conduct serological studies with the milk samples collected from these goats. Further mercaptoethanol test may be carried out so as to know the type of immunoglobulin involved, that may, perhaps indicate the duration of exposure.

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RESEARCH NOTE

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EFFECT OF WATER SOAKING OF CONCENTRATE ON THE INTAKE AND DIGESTIBILITY OF NUTRIENTS IN BUFFALOES

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In villages, farmers generally soak or boil the concentrates in water. The cakes and grains are soaked/boiled in the morning and used in the evening and vice-versa. Soaking of concentrate with water has been reported to increase the intake and digestibility of nutrients in cattle (Dalton *et al.*, 1953; Heuberger *et al.*, 1959). Holzer *et al.* (1975) on the other hand reported no effect of soaking on the voluntary intake and digestibility of nutrients in cows. With these contradictory reports and the likely age factor involved, the present investigation was undertaken to find out the effect of soaking of concentrate on the digestibility of nutrients in young and old milch buffaloes.

Sixteen lactating Murrah buffaloes in early lactation were selected from the herd of the Department of Livestock Production and Management. Of these 8 were old (a_1) (completed more than 8 lactations) and 8 were young (a_2) (completed up to 5 lactations). Each set of animals was sub-divided into two groups of 4 each. The animals in each group were matched for body weight and initial milk yield. Each age group of animals was allotted to the two treatments : s_1 getting water soaked concentrate mixture and s_2 with concentrate mixture without any soaking. The experiment was conducted in split plot factorial design with four replications, taking age (a) group in main plot and treatments(s) in sub-plots. The experiment lasted for 90 days starting from July 7, 1979.

Animals were fed individually according to their requirement for maintenance and milk production (Sen and Ray, 1971). Green jowar was the roughage used. A well mixed concentrate mixture comprising of maize 15 parts, barley 30 parts, groundnut cake 25 parts, wheat bran 30 parts, salt 2 parts and mineral mixture 1 part was fed in equal parts at both morning and evening milking after proper treatments. The samples of greens offered and left-overs were taken daily to determine the dry matter intake. Fresh water was offered both morning and evening. All other management practices were also similar for all the groups.

A conventional digestion trial with seven days collection period was conduc-

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ted at the end of the experiment. The samples of feed offered, residue left and faeces voided were analysed for proximate principles by standard methods (AOAC, 1970).

The chemical composition of green **jowar** and concentrate mixture used is given in Table 1. The crude protein content of the **jowar** and concentrate mixture, on dry matter basis was 5.87 and 19.25 per cent, respectively. The average daily intake of dry matter, DCP and TDN were not significantly influenced by age and soaking of concentrates (Table 2). The average dry matter intake per 100 kg body weight was 2.85±0.10 and 2.93±0.10 kg for soaked and unsoaked groups. It was 2.84±1.10 and 2.94±0.01 in case of old and young groups, respectively.

Digestibility of dry matter, crude protein, crude fibre, ether extract and nitrogen free extract was also not significantly influenced by the soaking of concentrates, age of the animals and their interaction (Table 3). The digestibility of nutrients except ether extract was slightly more in soaked concentrate fed group than unsoaked one. However, none of the differences were statistically significant. The results of present experiment are in agreement with those of Holzer *et al.* (1975). They also reported no effect of soaking of feed on voluntary intake and digestibility in cows. They, however, reported that soaking of feed resulted in significant increase in the proportion of propionic acid in the rumen liquor and non-significant decrease in that of acetic acid. Dalton *et al.* (1953) on the other hand had shown that moistening of con-

TABLE 1

Proximate composition of feeds on dry matter basis

Feeds	Crude protein (%)	Crude fibre (%)	Ether extract (%)	Nitrogen free extract (%)	Ash (%)
Jowar	5.87	33.10	1.15	51.27	8.61
Concentrate mixture	19.25	7.40	2.54	59.44	11.37

TABLE 2

Average daily intake of dry matter, DCP and TDN during experiment*

	No. of buffaloes	Average daily intake of		
		Dry matter (kg)	DCP (kg)	TDN (kg)
Age Groups :				
Old (a_1)	8	14.88±0.91	0.960±0.076	7.37±0.35
Young (a_2)	8	14.64±0.28	0.986±0.032	7.64±0.22
Treatments :				
Soaked concentrate (s_1)	8	14.88±0.74	0.992±0.065	7.70±0.35
Control (s_2)	8	15.54±0.60	0.954±0.050	7.32±0.21

*None of the means differed significantly.

TABLE 3

Average nutrient digestibility coefficient

	No. of buffaloes	Average digestibility coefficient for				
		Dry matter	Crude protein	Crude fibre	Ether extract	Nitrogen free extract
Age groups :						
Old (a_1)	8	57.33±0.84	61.27±2.12	47.57±1.69	50.61±1.80	61.53±0.83
Young (a_2)	8	58.09±0.95	62.99±0.84	49.05±6.43	52.35±3.40	61.58±0.97
Treatments :						
Soaked concentrate (s_1)	8	58.28±0.96	62.38±1.91	48.78±2.18	51.20±3.34	62.70±0.67
Control (s_2)	8	57.15±0.79	61.88±1.30	47.84±1.64	51.76±2.04	60.41±0.90
Treatment combinations :						
$a_1 s_1$	4	57.61±1.24	61.15±3.86	50.23±1.78	52.71±3.01	61.95±1.12
$a_1 s_2$	4	57.04±1.29	61.40±2.40	44.91±2.32	48 52±2.14	61.10±1.35
$a_2 s_1$	4	58.94±1.57	63.61±1.06	47.32±4.20	49.69±6.43	63.45±0.67
$a_2 s_2$	4	57.25±1.12	62.36±1.40	50.78±1.18	55.00±2.82	59.71±1.30

centrate for dairy cows increased their intake. The observations reported by Heuberger *et al.* (1959), Raven and Robinson (1961), Renton and Forbes (1973) and McCann and Mat-Sushima (1973) are also conflicting.

This experiment, therefore, suggests that the age old practice of soaking concentrates in water and then feeding them to buffaloes has no added advantage as it neither increases their intake nor the digestibility. The labour, time and money involved in the process, therefore, is not warranted.

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PRODUCTION OF BIOGAS FROM CATTLE WASTE SUPPLEMENTED WITH POULTRY WASTE AND SAW DUST

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ABSTRACT

Cattle waste (CW), mixture of cattle waste and poultry waste (CW+PW) and that of cattle waste, poultry waste and saw dust (CW+PW+SD) were allowed to digest anaerobically. Supplementation of CW with PW @ 10% resulted in increased volatile fatty acids (VFA) and higher gas production over CW alone and CW+PW+SD mixture. Also there was more reduction in C/N ratio during anaerobic digestion of CW+PW mixture than in CW alone or CW+PW+SD mixture.

Biogas is a gaseous mixture of methane, carbon dioxide, hydrogen and traces of few other gases produced by the anaerobic fermentation of organic waste materials. Methane which constitutes about 60% of the total gas produced imparts the property of combustibility to the biogas which can be used as fuel for cooking, lighting and running engines.

Over 70,000 biogas plants are now in operation in India, of which little over 10,000 have been installed in Haryana State alone. However, not all of them are working efficiently because in India biogas plants are mostly charged with cattle waste alone and the production of biogas from cattle waste for a variety of reasons is limited. Efficient utilisation of any waste for anaerobic fermentation depends upon its chemical composition and the microflora it harbours. In the present studies, the effect of supplementation of cattle waste with poultry waste and saw dust was studied with regard to biochemical changes during fermentation and the resultant effect on yield of biogas.

MATERIAL AND METHODS

Fresh cattle waste and poultry waste were collected from the Animal Farm of Haryana Agricultural University, Hissar while saw dust was collected from the local Saw Mill. The wastes were used on the same day after making slurry with tap water in a 1 : 1 ratio (W/V). Experiment was conducted in 5 laspirator bottles (working volume 3.750 l) having an outlet at the bottom to facilitate sampling without disturbing the system with the following treatments :

1. Cattle waste (CW) — 100%

2. CW + Poultry waste (PW)–90 : 10 (W/W, dry weight basis)
3. CW + PW + Saw dust (SD)— 80 : 10 : 10 (W/W, dry weight basis)

The waste was used @ 375 g/l container volume. The bottles were sealed with paraffin wax and wastes were allowed to ferment anaerobically at room temperature (30-33°C) for a period of eight weeks.

Thoroughly mixed samples were drawn at weekly intervals from each fermentor to analyse pH, volatile fatty acids (VFA), carbon, nitrogen, cellulose and lignin. Samples after determining pH and total VFA were dried in an oven at 80°C and were ground to a fine powder before using for further analysis.

The pH of the slurry was determined using an Elico pH meter model LI-10. Total VFA were estimated by steam distillation method after acidifying with H_2SO_4 to pH 2.0 (Kroman *et al.*, 1967) and expressed as ppm of acetic acid.

The volatile fatty acids were further analysed for acetic, propionic, iso-butyric, butyric, iso-valeric and valeric acids using Aimil-Nucon Gas Chromatograph fitted with FID and 2m long stainless steel column containing chromosorb-101 with injector, oven and detector temperatures of 200, 170 and 200 °C, respectively. The carrier gas was nitrogen @ 40 ml/min.

The total carbon content was estimated by the combustion method (Piper, 1966) and the total nitrogen by the micro-kjeldahl method (Bremner, 1965). Cellulose and lignin contents were estimated according to the method of Van Soest and Wine (1968). Total gas production was measured every day by water displacement method and expressed as litre/kg waste/week. Methane and carbon dioxide contents of the biogas were analysed by using an Orsat gas analyser.

RESULTS

From the perusal of data in Table 1, it is seen that the pH of the waste in all the cases decreased from above 7.0 to around 6.0 (5.85-6.05) in the first week itself and started increasing only from 4th week, after which the pH was around or above 7.0. The total volatile fatty acids (TVFA) level in the slurry increased from 1725 to 6630 ppm at the end of 3rd week, from 1740 to 7890 ppm at the end of 2nd week and from 1665 to 8325 ppm at the end of 4th week in case of CW, CW+PW and CW+PW+SD, respectively. The major gas production in all the treatments was in the last four weeks of fermentation except in CW+PW where gas production started after 3rd week.

When the VFA were analysed for the type and level of fatty acids present at various stages of fermentation, it was found that level of acetic acid decreased, showing its utilization right after 3rd week in CW and CW+PW and after 4th week in CW+PW+SD mixture (Table 2). In contrast to this, the propionic acid content increased gradually during fermentation in CW and CW+PW upto 7th week and in CW+PW+SD upto 8th week. The iso-butyric, iso-valeric and valeric acids when present

TABLE 1

Periodical changes in pH, TVFA and gas production during fermentation

Stages of fermentation (week)	Cattle waste			Cattle waste+Poultry waste			Cattle waste+Poultry waste+Saw dust		
	pH	TVFA (ppm)	Gas production*	pH	TVFA (ppm)	Gas production*	pH	TVFA (ppm)	Gas production*
0	7.50	1725	—	7.25	1740	—	7.20	1665	—
I	6.05	ND	1.370	5.95	6060	0.164	5.85	6150	0.219
II	6.15	6000	0.451	5.95	7890	0.507	5.85	6255	0.205
III	6.15	6630	0.412	6.00	7320	0.470	5.80	6675	0.176
IV	6.70	6300	1.515	6.85	5775	4.909	6.00	8325	0.849
V	7.25	ND	6.250	7.35	ND	6.298	7.25	5790	6.313
VI	7.15	2475	6.877	7.15	3120	8.131	7.05	3500	6.656
VII	6.90	ND	4.814	7.15	2850	7.390	6.90	3030	5.614
VIII	7.25	1290	4.787	7.40	1275	6.105	7.10	2475	5.595

ND=Not determined

*Litres/kg waste/week

TABLE 2

Analysis of various acids from VFA mixture

Acids (ppm)	Week III	IV	V	VII	VIII
			Cattle waste		
Acetic	4191	3920	483	552	474
Propionic	130	1478	2198	3002	1158
Iso-butyric	—	106	202	—	—
Butyric	1467	1643	1173	704	—
Iso-valeric	—	—	—	—	—
Valeric	372	374	459	567	—
			Cattle waste+Poultry waste		
Acetic	5498	3116	1026	600	395
Propionic	1682	2918	3190	3302	1030
Iso-butyric	105	176	220	—	—
Butyric	6759	8800	8213	—	—
Iso-valeric	—	—	68	—	—
Valeric	255	510	510	425	—
			Cattle waste+Poultry waste+Saw dust		
Acetic	5540	9408	394	960	237
Propionic	1711	2140	2392	2734	3012
Iso-butyric	105	229	220	122	98
Butyric	7108	782	900	—	440
Iso-valeric	—	—	187	—	—
Valeric	225	340	425	340	638

were found in low concentrations. Addition of PW to CW increased the production of butyric acid in CW+PW mixture as compared to CW; but it was not detected after 5th week. However, in CW+PW+SD mixture the butyric acid continued to be present after 3rd week but in low amounts.

During the anaerobic fermentation of waste materials, the organic solids are destructed via soluble compounds to gaseous end products. The extent of degradation depends upon various factors including both chemical as well as biological. When PW was added to CW, the % degradation of total solids (20.80 vs. 19.88) as well as volatile solids (28.61 vs. 22.78) was more than CW alone (Table 3). The degradation of these solids was still more (25.66% TS and 33.09% VS) in case of CW+PW+SD mixture.

However, there was no degradation of lignin even after addition of PW and/or SD to CW (Table 4). Although the reduction in C/N ratio was more (from 24.5 to 20.9) in CW+PW waste mixture over CW+PW+SD mixture and CW alone, the maximum cellulose degradation was in CW followed by CW+PW

TABLE 3

Degradation of solids during anaerobic digestion

Wastes	Total solids (%)			Volatile solids (%)		
	Initial	Final	Degradation	Initial	Final	Degradation
Cattle waste	9.61	7.70	19.88	79.40	77.10	22.78
Cattle waste+Poultry waste	9.47	7.50	20.80	82.70	74.50	28.61
Cattle waste+Poultry waste+ Saw dust	10.21	7.59	25.66	81.60	76.80	30.09

and CW+PW+SD mixture. The maximum gas production (35.974 l/kg waste/ 8 weeks) was obtained from CW+PW mixture over CW (26.476 l) and CW+ PW+SD mixture (25.627 l). The gas production in CW and CW+PW+SD was found to be almost equal. The methane content of the gas in all the treatments varied between 64-70% during the fermentation period, the remainder being carbon dioxide.

DISCUSSION

Besides cattle waste, a variety of organic wastes are available in plenty which can be exploited for efficient utilization. For variety of reasons, gas production from biogas plants, fed with cattle waste, is low. In order to increase the gas production from cattle waste, the effect of addition of poultry waste and saw dust in small quantities (10%) on biochemical changes during fermentation of wastes was studied.

A variety of microorganisms are involved in the anaerobic fermentation of organic wastes (Bryant, 1976). Some microorganisms hydrolyse the complex organic substances to monomers which are then fermented to various acids and gases, mainly acetic acid, CO_2 and H_2. These are finally utilised by methanogenic bacteria to yield methane. In the early stages of fermentation due to higher acid production, there is a fall in pH. However, due to acid utilization pH of the fermenting material gradually increases to neutral range. Present data supports these changes during the fermentation period. The reduction in acid concentration coincided with gas production suggesting that utilization of VFA in the digestion process was generally for methanogenesis.

It is believed that acids higher than acetic acid are first converted to acetic acid and H_2 by acetogenic bacteria (Bryant, 1976). Singh *et al.* (1980) have shown that there should be a balanced and continuous production of acetate during cattle waste fermentation for methane production to continue at an optimum rate. The production of propionate is not desirable because the further utilization of propionate is slow (Jaffries *et al.*, 1978). The results obtained during the present studies are in line with these findings. Higher cellulose degradation will, therefore, not necessarily result in

TABLE 4

Changes in composition of wastes during anaerobic digestion and production of biogas

Wastes	Lignin (%)		C/N ratio		Cellulose (%)			Total gas production*
	Initial	Final	Initial	Final	Initial	Final	Degradation	
Cattle waste	20.12	22.20	24.4	23.1	22.81	18.04	35.00	26.476
Cattle waste+Poultry waste	18.66	22.56	24.5	20.9	23.66	20.25	29.69	35.974
Cattle waste+Poultry waste+Saw dust	19.15	23.66	25.6	23.6	25.25	22.56	23.81	25.627

*Litres/kg waste/8 weeks

higher gas production unless the products of hydrolysis are fermented only to acetate, CO_2 and H_2. This is, however, dependent upon the partial pressure of hydrogen in the system (Ianotti *et al.*, 1973; Chen and Wolin, 1977; Latham and Wolin, 1977). Though the cellulose degradation was less in CW+PW mixture as compared to CW, the gas production was maximum from CW+PW mixture. On the other hand even with differences in the extent of cellulose degradation in CW and CW+PW+SD mixture, the gas production in both the treatments was almost equal.

Lignin was not found to be degraded. The increase in lignin per cent is, however, due to reduction in total solids. These results suggest that gas production can be increased by supplementing the cattle waste with poultry waste @ 10%.

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TESTING CARBOXIN, THIABENDAZOLE AND HINOSAN FOR GENO-TOXICITY ON *SACCHAROMYCES CEREVISIAE*

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ABSTRACT

Treatment of diploid cells of *Saccharomyces cerevisiae* with carboxin and thiabendazole at a concentration of 25, 50, 100 and 200 µg/ml and with hinosan at a concentration of 25, 50, 100, 200 µl/ml for 30, 60, 90 and 120 min did not cause any increase in mitotic gene conversion and reverse mutation. There was no cell killing after carboxin and thiabendazole treatment, whereas there was significant killing after treatment with hinosan.

Among the environmental chemicals with possible genetic hazards to man, the pesticides play an important role since residues remain on food and are ingested by man. There is also a risk of occupational exposure. Recent findings that some of the pesticides are mutagenic have led many geneticists to regard them as serious hazard for mankind if they are released untested (Siebert *et al.*, 1970; Parry, 1973; Fahrig, 1974; Siebert and Eisenbrand, 1974; Siebert and Lemperle, 1974; McCann *et al.*, 1975; Shirasu *et al.*, 1976; Bignami *et al.*, 1977). A major problem has been the development of test-systems capable of detecting and characterizing mutagenic chemicals. A system for detecting their genetic activity has been developed for yeast by Zimmermann *et al.* (1975). Using the same system three systemic fungicides, carboxin (2, 3-dihydro-6-methyl-5-phenylcarbamoyl 1-1, 4-oxathiin), thiabendazole (2-(Thiazol-4-yl) benzimidazole) and hinosan (O-ethyl-S, S-diphenyl phosphorodithioate) were tested for their genetic activity. These fungicides did not cause any increase in mitotic gene conversion and reverse mutation in diploid yeast.

MATERIAL AND METHODS

D7 strain of yeast used in these studies has alleles *trp 5-12/trp 5-27* to detect mitotic gene conversion and *ilv 1-92/ilv 1-92* for the detection of reverse mutation This strain was supplied by Dr. Zimmermann. Technical grade material of the fungicides was provided by Dr. R. K. Grover. D7 cells grown on YEPD plates at 30°C for 48 h were harvested, washed twice with sterile water and suspended in 0.1M phosphate buffer pH 7.0. 5×10^7 cells/ml were treated with different concentrations of the fungicide solution in acetone for different periods of time. The final concentration of acetone was 5 per cent. The reaction was stopped by dilution and immediate plating.

Survivors were scored on synthetic complete medium which contained minimal medium of Wickerham (1946) supplemented with amino acids, uracil and adenine as described by Zimmermann (1975). About 300 cells were plated on complete medium to score survivors and 3×10^5 cells on to each plate of tryptophanless medium to score gene convertants. For scoring revertants 3×10^6 cells were plated on to each plate of isoleucinless medium. There were 5 plates for each treatment time. For survivors and gene convertants the plates were scored after 5 days, whereas revertants were scored after 7 days of incubation at 30°C.

RESULTS AND DISCUSSION

The results of testing carboxin, thiabendazole and hinosan for induction of mitotic gene conversion and reverse mutation in diploid yeast cells exposed to different concentrations of these compounds for various treatment times are shown in Tables 1-3. The results show

TABLE 1

Per cent survival and frequencies of revertants and mitotic gene convertants by carboxin

Treatment	Treatment time (min)	% Survival	Revertants/ 3×10^6 survivors	Convertants/ 3×10^5 survivors
Buffer		100.0	5	8
5% Acetone	30	101.0	4	6
Carboxin (μg/ml)				
25		100.4	3	11
50		99.8	5	9
100		98.5	4	7
200		101.5	6	10
Buffer		100.0	3	33
5% Acetone	60	99.7	3	31
Carboxin (μg/ml)				
25		101.1	4	31
50		100.6	3	30
100		102.0	3	31
200		98.8	3	32
Buffer		100.0	1	48
5% Acetone	90	101.0	1	51
Carboxin (μg/ml)				
25		99.6	1	46
50		100.4	1	45
100		97.9	1	49
200		98.8	1	50
Buffer		100.0	1	5
5% Acetone	120	99.2	2	6
Carboxin (μg/ml)				
25		98.8	1	6
50		101.0	1	4
100		100.3	2	5
200		99.4	1	5

TABLE 2

Per cent survival and frequencies of revertants and mitotic gene convertants by thiabendazole

Treatment	Treatment time (min)	% Survival	Revertants/ 3×10^6 survivors	Convertants/ 3×10^5 survivors
Buffer		100.0	5	13
5% Acetone	30	102.0	3	12
Thiabendazole (μg/ml)				
25		99.7	3	12
50		99.4	6	16
100		101.1	3	15
200		98.3	5	15
Buffer		100.0	5	6
5% Acetone	60	98.2	5	6
Thiabendazole (μg/ml)				
25		101.5	7	8
50		98.5	6	5
100		100.7	5	4
200		100.0	3	5
Buffer		100.0	1	7
5% Acetone	90	101.2	1	5
Thiabendazole (μg/ml)				
25		100.5	0	4
50		98.7	1	5
100		99.5	0	6
200		96.1	0	7
Buffer		100.0	1	7
5% Acetone	120	99.6	2	8
Thiabendazole (μg/ml)				
25		98.4	1	10
50		101.0	1	9
100		98.1	2	6
200		100.4	2	9

that treatment of yeast cells with these compounds gave the same frequencies of gene convertants and revertants as were observed for buffer and acetone treated cells. No significant cell killing was observed when the cells were treated with carboxin and thiabendazole but hinosan treatment significantly reduced the survival. The absence of lethal and genetic effects in case of carboxin and thiabendazole may be due to lack of penetration of these compounds into the cells. Hinosan treatment killed cells but failed to induce any genetic effects. In bacteria also, hinosan has been reported to be genetically inactive by Shirasu *et al.* (1976). Since in the present studies the treatment of yeast cells with these compounds did not increase the frequencies of convertants and revertants over the controls, it is, therefore, concluded that these compounds are not convertogenic and

TABLE 3

Per cent survival and frequencies of revertants and mitotic gene convertants by hinosan

Treatment	Treatment time (min)	% Survival	Revertants/ 3×10^6 survivors	Convertants/ 3×10^5 survivors
Buffer		100.0	3	15
5% Acetone	30	98.3	3	16
Hinosan (µl/ml)				
25		85.3	4	14
50		77.1	4	18
100		53.4	5	13
200		35.3	5	12
Buffer		100.0	1	15
5% Acetone	60	102.7	1	15
Hinosan (µl/ml)				
25		67.4	1	18
50		60.1	1	16
100		8.5	2	19
200		1.7	0	12
Buffer		100.0	3	20
5% Acetone	90	95.9	5	15
Hinosan (µl/ml)				
25		7.8	3	24
50		3.7	5	16

mutagenic for yeast. From the present studies it seems that the use of these fungicides would be safer as the residual amounts consumed by human beings will not cause genetic hazards. However, it is suggested that further tests on these fungicides using some mammalian test system be carried out before these results are finally extrapolated to human beings.

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EFFECT OF CARBONATE IONS ON THE EARLY SEEDLING GROWTH OF MOONG GENOTYPES

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ABSTRACT

Thirteen genotypes of moong *(Vigna radiata* Wilczeck) were studied for their early seedling growth under increasing carbonate (as sodium carbonate) concentrations, keeping sodium concentration constant at 40 me/l using NaCl. Length of the root and hypocotyl and fresh weight of the embryo axis were generally reduced by carbonate, however, the effect did not increase in all the genotypes with increasing carbonate concentrations. The various parameters studied were also not equally affected by the different concentrations of carbonate used. The effect of increasing carbonate concentrations was the least in Sheela and maximum in case of S-9. The present studies support the view that the physical soil conditions in alkali soils are the major factors affecting germination rather than the concentrations of ions as such. However, carbonate is much more toxic than sodium and chloride ions to germination of moong.

The concentrations of carbonate ions have been reported to occur over a wide range in irrigation waters. The effects of increasing carbonate concentrations, which are mainly accompanied by high sodium, are well known on the physical properties of soil. Bernstein and Pearson (1956) suggested that the crusting and poor aeration are the factors which reduce germination in alkali soils. Wide differences have been reported amongst the various genotypes of moong and wheat for their germination response to various salts including Na_2CO_3 and NaCl (Puntamakar *et al.*, 1970; Sharma *et al.*, 1971). However, the effects observed were that of the two ions (Na^+ and CO_3'') together and not that of carbonate alone. Therefore, in the present studies, an attempt was made to segregate the effects of carbonate ions from sodium on the early seedling growth of moong genotypes.

MATERIAL AND METHODS

Seeds of various genotypes of moong *(Vigna radiata* Wilczeck) were surface sterilized with sodium hypochlorite. Ten seeds were placed in each petri dish containing a filter paper (9 cm). To each petri dish, 8 ml of the treatment solution was added. To study the effects of carbonate ions alone, the concentration of sodium was kept constant (40 me/l) by using varying combinations of NaCl* and

*NaCl was used to compensate for rest of the sodium in each case, as in the preliminary studies NaCl upto 40 me/l was not found to be deleterious to the seedling growth of moong during germination.

Na_2CO_3, so as to have 0, 10, 20, 30 and 40 me/l of carbonate. Distilled water served as a control for all. The petri dishes were kept in the germination chamber at a temperature of 30±1°C. Each treatment had three replicates. The length of the root and hypocotyl and fresh weight of the embryo axis were determined after 72 h of sowing.

RESULTS AND DISCUSSION

A concentration of 40 me/l of NaCl, i.e., 0 carbonate did not affect or increase the length of the root in all the genotypes except in ML-5, where the root length was reduced in comparison with distilled water control (Table 1). The carbonate ions were found to reduce the length of the root, however, the effect did not increase with increasing concentration in all the genotypes studied. No reduction over control was observed at any of the carbonate concentrations used in the genotype H-70-21. In ML-5, Kheda-10, Sheela and B-105, the effect did not increase with increase in carbonate above 20 me/l. Reductions in root length were most drastic in the case of S-9.

The length of the hypocotyl was either reduced or not affected by 40 me/l NaCl (Table 2). A concentration of 10 me/l of carbonate was more depressive than 40 me/l NaCl in six genotypes, whereas in the rest, it was as effective as 40 me/l NaCl. A further increase in carbonate to 20 me/l did not result in any appreciable effect upto 30 me/l in ML-6, Kheda-10 and S-8 and upto 40 me/l in Sheela. However, in others, there was a decrease in length with

TABLE 1

Effect of increasing carbonate ion concentrations on the length of root (cm) of moong genotypes, 72 h after sowing

Genotypes	Carbonate (me/l)						C. D. at
	C	*0*	*10*	*20*	*30*	*40*	*5% level*
H-70-21	3.0	3.7	2.8	2.9	2.7	2.9	0.69
ML-1	3.6	6.8	4.3	2.5	1.5	1.0	0.33
ML-5	4.3	3.8	3.2	2.6	2.3	2.1	0.53
ML-6	4.0	4.8	2.8	3.0	3.0	2.2	0.60
ML-9	6.0	6.3	5.0	5.2	2.9	2.9	0.51
Madira	5.0	5.1	3.6	2.0	2.1	1.1	0.57
Pusa Baisakhi	4.8	6.3	3.5	3.4	2.9	1.8	0.45
Kheda-10	3.4	3.9	3.0	2.1	1.9	1.6	0.53
Cot-71	4.6	6.8	4.6	2.6	2.7	1.6	0.77
Sheela	4.0	4.0	3.4	2.3	2.5	2.5	0.62
S-8	4.4	5.4	3.0	2.3	2.2	1.5	0.66
S-9	4.5	5.4	3.0	1.7	1.0	0.5	0.55
B-105	3.7	4.1	2.6	1.7	1.9	1.5	0.51

C=Distilled water.

TABLE 2

Effect of increasing carbonate ion concentrations on the length of hypocotyl (cm) of moong genotypes, 72 h after sowing

Genotypes	Carbonate (me/1)						C. D. at 5% level
	C	0	10	20	30	40	
H-70-21	8.1	6.6	6.9	6.0	5.5	5.4	1.00
ML-1	8.6	9.2	8.4	6.0	3.7	2.9	1.00
ML-5	9.2	7.2	7.6	6.4	5.5	4.3	0.90
ML-6	8.9	8.7	5.7	6.1	5.7	4.6	1.01
ML-9	11.1	9.0	9.2	8.3	6.2	6.3	1.28
Madira	9.2	7.2	7.3	5.9	4.0	2.1	1.30
Pusa Baisakhi	8.1	6.1	5.5	4.8	3.8	2.3	1.21
Kheda-10	6.8	4.7	4.3	3.8	4.4	2.6	1.02
Cot-71	8.0	7.6	6.2	4.6	3.6	2.5	1.25
Sheela	3.2	3.4	2.5	2.7	2.4	2.0	0 77
S-8	8.3	6.3	5.1	5.0	4.6	4.0	1.00
S-9	7.9	7.5	5.4	2.3	2.3	1.0	1.21
B-105	5.3	5.4	4.9	3.3	2.8	2.1	1.12

C=Distilled water.

TABLE 3

Effect of increasing carbonate ion concentrations on the fresh weight (mg) of the embryo axis of moong genotypes, 72 h after sowing

Genotypes	Carbonate (me/l)						C. D. at 5% level
	C	0	10	20	30	40	
H-70-21	386	373	369	317	305	274	52.3
ML-1	253	286	237	229	142	113	41.1
ML-5	257	219	222	213	199	170	51.5
ML-6	253	235	225	222	197	163	33.3
ML-9	408	333	327	289	235	208	44.5
Madira	310	271	251	225	177	98	32.2
Pusa Baisakhi	324	244	204	218	212	130	40.4
Kheda-10	306	260	214	200	186	133	32.6
Cot-71	279	273	255	177	168	126	29.8
Sheela	148	134	130	131	118	124	31.5
S-8	263	226	257	183	188	132	33.4
S-9	237	200	177	133	93	38	27.7
B-105	269	223	218	151	148	132	31.4

C=Distilled water.

increase in carbonate concentrations, except that in H-70-21 and ML-9, the decrease in hypocotyl length did not increase further above 20 and 30 me/l, respectively. Reductions in hypocotyl length were again most drastic in case of S-9.

In germination studies, the emergence of the radicle from the seed or emergence of the plumule/coleoptile from the soil is taken as an index of germination. However, the present studies indicate that both the parameters, radicle length (serving as an index of seedling establishment) and hypocotyl length (resulting in the emergence of the seedling from the soil) should be considered alongwith the percentage of germination (which is generally used alone) in determining the relative salt resistance of genotypes. This type of information may further help in various breeding programmes to increase salt resistance of plants at the germination stage.

The fresh weight of the embryo axis in all the genotypes was affected by 40 me/l NaCl in the same way as the hypocotyl length (Tables 2 and 3). Carbonate at 10 me/l was more depressive than 40 me/l NaCl in case of ML-1, Pusa Baisakhi and Kheda-10. The reduction in fresh weight with increasing carbonate concentrations increased in nearly half of the genotypes tested. In Sheela, the various treatments did not statistically differed from one another, whereas in ML-6, Pusa Baisakhi and Kheda-10, the reductions occurred further only when the carbonate was raised to 40 me/l. In H-70-21 and B-105, the effect did not increase with increase in carbonate above 20 me/l. S-9 was again the worst affected amongst all the genotypes.

Alkali soil conditions delay and reduce germination. The data presented here indicate that almost all the moong genotypes should germinate under alkali soil conditions if sodium and carbonate ions were the factors determining germination, however, it is not so. Thus, the present studies support the earlier view of Bernstein and Pearson (1956) that the physical soil conditions seem to be more important than the ions responsible for alkali soil conditions leading to poor germination of crop plants in such soils. However, when Na^+, Cl' and CO_3'' were compared for their effects on germination, CO_3'' at equivalent concentrations was much more toxic than sodium and chloride ions.

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RELATIONSHIP BETWEEN PHOTOSYNTHETICALLY ACTIVE RADIATION AND SOLAR RADIATION IN AN ARID AND WARM CLIMATE OF HISSAR

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Data on photosynthetically active radiation (PAR) density ($\mu E\ m^{-2}sec^{-1}$) are used for modelling growth and yield of crops (Loomis and Williams, 1963; Arkin *et al.*, 1976). Since PAR data are not generally available and solar radiation (wm^{-2}) is measured at several locations throughout the world, it would be desirable to estimate PAR from solar radiation.

In this paper the relations between PAR and solar radiation, measured in an arid and warm climate of Hissar (India) are presented.

The diurnal measurements on incoming solar radiation and PAR were made on September 4, 11, 18 and 25, 1980 at the Research Farm of Haryana Agricultural University, Hissar, which is located at 29° 10′ latitude north and 75° 46′ longitude east at an elevation of 215.2 m above sea level. Incoming solar radiation and PAR were measured with a quantum/radiometer/photometer (LI 185A) in combination with pyranometer sensor (LI 200S) and quantum sensor (LI 190S), respectively. The data were recorded at 30 min interval.

The data were analysed by linear regression of PAR on incoming solar radiation with a programmable calculator "HP 34".

Linear regression of PAR on incoming solar radiation (Fig. 1) indicated linear relationship, which is given below : $Y=-9.96+1.97X$; where X=solar radiation density (wm^{-2}) and Y=PAR density ($\mu E\ m^{-2}\ sec^{-1}$). High value of r^2 (0.99) shows that predicted values were in close proximity with the observed values.

The results indicate that PAR can be estimated from solar radiation data with standard error from regression to be 40 $\mu E\ m^{-2}\ sec^{-1}$ using a regression equation computed.

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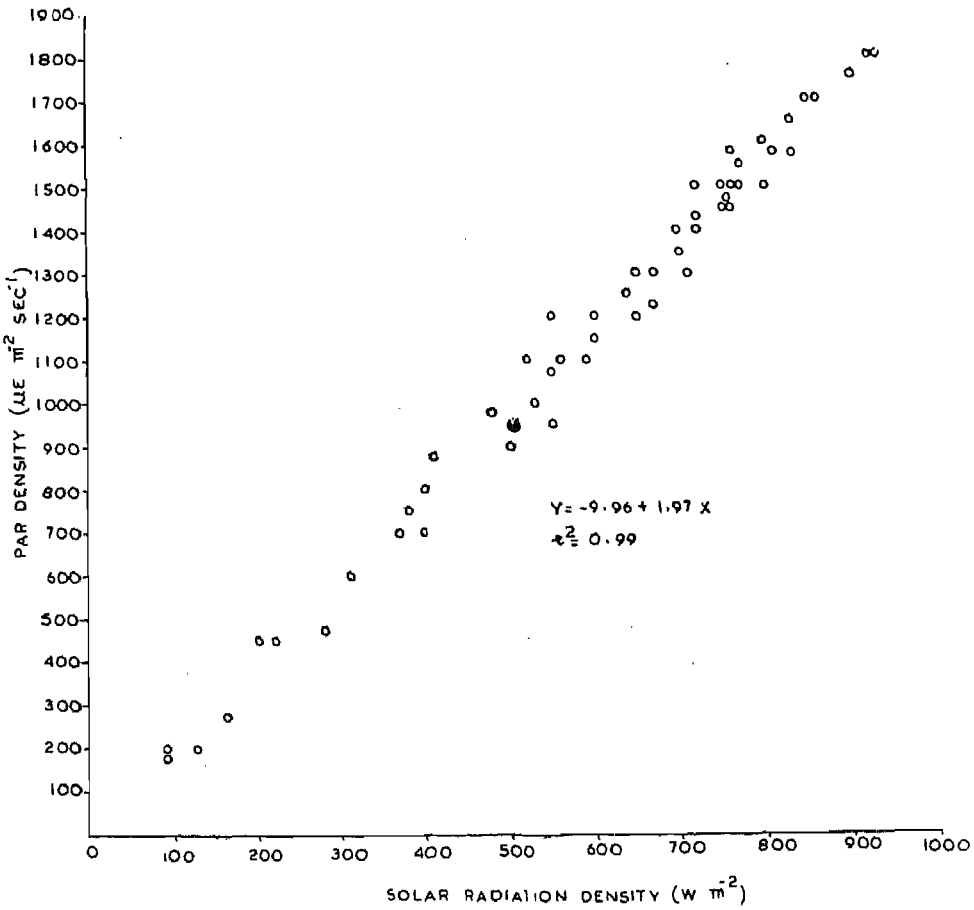


Fig. 1. Relationship between solar radiation and PAR density.

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STUDIES ON GENETIC VARIABILITY AND CORRELATION COEFFICIENTS IN CLUSTER BEAN (*CYAMOPSIS TETRAGONOLOBA* (L.) TAUB)

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ABSTRACT

Genetic variability and correlation studies in a collection of 29 indigenous varieties of guar revealed a wide range of variation for all the characters. Number of branches, number of clusters and yield per plant were found to have comparatively high genetic coefficients of variation than other characters. All the characters except number of pods, height of plant and number of days to first pod setting showed high heritability with high genetic advance (% of mean) which may be due to additive gene effects. Yield was highly correlated with number of pods, length of pods, number of clusters per plant and height of plant. It appears that these characters may be used for selecting high yielding plants in guar.

Cyamopsis tetragonoloba (L.) Taub is an important vegetable crop grown very commonly in northern India and sufficient area has come under this crop in southern plains. In the low rainfall areas of plains of northern India it is the most common poor man's vegetable crop. A good number of useful indigenous strains are available in the northern plain. Since many of the plant characters, which are of economic value, are quantitatively inherited and highly influenced by environmental conditions, it is difficult to judge whether observed variation is heritable or due to environment. Therefore, there is imperative need of partitioning the observed variability into its heritable and non-heritable components. Correlation can show relative influence of various components on yield and indicate those upon which more emphasis should be placed by the breeder for selection. The purpose of the present investigation was to gather information on genetic variability and correlation for yield and its components in a collection of 29 indigenous varieties of guar, which is a basis for further breeding programme.

MATERIAL AND METHODS

The experiment conducted in July 1979 was laid out in a randomized block design with 29 lines in four replications. Each variety was sown in 4.5 m long rows with 45 cm distance between rows and 30 cm distance between plants. Data were recorded on five randomly selected plants for yield of green pods per plant, number of clusters per plant, number of pods per

plant, length of pods, height of plant, number of branches per plant, number of nodes to first pod setting and number of days to first pod setting. The coefficient of variation was estimated according to Burton (1952). Broad sense heritability was calculated by the method of Burton and De Vane (1953). The expected genetic advance was calculated by using formula as suggested by Lush (1949) and Johnson *et al.* (1955) and correlations were worked out according to Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

It was observed that genotype HG-11 gave maximum yield followed by HG-15 and HG-5, whereas HG-8 yielded lowest. The maximum height was recorded in HG-29 and HG-11. Variety Pusa Navbahar was the earliest among all the varieties (Table 1).

TABLE 1

Mean performance of various varieties of guar

Variety	Yield per plant (g)	Number of pods/ cluster	Length of pod (cm)	Number of clusters per plant	Height of plant (cm)	Number of branches per plant	Number of nodes to first pod setting	No. of days to first pod setting
Pusa Navbahar	414	9.00	9.10	29.67	62.91	2.11	2.47	29.30
HG-2	384	10.40	5.77	40.11	74.25	5.00	4.18	40.70
HG-3	408	9.87	7.50	31.78	74.50	5.23	4.20	36.20
HG-4	374	9.60	7.33	32.78	80.88	4.93	3.47	36.33
HG-5	510	9.60	7.43	39.56	97.40	4.00	4.33	35.47
HG-6	485	11.93	5.53	56.65	80.67	5.60	4.27	34.53
HG-7	264	11.66	4.50	39.28	67.37	5.56	3.45	38.77
HG-8	33	8.13	6.23	38.00	76.83	6.39	4.27	40.17
HG-9	332	11.00	7.93	25.61	74.80	2.20	2.53	36.27
HG-10	223	10.40	5.97	43.67	84.35	4.83	4.13	39.80
HG-11	569	11.27	7.67	27.15	105.87	3.23	3.40	37.00
HG-12	348	9.20	5.20	40.50	57.33	6.50	5.50	42.00
HG-13	358	9.07	5.97	77.83	96.90	5.89	4.73	36.00
HG-14	392	13.73	7.53	16.67	88.53	1.93	2.73	35.47
HG-15	531	8.40	9.07	49.29	78.07	4.27	4.07	37.27
HG-16	451	13.67	5.90	39.62	92.80	3.00	5.20	37.57
HG-17	428	11.67	4.90	34.62	82.80	2.50	3.00	36.00
HG-18	461	9.10	5.30	53.44	68.50	2.00	3.30	38.00
HG-19	471	11.10	6.30	58.44	78.50	2.50	3.60	30.90
HG-20	329	11.80	6.30	21.15	60.00	1.33	2.60	39.31
HG-21	339	11.40	5.55	33.25	88.00	3.00	4.43	30.20
HG-22	231	10.10	6.45	31.90	63.20	2.70	4.00	29.60
HG-23	145	10.40	5.65	30.33	80.20	2.80	4.30	30.20
HG-24	335	10.90	5.90	24.75	79.70	2.50	3.60	29.33
HG-25	168	9.20	9.20	18.00	70.00	1.40	2.67	30.80
HG-26	178	15.10	6.37	16.08	82.37	2.10	3.03	32.80
HG-27	248	10.70	5.75	61.42	92.00	3.06	3.60	29.60
HG-28	302	9.20	6.10	26.50	70.00	3.75	4.25	35.60
HG-29	312	14.90	6.25	23.93	107.63	1.20	3.10	29.33
C.D. at 5%	216	3 18	1.29	19.61	19.42	2.98	0.85	3.47

The range, general mean, 'F' values, coefficient of variation, genotypic and phenotypic variances for each character are presented in Table 2. Highly significant differences were recorded among varieties for all the characters. This suggests that the population was amenable to selection for all these characters. A wide range of variation was noticed for all the characters. High variations for various characters in guar have also been reported by Sanghi *et al.* (1964), Tikka (1975) and Mital *et al.* (1969).

The coefficients of variation, heritability and genetic advance are given in Table 3. The genetic coefficients of variation for different characters ranged from 10.20 for number of days to first pod setting to 34.81 for number of clusters per plant. Comparatively high genetic coefficient of variation was observed for number of clusters, number of branches and yield of green pods, while it was low for others. However, with the help of genetic coefficients of variation alone it is not possible to determine the amount of variation that is heritable, therefore, the heritability estimates are important. Highest heritability for number of days to first pod setting (73.10) and lowest for number of branches (28.66) were observed. Heritability values for rest of the characters were fairly high. In the present studies the heritability estimates of yield of green pod was 33.80, whereas very low heritability for yield was reported by Sanghi *et al.* (1964) in guar. The genetic advance as percentage of mean ranged from 15.30 for number of pods to 51.60 for number of clusters per plant. Johnson

TABLE 2

Mean, range, coefficient of variation, phenotypic and genotypic variances for different characters in guar

Characters	Mean	Range	Coefficient of variation	'F' value	Phenotypic variance	Genotypic variance
Yield per plant (g)	346.08±110.54	33.00–569.33	39.23	2.53**	23683.60	9356.17
Number of pods per plant	10.75± 1.62	8.13– 14.90	18.49	2.47**	5.89	1.94
Length of pods (cm)	6.40± 0.66	4.50– 9.10	12.60	5.80**	1.69	1.04
Number of clusters per plant	36.58± 10.01	16.08– 77.83	33.51	4.24**	312.42	162.18
Height of plant (cm)	79.87± 9.91	57.73–107.63	15.19	3.34**	261.92	114.69
Number of branches per plant	3.50± 1.52	1.20– 6.50	53.14	2.21**	4.85	1.39
Number of nodes to first pod setting	3.73± 0.44	2.74– 5.50	14.14	6.53**	0.80	0.52
Number of days to first pod setting	35.19± 1.77	29.30– 42.00	6.20	9.17**	17.54	12.83

**Significant at 1% level.

TABLE 3

Estimates of genetic parameters for eight characters in guar

Characters	Phenotypic coefficients of variation	Genotypic coefficient of variation	Heritability	Genetic gain	Genetic advance (% of mean)
Yield per plant (g)	48.22	28.03	33.80	115.84	33.57
Number of pods per plant	22.58	12.96	32.94	1.64	15.30
Length of pods (cm)	20.31	15.93	61.54	2.08	32.50
Number of clusters per plant	48.32	34.81	51.91	18.90	51.66
Height of plant (cm)	20.26	13.41	43.79	14.60	18.28
Number of branches per plant	62.92	33.68	28.66	1.30	37.19
Number of nodes to first pod setting	23.98	19.33	65.00	1.20	32.30
Number of days to first pod setting	11.90	10.20	73.10	6 31	17.90

et al. (1955) with studies on soybean have suggested that heritability alongwith genetic gain was usually more helpful than the heritability estimates alone in predicting the resultant effect for selecting the best individuals. In the present study, high heritability with high genetic advance (% of mean) was observed for all the characters except number of pods per plant, height of plant and number of days to first pod setting. The characters like length of pod, number of clusters per plant, number of branches, yield per plant and number of nodes to first pod setting have shown a high heritability and high genetic advance (% of mean) which indicated that most probably the heritability was due to additive gene effects (Panse, 1957). Therefore, selection based on phenotypic performance for these characters will lead to select a desired plant type.

Correlation coefficients obtained between pairs of characters in all possible combinations are presented in Table 4. The number of pods per plant, length of pod, number of clusters per plant, height of plant and number of days to first pod setting were positively correlated with the yield per plant and selection for these characters would be worthwhile. Similar results have also been reported by Sanghi and Sharma (1964) and Mital and Thomas (1959) in guar. Number of branches showed a negative correlation with yield. Significantly high correlation between number of pods and plant height signifies that plants having more height will have more number of pods. The remaining characters except yield showed negative correlation with number of pods per plant. Almost similar trend was also observed for length of pod. Highly significant positive correlations were found between number of clusters per plant and number of branches and number of nodes to first pod setting. Number of branches showed strong and positive correlation with number of

TABLE 4

Correlation between yield and various plant characters

Characters	Number of pods per plant	Length of pod (cm)	Number of clusters per plant	Height of plant (cm)	Number of branches per plant	Number of nodes to first pod setting	Number of days to first pod setting
Yield per plant (g)	0.2336	0.3435	0.2602	0.2373	−0.0199	0.0333	0.1765
Number of pods per plant		−0.1866	−0.3556	0.4186*	−0.4503*	−0.2504	−0.2777
Length of pods (cm)			−0.2260	−0.0384	−0.1654	−0.3042	0.0241
Number of clusters per plant				0.1440	0 4971**	0.4648**	0.1277
Height of plant (cm)					−0.0809	0.0905	−0.2907
Number of branches per plant						0.6686**	0.5507**
Number of nodes to first pod setting							0.2120

*Significant at 5% level

**Significant at 1% level

clusters, number of nodes and days to first pod setting while negative correlation was recorded with number of pods.

From heritability, genetic advance and correlation coefficient studies it became obvious that the number of clusters per plant, length of pod and height of plant were the main characters contributing towards the yielding potential in this crop.

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EFFECT OF GROWTH REGULATORS ON GROWTH, FLOWERING, YIELD AND QUALITY OF MUSKMELON

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ABSTRACT

Effect of ethrel, cycocel, maleic hydrazide and ascorbic acid on growth, flowering, yield and quality of muskmelon was studied during two consecutive years 1978 and 1979 Ethrel treatment was found effective in inducing hermaphrodite flowers at lower node, increasing the number of perfect flowers, number of fruits and ultimately the yield of crop. Ethrel 500 ppm suppressed the male flowers and male to female sex-ratio was lowered. It is concluded that sex-ratio in muskmelon can be modified and the yield of fruits can be significantly increased by spray of 500 ppm ethrel.

A number of studies have been conducted on the effect of growth regulators on various species and varieties of plants (Choudhury and Phatak, 1959; Phinney *et al.*, 1957; Prasad and Tyagi, 1963; Mishra and Sharma, 1965; Gaur and Joshi, 1966; Randhawa and Singh, 1970). It has also been reported that growth regulators are highly specific in nature. However, studies regarding use of these growth regulators in enhancing crop productivity are scanty. Keeping this in view, the present investigations were undertaken to study the effect of different concentrations of ethrel, cycocel, maleic hydrazide and ascorbic acid on growth, flowering, quality and yield of muskmelon.

MATERIAL AND METHODS

The work was carried out at Vegetable Research Farm during 1978 and 1979 on muskmelon var. Hara Madhu. The soil of the experimental field was sandy-loam with pH 8.6 and contained 0.44% organic C, 40 kg/ha available phosphorus, 550 kg/ha available potash and 0.52 mmhos/cm ECe. The field was prepared by incorporating farm yard manure at the rate of 150 q/ha three weeks before sowing. Recommended doses of 80 kg nitrogen, 40 kg P_2O_5 and 25 kg K_2O/ha were applied to the experimental fields; and other intercultural and plant protection measures were adopted as and when required. The experiment was laid out in a randomized block design in four replications. About three seeds were sown on one side of 3.5 m long beds at the depth of 2.3 cm per hill with spacing of 2 m and 50 cm between rows and plants, respectively. After germination, only one plant per hill was allowed to grow so that the experimental unit consisted of seven uniformly vigorous plants in a row. The treatments consisted of aqueous sprays of ethrel at

TABLE 1

Effect of growth regulators on growth and yield in muskmelon var. Hara Madhu

Chemical conc. (ppm)		Length of main axis (cm)	Internodl length (cm)	No. of branches/ plant	Flesh thick-ness (cm)	Total soluble solids (%)	No. of fruits per plant		Total yield (q/ha)		
							1978	1979	1978	1979	Av.
Control		216.2	10.6	7.3	2.5	12.2	1.8	2.1	165.2	145.7	155.5
Ethrel	100	216.4	10.3	7.1	2.9	13.0	2.2	2.3	177.9	159.1	168.5
	250	219.2	10.5	7.3	3 1	13.3	2.4	2.7	185.8	168.6	177.2
	500	221.4	11.0	7.8	3.4	13.4	2.8	2.8	192.3	170.1	181.2
Cycocel	100	218.2	10.8	7.0	2.7	12.8	2.0	2.2	174.7	152.9	163.8
	250	215.8	10.2	7.2	2.9	12.7	2.2	2.3	179.2	158.9	169.0
	500	210 2	10.1	7.2	3.3	12.8	2.2	2.3	179.8	157.4	168.6
MH	50	213.4	10.3	7.4	2.9	12.4	1.9	2.1	175.2	151.7	163 5
	100	213.8	10 0	7.1	2.9	12.7	2.1	2.3	183.9	152.6	168.2
	250	205.6	9.8	6.8	3.1	12.9	2.3	2.4	186.7	154.3	170.5
Ascorbic acid	25	217.7	10.8	7.0	2.9	12.2	2.2	2.1	173.9	152.2	163.0
	50	215.4	10.7	7.1	3.0	12.3	2.3	2.2	177.0	156.8	166.9
	100	219.4	10.7	7.2	3.0	12.9	2.4	2.4	180.0	162.4	171.2
C. D. at 5%		3.4	NS	NS	NS	NS	0.5	0.3	6.7	7.1	

100, 250 and 500 ppm; cycocel at 100, 250 and 500 ppm; maleic hydrazide (MH) at 50, 100 and 250 ppm; ascorbic acid at 25, 50 and 100 ppm and water spray as control giving a total of 13 treatments per replication. Spray of the various chemicals was done twice at 2 and 6 true leaf stage, respectively. The data were recorded on various growth, flowering, quality and yield characters.

RESULTS AND DISCUSSION

The influence to various plant growth regulators on growth, quality and yield characters is presented in Table 1. A perusal of data indicated that ethrel 500 ppm stimulated the elongation of main axis over all other treatments followed by ascorbic acid 100 ppm. Treatments of ethrel 250 ppm and cycocel 100 ppm proved equally effective in the elongation of main axis. No significant differences were observed between the treatments in respect of internodal length. However, maximum length of internode was recorded under 500 ppm ethrel. Data on number of branches revealed that the differences were not significant, however, ethrel 500 ppm produced maximum number of branches and the lowest number of branches was obtained with MH 250 ppm. The present studies revealed that the elongation of main axis, internodal length as well as formation of side branches were increased with the increase in ethrel level, whereas MH suppressed the growth possibly due to the inhibitory effect of MH on growth of main axis. Randhawa and Singh (1970) also reported similar results in muskmelon. The beneficial effects of these chemicals at specific concentrations could be attributed to an increased rate of photosynthetic activity, accelerated transport and efficiency of utilizing photosynthetic products, resulting in the cell division (Phinney *et al*, 1957). Increased growth may probably be due to stimulatory action of increased auxin production which softens the cell wall by increasing its plasticity (Tagawa and Bonner, 1957) resulting in stimulation of the growth. Another probable reason may be the osmotic uptake of water under the influence of plant growth regulators which maintain a swelling force against the softening of cell wall or due to the stimulus caused by these growth regulators in the absorption of available nutrients present in the soil. Similar results were also reported by Mishra and Sharma (1965) and Randhawa and Singh (1970).

It is apparent from data in Table 1 that thickness of the flesh was increased with 500 ppm ethrel treatment. It is further evident that there was an increase in T.S.S. with the application of increased levels of ethrel.

There was an increase in the number of fruits per plant with the increase in the concentration of ethrel and ascorbic acid. The highest fruit yield per hectare was recorded under the influence of 500 ppm ethrel in comparison to other treatments which were also significantly superior to control and the yield increased with the increase in the level of various growth regulators. The data relating to fruit yield showed the possibilities for increasing yield to an appreciable extent in andromonoecious muskmelon under the influence of ethrel. The higher yield was obtained as a result of more number of hermaphrodite flowers per plant and

TABLE 2

Effect of growth regulators on sex expression in muskmelon var. Hara Madhu

Chemical conc. (ppm)		Number of days to first male flower		Number of days to first hermaphrodite flower		Nodes to first male flower		Nodes to first hermaphrodite flower		Sex ratio (Female : Male)	
		1978	1979	1978	1979	1978	1979	1978	1979	1978	1979
Control		58.2	44.0	64.7	54.5	1.4	3.4	5.7	6.4	1 : 7.5	1 : 5.2
Ethrel	100	60.5	45.0	58.7	52.0	4.6	3.2	3.1	4.1	1 : 2.1	1 : 1.5
	250	62.5	45.0	58.0	51.0	5.1	3.9	2.1	3.3	1 : 1.8	1 : 1.4
	500	65.0	45.3	57.5	50.2	5.2	3.8	1.5	2.7	1 : 1.6	1 : 1.2
Cycocel	100	56.2	44.3	63.0	53.0	1.0	3.6	5.6	5.9	1 : 7.4	1 : 5.2
	250	56.5	44.3	62.7	52.0	1.2	3.0	5.4	6.0	1 : 7.2	1 : 4.8
	500	56.5	44.8	62.0	52.0	1.0	2.4	5.2	5.5	1 : 7.2	1 : 4.8
MH	50	56.7	43.3	64.5	52.9	1.4	3.8	5.7	5.9	1 : 7.3	1 : 3.9
	100	56.5	43.7	64.0	53.1	1.0	3.9	5.6	6.2	1 : 6.9	1 : 3.9
Ascorbic acid	25	56.7	43.3	64.0	54.4	1.4	3.5	5.6	5.9	1 : 7.1	1 : 4.0
	50	56.2	44.0	63.5	53.7	1.0	3.4	5.6	5.9	1 : 6.2	1 : 3.8
	100	56.5	44.7	61.7	53.0	1.0	3.2	4.7	5.7	1 : 5.7	1 : 3.7
C. D. at 5%		3.0	NS	1.8	2.1	1.0	NS	1.7	1.4	1.8	1.7

better vegetative growth. Similar results were also reported by Randhawa and Singh (1970) in muskmelon. An increase in fruit yield in treated plants may further be attributed to the reason that plants remained physiologically more active to build up sufficient food stock for the developing flowers and fruits, ultimately leading to higher yield.

The number of nodes and days to first male and hermaphrodite flower and sex-ratio were recorded and are presented in Table 2. It was found that during both the years, maximum number of days and nodes to first male flower were observed in ethrel 500 ppm. The data further revealed that ethrel at all concentrations induced the hermaphrodite flowers earlier and at lower node. Ethrel at all the three concentrations produced first hermaphrodite flower between 2nd to 4th node, whereas in the control the first hermaphrodite flower appeared on the 6th node. The appearance of first hermaphrodite flower on early nodes is a fair indication of earliness. The sex-ratio showed that there was a suppression in the number of male flowers with all the ethrel concentrations. All the treatments with ethrel resulted in lower sex-ratio values than the other treatments as well as the control in both the years.

It is evident that ethrel was effective in inducing earliness, increasing number of hermaphrodite flowers, number of fruits and ultimately the yield of crop.

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EFFECT OF FARM YARD MANURE AND POLYVINYL ACETATE ON HYDRAULIC CONDUCTIVITY AND SOIL WATER AVAILABILITY IN SODIC SOILS

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ABSTRACT

A laboratory study was undertaken to evaluate the effect of farm yard manure (FYM) and polyvinyl acetate (PVAc) on hydraulic conductivity, dispersion percentage and soil moisture availability of sodic soils. An increase in hydraulic conductivity and decrease in dispersion percentage with the addition of FYM and PVAc were observed in two sodic soils studied, i. e., clay and loam. The increase in hydraulic conductivity was attributed to the change in orientation of silt and clay particles rather than increase in the size of water stable soil aggregates. The available soil moisture increased with the addition of FYM and FYM + PVAc, however, it decreased with the addition of PVAc. With time, in all the treatments, there was an improvement in the soil structural parameters studied.

An excess of exchangeable sodium causes dispersion of clay and reduces the soil permeability. Soil permeability affects the reclamation process and available soil moisture. Farm yard manure (FYM) and soil conditioners have been widely used separately for improvement of soil structure (Pugh *et al.*, 1960; Wang and Lin, 1970; Suneja *et al.*, 1979). However, the effect of soil conditioner and farm yard manure when used alone or in combination, on soil physical properties of sodic soils has not been studied. In this paper, the effect of PVAc and FYM when applied alone and in combinations in clay sodic and loam sodic soils on their hydraulic conductivity, dispersion percentage and available water capacity has been reported.

MATERIAL AND METHODS

Mechanical analysis was done by international pipette method, organic matter by Walkley and Black's rapid titration method (Piper, 1950) and saturation percentage as described by Richards (1954). The physico-chemical characteristics of the two soils used for the present study are given in Table 1.

The soils were made sodic by method of Bains and Fireman (1964). The ESP values obtained were 49.1 and 48.2 in soil I (clay sodic) and soil II (loam sodic), respectively.

Soils were incubated in plastic containers at room temperature with farm yard

TABLE 1

Description of soils

Soil property	Clay sodic	Loam sodic
Clay (%)	47.6	18.6
Silt (%)	22.8	17.0
Sand (%)	29.6	64.4
Textural class	Clay	Loam
Organic matter (%)	1.15	0.672
Saturation (%)	46.0	33.0
pH 1:2	7.3	8.2
EC 1:2 (mmhos/cm)	1.68	1.32
CEC (me/100 g)	18.45	12.55

manure (FYM) and polyvinyl acetate (PVAc) for 1, 15, 30, 90 and 180 days at soil saturation moisture content. FYM and PVAc solution in benzene in the ratio of 2 : 7 (PVAc : Benzene) were thoroughly mixed with the soil. For combination solution treatment, FYM was followed by PVAc. The loss in weight was maintained every week by addition of water. Soil after each incubation period was air dried, passed through 2 mm screen and stored in air tight plastic containers. Hydraulic conductivity was determined by method 34b as outlined by Richards (1954). Available moisture was calculated by difference from the amount of moisture retained at 1/3 and 15 bar. Dispersion percentage was determined by the method of Dermott (1967).

RESULTS AND DISCUSSION

Hydraulic Conductivity

In general, there was an increase in hydraulic conductivity over control under all the treatments in both the soils. The maximum increase in hydraulic conductivity was observed with 1.0% PVAc treatment in clay sodic soil and with 0.5% FYM+0.5% PVAc treatment in loam sodic soils. In clay sodic soil, both 1% PVAc and FYM+PVAc treatments were at par, but in loam sodic soil 0.5% FYM + 0.5% PVAc was superior to 1.0% PVAc. Each treatment differed significantly. Increase in hydraulic conductivity in clay and loam sodic soils was possible because of organic molecules in both FYM and PVAc (Baver *et al.*, 1976) that serve as binding material. The binding of silt and clay particles resulted in the increase in macropores and hydraulic conductivity. Hydraulic conductivity in sodic soils increased on treatment with soil conditioners (Allison, 1956).

Hydraulic conductivity in both the soils increased with the increase in incubation period. The effect of FYM and PVAc when applied together was additive at and after 30 and 15 days in clay sodic and loam sodic soils, respectively. Decomposition of organic matter in the presence of soil conditioner, with the passage of time, restored the binding power of PVAc in both soils, resulting in an increase in hydraulic conductivity. Increase in hydraulic conductivity with increase in incubation period when PVAc alone was applied may be due to increasing release of PVAc with the progressive decomposition of benzene which was used as a solvent.

Lower values of hydraulic conductivity in clay sodic soil than loam sodic soil and relatively greater improvement in loam sodic soils appears to be related to the clay content. The higher clay content in clay soil clogs the pores due to swelling and deflocculation on wetting.

Correlation Studies

The relationship between water stable aggregates > 1.0 mm (X) and hydraulic

TABLE 2

Effect of farm yard manure, soil conditioner and incubation period on hydraulic conductivity (cm/h) in clay sodic and loam sodic soils (average of two replications)

Treatments	Incubation period (days)					
	1	15	30	90	180	Mean
			Clay sodic soil			
Control	0.0002	0.0002	0.0002	0.0003	0.0003	0.00024
FYM 0.5%	0.0028	0.0029	0.0038	0.0044	0.0046	0.0037
FYM 0.5%+PVAc 0.5%	0.0045	0.0047	0.0079	0.0210	0.2010	0.0120
PVAc 0.5%	0.0029	0.0027	0.0027	0.0044	0.0044	0.0034
PVAc 1.0%	0.0072	0.0068	0.0210	0.0210	0.0210	0.0154
Mean	0.0037	0.0038	0.0047	0.0082	0.0090	—
C. D. at 5% : Treatment and Incubation period : 0.0068; Interaction : 0.0018						
			Loam sodic soil			
Control	0.039	0.039	0.039	0.034	0.043	0.039
FYM 0.5%	0.059	0.062	0.099	0.099	0.122	0.088
FYM 0.5%+PVAc 0.5%	0.285	0.290	0.358	0.594	0.600	0.425
PVAc 0.5%	0.265	0.159	0.194	0.336	0.358	0.262
PVAc 1.0%	0.318	0.340	0.338	0.503	0.522	0.404
Mean	0.193	0.178	0.206	0.313	0.332	—
C. D. at 5% : Treatment and Incubation period : 0.007; Interactions : 0.016						

TABLE 3

Effect of farm yard manure, soil conditioner and incubation period on available water (between 1/3 and 15 atm. tension) in clay sodic and loam sodic soils expressed as per cent on oven dry basis (average of two replications)

Treatments	Incubation period (days)					
	1	15	30	90	180	Mean
			Clay sodic soil			
Control	11.46	11.58	12.10	12.32	12.31	11.95
FYM 0.5%	11.89	12.46	12.65	13.11	13.72	12.28
FYM 0.5%+PVAc 0.5%	12.01	12.43	13.13	13.69	14.89	13.23
PVAc 0.5%	11.15	11.46	11.71	12.33	13.25	11.98
PVAc 1.0%	10.86	11.61	11.77	12.07	12.69	11.80
Mean	11.77	11.91	12.27	12.70	13.37	—
C. D. at 5% : Treatment and Incubation period : 0.97; Interaction : NS						
			Loam sodic soil			
Control	10.17	10.41	11.10	10.94	11.22	10.77
FYM 0.5%	10.77	10.91	11.55	11.68	12.68	11.52
FYM 0.5%+PVAc 0.5%	10.43	11.22	11.64	12.87	13.56	11.94
PVAc 0.5%	9.38	9.95	10.76	11.48	12.11	10.74
PVAc 1.0%	9.49	10.48	10.85	11.24	12.32	10.98
Mean	10.05	10.59	11.18	11.64	12.38	—
C. D. at 5% : Treatment and Incubation period : 1.19; Interaction : NS						

conductivity (Y) studies revealed a highly significant correlation coefficient (0.69) in loam sodic soil (although with a considerable deviation) and non-significant correlation in clay sodic soil.

The regression equation for loam sodic soil was :

$$\text{Log } Y = -1.16 + 0.0158\ X$$

There are two possible reasons for the non-significant correlation in clay sodic soil and observed deviation in loam sodic soil. Firstly, there may be some factors other than aggregate size which affect the hydraulic conductivity of soil. Secondly, the wet sieving technique might have broken the aggregates which were weakly held together.

In order to confirm this, relationship between dispersion percentage (X) and hydraulic conductivity (Y) was studied. There existed highly significant negative correlation in both clay sodic (0.87) and loam sodic (0.94) soils.

The regression equation for clay sodic soil was :

$$\text{Log } Y = 1.602 - 0.0518\ X$$

and for loam sodic soil was :

$$\text{Log } Y = 1.04 - 0\ 0265\ X$$

It may be inferred from the above discussion that hydraulic conductivity depends upon the pore size distribution of the soil which is governed to a large extent by the orientation of silt and clay particles and not by the size of the aggregates.

Available Soil Moisture

In both the soils, application of FYM alone and in combination with PVAc increased the available moisture capacity significantly over control (Table 3). The highest values of 13.23 and 11.94 per cent for clay sodic and loam sodic soils, respectively were observed in 0.5% FYM +0.5% PVAc. Increase in available moisture values was also reported by Tyulin *et al.* (1967) and Biswas and Khosla (1971) in normal soils. There was a significant increase in available moisture capacity with the incubation period in both the soils.

However, the effect of PVAc @ 0.5 and 1.0 per cent was of lesser magnitude in the two soils. Lower values in PVAc treatment may be explained on the basis of size of pores formed. The pores appear to be of such sizes that drained at suction of 1/3 bar. A decrease in water holding capacity between 1/3 and 15 bar, after treatment with soil conditioner, has been observed by Doyle and Hamlyn (1960) and Nath (1967) in normal soils.

The above discussion reveals that the addition of FYM increases the efficacy of PVAc in sodic soils with respect to soil structural parameters.

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GENETIC VARIABILITY STUDIES IN COWPEA (*VIGNA SINESIS* L. SAVI) UNDER DRY FARMING CONDITIONS

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ABSTRACT

Genetic variability studies for six traits in a group of 40 genotypes of cowpea revealed highly significant differences for all the characters under study except number of pods per cluster. A wide range of variation was recorded for yield per plant, days to flowering and plant height. Genotypes C-49 and Pusa Dofasli were found superior regarding their mean yield per plant under dry farming conditions. Yield per plant had highest genotypic and phenotypic coefficients of variation. High heritability estimates and high percentage of genetic advance were also recorded for yield per plant.

Cowpea *(Vigna sinesis* L. Savi.*)* is a most common green vegetable grown throughout the country. It is a rich and an inexpensive source of vegetable protein. Though this crop does best under irrigated conditions it also performs well under low rainfall areas where it is considered to be the most common poor man's vegetable. Collection of wide and comprehensive germplasm is very essential for the study of genetic variability which ultimately helps in formulating the effective breeding programme for its further improvement. As a little information is available on diversity studies under dry farming conditions, the present investigation was undertaken with a view to study the genetic diversity in a group of 40 genotypes under dry farming conditions.

MATERIAL AND METHODS

The present experiment was conducted at Dry Farming Vegetable Research Station, Bawal, in July 1975. Bawal is situated in semi-arid region of Haryana with annual rainfall of 500 mm. Rainfall at Bawal during the period of experimentation was as follows :

Month	Average rainfall (mm)
July	232.18
August	233.40
September	39.00
October	39.40

Seeds of 40 genotypes of cowpea were sown in rows keeping a distance of 60 cm between rows and 30 cm between plants. Experiment was laid out in a randomized block design with three replications. Five plants were selected at random leaving the border plants for recording the data on various characters. No irrigation was applied during the entire course of experimentation while the sowing was done after first rain showers.

Data were recorded on number of days to first flowering, root length, plant height, pod length, number of pods per cluster and yield per plant. Heritability (in broad sense) was calculated as per formula suggested by Burton and DeVane (1953) and coefficient of variation as suggested by Burton (1952). The expected genetic advance was calculated by using formula as suggested by Lush (1949).

RESULTS AND DISCUSSION

The mean values of various characters studied in a collection of 40 strains of cowpea alongwith respective critical differences at 5% and 1% level of significance are presented in Table 1. Highly significant differences among the genotypes for all the characters except number of pods per cluster were observed in this study. The genotypes studied differed significantly for days to first flowering, root length, plant height, pod length and yield per plant, showing quite a good degree of genetic variability among the genotypes. Genotype C-49 proved to be the highest yielder with 1.803 kg green pods per plant under rainfed conditions closely followed by Pusa Dofasli (1.633 kg), C-13(1.403 kg) and C-42 (1.403 kg). Variety Pusa Barsati took minimum number of days for first flowering (43), closely followed by Pusa Dofasli (44) while genotype C-38 took maximum number of days (92.33) for this trait. Maximum root length was recorded in case of C-7 (63.0 cm) and minimum in case of Pusa Dofasli (26.0 cm) while maximum plant height was observed in C-21 (145.0 cm) and minimum in C-35 (69.0 cm). C-31 (16.13 cm) and Pusa Barsati (15.00 cm) were found superior for pod length, whereas C-45 (12.07 cm) and C-8 (12.13 cm) were recognised as the inferior genotypes for this character.

The range, general mean, standard error, F-value, coefficient of variability, genotypic, phenotypic and error variance for five characters are presented in Table 2. The range of variation indicated that yield per plant (0.403-1.803 kg), days to first flowering (43.0-82.3) and plant height (69.0-145.0 cm) had wide range of phenotypic variability with the mean of 0.921 ± 0.014, 74.51 ± 1.51 and 102.90 ± 20.05, respectively. Coefficient of variation was highest for plant height (23.82%). Phenotypic (76.867) and genotypic (73.452) variance recorded were highest for days to first flowering. On the other hand, plant height exhibited lowest phenotypic and genotypic variance. The characters showing high range of variation have more scope for improvement.

The genetic coefficient of variation, genetic advance as such and also as the per cent of mean and heritability estimates are presented in Table 3. The range of genotypic coefficient of variation (GCV) was from 4.69 per cent (pod length) to 32.92 per cent (yield per plant), while phenotypic coefficient of variation (PCV) ranged from 8.28 per cent (pod length) to 32.97 per cent (yield per plant). The traits root length and plant height showed 13.52 per cent and 10.28 per cent GCV, respectively. Yield per plant had high genotypic as well as phenotypic coefficients of variation which suggested a greater scope of selection for this character. It is evident from the results that the material

TABLE 1

Mean performance of different genotypes of cowpea

Genotypes	Days to first flowering	Root length (cm)	Plant height (cm)	Pod length (cm)	No. of pods per cluster	Total yield/ plant (kg)
1. C-37	69.33	45.00	136.0	13.27	2.00	0.905
2. C-11	79.00	45.33	137.0	12.73	2.00	0.856
3. C-20	68.67	53.33	126.0	13.33	2.00	1.056
4. C-10	74.67	42.17	110.0	13.47	1.67	0.905
5. C-48	69.67	36.33	116.0	13.93	1.67	1.003
6. Pusa Barsati	43.00	44.83	110.0	15.00	1.87	0.905
7. Pusa Dofasli	44.00	26.00	102.0	13.10	1.67	1.633
8. C-31	70.67	45.33	114.0	16.13	1.93	1.053
9. C-8	78.33	38.50	123.0	12.12	1.73	0.653
10. C-33	77.00	43.50	122.0	14.67	2.11	0.403
11. C-9	78.33	40.17	109.0	14.20	1.67	0.506
12. C-16	77.67	46.17	83.0	14.80	1.73	0.703
13. C-15	80.67	44.00	11.0	13.70	1.80	1.370
14. C-47	79.00	41.33	103.0	13.58	1.80	0.533
15. C-28	80.33	46.33	72.0	13.30	1.87	0.902
16. C-5	80.33	45.50	91.0	12.13	1.53	0.553
17. C-18	69.67	51.83	99.0	12.57	1.67	1.230
18. C-39	80.33	48.17	115.0	12.57	1.73	0.803
19. C-21	80.33	45.33	145.0	13.53	1.67	0.953
20. C-36	80.67	45.00	103.0	13.17	1.47	0.903
21. C-4	79.00	41.83	105.0	13.47	1.60	0.753
22. C-26	70.67	44.00	136.0	12.93	1.67	1.053
23. C-24	80.67	42.33	112.0	13.00	1.53	1.053
24. C-35	78.33	40.83	69.0	12.70	1.60	0.707
25. C-43	81.67	46.33	89.0	14.27	1.67	1.008
26. C-45	79.67	46.83	103.0	12.07	1.80	0.953
27. C-38	82.33	46.83	93.0	13.50	1.73	0.725
28. C-27	77.67	50.17	85.0	12.17	1.80	0.708
29. C-49	76.67	42.50	96.0	13.17	1.73	1.803
30. C-44	75.00	43.83	81.0	12.63	1.67	0.753
31. C-41	77.67	40.17	92.0	13.27	1.80	0.653
32. C-14	77.33	42.00	103.0	13.60	1.80	0.653
33. C-13	69.67	39.33	102.0	12.33	1.60	1.403
34. C-46	66.33	38.00	96.0	13.63	1.87	1.303
35. C-22	79.00	38.00	90.0	13.00	1.60	0.757
36. C-30	79.67	37.00	96.0	13.90	1.73	0.707
37. C-42	70.00	58.50	80.0	13.67	1.87	1.403
38. C-6	70.33	35.50	102.0	12.77	1.87	0.953
39. C-7	69.00	63.00	81.0	13.47	1.60	0.957
40. C-23	78.00	51.00	77.0	12.93	1.67	0.702
C. D. at 5%	2.957	5.702	39.3	1.490	NS	0.028
C. D. at 1%	3.887	7.494	51.6	1.958	NS	0.036

TABLE 2

Genotypic and phenotypic variations in cowpea

Parameters	Days to first flowering	Root length (cm)	Plant height (cm)	Pod length (cm)	Yield per plant (kg)
Range	43.00–82.33	26.0–63.0	69.0–145.0	12.07–16.13	0.403–1.803
Mean±S. E.	74.51±1.51	44.07±2.91	102.90±20.05	13.66±0.76	0.921±0.014
F. Value	63.524**	3.393**	1.561**	2.422**	920.000*
C. V. (%)	2.48	8.09	23.82	6.83	1.88
Genotypic variance	73.452	35.521	0.0112	0.411	0.0919
Phenotypic variance	76.867	48.218	0.0713	1.278	0.0922
Error variance	3.415	12.697	0.0601	0.867	0.0003

*Significant at 5% level.
**Significant at 1% level.

TABLE 3

Estimates of co-efficients of variation, genetic advance and heritability for five characters in cowpea

Parameters	Days to first flowering	Root length	Plant height	Pod length	Yield/plant
Genotypic coefficient of variation (GCV)	11.50	13.32	10.28	4.69	32.92
Phenotypic coefficient of variation (PCV)	11.77	15.76	25.95	8.28	32.97
Expected genetic advance (GA)	17.281	10.538	0.087	0.750	0.623
Genetic advance (% of mean)	23.193	23.910	8.410	6.490	67.690
Heritability (%) (Broad sense)	95.56	73.67	15.71	32.16	91.67

under study may offer some scope for improvement of some traits. These findings are in close agreement with those of Lakshmi and Goud (1977) and Tikka *et al.* (1977) in cowpea.

The heritable portion of variation was obtained by calculating the heritability estimates. Heritability estimates have been found to be satisfactory tools for selection based on phenotypic performance, but heritability estimates coupled with genetic advance have been reported to be the most effective tools for effective selection. It is further evident from Table 3 that high heritability was recorded for yield per plant(91.67%), days to first flowering (95.56%) and root length (73.67%). High heritability estimates for days to flowering and pod length have been reported by Bordia *et al.* (1973) and Tikka *et al.* (1977). However, Trehan

et al. (1970) reported low heritability for number of days to flowering in cowpea. In the present study, genetic advance ranged from 5.49% for pod length to 67.69% for yield per plant. It can be concluded from the estimates of genetic advance that on an average it would be possible to improve yield by about 0.623 kg, pod length by 0.75 cm and number of days to first flowering by 17.28 days. The only character, yield per plant, had high heritability and high genetic advance (% of mean) which is a desirable character. These results are in close agreement with the findings reported by Lakshmi and Goud (1977). Therefore, it suggests that selection could be effective for this character alone and the improvement for the character through selection could be maintained in further generations.

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SOME FACTORS AFFECTING AVAILABILITY OF ZINC IN SOILS OF HARYANA—AN INCUBATION STUDY

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ABSTRACT

Laboratory experiments were conducted to study the effect of texture, $CaCO_3$ and organic matter on the availability of Zn in some representative soils of Haryana (Typic Udorthent, Typic Ustochrept, Typic Camborthids, Typic Torripsamments and Typic Ustipsamments). The amount of applied Zn after 2 h of contact, extractable in water, N NH_4OAc (pH 7.0), 0.1 N HCl and 1 N HCl was 2.1, 11.5, 83.6 and 90.7 per cent, respectively, showing conversion of a larger portions of applied Zn to forms not readily available. Incubation period affected the acid extractable but not the water and N NH_4OAc extractable Zn. Application of $CaCO_3$ resulted in a decreased availability of soil and applied Zn particularly with $CaCO_3$ level of 8 per cent. The enhanced incubation generally reduced the adverse effect of $CaCO_3$ on the availability of the soil Zn, whereas reverse was noted for applied Zn. The availability of Zn decreased with organic amendments applied to soil. The availability of soil Zn increased with time but of applied Zn initially decreased and increased afterwards suggesting the release of organic bound Zn.

Some of the factors which affect Zn availability are $CaCO_3$, organic matter and texture. Brown (1950) reported that fine-textured soil fixed more Zn than coarse textured. In calcareous soils, total content of Zn is not less than the non-calcareous soils still the availability is low (Thorne *et al.*, 1942). The availability of Zn decreased by organic matter (Mitchell, 1968). Shukla *et al.* (1971) reported that nature and quantity of organic matter and soil might affect the availability of Zn. Very little information is available on the above aspects on the alluvial soils of India in general and Haryana in particular where a wide spread deficiency of Zn has been reported (Shukla and Chaudhary, 1976).

In view of the above, the present study was undertaken to investigate the affect of soil texture, $CaCO_3$ and different sources of organic matter on the availability of Zn in soil.

MATERIAL AND METHODS

Six surface soil samples, Typic Udorthent (Bharog and Bangalore loamy sands), Typic Ustochrept (Kharkholi loam), Typic Camborthids (Biggar sandy loam), Typic Torripsamments (Kirhan sand), Typic Ustipsamments (Narnaul loamy sand), were collected for various laboratory experiments. Physico-chemical characteristics (Table 1) of samples except Zn, were determined by methods

TABLE 1

Physico-chemical characteristics of soils utilized for various studies

Soil characteristics	Bangalore	Kharkholi	Bharog	Biggar	Kirhan	Narnaul
Sand (%)	83.8	47.8	84.8	76.8	91.3	87.8
Silt (%)	3.0	35.0	6.0	12.0	0.3	3.0
Clay (%)	13.2	17.2	9.2	11.2	9.2	9.2
Textural class	Loamy sand	Loam	Loamy sand	Sandy loam	Sand	Loamy sand
pH (1 : 2)	7.6	7.8	8.2	8.0	8.4	8.5
EC (mmhos/cm)	0.40	0.80	0.35	0.61	0.25	0.79
$CaCO_3$ (%)	0.80	1.05	0.70	4.10	1.75	1.75
Field capacity (%)	9.68	19.58	7.00	12.14	4.70	8.00
O. C. (%)	0.14	0.53	0.11	0.49	0.14	0.22
CEC (me/100 g)	6.61	9.67	3.83	6.00	4.48	6.25
Available Zn (ppm)	0.14	0.30	0.10	0.13	0.05	0.10
Total Zn (ppm)	26	80	46	44	56	27

as outlined by Kanwar and Chopra (1967). Available and total Zn were determined by the method of Cowling and Miller (1941) and Kanehiro and Sherman (1965), respectively. Material and methods for different experiments are described below :

(a) **Retention of Zn in soils.** One fifty g air-dried soil, passed through 1 mm sieve was filled into glass tumblers. Treatments consisted of two levels, i.e., 0 and 10 ppm of Zn as $ZnSO_4.7H_2O$. Each sample in the tumbler was moistened to field capacity and covered with aluminium foil having holes to facilitate aeration. The samples were incubated in a BOD incubator at 28±1°C. Sampling was done after 0 (after 2 h), 7, 14, 28 and 56 days of incubation and each sample was extracted with four extractants, 1 N HCl, N/10 HCl, N ammonium acetate (pH 7.0) and double distilled water. In each case 2.5 g air dried soil was shaken with 25 ml of extractant for one hour on a mechanical shaker and filtered through Whatman filter paper No. 42. Zinc was determined by atomic absorption spectrophotometry.

(b) **Effect of applied calcium carbonate on the availability of Zn.** For this study Bharog loamy sand soil was used and its $CaCO_3$ content was raised to 1, 2, 4 and 8 per cent with A. R. grade $CaCO_3$. Other experimental details were same as described under (a).

(c) **Effect of organic amendments on Zn availability.** For this study, farm yard manure, guar and wheat straw were added at the rate of 0.5% of soil weight after sieving them through 1 mm sieve to a Biggar sandy loam and mixed thoroughly. Other experimental details were same as described earlier.

TABLE 2

Effect of incubation period on the extractability of soil and applied zinc in different soils with various extracting solutions

Incubation period	Bangalore loamy sand		Kharkholi loam		Bharog loamy sand		Biggar sandy loam		Kirhan sand		Narnaul loamy sand		Mean
(days)	0	10	0	10	0	10	0	10	0	10	0	10	
						Water extractable Zn (ppm)							
0	0.065	0.248	0.034	0.247	0.023	0.0263	0.056	0.264	0.010	0.263	0.031	0.198	0.141
7	0.070	0.228	0.039	0.0243	0.026	0.214	0.066	0.253	0.011	0.258	0.035	0.185	0.136
14	0.063	0.216	0.041	0.222	0.039	0.206	0.077	0.236	0.011	0.278	0.037	0.186	0.134
28	0.080	0.228	0.045	0.236	0.037	0.223	0.070	0.250	0.012	0.264	0.031	0.188	0.137
56	0.066	0.216	0.041	0.236	0.026	0.265	0.064	0.257	0.011	0.258	0.033	0.172	0.137
Mean	0.067	0.227	0.040	0.250	0.030	0.234	0.067	0.252	0.011	0.264	0.033	0.186	—
C. D. (.05) Zn 0.041; Soil 0.007; Zn × Soil 0.017; All others NS.													
						N NH_4OAc (pH 7.0) extractable Zn (ppm)							
0	0.132	1.570	0.140	0.025	0.059	2.135	0.120	1.350	0.022	1.825	0.097	0.825	0.0775
7	0.133	0.925	0.163	0.625	0.070	2.455	0.131	1.495	0.025	1.600	0.100	0.690	0 701
14	0.130	0.900	0.145	0.835	0.109	1.525	0.136	1.125	0.023	1.560	0.100	0.850	0.619
28	0.133	1.025	0.168	0.350	0.090	1.650	0.126	1.725	0.030	1 950	0.075	1.325	0.722
56	0.134	1.410	0.165	1.000	0.060	1.900	0.122	1.285	0.024	1.500	0.100	1.575	0.773
Mean	0.132	1.166	0.156	0.767	0.078	1.933	0.127	1.396	0.025	1.685	0.098	1.053	—
C. D. (.05) Zinc 0.012; Soil × Zn 0.048; All others NS.													
						0.1 N HCl extractable Zn (ppm)							
0	3.44	12.95	1.45	10.30	1.04	10.15	2.53	11.73	1.24	9.88	1.74	10.20	6.44
7	3.69	12.00	1.68	10.15	1.20	9.73	3.04	11.50	1.39	9.58	1.91	10.00	6.32
14	3.39	11.43	1.61	9.28	1.84	9.40	3.54	10.78	1.49	10.30	2.00	10.48	6.29
28	3.68	12.03	1.86	9.85	1.70	10.15	3.23	11.38	1.68	10.00	1.69	10.00	6.44
56	3.46	11.43	1.68	9.58	1.43	9.55	2.84	11.73	1.31	9.38	1.88	9.70	6.18
Mean	3.55	11.96	1.66	9.83	1.44	9.79	3.04	11.42	1.40	9.86	1.84	10.22	—
C. D. (.05) Zinc 0.08; Soil 0.29; Zn × Interval 0.14; All others NS.													
						N HCl extractable Zn (ppm)							
0	3.96	14.85	2.49	12.00	1.73	10.90	3.39	12.63	1.56	10.65	2.56	12.65	7.44
7	4.31	14.60	2.56	11.55	1.80	10.48	3.51	13.23	1.78	10.95	2.69	11.43	7.40
14	4.68	14.58	3.19	12.03	1.85	11.70	3.60	12.75	1.73	11.43	2.86	12.00	7.61
28	4.56	13.88	2.86	11.60	1.65	10.63	3.64	12.15	1.90	10.95	2.85	12.80	7.45
56	4.60	13.10	3.21	10.95	1.65	10.00	3.86	12.10	1.79	10.15	3.00	10.00	7.08
Mean	4.42	13.94	2.86	11.67	1.74	10.74	3.60	12.57	1.75	10.82	2.79	11.89	—
C. D. (.05) Zinc 0.10; Soil 0.17; Zn × Interval 0.22.													

RESULTS AND DISCUSSION

Retention of Zn in Soils

It is evident from Table 2 that only a very small amount of soil Zn was present in water soluble forms (0.010 to 0.070 ppm). Ninety eight per cent of the added Zn was converted to water insoluble forms within 2 h of contact. These results are in agreement with Shukla *et al.* (1971).

Though ammonium acetate extracted more Zn than water, only a small fraction of soil Zn existed in ammonium acetate soluble or exchangeable forms (0.022 to 0.156 ppm) (Table 2). Eighty six per cent of the added Zn was converted to ammonium acetate insoluble forms within 2 h of contact. It appeared that even 2 h of contact with the soil mass was sufficient to bring equilibrium between ammonium acetate soluble Zn and soil. The effect of texture on water soluble and exchangeable Zn was not clearly evident perhaps due to low quantity of added Zn and high pH of the soils (Table 1) which might have played a dominant role. Shukla and Mittal (1979) also made similar observations.

In contrast to water soluble and exchangeable Zn, a large percentage of soil (95%) and applied Zn (83%) were soluble in N/10 HCl, which were several folds more than other two extractants. Dwivedi and Shankar (1976) also reported that the amount of Zn extracted was in the order : 0.1 N HCl > N NH_4OAc> water. The quantity of acid soluble Zn was affected by the length of incubation period, whereas no such effect was observed on water soluble and exchangeable Zn. N HCl extracted a slightly higher amount of Zn than N/10 HCl. The effect of incubation of HCl extractable applied Zn showed that with time more and more Zn was converted to forms which were sparingly soluble. The less effect on soil Zn indicated that it had already attained equilibrium.

Comparison of various extractants have shown that after addition of Zn a small fraction remained water soluble (2.10%) and exchangeable (11.50%) while most of it was converted to forms, which were soluble in acid (83.6 to 90.7%). Further, some of added Zn was not extractable even in N HCl indicating thereby the conversion and placement of Zn to such sites from where H^+ ions of acid could not replace it.

Effect of Addition of $CaCO_3$ on the Availability of Zn in Bharog Loamy Sand

The availability of both soil and applied Zn decreased with an increase in $CaCO_3$ level (Table 3). The per cent decrease in the availability of added Zn was 5, 8, 8 and 27 per cent as $CaCO_3$ level were raised to 1, 2, 4 and 8 per cent by weight of soil, respectively. The corresponding values for soil Zn were 13, 15, 24 and 36 per cent. This indicated that only high levels of $CaCO_3$ markedly affected the availability of applied Zn. This might be due to more adsorption as the $CaCO_3$ added was in amorphous form and/or precipitation of added Zn at high levels of liming. Pauli *et al.* (1968) also reported a decrease in water soluble Zn with $CaCO_3$ application. The length of incubation period also affected the

TABLE 3

Effect of $CaCO_3$ addition on the availability of soil and applied Zn in Bharog loamy sand

Incubation period (days)	Calcium carbonate (%)									Mean
	0.7	1.0	2.0	4.0	8.0	0.7	1.0	2.0	4.0	8.0	
	Soil Zn (ppm)					Applied Zn (ppm)					
0	1.15	0.98	1.00	0.85	0.80	11.15	11.00	10.30	9.75	7.85	5.48
7	1.20	1.08	0.98	0.88	0.85	9.75	9.10	9.05	9.00	7.40	4.95
14	1.67	1.34	1.35	1.08	0.90	9.40	9.35	9.35	9.50	7.20	5.11
28	1.70	1.60	1.55	1.38	1.05	10.15	9.00	8.60	9.15	7.10	5.13
56	1.43	1.18	1.15	1.25	0.98	9.55	8.90	8.80	8.70	6.90	4.86
Mean	1.43	1.24	1.21	1.00	0.92	9.99	9.47	9.18	9.22	7.29	—

C. D. (.05) Zinc 0.19; $CaCO_3$ 0.30; Time 0.30; $CaCO_3$ × Time 0.42; $CaCO_3$ × Zinc 0.42; All others NS.

TABLE 4

Effect of added organic amendments on the availability of Zn in Biggar sandy loam soil

Incubation period	No manure		FYM		Guar straw		Wheat straw		Mean
(days)	0	10	0	10	0	10	0	10	
0	2.52	11.72	2.30	10.50	1.72	11.45	1.74	10.32	6.53
7	3.04	11.50	2.20	9.70	2.01	10.95	2.08	10.30	6.47
14	3.34	10.70	2.55	9.85	2.50	10.30	2.54	9.70	6.46
28	3.25	11.37	2.73	9.10	2.40	10.00	1.99	9.57	6.30
56	2.83	11.73	2.35	10.15	2.52	10.40	2.46	10.47	6.61
Mean	3.04	11.40	2.43	9.86	2.23	10.62	2.16	10.07	—

CD (.05) Zinc 0.26; Organic amendments 0.37; Organic amendments × Zinc 0.27; Zinc × Interaction 0.42; Internal NS; Organic amendments × Interval NS.

availability of Zn depending upon soil or applied Zn. The amount of soil Zn increased upto 28 days of incubation irrespective of $CaCO_3$ treatment, whereas the amount of applied Zn decreased with time.

Effect of added Organic Amendments on the Availability of Zn in Biggar Sandy Loam

The organic amendments decreased the availability of soil Zn (Table 4). The decrease was highest with the application of wheat straw (28.9%) followed by guar straw (26.6%) and farm yard manure (20.06%), however, differences among different organic amendments were non-significant.

Similar to soil, the availability of applied Zn was also decreased by organic amendments (Table 4). The highest decrease (13.5 %) was noted when FYM was applied, followed by wheat straw (11.7%) and guar straw (6.9%). The differences in the effect of farm yard manure, wheat and guar straw were statistically non-significant. The decrease in the extractability of Zn could be due to the formation of chelates of low solubility and high stability by the decomposing organic matter. The reduction in Zn availability of applied Zn was more with farm yard manure than wheat straw, perhaps due to wider C/N ratio and slow rate of decomposition of the latter than the former. Shukla *et al.* (1978) and Dikshit *et al.* (1978) also reported decreased Zn content in maize and rice with the application of FYM and wheat straw, respectively.

The availability of soil Zn increased upto an incubation period of 14 days. With further prolongation, there was no definite trend in various treatments. The availability of applied Zn appeared to decrease during the first 28 days of incubation, but with further prolongation of period, no definite pattern was observed. No interaction was observed between organic amendments and length of incubation period. However, it was seen that the decrease in availability of added Zn was more pronounced at 7 days in FYM, whereas the least decrease was observed in wheat straw when compared with Zn availability at zero day of incubation. The availability of Zn increased after 28 days of incubation, suggesting that the release of organic bound Zn might have started.

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EFFECT OF IRON AND NITROGEN LEVELS ON DRY MATTER YIELD AND NUTRIENTS UPTAKE BY MAIZE (*ZEA MAYS* L.)

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ABSTRACT

The effects of different levels of N and Fe were studied on dry matter yield and uptake of N, P, Fe and Mn by maize crop under green-house conditions. There was significant increase in dry matter yield of maize at various levels of N and Fe, however, N had more pronounced effect in comparison to Fe. The N and P uptake increased significantly at all levels of applied N, but there was no significant increase with different levels of Fe. Iron and Mn uptake increased significantly with increased levels of Fe and N and their interaction was significant in both the cases.

Growth of plants is regulated by adequate supply of all the essential plant nutrients and the limitation of any essential nutrient impairs their growth and development. It is well established that N plays a unique role in plant growth. But N behaviour in the presence of variable doses of Fe is still to be understood. There are reports that N and Fe play a significant role in chlorophyll content and other body building constituents of plants (Agarwala and Sharma, 1976). But the information on effect of N and Fe on dry matter yield and nutrient uptake is limiting and, thus, the present work was undertaken.

MATERIAL AND METHODS

The experiment was conducted in polythene lined earthen pots (dia. 25 cm) each containing 4.0 kg of loamy sand, having pH 8.2, ECe 0.84 mmhos/cm, organic carbon 0.25%, $CaCO_3$ in traces and CEC 3.75 meq/100 g of soil. Available N (34.0 ppm), P (4.0 ppm) and Fe (4.25 ppm) were determined as per the methods of Subbiah and Asija (1956), Olsen *et al.* (1954), and Olsen and Carlson (1949), respectively. Nitrogen and Fe were applied in solution form @ 0, 40, 80 and 160, and 0, 5, 10 and 20 ppm through urea and $FeSO_4$ (A. R. grade), respectively. Each treatment combination was replicated thrice. As the soil was deficient in P, K, Ca, Mn and Zn, these nutrients were applied as basal dose @ 60, 60, 10, 5 and 5 ppm through single superphosphate, muriate of potash, calcium chloride, manganese sulphate and zinc sulphate, respectively. Four plants of maize (var. Vijay) were grown in each pot upto 45 days of sowing. The dry matter yield was recorded. Plant

samples were ground in a Wiley mill and analysed for N (Lindner, 1944), P (Koenig and Johnson, 1942), Fe and Mn by atomic absorption spectrophotometer model AA 120 Varian Techtron.

RESULTS AND DISCUSSION

A perusal of the data in Table 1 clearly indicate that dry matter yield increased significantly with increasing levels of applied N. The magnitude of response to N application was two to three folds at 40, 80 and 120 ppm N. However, the response to higher level of N was not proportionate to its dose. These results corroborate the earlier findings of Dahiya *et al.* (1976, 1980) and Dahiya and Bhatia (1978).

The dry matter yield also increased with increasing level of applied Fe, but significant response over control was observed only at 10 and 20 ppm Fe (Table 1). Dry matter yield also increased significantly over 5 ppm Fe. Singh and Dahiya (1976) and Dahiya and Singh (1980) also observed increased dry matter yield of pea and oat with the application of 5 and 10 ppm Fe in a light textured soil. No interaction was found between Fe and N with respect to dry matter yield of maize.

Uptake of Nitrogen

It is apparent that N uptake increased significantly with increasing level of applied N (Table 1). The mean N uptake values at 0, 40, 80 and 160 ppm N were 40.34, 156.05, 211.71 and 351.81 mg N/pot, respectively. This clearly shows that there was 2.85, 4.2 and 7.72 fold increase in N uptake at 40, 80 and 160 ppm N, respectively. All the treatments differed significantly among themselves. With the application of Fe, the uptake of N did

TABLE 1

Effect of different levels of nitrogen and iron on dry matter yield and uptake of nitrogen and phosphorus by maize shoot

	Dry matter yield (g/pot)	Nitrogen uptake (mg N/pot)	Phosphorus uptake (mg P/pot)
Levels of N (ppm)			
0	4.08	40.34	17.96
40	12.80	156.05	44.57
80	16.40	211.71	55.30
160	17.50	351.81	68.96
C.D. (0.05)	1.25	10.82	9.37
Levels of Fe (ppm)			
0	11.77	185.42	43.82
5	12.06	185.25	44.86
10	13.13	191.14	48.45
20	13.82	198.11	50.01
C.D. (0.05)	1.25	NS	NS

not increase significantly, however, there was some increasing trend in N uptake with increasing amount of Fe. The interaction between N and Fe was also non-significant. Dahiya and Bhatia (1978) and Dahiya *et al.* (1980) also observed increased N uptake with increasing amount of N in wheat crop.

Uptake of Phosphorus

The uptake of P increased considerably with an increase in the level of applied N (Table 1). However, application of Fe did not increase P uptake significantly, but there was an overall improvement in P uptake which could be attributed to increase in dry matter yield. Dahiya and Bhatia (1978) and Dahiya *et al.* (1976, 1980) also recorded an increase in P uptake in wheat with an increase in the level of applied N. However, Singh and Dahiya (1976) and Dahiya and Singh (1976 and 1980) observed reduced P uptake in pea and oat crops, respectively, with increasing amount of Fe.

Uptake of Iron

It is clear from Table 2 that Fe uptake increased significantly with the application of various doses of N and Fe. This indicated that N application exercised a synergistic effect on Fe uptake. This sort of behaviour might be expected in view of the role played both by Fe and N in chlorophyll content of plants as reported by Tisdale and Nelson (1970) and Agarwala and Sharma (1976).

As the levels of Fe increased from 0 to 5, 10 and 20 ppm at no N, the Fe uptake increased non-significantly from 1.35 to 1.79, 1.34 and 1.64 mg Fe/pot, respectively. Combination of 20 ppm Fe with different levels of N resulted in significant increase in Fe uptake, which could be attributed to increased dry matter yield. The mean values of Fe uptake at 0, 40, 80 and 160 ppm were 1.53, 4.13, 5.96 and 6.18 mg Fe/pot, respectively.

Uptake of Manganese

Manganese uptake increased significantly with increasing amount of applied N in presence as well as in absence of Fe (Table 3). Manganese uptake also increased with the application of Fe in comparison to control but different levels of Fe did not differ among themselves.

TABLE 2

Effect of different levels of nitrogen and iron on uptake of iron (mg/pot) in maize shoot

Levels of iron (ppm)	Levels of nitrogen (ppm)				
	N_0	N_{40}	N_{80}	N_{160}	Mean
0	1.35	3.76	5.25	5.78	4.03
5	1.79	4.18	4.44	6.07	4.37
10	1.34	4.19	6.64	6.12	4.57
20	1.64	4.40	6.52	6.74	4.83
Mean	1.53	4.13	5.96	6.18	—

C.D. (0.05) for N=0.23.
C.D. (0.05) for Fe=0.23.
C.D. (0.05) for N×Fe=0.46.

TABLE 3

Effect of different levels of nitrogen and iron on uptake of manganese (mg/pot) in maize shoot

Levels of iron (ppm)	Levels of nitrogen (ppm)				
	N_0	N_{40}	N_{80}	N_{160}	Mean
0	0.23	0.43	0.69	0.85	0.55
5	0.26	0.55	0.74	0.88	0.61
10	0.34	0.45	0.65	0.95	0.60
20	0.24	0.57	0.66	1.05	0.63
Mean	0.27	0.50	0.68	0.93	—

C.D. (0.05) for N=0.045.
C.D. (0.05) for Fe=0.046.
C.D. (0.05) for N×Fe=0.09.

Moreover, magnitude of Mn uptake was considerably higher with different levels of applied N than Fe. However, these observations are contrary to those reported by Dahiya and Singh (1976, 1980) who observed a negative relationship between Mn uptake and Fe in pea and oat crops, respectively. A significant interaction between N and Fe on Mn uptake was noted.

It is suggested that when N is limiting a lower level of Fe will be beneficial in increasing the dry matter yield of maize; but when N supply is sufficient then increased dry matter yield can also be obtained by increasing the Fe application.

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EFFECT OF RATE AND TIME OF NITROGEN APPLICATION ON YIELD OF BERSEEM FODDER AND RESIDUAL EFFECT ON SORGHUM/MAIZE FODDER

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ABSTRACT

Effect of nitrogen and its time of application on berseem was studied during 1975-76 and 1976-77. With the increase of rate of nitrogen from 40 to 120 kg N/ha, the yield of berseem fodder increased. Phosphorus alone gave about 90% higher yield over the unfertilized control treatments. Although, there was no significant difference in yield due to split application of nitrogen, there was an indication that two-split application proved slightly superior to other treatments. 40 kg N/ha in combination with 150 kg P_2O_5/ha proved the best treatment for return per rupee of investment. There were no consistent results on the yield of succeeding crop of sorgum or maize fodder obtained due to residual effect of N or P applied to berseem crop. Soil analysis revealed that nitrogen status increased with increase in the level of N or its application frequency after each crop.

In the beginning when roots are not properly developed and the plants are not able to meet their full nutrient requirement through symboisis, applying a small amount of nitrogen to legumes to stimulate growth in early stages has been found very useful and indispensable by many workers. As such, during phosphate manuring of berseem, a farmer would normally apply at least 20 kg N/ha in order to boost the crop. More recently, authors have shown that increased rate of nitrogen application ranging from 20 to 200 kg N/ha have been beneficial from yield potential point of view if sufficient quantity of phosphorus is applied simultaneously to berseem crop. Chopra (1950) indicated that 88 kg N/ha increased the berseem yield. Experiments conducted by Nijhawan and Singh (1952) have shown that, at Karnal, the combination of 100 lb N with 200 lb P_2O_5 (1 : 2) and 200 lb N with 200 lb P_2O_5 (2 : 2) gave maximum response among all the ratios tried. At Ludhiana, 200 lb N alongwith 200 lb P_2O_5 per acre (2 : 2) gave the maximum yield. Similarly, at Gurdaspur, maximum yield was recorded with 200 lb N+100 lb P_2O_5 (2 : 1) per acre. Ganguli *et al.* (1970) reported that green fodder yields showed positive responses of 51.57 and 148.98 q/ha at 50 and 100 kg N/ha, respectively over no nitrogen application.

Normally, berseem gives 5 to 6 cuttings during the entire growing period of the crop. How far higher rate of nitro-

gen and its split application would be successful in further improving the yield of crop, was the aim of this research work.

MATERIAL AND METHODS

Field experiments were carried out during 1975-76 and 1976-77 involving three levels of N (40, 80 and 120 kg N/ha) and six times of nitrogen application : (i) all nitrogen at sowing; (ii) half nitrogen at sowing and half at first cutting; (iii) half nitrogen at sowing and the remaining half in two equal splits at first and second cuttings; (iv) half nitrogen at sowing and the remaining half in three equal splits at first, second and third cuttings; (v) half nitrogen at sowing and the remaining half in four equal splits at first, second, third and fourth cuttings; and (vi) half nitrogen at sowing and the remaining half in five equal splits at first, second, third, fourth and fifth cuttings. A basal application of 150 kg P_2O_5+50 kg K_2O per hectare was also applied to the above treatments. Two additional treatments, (i) no nitrogen and no phosphorus, and (ii) only 150 kg P_2O_5/ha, were included in the study.

The initial fertility status of the soil showed 0.45% organic carbon with 6 and 190 kg of available P_2O_5 and K_2O, respectively. The soil was sandy loam having a pH 8.5. The experiment was laid out in randomized block design with three replications. Urea, superphosphate and muriate of potash were used as source of N, P and K, respectively. The plot size was 7.2×3.6 m.

Berseem, variety Tetraploid T-724, popularly called Pusa Giant Berseem, was sown on October 23 and October 8 for the seasons 1975-76 and 1976-77, respectively at the rate of 20 kg seed/ha. Thirteen irrigations were applied to berseem crop each year. The last cutting of berseem fodder was done on April 30 and 27 during 1975-76 and 1976-77, respectively. The economics of berseem fodder was worked out as detailed by Jensen and Williams (1963) taking the rates of green fodder and seed as Rs. 15/q and 1800/q, and cost of N, P_2O_5 and K_2O as Rs. 4.35, 2.85 and 1.20/kg, respectively. Sorghum and maize fodder were grown after the first and second crop of berseem, respectively to study the residual effect of N or P. No irrigation was applied either to sorghum or maize fodder crop.

Composite soil samples were taken from 30 cm soil layer after the harvest of berseem and the following crop each season in order to assess the quantum of N left over in the soil.

RESULTS AND DISCUSSION

Effect of N and P

There was a general trend of increase in berseem fodder yield at each cutting in both the seasons with successive increase in the level of nitrogen (Table 1). There was significant difference in the total yield due to various levels of nitrogen in both the seasons. In 1976-77, 80 kg N/ha proved significantly superior to 40 kg N/ha. Likewise, 120 kg N/ha gave significantly higher yield over 80 kg N/ha in the same season, while in 1975-76, only 120 kg N/ha proved significantly superior to 40 kg N/ha. Out of six cuttings, the differences due to various levels of nitrogen were significant at

TABLE 1

Effect of N and P on yield of berseem fodder and its economics

Levels of N and P_2O_5 (kg/ha)	Yield of fodder (q/ha) Number of cuttings							Economics (Rs/ha)	
	1	2	3	4	5	6	Total	Net return	Return per rupee
				1975-76					
N_0+P_0	24	103	112	86	96	63	484	6260	6.26
N_0+P_{150}	147	199	184	159	143	76	908	12292	8.61
s.e.m.±	8.3	11.8	7.9	7.7	10.4	9.4	30.6	—	—
C.D. at 5%	23.8	33.8	22.8	22.3	30.0	NS	87.9	—	—
$N_{40}+P_{150}$	164	206	184	168	140	71	933	12393	7.74
$N_{80}+P_{150}$	176	203	191	170	150	75	965	12699	7.15
$N_{120}+P_{150}$	177	210	203	170	156	75	991	12915	6.63
s.e.m.±	3.3	4.8	3.2	3.2	4.2	3.8	12.5	—	—
C.D. at 5%	9.6	NS	9.3	NS	12.2	NS	35.9	—	—
				1976-77					
N_0+P_0	71	90	82	103	98	25	469	6035	6.04
N_0+P_{150}	100	145	171	188	174	111	889	11907	8.34
s.e.m.±	16.6	16.5	10.4	6.9	11.8	11.8	15.5	—	—
C.D. at 5%	NS	NS	29.9	19.7	33.0	33.9	45.5	—	—
$N_{40}+P_{150}$	121	154	166	183	161	108	893	11793	7.36
$N_{80}+P_{150}$	133	158	172	184	167	112	926	12114	6.82
$N_{120}+P_{150}$	144	165	177	188	178	111	963	12495	6.41
s.e.m.±	6.7	6.7	4.2	2.8	4.8	4.8	6.3	—	—
C.D. at 5%	19.2	NS	NS	NS	13.8	NS	18.1	—	—

first and third cuttings in 1975-76 and at first and fifth in 1976-77. A comparison between unfertilized control treatment and the one receiving only 150 kg P_2O_5/ha revealed that the latter outyielded the former by about 90% and these results confirm the earlier findings (Tomer, 1969; Sinha, 1972; Singh and Singh, 1977; Husain and Bains, 1978). The reason is obvious because legumes require more phosphorus for efficient utilization of added nitrogen and nitrogen fixed by *Rhizobium* in nodules.

The economics worked out for berseem fodder revealed that the net return also increased progressively with the increase in the level of N having a basal application of 150 kg P_2O_5/ha in both the years, but considering return per rupee of investment 40 kg N/ha accompanied by 150 kg P_2O_5/ha proved the best combination to get high remuneration, i.e., 7.74 and 7.36 in 1975-76 and 1976-77, respectively. It is interesting to note that even in absence of any nitrogen, the application of 150 kg P_2O_5/

ha alone resulted in return more or less of the same magnitude as in case of 40, 80 and 120 kg N/ha with 150 kg P_2O_5/ha.

Effect of Time of N Application

There was no significant difference in total yield of berseem fodder due to split application of nitrogan in any of the two seasons (Table 2). However, nitrogen application at sowing and at first cutting pushed up a little bit the total yield in each year over the other treatments. Out of six cuttings, the differences in yield among the treatments were observed at second and fourth cuttings in 1975-76 and at only first cutting in 1976-77. It seems that nitrogen applied as top-dressing at various times was not fully utilized by the crop plants because it was not incorporated in the soil as berseem was sown broadcast.

Residual Effect of N and P

Although there was an indication that the yield of sorghum or maize fodder increased with increase in the level of N, except at 120 kg N/ha, the differences were marginal and far below the significance level (Table 3). Such residual

TABLE 2

Effect of time of nitrogen application on yield of berseem fodder (q/ha)

Time of N application	Number of cuttings						
	1	2	3	4	5	6	Total
			1975-76				
All at sowing	169	193	188	162	156	75	943
Two-split	179	221	198	177	152	80	1007
Three-split	174	213	194	169	152	67	969
Four-split	174	206	195	163	144	77	949
Five-split	167	201	190	170	149	79	956
Six-split	171	204	190	175	141	76	957
s.e.m.±	4.8	6.9	4.6	4.4	6.0	5.4	17.7
C.D. at 5%	NS	19.7	NS	12.7	NS	NS	NS
			1976-77				
All at sowing	147	162	166	184	169	107	935
Two-split	147	166	168	186	174	114	970
Three-split	107	148	168	187	164	108	882
Four-split	138	167	180	187	173	112	957
Five-split	124	155	167	186	167	112	911
Six-split	133	157	165	180	163	108	906
s.e.m.±	8.6	9.5	6.0	3.9	6.8	6.8	8.9
C.D. at 5%	27.4	NS	NS	NS	NS	NS	NS

TABLE 3

Residual effect of N and P on yield of sorghum and maize fodder (q/ha)

	1975-76	1976-77
	Sorghum fodder	Maize fodder
Levels of N and P_2O_5 (kg/ha)		
N_0+P_0	325	395
N_0+P_{150}	347	404
s.e.m.±	22.9	38.5
C.D. 5%	NS	NS
$N_{40}+P_{150}$	335	379
$N_{80}+P_{150}$	359	385
$N_{120}+P_{150}$	345	390
s.e.m.±	9.5	15.7
C.D. at 5%	NS	NS
Time of N application		
All at sowing	336	383
Two-split	346	415
Three-split	333	365
Four-split	364	404
Five-split	354	376
Six-split	343	367
s.e.m.±	13.2	22.2
C.D. at 5%	NS	NS

effect of N or P in both the years was mainly due to increased production of sorghum or maize fodder as a result of high fertility builtup alone by berseem fodder rather than the nutrients added to the crop, because berseem is known to be one of the best legumes to maintain soil fertility when included in rotation. In other words, the residual effect of N or P was marked by the fertility developed by berseem crop.

Similarly, the residual effect of time of nitrogen application did not reveal information to conclude anything as both sorghum and maize fodder were not influenced by the treatment for the same reason.

Available N in Soil

Soil analysis revealed that there was a general trend of increase in available N after berseem or following crop with the successive rise in the rate of nitrogen application during both the years (Fig. 1). After berseem, there was much more available N in soil compared with that after sorghum or maize fodder. The

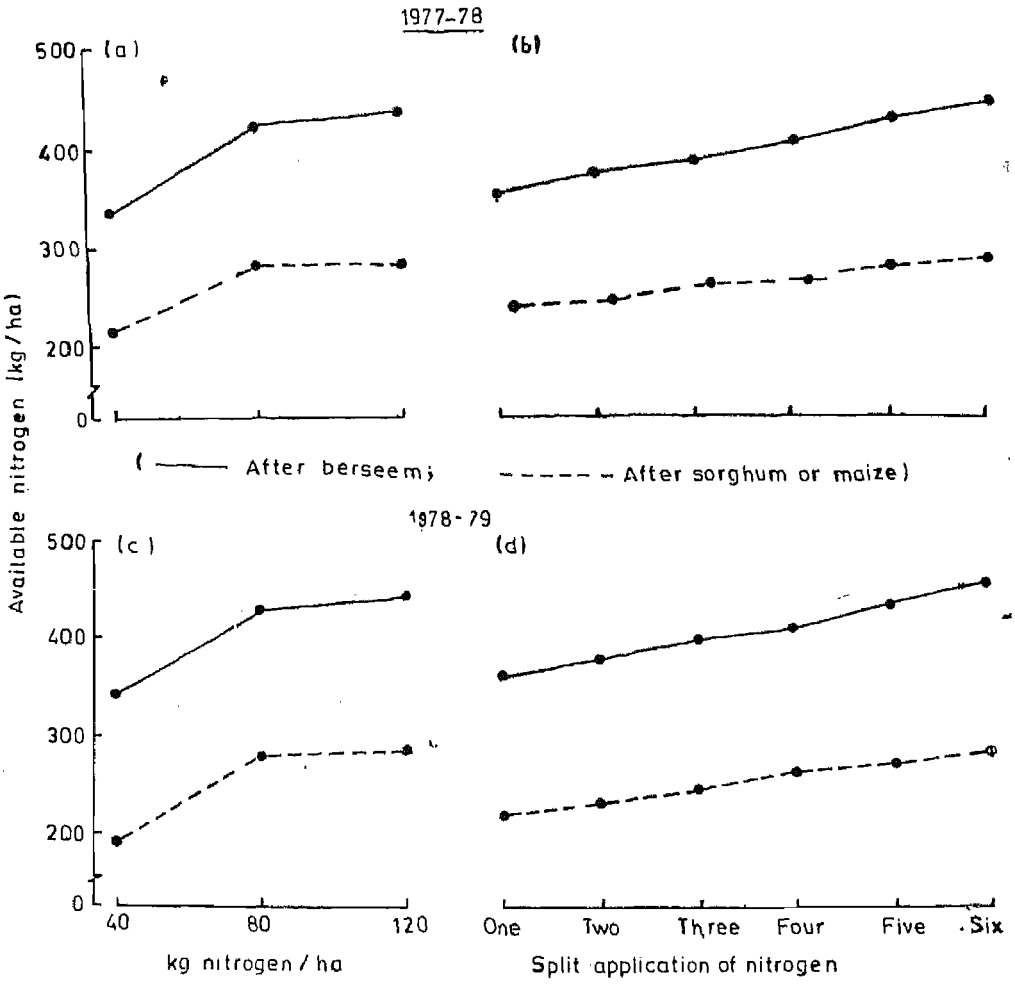


Fig. 1. Available nitrogen in 0-30 cm soil layer after berseem and sorghum/maize as influenced by rate and split application of nitrogen.

reason is obvious as the two cereal crops were exhaustive and thus used most of the remaining native N. As the frequency of nitrogen application increased, the available N in soil either after berseem or the following crop showed a trend of increase suggesting that nitrogen at split applications was not fully utilized by the crop.

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EFFECT OF HERBICIDE CONTAMINATED WATER ON GERMINATION OF SEEDS OF VARIOUS CROPS

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ABSTRACT

Experiment was conducted in petri dishes to study the effect of contaminated water comprised of herbicide treatments viz., 2, 4-D and diuron at 2.5 and 5.0 ppm and paraquat at 0.5 and 1.0 ppm concentrations alongwith distilled water as control, on germination and shoot and root lengths of wheat, gram, green gram, pearl millet and cotton. Initially all the treatments did not affect germination percentage of seeds of all the crops but seedlings of gram and cotton died immediately after germination, in case of 2, 4-D treatments. Shoot length in wheat, green gram and pearl millet was not appreciably affected by both the concentrations of diuron and paraquat, whereas their higher concentrations inhibited shoot length of gram. 2, 4-D at both the concentrations had inhibitory effect on shoot length of all the crops, except wheat. Root length of all the crops was reduced significantly in all treatments in comparison to control, except with that of diuron in case of pearl millet and paraquat in case of cotton. Cotton and gram did not exhibit any root or shoot growth under the influence of 2, 4-D.

Man's increased concern with aquatic environment has resulted in strong need for new means of managing aquatic vegetation. One of the most important concepts of management is to control undesirable plants through the use of herbicides. But water may get contaminated with herbicides, while it is to be used for irrigating crops and may affect the germination, growth and yield of various crops. Timmons (1967) stressed the necessity of having information on herbicides residues in irrigation water and consequent effect on field crops. Herbicides may have inhibiting or stimulating effect on germination and seedling growth. Since germination stage is considered to be the most sensitive to herbicides and, thus, it can be employed for the evaluation of toxicity of herbicides.

MATERIAL AND METHODS

Laboratory experiment was conducted in the petri dishes to study the affect of different herbicides on germination of wheat, gram, green gram, pearl millet and cotton. The herbicides being diuron and 2, 4-D at 2.5 and 5.0 ppm and

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paraquat at 0.5 and 1 ppm concentrations. These concentrations were selected on the basis of preliminary observations recorded in the trial of herbicidal control of Hydrilla. Ten seeds of each crop viz., wheat cv. Kalyansona, gram cv. H-208, green gram cv. T-44, pearl millet cv. PHB-14 and cotton cv. H-777 were kept in petridishes in germinator at 25°C temperature for wheat and gram and at 30 to 35°C temperature for green gram, pearl millet and cotton. The solutions were applied uniformly in all treatments. There were three replications in all. Germination was recorded after 10, 10, 6, 6 and 8 days for wheat, gram, green gram, pearl millet and cotton, respectively. The observations on root and shoot lengths were also recorded at the end of experiment.

RESULTS AND DISCUSSION

Germination Percentage

Both concentrations of all the herbicides did not show any inhibiting effect on the germination percentage of wheat, gram and green gram as there was cent per cent germination with all treatments (Table 1). In case of cotton, three were non-significant differences among all the treatments though the germination percentage varied from 70 to 90 per cent. But after about four days, the seeds of gram and cotton became black in colour and died in case of 2, 4-D contaminated water due to its phytotoxic effect. 2, 4-D also inhibited the germination of pearl millet in comparison to paraquat treatments, though there was non-significant difference with that of control treatment.

TABLE 1

Effect of different concentrations of herbicides on seed germination percentage

Treatment		Germination percentage after days				
		10		6		8
		Wheat	Gram	Green gram	Pearl millet	Cotton
Control		100	100	100	65(53.78)	90(76.71)
Diuron	2.5 ppm	100	100	100	65(53.78)	80(70.38)
	5.0 ppm	100	100	100	60(50.89)	80(63.43)
Paraquat	0.5 ppm	100	100	100	70(56.79)	90(76.71)
	1.0 ppm	100	100	100	65(53.78)	85(67.50)
2, 4-D	2.5 ppm	100	100*	100	50(45.00)	70*(57.10)
	5.0 ppm	100	100*	100	45(42.11)	70*(64.61)
s.e.m. ±		—	—	—	(4.06)	(8.84)
C. D. at 5%		—	—	—	(14.06)	(NS)

*Seeds germinated but died.

Data in parentheses are angular transformation.

Brezny *et al.* (1971) also found that none of the tested herbicides was harmful to the germination at concentrations ranging from 0.5 to 10 ppm but inhibition in growth of seedlings was noticed with higher concentration in most of the crops.

Shoot and Root Lengths

Data recorded on the shoot and root lengths of wheat, gram, green gram, pearl millet and cotton seedlings are presented in Table 2.

Wheat

There was non-significant effect of all herbicides at both the concentrations on shoot length but these had marked effect in reducing the root length. Minimum root length was observed in case of diuron at 5.0 ppm concentration. Next herbicide in order in reducing root length was paraquat whose higher concentration gave significantly more root length as compared to higher concentration of diuron and recorded significantly less root length as compared to 2, 4-D at both the concentrations. In case of 2, 4-D though the root length recorded at both the concentrations was significantly less as compared to control, yet it was found to be least effective in reducing root length of wheat in comparison to other two herbicides. Voevodin *et al.* (1975) also reported that 2, 4-D amine when applied to wheat at early stages did not affect subsequent germination of seeds but did have an affect on the formation of embryo and on growth processes in germinating embryo.

Gram

Maximum shoot length of gram was recorded under untreated control which was significantly more than that under all other treatments except diuron at 2.5 ppm concentration. There was non-significant difference between diuron and paraquat in respect of shoot length at both concentrations. Similar was the trend in case of root length. The untreated control gave significantly more root length as compared to all other treatments. Diuron was found to be more effective in reducing root length as compared to paraquat, though there was non-significant difference.

2, 4-D was found to be most phytotoxic to gram because it killed the seeds after germination at both concentrations. Audus (1964) also reported that many herbicides were effective in inhibiting the germination and crop growth.

Green gram

No significant differences were observed in shoot length recorded under diuron and paraquat treatments at both concentrations as compared to untreated control. Maximum shoot length of 15.10 cm was obtained under paraquat at 1.0 ppm concentration which was slightly more as compared to untreated control though the difference was non-significant. 2, 4-D at both concentrations inhibited drastically the shoot length of green gram as the shoot length obtained was significantly less as compared to all other treatments. Maximum root length was obtained under untreated control which was statistically at par with that of paraquat at 0.5 ppm concentration. Minimum root length of 0.67 cm was obtained under 2, 4-D at 5 ppm concentration which was at par with all

TABLE 2

Effect of different treatments on the shoot and root lengths of various crops

Treatments		Shoot and root lengths (cm)									
		Wheat		Gram		Green gram		Pearl millet		Cotton	
		Shoot	Root	Shoot	Root	Shoot	Root	Shoot	Root	Shoot	Root
Control		12.35	10.78	6.56	20.86	14.05	4.22	8.58	5.40	4.83	2.49
Diuron	2.5 ppm	12.52	4.94	4.73	5.60	14.70	1.83	8.83	5.99	6.48	1.96
	5.0 ppm	11.52	4.05	2.19	1.39	13.87	1.56	7.91	6.00	4.45	2.11
Paraquat	2.5 ppm	11.65	7.45	3.88	8.34	14.13	2.73	7.00	4.25	7.33	2.89
	5.0 ppm	12.33	5.98	3.31	6.13	15.10	2.16	5.73	2.66	5.33	2.78
2, 4-D	2.5 ppm	13.30	8.95	0.00	0.00	6.08	0.92	5.83	1.16	0.00	0.00
	5.0 ppm	12.82	8.02	0.00	0.00	4.92	0.67	4.83	0.48	0.00	0.00
s.e.m. ±		1.05	0.51	0.85	2.15	1.04	0.55	0.54	0.65	0.23	0.16
C. D. at 5%		NS	1.78	2.96	7.46	3.60	1.91	1.88	2.24	0.81	0.55

other treatments except untreated control and paraquat at 0.5 ppm concentration. The root length obtained under 2, 4-D at 2.5 ppm was significantly lower than control but it was at par with all other treatments.

Pearl millet

Paraquat at higher concentration produced significantly less shoot length in comparison to both concentrations of diuron and untreated control treatments, whereas it was at par with its lower concentration and both concentrations of 2, 4-D. Minimum shoot length at 4.83 cm was observed under 2, 4-D at 5 ppm concentration.

Maximum root length was observed under diuron treatments which showed non-significant difference with untreated control and paraquat at 0.5 ppm treatments. Minimum root length of 0.48 cm was obtained under 2, 4-D at 5 ppm concentration which was at par with its lower concentration and also with paraquat at 1 ppm concentration. There was non-significant difference of root length between both concentrations of paraquat but higher concentration gave significantly less root length as compared to diuron and untreated control and it was at par with 2, 4-D treatments.

Cotton

Different herbicides showed varying effects on shoot length of cotton. Maximum shoot length of 7.33 cm was observed under paraquat at 0.5 ppm concentration which was followed by diuron at 2.5 ppm and then paraquat at 1 ppm concentration. All these three treatments differ significantly with each other. The shoot length of 4.83 cm under untreated control was at par with higher concentrations of diuron and paraquat which differ significantly with each other. 2, 4-D was found to be very much phytotoxic to cotton seedlings as these were killed. Maximum root length of 2.89 and 2.78 cm was recorded under low and high concentration of paraquat, respectively, which was at par with untreated control and these were significantly more as compared to diuron treatments. Though, under diuron treatments less root lengths were obtained but these were at par with control treatments.

Brezny *et al.* (1971) also found diuron as toxic to almost all the crops when used at more than 0.5 ppm concentration, whereas it showed stimulated action on barley and peas. Mazerine Kiss (1966) and Bozic (1967) also reported that low concentration of some of the herbicides may also act as stimulant during germination and growth stages. But Dalvi (1975) reported secbumeton at 100 ppm inhibitory to the seed germination and seedling growth of mungbean and wheat bioassays.

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EFFECT OF LONG-TERM APPLICATIONS OF FARM YARD MANURE AND NITROGEN. I. CROP YIELDS AND ACCUMULATION OF ORGANIC CARBON

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ABSTRACT

A long-term experiment was conducted on the use of FYM and nitrogen on crop yields and accumulation of organic carbon in bajra-wheat sequence. Under maximum application of FYM (740 tons) through 45 tons/ha twice a year during 1967-77, 23.55 tons of organic carbon was retained which was about 3.18% of the added organic carbon. When low amount of organic matter (15 tons FYM/ha) was added higher percentage (upto 7.10%) was retained as organic carbon in the soil. Winter application under all doses left more organic carbon in the soil than summer application.

Yield of wheat and bajra increased with increasing doses of FYM and nitrogen. Cumulative mode of FYM was found best followed by direct and residual in wheat and bajra both. The response of wheat to added FYM at 15 tons/ha was of higher order in absence of nitrogen (32.3 kg/ton FYM) than that with 120 kg N/ha (23.3 kg/ton FYM) which decreased to 16.0 and 8.7 kg at 45 tons FYM/ha with 0 and 120 kg N/ha, respectively. Bajra response to FYM at 15 tons/ha was highest (30.8 kg grain/ton FYM) without nitrogen which decreased to 13.5 kg at 45 tons/ha FYM and with 120 kg N/ha, the responses further decreased to 14.7 and 5.9 kg grain/ton FYM at 15 and 45 tons FYM/ha, respectively. The best combination was 15 tons FYM and 120 kg N/ha.

Continuous use of chemical fertilizers for getting maximum yields may deplete the inherent fertility of the soil much faster than it can be replenished through addition of crop residues. The inherent soil fertility may be maintained by the judicious use of inorganic fertilizers more specifically nitrogen alongwith bulky organic manures. Increased yields of cereals and other crops due to long-term applications of farm yard manure have been reported by Sen and Bonde (1962), Das *et al.* (1966) and Raheja *et al.* (1971). The use of inorganic fertilizers alongwith organic manures was found more advantageous than either of the alone (Naphade and Bhoyar, 1975; Haan and Lubbers, 1976; Jenkinson and Johnston, 1977).

Under tropical conditions due to high summer temperature the oxidation of

organic matter in the soil is very fast. Under such situations it was not known at what level of organic matter addition a build up could be expected, what and how much extra advantage the addition of organic matter would give and what mode and amount of application would be suitable. Keeping these points in view a long-term manurial trial was laid out in 1967.

MATERIAL AND METHODS

A long-term experiment on the use of FYM and inorganic nitrogen fertilizer was started with **bajra**-wheat rotation. The experiment was laid out in a split plot design. The treatments in the main plots included combinations of three modes of FYM application, i.e., in **kharif** (rainy season), in **rabi** (winter) and in both **kharif** and **rabi** at the rate of 0, 15, 30 and 45 tons/ha. Each main plot was divided into three sub-plots on which three levels of nitrogen, i.e., 0, 60 and 120 kg/ha were superimposed. Levels of FYM were designated as F_0, F_1, F_2 and F_3, whereas nitrogen levels as N_0, N_1 and N_2.

The experiment had four replications and gross plot size was 10×6 m. In all there were 30 treatment combinations and 120 total plots. The soil was sandy loam with pH 8.2 and available N, P_2O_5 and K_2O were 201, 30 and 600 kg/ha, respectively, at the start of the experiment.

FYM was applied 20 days before sowing of the crops and mixed in the soil. Nitrogen was applied through urea, half at sowing and remaining half at first irrigation. Irrigations were applied as and when required and all other agronomic practices were followed during the tenure of the experiment. Wheat and **bajra** crops were grown in **rabi** and **kharif**, respectively, and their yields were recorded plot-wise, which were put to statistical analysis.

After the harvest of wheat crop (1977-78), soil samples from 0-15 cm depth were collected plot-wise and analysed for organic carbon content by Walkley and Black's wet oxidation method. On the basis of carbon content in treated and control plots, organic carbon accumulation was calculated.

RESULTS AND DISCUSSION

Organic Carbon Accumulation

The accumulation of organic carbon increased with the increasing doses of FYM (Table 1). Large additions of FYM during experimentation and more roots and other plant materials left in the soil might have contributed towards the build-up of organic carbon. Acharya and Rajagopalan (1956), Kanwar and Prihar (1962), Sandhu and Meelu (1974), and Ruhal and Shukla (1979) also reported similar increase in organic carbon due to FYM applications under different agro-climatic conditions. The highest organic carbon (7.1%) was accumulated in the plots where 15 tons/ha FYM was added in **rabi** only. However, there was not much difference in **kharif** or both season application at 15 tons/ha. At 30 and 45 tons/ha FYM application there was no difference in accumulation of organic carbon whether FYM was added in **rabi** or **kharif**. Cumulative application at 30 and 45 tons/ha left lowest percentage of organic carbon in the soil, but total accumulation

TABLE 1

Organic matter turn-over with respect to different levels of FYM and nitrogen and modes of FYM application

Treatments		FYM application			Mean
		F_1	F_2	F_3	
		Organic matter (tons/ha)			
Mode of FYM application					
Rabi+Kharif	Added	250.00	495.00	740.00	495.00
	Accumulated	13.03	13.57	23.55	16.70
		(5.21)	(2.74)	(3.18)	(3.37)
Rabi	Added	125.00	247.50	370.00	247.50
	Accumulated	8.87	10.52	13.39	10.93
		(7.10)	(4.25)	(3.62)	(4.42)
Kharif	Added	125.00	247.50	370.00	247.50
	Accumulated	6.31	10.97	12.49	9.94
		(5.05)	(4.43)	(3.38)	(4.02)
N(kg/ha) application					
N_0	Added	166.67	330.00	493.33	330.00
	Accumulated	10.26	13.17	16.52	13.32
		(6.16)	(3.99)	(3.35)	(4.04)
N_{60}	Added	166.67	330.00	493.33	330.00
	Accumulated	9.54	9.85	16.08	11.82
		(5.72)	(2.99)	(3.26)	(3.58)
N_{120}	Added	166.67	330.00	493.33	330.00
	Accumulated	8.46	12.05	16.84	12.45
		(5.08)	(3.65)	(3.41)	(3.77)
Mean	Added	166.67	330.00	493.33	330.00
	Accumulated	9.40	11.69	16.48	12.53
		(5.64)	(3.54)	(3.34)	(3.80)

Figures in the parentheses are the per cent organic carbon accumulated.

of organic carbon was higher. Under tropical conditions due to higher temperature and higher microbial activity the destruction of organic matter is rapid. Under such conditions build-up of organic carbon is very slow. A slight but constant increase in organic carbon even under tropical conditions has also been reported by Sundra Rao and Krishan (1963) and Ruhal (1978).

Similarly when effects of nitrogen were isolated the total as well as per cent accumulation of organic carbon with increase in nitrogen decreased. There was more accumulation of total and less per cent carbon with increasing doses of FYM in presence of nitrogen too. The highest accumulation was, however, observed in absence of added nitrogen. Acharya and Rajagopalan (1956), Mandal

and Pain (1965) and Bandyopadhya *et al.* (1969) also reported that carbon content of soil remained unchanged with continuous applications of chemical fertilizers.

Yield of Wheat

The yield of wheat grain (1969-70) by varying doses of FYM under cumulative and residual mode of application showed increasing trend but under direct mode the yield declined with increase in FYM dose (Table 2). Direct application of FYM in case of wheat did not show its effect except in 1975-76 where the yield increased with increasing doses of FYM. The residual effect of increasing FYM application was found positive from 1970-71 to 1976-77 which could be attributed to the proper decomposition of organic matter and more release of nutrients in the field.

In absence of FYM, 60 kg/ha application of nitrogen gave maximum response but higher yield levels were obtained with the combination of FYM and N (Table 3). At lower levels of FYM, application of nitrogen gave higher response than at higher FYM level. Since the doses of FYM during 1976-77 and 1977-78 were reduced to 5, 7.5 and 10 tons/ha, the yield of wheat with most of the treatments of FYM in absence of nitro-

TABLE 2

Effect of mode and levels of FYM application on the grain yield of wheat (q/ha) in different years

Treatments		1969-70	1970-71	1972-73	1975-76	1976-77	1977-78	Average
Cumulative	F_1	15.20	27.83	28.71	34.54	23.65	23.46	25.57
	F_2	15.93	28.59	31.40	36.34	27.85	24.91	27.50
	F_3	17.43	32.84	30.90	37.38	29.14	26.50	29.03
	Average	16.19	29.75	30.34	36.09	26.88	24.95	27.37
Direct	F_1	17.00	28.38	25.85	30.26	25.14	23.86	25.08
	F_2	15.70	27.43	27.64	31.05	27.12	24.15	25.52
	F_3	13.43	27.81	26.24	32.16	25.78	23.91	24.89
	Average	15.38	27.87	26.58	31.16	26.01	23.97	25.16
Residual	F_1	11.87	26.23	17.85	25.82	26.10	22.29	21.69
	F_2	16.90	26.41	19.86	28.61	26.91	24.43	23.85
	F_3	14.20	27.34	21.83	29.92	27.02	23.81	24.02
	Average	14.32	26.66	19.85	28.12	26.68	23.51	23.19
Average		15.30	28.10	25.59	31.79	26.52	24.15	—

C. D. at 5% for

Mode	=0.802
FYM	=0.802
Mode × FYM	=1.39
Years	=0.96
Years × Mode	=1.96

TABLE 3

Effect of nitrogen, superimposed on different levels of FYM, on the grain yield of wheat (q/ha) in different years

Treatments		1969-70	1970-71	1972-73	1975-76	1976-77	1977-78	Average
F_0	N_0	9.70	17.10	10.60	9.90	11.30	10.30	11.48
	N_1	13.80	24.70	25.10	23.60	25.00	21.10	22.22
	N_2	18.80	26.60	29.40	28.90	30.40	30.70	27.47
	Average	14.10	22.80	21.70	20.80	22.23	20.70	20.39
F_1	N_0	11.06	23.70	16.18	20.00	14.80	12.20	16.32
	N_1	14.53	28.80	24.71	32.60	26.40	23.30	25.06
	N_2	18.50	29.90	31.61	38.10	33.70	34.10	30.97
	Average	14.70	27.47	24.13	30.23	24.97	23.20	24.12
F_2	N_0	12.00	22.40	19.89	21.20	14.60	13.50	17.27
	N_1	15.80	28.70	27.57	35.30	29.80	24.10	26.88
	N_2	20.73	31.30	31.45	39.50	37.50	35.80	32.73
	Average	16.18	27.47	26.30	32.00	27.30	24.50	25.62
F_3	N_0	10.37	26.20	21.52	24.10	16.50	14.40	18.68
	N_1	15.33	31.30	28.93	36.30	30.40	24.80	27.84
	N_2	19.37	31.50	28.40	39.10	35.00	35.00	31.40
	Average	15.02	29.33	26.28	33.16	27.30	24.73	25.97
Average		15.00	26.77	24.61	29.05	25.45	23.28	—

C. D. at 5% for

FYM	=0.785
Nitrogen	=0.681
Years	=0.96
Years × FYM	=1.92

gen showed decline during these years, but with 120kg N/ha the yield levels were maintained. Since the soil was deficient in nitrogen, application of FYM in small amounts could not fulfil the requirement of nitrogen for wheat without adding inorganic nitrogenous fertilizer, but when nitrogen was added the original yield levels were maintained. Naphade and Bhoyar (1975) and Haan and Lubbers (1976) advocated the use of inorganic fertilizers with FYM to get the maximum yield.

Different amounts of FYM application in the year 1969-70 gave minimum yield of wheat (Table 3), most probably due to the incomplete decomposition of organic manure in the very first winter season. Maximum yield was recorded in 1975-76. However, the yield decreased during 1976-78 because the doses of FYM were reduced. Increasing doses of FYM upto 30 tons/ha significantly increased the yield over control and the lower level but the difference between 30 and 45 tons/ha was not significant.

The responses of wheat to added FYM at 15 tons/ha were of higher order in absence of nitrogen (32.3 kg/ton FYM) than that with 120 kg N/ha (23.3 kg/ton FYM) which decreased to 16.0 and 8.7 kg at 45 tons FYM/ha with 0 and 120 kg N/ha, respectively.

Increasing doses of nitrogen in different years were found to increase yield regularly (Fig. 1) which indicates that if high doses of organic matter are added continuously low supplemental doses of inorganic nitrogen would be needed. It is clear from Fig. 2 that when 45 tons FYM/ha was added alongwith 60 kg N/ha the yield of wheat grain was as high as with 120 kg N alone. It indicates that 60 kg N is substitute of 45 tons FYM/ha which would contain about 200 kg N which means that about 30% of organic nitrogen is utilized by the crop. The responses of wheat to applied nitrogen were of higher order at 60 kg N/ha than at 120 kg N/ha in presence of organic matter (Fig. 2). As the level of FYM increased the per kg response to applied nitrogen decreased from 17.9 to 15.3 with 60 kg N/ha and from 13.3 to 10.6 with 120 kg N/ha.

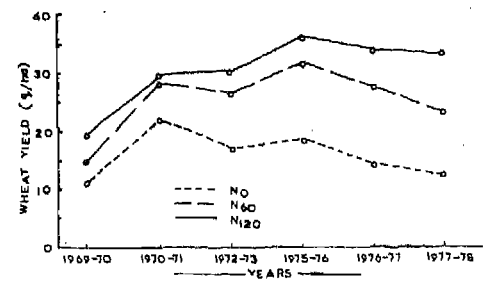


Fig. 1. Nitrogen responses of wheat grain in different years.

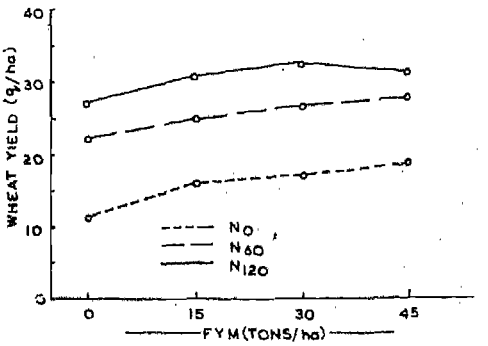


Fig. 2. Interaction of FYM and nitrogen on the grain yield of wheat.

Application of FYM to both crops every season (cumulative) was found better than direct and residual applications, followed by direct application (Table 2), mainly due to the double amount of FYM applied in cumulative treatment at each level of application. From 1969-70 to 1975-76, the differences between different modes were quite distinct and significant but in 1976-77 and 1977-78, though the trend was the same but not significant, which was mainly due to the reduction in FYM doses and it could be postulated that the effects in these years were the residual effects of the previous high doses of FYM in all the modes of application. On the whole, direct application of FYM was found superior than its residual effect. Under high temperature conditions whatever organic matter is added that is easily decomposed in one crop season and the nutrients thus released are utilized by the same crop. In winter season, the conditions of temperature and moisture in this area remain suitable for slow decomposition of organic matter.

Cumulative and residual effect of FYM application was more at higher levels

but direct application was more effective at lower levels. When more amount of FYM was added directly before sowing the crop, more time for the proper decomposition and release of nutrients was needed. During this period, immobilization of nitrogen might have taken place more with high FYM doses. Such effects were less in case of low FYM doses.

Yield of Bajra

Except 1974, increasing levels of FYM were found to give increasing yield under cumulative mode of application, but the similar trend was observed during 1972, 1974 and 1976 under direct FYM application and no such trend was obtained in any of the year in case of residual effect.

No definite trend of FYM and nitrogen combinations was observed in 1970 (Table 5), but increasing doses of nitrogen at different FYM levels increased grain yield in 1972, 1974, 1976 and 1977 with exceptions at 45 tons/ha FYM level in 1972 and 15 tons/ha FYM level in 1976. The response of **bajra** to 60 kg N/ha was maximum (10.9 kg grain/kg N) in absence of FYM, and additional nitrogen upto 120 kg N/ha did not enhance the yield (5.1 kg grain/kg N), but at 30 tons/ha FYM level, 120 kg N/ha also gave response (4.7 kg grain/kg N) over 60 kg N/ha application. In rainy season more losses of nitrogen are expected due to high temperature (volatilization) and excessive moisture (leaching) in the absence of organic matter but high organic matter content

TABLE 4

Effect of mode and levels of FYM application on the grain yield (q/ha) of **bajra** in different years

Treatments		1970	1972	1974	1976	1977	Average
Cumulative	F_1	22.50	27.88	16.57	25.28	16.82	21.81
	F_2	23.50	29.59	12.54	29.79	19.19	22.92
	F_3	24.50	29.91	15.16	30.18	20.98	24.15
	Average	23.50	29.13	14.76	28.42	18.99	22.96
Direct	F_1	25.20	26.15	13.08	26.63	19.50	22.11
	F_2	21.80	28.18	14.26	27.83	16.94	21.80
	F_3	23.00	29.28	14.74	28.02	18.36	22.68
	Average	23.33	27.87	14.03	27.49	18.27	22.20
Residual	F_1	22.80	23.52	14.84	27.23	16.51	20.98
	F_2	22.80	21.02	13.91	23.87	16.90	19.70
	F_3	23.50	27.14	15.24	24.77	16.23	21.38
	Average	23.03	23.89	14.66	25.29	16.55	20.69
Average		23.29	26.96	14.48	27.07	17.94	—
C. D. at 5% for							
	Mode		=1.30				
	Years		=1.69				

is expected to minimize the losses by retaining some of the nitrogen through immobilization and on its exchange sites.

Different levels of FYM did not vary significantly among themselves but they were found significantly better than no FYM treatments (Table 5), suggesting thereby that regular but small dressings of FYM were as effective as high applications. No regular yield pattern with increasing doses of FYM was observed during 1970 and 1974 while other years showed an increasing yield with FYM doses.

Responses of 60 kg N/ha on the grain yield of **bajra** were found greater than 120 kg N/ha in all the years except 1976 where higher levels of nitrogen further increased grain yield and the overall yield was also highest in this year (Fig. 3). In 1977, highest response of **bajra** to nitrogen at both 60 and 120 kg N/ha levels was obtained, which could be attributed, in general, to the lower yield and stabilization of the long-term experiment by that time. In the first year of experimentation (1970) the yield with 120 kg N/ha was lower than 60 kg N/ha may be due to theoretical maxima of response reaching around 60 kg N/ha

TABLE 5

Effect of nitrogen, superimposed on different levels of FYM, on the grain yield of **bajra** (q/ha) in different years

Treatments		1970	1972	1974	1976	1977	Average
F_0	N_0	19.50	14.81	9.08	21.63	10.80	15.16
	N_1	25.00	26.02	13.86	24.20	19.50	21.72
	N_2	20.50	27.74	13.97	24.25	19.82	21.26
	Average	21.70	22.86	12.30	23.36	16.71	19.39
F_1	N_0	22.67	23.15	13.83	25.46	13.80	19.78
	N_1	25.80	25.46	15.02	24.43	17.16	21.57
	N_2	22.00	28.60	15.65	29.24	21.87	23.47
	Average	23.49	25.74	14.83	26.38	17.61	21.61
F_2	N_0	20.50	24.61	11.90	24.90	15.21	19.42
	N_1	22.20	26.17	13.65	27.45	16.06	21.11
	N_2	25.50	28.01	15.16	29.13	21.75	23.91
	Average	22.73	26.26	13.57	27.16	17.67	21.48
F_3	N_0	24.33	28.67	13.82	24.88	14.51	21.24
	N_1	25.67	27.68	15.29	27.53	18.98	23.03
	N_2	21.00	29.99	16.03	30.56	22.07	23.93
	Average	23.67	28.78	15.05	27.66	18.52	22.74
Average		22.89	25.91	13.94	26.14	17.63	—
C. D. at 5% for							
		FYM	=1.27				
		Nitrogen	=1.10				
		Years	=1.42				

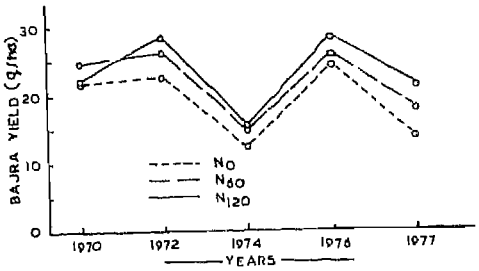


Fig. 3. Nitrogen responses of bajra grain in different years.

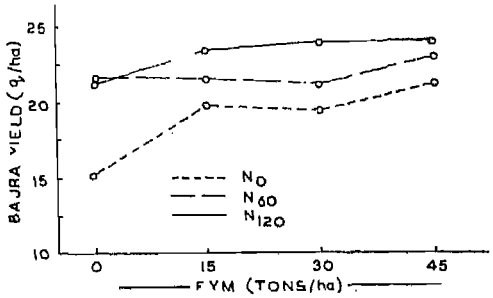


Fig. 4. Interaction of FYM and nitrogen on the grain yield of bajra.

as the crop stand comparatively was better at this level. As the experiment advanced the requirement of **bajra** crop for nitrogen increased and the maxima of responses shifted from 60 to 120 kg N/ha.

Direct application of FYM to **bajra** crop proved to be better than its residual effects (Table 4) and statistically at par with cumulative applications; though the cumulative mode of FYM application received double the amount of FYM than single dose, even then there was no substantial effect of higher amount. Higher doses of organic materials lead to comparatively higher losses of carbon in tropical climate as indicated by the data in Table 1. In 1974, being a dry year, differences between different modes of FYM application were not clear as the FYM added in one or both the seasons was oxidised due to persistent high temperatures.

Bajra crop responded maximum to 60 kg N/ha in absence of FYM and the yield almost remained constant with additional nitrogen application (Fig. 4). In presence of 15 and 30 tons/ha levels of FYM the responses to nitrogen were more with 120 kg N than with 60kg N/ha but with 45 tons/ha FYM, 60 kg N was more effective and law of diminishing returns started thereupon. Various doses of FYM (15, 30 and 45 tons/ha) were statistically at par but significantly superior than control (F_0). Responses of **bajra** to FYM at 15 tons/ha were highest (30.8 kg grain/ton FYM) in absence of nitrogen which decreased to 13.5 kg at 45 tons FYM/ha. With 120 kg N/ha, the responses further decreased to 14.7 and 5.9 kg grain/ton FYM at 15 and 45 tons FYM/ha, respectively.

Application of 15 tons/ha of FYM was found most effective when it was applied directly to the crop (Table 4) than its residual or even cumulative effect when FYM was applied 15 to 20 days before sowing the crop and mixed in the field followed by a light irrigation. At 30 tons/ha FYM level also direct application was statistically at par with cumulative though it received double the amount of FYM, but at 45 tons/ha FYM level cumulative application was found significantly better than direct and residual applications.

Working on long-term use of FYM Iversen (1960), Sen and Bonde (1962),

Das *et al.* (1966) and Raheja *et al.* (1971) also reported increased yields of crops with FYM additions. FYM is not only a source of plant nutrients but also acts as an amendment for improving the structure and aggregation of the soil which might indirectly contribute to yield increases, as reported by Widdowson *et al.* (1963).

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GENETICS OF DAYS TO HEADING AND MATURITY IN PEARL MILLET

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ABSTRACT

The combining ability analysis and component analysis of days to heading and maturity utilizing 15 parent diallel cross without reciprocals under three different test environments in pearl millet revealed that both additive and non-additive genetic variances were important in the expression of both the characters under different environments. However, the non-additive genetic variance was found to be predominant in both the analyses. It was also concluded that array means could effectively be used in selecting the superior inbreds. The results also indicated that gene action for days to heading was in close confirmity with that for days to maturity.

Heading in pearl millet has for long been considered a reliable criterion of final maturity. Keeping this in view the geneticists have worked out the gene action for days to heading 'primarily a guide to genetics of maturity'. Although a number of workers have reported gene action for heading in pearl millet using different designs or analytical approaches, there is hardly any published reference available on gene action for grain maturity. In the present study, an effort has been made to work out the gene action for both the heading time and grain maturity so as to acquire data on the relative interdependability of these characters.

MATERIAL AND METHODS

Diallel crosses were made with 15 diverse inbreds of pearl millet in all possible combinations excluding reciprocals. The 105 F_1's and 15 parents with one check (HB-3) were grown in a simple lattice design with four replications in three different environments viz., two different locations and two agronomic variables at the same location. These three environments are referred to as E I, E II and E III. The material was sown in one row plot of 4.5 m length and 45 cm apart. Data on five competitive plants were recorded in each replication under each environment. For days to heading, number of days were calculated from the date of sowing to date of emergence of the main head just across the whorl of the boot leaf. Similarly for maturity, total number of days were calculated from date of sowing to maturity of at least 80% heads on the plant, so that the plant is ready for harvest. Seed moisture was also measured

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with the help of seed moisture meter and maturity was considered as achieved when moisture per cent in the grain fell to 13.5 per cent.

Estimates of combining ability and genetic parameters were computed by method II, model 1 of Griffing (1956) and Hayman (1954), respectively. Unbiased estimates of general combining ability (σ^2g) and specific combining ability (σ^2_s) along with the ratio σ^2_s/σ^2_g were also estimated to know the relative magnitude of additive and non-additive genetic components.

RESULTS AND DISCUSSION

ANOVA (Table 1) indicated significant differences for both the characters over all environments in respect of different progenies including parents and F_1 hybrids. The variances due to general combining ability and specific combining ability were significant for days to heading and maturity in all the test environments (Table 2). It was concluded from the ratio σ^2_s/σ^2_g that both types of gene action were important but the latter played a greater role in all the environments. In fact, the combining ability variances are not the precise estimates of additive and dominance components of genetic variance, as otherwise obtained in case of variance component analysis of Hayman (1954) because these variances are not independent of non-allelic interaction. Thus, Hayman's diallel analysis was also conducted. It was found (Table 3) that both additive (D) and dominance (H_1) genetic components were significant for days to heading and maturity in all environments. The mean degree of dominance summed over all the loci $(H_1/D)^{1/2}$ in E I, E II and E III for the characters was of the order of over-dominance. Sometimes, this measure of dominance $(H_2/D)^{1/2}$ in the component analysis may not give reliable estimates because particular combination of positive and negative alleles or a gene distribution may seriously influence this ratio. So, in order to have the true picture, the ratio H_1/D was compared with σ^2_s/σ^2_g (Table 2) which showed high confirmity to each other. Similar results were also reported by Phul and Singh (1970), Gill *et al.* (1974) and Tyagi *et al.* (1975) for days

TABLE 1

Analysis of variance for the simple lattice design in respect of days to heading and maturity under different environments

Source of variation	d. f.	Mean squares					
		Days to heading			Days to maturity		
		E I	E II	E III	E I	E II	E III
Replications	3	41.17	4.10	53.40	11.10	2.97	11.90
Blocks	40	18 44*	4.07*	20.60*	5.28*	2.70*	7.88*
Genotypes	120	35.06*	44.44*	30.76*	41.75*	34.25*	23.10
Error	360	7.41	5.40	6.88	2.99	3.93	2.94

*Significant at P=0.05.

TABLE 2

Analysis of variance for general and specific combining ability in respect of parents and one set of diallel crosses (F_1's) for days to heading and maturity

Source of variation	d. f.	Mean squares					
		Days to heading			Days to maturity		
		E I	E II	E III	E I	E II	E III
General combining ability	14	21.60*	41.80*	17.72*	28.74*	25.70*	8.68*
Specific combining ability	105	7.46*	7.36*	5.90*	7.05*	6.51*	5.26*
Error	320	1.85	1.35	1.72	0.76	0.98	0.74
σ^2_S/σ^2_E		4.83	2.52	4.44	3.82	3.81	9.63
H_1/D		3.20	2.34	1.20	6.50	2.79	4.20

*Significant at P=0.05.

TABLE 3

Estimates of genetic components of variance for days to heading and maturity

Component of variation	Days to heading			Days to maturity		
	E I	E II	E III	E I	E II	E III
D	9.78 ±1.04	13.41 ±0.10	102.67 ±2.73	6.38 ±1.38	10.16 ±0.98	6.01 ±1.28
H_1	31.29 ±1.94	31.47 ±1.86	124.10 ±5.07	40.19 ±2.57	28.35 ±1.81	25.40 ±2.37
H_2	24.07 ±1.57	24.01 ±1.50	43.34 ±4.09	29.57 ±2.07	21.67 ±1.46	17.57 ±1.92
h^2	0.34 ±1.04	10.39 ±1.00	18.66 ±2.73	0.30 ±1.38	9.40 ±0.98	0.08 ±1.28
F	12.00 ±2.32	10.85 ±2.22	178.06 ±6.06	10.41 ±3.07	10.72 ±2.16	11.52 ±2.84
E	1.85 ±0.26	13.49 ±0.25	1.71 ±0.68	0.74 ±0.34	0.98 ±0.25	0.73 ±0.32
Degree of dominance	1.79	1.53	1.09	2.51	1.67	2.05
$H_2/4H_1$	0.19	0.19	0.09	0.18	0.19	0.17
$\frac{\sqrt{(4DH_1)^{1/2}+F}}{\sqrt{(4DH_1)^{1/2}-F}}$	2.04	1.72	8.46	1.96	1.92	2.74
h^2/H_2	—0.01	0.43	0.43	0.00	0.43	0.005
Heritability (n. s.)	26.81	34.01	18.46	16.30	32.03	26.34

to ear emergence. The ratio, $H_2/4H_1$ varied in the present material from 0.09 to 0.19, showing thereby, the asymmetrical distribution of dominant and recessive alleles, i. e., u=v among the parents. The present results in this regard were similar to those of Phul *et al.* (1970) for days to ear emergence.

The ratio $\sqrt{4DH_1}+F/\sqrt{4DH_1}-F$, ranged from 1.96 to 8.46, which probably implies that for every one recessive gene there were one to nine dominant alleles involved in the inheritance of these characters.

The low value of ratio h^2/H_2 for all the characters over all environments indicated that it might have been underestimated and as such, no valid interpretation about gene groups exhibiting dominance can be made.

The narrow sense heritability estimated according to Crumpacker and Allard (1962) differed from one environment to another because of substantial influence of genotype × environment interaction (Table 4) on the estimates of variance components. In the present study, heritability for days to heading ranged from about 18 to 34% over different environments and for maturity it ranged from about 16 to 32 per cent. These estimates, being low to moderate, emphasize the role of non-additive genetic variances. In the literature, reports regarding heritability estimates are found

TABLE 4

Pooled analysis of variance for days to heading and days to maturity in pearl millet

Character	Genotypes	Environment (L)	Genotypes × Environment (L)	Pooled deviation	Pooled error
Days to heading	20.48*	9147.59*	3.17*	3.99*	1.64
Days to maturity	13.56*	10178.57*	4.56*	6.48*	0.82

*Significant at P=0.05.

TABLE 5

Three best parents selected on the basis of *per se* performance, array means and gca effects

Characters	Rank	*Per se* performance	Array means	gca effects
Days to heading	I	H-38	H-38	H-38
	II	Senegal-8180	I. P.-2087	I. P.-2087
	III	H-789	J-104	J-104
Days to maturity	I	H-789	H-38	H-38
	II	J-104	J-104	J-104
	III	H-38	J-934	J-934

TABLE 2

Analysis of variance for general and specific combining ability in respect of parents and one set of diallel crosses (F_1's) for days to heading and maturity

Source of variation	d. f.	Mean squares					
		Days to heading			Days to maturity		
		E I	E II	E III	E I	E II	E III
General combining ability	14	21.60*	41.80*	17.72*	28.74*	25.70*	8.68*
Specific combining ability	105	7.46*	7.36*	5.90*	7.05*	6.51*	5.26*
Error	320	1.85	1.35	1.72	0.75	0.98	0.74
σ^2_S/σ^2_E		4.83	2.52	4.44	3.82	3.81	9.63
H_1/D		3.20	2.34	1.20	6.50	2.79	4.20

*Significant at P = 0.05.

TABLE 3

Estimates of genetic components of variance for days to heading and maturity

Component of variation	Days to heading			Days to maturity		
	E I	E II	E III	E I	E II	E III
D	9.78 ±1.04	13.41 ±0.10	102.67 ±2.73	6.38 ±1.38	10.16 ±0.98	6.01 ±1.28
H_1	31.29 ±1.94	31.47 ±1.86	124.10 ±5.07	40.19 ±2.57	28.35 ±1.81	25.40 ±2.37
H_2	24.07 ±1.57	24.01 ±1.50	43.34 ±4.09	29.57 ±2.07	21.67 ±1.46	17.57 ±1.92
h^2	0.34 ±1.04	10.39 ±1.00	18.66 ±2.73	0.30 ±1.38	9.40 ±0.98	0.08 ±1.28
F	12.00 ±2.32	10.85 ±2.22	178.06 ±6.06	10.41 ±3.07	10.72 ±2.16	11.52 ±2.84
E	1.85 ±0.26	13.49 ±0.25	1.71 ±0.68	0.74 ±0.34	0.98 ±0.25	0.73 ±0.32
Degree of dominance	1.79	1.53	1.09	2.51	1.67	2.05
$H_2/4H_1$	0.19	0.19	0.09	0.18	0.19	0.17
$\frac{\sqrt{(4DH_1)^{1/2}+F}}{\sqrt{(4DH_1)^{1/2}-F}}$	2.04	1.72	8.46	1.96	1.92	2.74
h^2/H_2	—0.01	0.43	0.43	0.00	0.43	0.005
Heritability (n. s.)	26.81	34.01	18.46	16.30	32.03	26.34

to ear emergence. The ratio, $H_2/4H_1$ varied in the present material from 0.09 to 0.19, showing thereby, the asymmetrical distribution of dominant and recessive alleles, i. e., u=v among the parents. The present results in this regard were similar to those of Phul *et al.* (1970) for days to ear emergence.

The ratio $\sqrt{4DH_1}+F/\sqrt{4DH_1}-F$, ranged from 1.96 to 8.46, which probably implies that for every one recessive gene there were one to nine dominant alleles involved in the inheritance of these characters.

The low value of ratio h^2/H_2 for all the characters over all environments indicated that it might have been underestimated and as such, no valid interpretation about gene groups exhibiting dominance can be made.

The narrow sense heritability estimated according to Crumpacker and Allard (1962) differed from one environment to another because of substantial influence of genotype × environment interaction (Table 4) on the estimates of variance components. In the present study, heritability for days to heading ranged from about 18 to 34% over different environments and for maturity it ranged from about 16 to 32 per cent. These estimates, being low to moderate, emphasize the role of non-additive genetic variances. In the literature, reports regarding heritability estimates are found

TABLE 4

Pooled analysis of variance for days to heading and days to maturity in pearl millet

Character	Genotypes	Environment (L)	Genotypes × Environment (L)	Pooled deviation	Pooled error
Days to heading	20.48*	9147.59*	3.17*	3.99*	1.64
Days to maturity	13.56*	10178.57*	4.56*	6.48*	0.82

*Significant at P=0.05.

TABLE 5

Three best parents selected on the basis of *per se* performance, array means and gca effects

Characters	Rank	*Per se* performance	Array means	gca effects
Days to heading	I	H-38	H-38	H-38
	II	Senegal-8180	I. P.-2087	I. P.-2087
	III	H-789	J-104	J-104
Days to maturity	I	H-789	H-38	H-38
	II	J-104	J-104	J-104
	III	H-38	J-934	J-934

to be highly variable (Phul, 1963; Gupta and Singh, 1967; Pokhariyal *et al.* 1967; Phul *et al.*, 1970); Singh, 1976.

A consideration of the general combining ability effects of the parental inbreds revealed that H 38, J 934 and J 104 were the most desirable parents in respect of earliness as they possessed consistently significant negative gca effects for days to heading under all the environments. As regards maturity, inbred J 104 was spotted out to be the best combiner as it also showed the significant negative gca estimates over all environments. As is evident from Table 5, the three top most good combiners, selected on the basis of their gca effects were the same as those selected on the basis of *per se* performance. Singh (1974) and Pethani (1976) came to the same conclusion in respect of pearl millet and showed that there existed a high positive correlation between the array means and general combining ability effects.

The results indicated that in pearl millet gene action for days to heading was in close confirmity with that for days to maturity.

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CORRELATIONS AND PATH ANALYSIS IN MUNGBEAN (*VIGNA RADIATA* (L.) WILCZEK)

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ABSTRACT

Yield was found to be positively associated with days to maturity, number of clusters per plant, number of pods per plant and number of grains per pod. The path analysis studies revealed that an ideal plant of mungbean should have higher number of clusters and pods per plant and grains per pod. Thus, the maximum weightage should be given to these characters, while formulating selection indices for the improvement of yield in mungbean.

Yield is dependent on several components which contribute both directly and indirectly. The magnitude and mode of contribution of each component character can be assessed through correlation and path analysis studies. After having this information, the breeding programme and the selection criteria can be directed to develop varieties which would not only be high yielding when sown as a pure crop but would also be suitable for intercropping. The present study, therefore, was undertaken to establish correlations, if any, among the quantitative characters, including the yield and also to find out the direct and indirect effects of yield components on yield through path analysis in mungbean.

MATERIAL AND METHODS

In the present study 10 parents and their 21 hybrids produced by crossing three males (K 851, PS 16 and H 70-16) to seven females (ML 1, ML 3, S 8, No. 239, CES 55, G 65 and P 426) were grown in a randomized complete block design with three replications. Each genotype was sown in a single row of 5m length, adopting a spacing between rows and plants within the row 50 and 10 cm, respectively. The observations in each genotype were recorded on five randomly selected plants on plant height (cm), days to maturity, number of clusters per plant, number of pods per cluster, number of pods per plant, pod length (cm), number of grains per pod, 100-grain weight (g) and yield per plant (g). Mean values of five plants for each treatment in each replication were used in the analysis of variance, covariance and finally computing correlations. Direct and indirect effects of various characters on seed yield were calculated according to the method given by DeWey and Lu (1959).

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TABLE 1

Genetic (above diagonal) and phenotypic (below diagonal) correlations among nine characters in mungbean

Characters	Plant height	Days to maturity	No. of clusters/plant	No. of pods/cluster	No. of pods/plant	Pod length	No. of grains/pod	100-grain weight	Yield/plant
Plant height	1.00	0.252	0.401	0.150	0.342	—0.098	0.425	—0.312	0.294
Days to maturity	0.217	1.00	0.432	0.066	0.454	0.016	0.410	0.181	0.418
No. of clusters/plant	0.368*	0.470**	1.00	0.148	0.971	—0.078	0.417	—0.277	0.864
No. of pods/cluster	—0.114	0.055	—0.057	1.00	0.253	—0.180	0.162	—0.043	0.290
No. of pods/plant	0.303	0.421*	0.914*	0.278	1.00	—0.122	0.358	0.270	0.902
Pod length	—0.197	0.012	—0.122	—0.062	0.155	1.00	0.215	0.894	0.204
No. of grains/pod	0.364*	0.369*	0.392*	—0.099	0.333	0.139	1.00	—0.207	0.455
100-grain weight	—0.298	0.176	—0.259	—0.042	0.264	0.755**	—0.201	1.00	—0.008
Yield/plant	0.268	0.363*	0 815**	0.145	0.847**	0.198	0.433*	—0.010	1.00

*,**Significant at 5% and 1%, respectively.

TABLE 2

Path coefficient analysis in mungbean on the basis of genotypic correlations

Characters	Plant height	Days to maturity	No. of clusters/plant	No. of pods/cluster	No. of pods/plant	Pod length	No. of grains/pod	100-grain weight	Genotypic correlations with yield
Plant height	**—0.1314**	—0.0005	0.3298	0.0296	0.0247	—0.0203	0.0356	0.0263	0.2938
Days to maturity	—0.0331	**—0.0020**	0.3553	0.0130	0.0328	0.0032	0.0343	0.0149	0.4184
No. of clusters/plant	—0.0527	—0.0009	**0.8226**	0.0292	0.0701	—0.0162	0.0349	—0.0230	0.8641
No. of pods/cluster	—0.0197	—0.0001	0.1217	**0.1972**	0.0183	—0.0373	0.0136	—0.0036	0.2091
No. of pods/plant	—0.0450	—0.0009	0.7987	0.0499	**—0.0722**	—0.0253	0.0299	0.0224	0.9019
Pod length	0.0128	—0.0000	—0.0642	—0.0355	—0.0088	**0.2074**	0.0180	0.0741	0.2035
No. of grains/pod	—0.0559	—0.0008	0.3430	0.0319	0.0258	0.0445	**0.0837**	—0.0172	0.4550
100-grain weight	—0.0417	—0.0004	—0.2280	—0.0085	0.0195	0.1853	—0.0173	**0.0829**	—0.0082

Residual effect=0.3559

(Figures in bold indicate direct effects)

RESULTS AND DISCUSSION

Correlations

The correlation coefficients among nine characters under study were estimated at phenotypic and genotypic levels and are given in Table 1. In almost all the cases the genotypic correlations were found higher than the phenotypic correlations. This suggested that the environmental factors were responsible for suppressing the expression of genotypic correlations. On this basis genotypic correlations have been discussed in detail.

Seed yield was found to have significant positive correlation with number of clusters per plant, number of pods per plant, number of grains per pod, and days to maturity. The findings are in conformity with those reported by Ramanujam (1975) in pulse crops. On the other hand, yield had negative but non-significant association with grain weight. Khan (1949), Chandra (1960) and Athwal and Sandha (1967) in gram and Malhotra *et al.* (1972) in soybean have also reported negative association of yield with grain weight. The highest positive association of grain weight with pod length and negative association with number of grains per pod revealed that the varieties having bold seeds tend to possess long pods but would be filled with a few seeds. Pod length was strongly associated with 100-grain weight and grains per pod. This is in conformity with the observations of Giriraj and Vijay Kumar (1974) in mungbean. Number of pods per plant was strongly and positively correlated with yield, plant height, days to maturity number of clusters per plant, number of pods per cluster and grains per pod. It appears that delay in maturity might result in increase in plant height and total number of flowers and pod set and consequently the high yield. Giriraj and Vijay Kumar (1974) have also drawn the similar conclusions.

Path Analysis

Path coefficient analysis was done to estimate direct and indirect effects of all the characters on yield by partitioning genotypic correlations (Table 2).

The number of clusters per plant, number of pods per cluster and pod length were found to have positive and direct effects on yield. The number of pods per plant and number of grains per pod had also very high positive direct effect on yield. However, their positive effect was dissipated by very high negative indirect effect via height. On the other hand, plant height and days to maturity had negative direct effect on yield. However, their contribution to yield, if any, was mainly through number of clusters and pods and grains per pod. Except the indirect effect of pod length with plant height, all other characters exhibited negative indirect effects via plant height and days to maturity. Therefore, maximum weightage should be given to main yield components like number of clusters and pods per plant and grains per pod while formulating selection indices for yield in mungbean.

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STUDIES ON FLOWERING AND SEX RATIO IN SOME BER (*ZIZYPHUS MAURITIANA* LAMK.) CULTIVARS

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ABSTRACT

During the studies of flowering habit in different ber cultivars viz., Gola Gurgaon, Muria, Kaithli, Chhuhara and Umran, during 1974-76, inflorescence, in general, was found as axillary cyme. The flowering period was from 3rd week of September to the end of November. Umran had the highest percentage of hermaphrodite flowers (22.22%) while the lowest was recorded in 'Chhuhara' (13.60%). During the early part of flowering season, percentage of hermaphrodite flowers remained low which increased with the advancement of the season.

For a successful systematic crop improvement, it is essential to study the flowering behaviour of a particular crop. It is a pre-requisite to any hybridization programme as it provides useful information and helps in synchronizing the periods of anthesis, dehiscence, etc. among the cultivars/species to be used as parents. Keeping this in view, studies were undertaken on the flowering habit, flowering season and sex ratio in five potential-parent cultivars of ber.

MATERIAL AND METHODS

The studies were carried out at Regional Research Station of Haryana Agricultural University at Gurgaon during the years 1974-76. Three uniform healthy trees of each cultivar namely Gola Gurgaon, Muria, Kaithli, Chhuhara and Umran were earmarked. Ten, well scattered shoots on each tree were tagged for recording different observations.

Flowering habit was determined by ascertaining whether the flowers were borne in the axil of the leaf or terminally as solitary or in clusters. Period of flowering was recorded from the emergence of first bloom to the time when bloom stopped. About 100 flowers per shoot were closely observed and were classified as male and hermaphrodite. The data recorded during 1974, 1975 and 1976 were pooled and analysed statistically.

RESULTS AND DISCUSSION

Flowering Habit

The flowers in all the cultivars studied, were borne in clusters in the axil of leaves. Flowering was more profuse on mature wood as compared to current season growth. The inflorescence was axillary cyme in all the cultivars. The number of flowers per cluster ranged between 10 to 22. The flowers on lower portion of the branch were first to open

and progressed towards apex. The central flowers within the cluster opened earlier while those around the edges opened later. These observations are in conformity with the earlier reports from Uttar Pradesh (Teotia and Chauhan, 1963; Yamdagni *et al.*, 1967) showing thereby the negligible effect of season on these attributes.

Time and Duration of Flowering

Vegetative growth in all the cultivars studied, started by the first week of July and continued upto November. The flowering started in the 3rd week of September in Umran and Muria while in other cultivars it started in 4th week of September. Likewise, flowering was completed by the 3rd week of November in all the cultivars except in Kaithli where it continued up to the end of November. The maximum duration of flowering was recorded in Umran, followed by Chhuhara, Kaithli and Gola Gurgaon (Table 1).

An early cultivar Gola Gurgaon and late ripening Umran had the minimum and maximum duration of flowering, respectively. The critical perusal of data clearly indicated that the period of flowering in all the five cultivars was overlapping each other. Thus, any two of these can successfully be used as parents in a hybridization programme.

Sex Ratio

Two types of flowers were observed in ber, i. e., male and hermaphrodite. The stamens were well developed with rudimentary style in male flowers while in hermaphrodite both the style and stigma were well developed. The data in Table 1 clearly indicated that the male flowers constituted the major portion of flowers in ber. Percentage of hermaphrodite flowers was more than 20% in Gola Gurgaon and Umran while it was as low as 13.60% in Chhuhara and this may be

TABLE 1

Period, duration of flowering and sex ratio in different ber cultivars (1974-76)

S. No.	Variety	Date of first bloom	Date when flowering stopped	Duration of flowering in days	Male flowers (%)	Hermaphrodite flowers (%)
1.	Gola Gurgaon	Sep. 29	Nov. 17	50	79.85	20,15
2.	Muria	Sep. 19	Nov. 13	52	83.33	16.67
3.	Kaithli	Sep. 27	Nov. 30	55	81.36	18.64
4.	Chhuhara	Sep. 21	Nov. 17	58	86.40	13.60
5.	Umran	Sep. 17	Nov. 18	63	77.78	22.22

TABLE 2

Sex expression as influenced by season in Gola Gurgaon cultivar (1974-76)

Observation period	Male flowers (%)	Hermaphrodite flowers (%)
Sep. to Mid Oct.	91.11	8.89
Mid Oct. to Nov.	28.81	71.19
Mean	59.96	40.04

the important factor for better yield in these two cultivars. The prevailing season during the flowering period affected the sex ratio. The data in Table 2 clearly indicated that more than 90% of the flowers upto the middle of October were male and with the advancement of season, percentage of hermaphrodite flowers increased. Similarly, Singh *et al.* (1970) also found increased hermaphrodite flowers with the advancement in season. On an average, it was 71.19% from middle October to November. This clearly showed the effect of atmospheric factors especially temperature on the sex ratio as with the advancement of season, temperature decreases under northern Indian conditions where these studies were carried out. Therefore, the bloom coming after the middle of October may result in better fruit set and hybridization work should be carried out during this period.

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CONTROLLING POST-HARVEST DECAY OF MUSKMELON FRUITS BY COATING WAX-EMULSION AND FUNGICIDES

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ABSTRACT

The influence of different coatings on muskmelon fruit with wax emulsion and fungicides alone and in combination was studied. Coating the fruits with Thiabendazole and Roveral tended to decrease the decay loss over non-treated fruits. The addition of Waxol-0-12 to 500 μg/ml Thiabendazole increased the storage life of fruits by reducing the decay upto 6 days after storage. Coating of Waxol-0-12 alone was not effective in reducing the decay loss over control. Much of the decay was caused by *Thielaviopsis paradoxa* (de Seynes) Hoehn and *Trichothecium roseum* Link.

Considerable quantity of muskmelon fruits (*Cucumis melo* L.) is lost due to fungal decay during the process of harvesting, packing, transportation and marketing. Weekly observations of post-harvest in laboratory and principal fruit market of Hissar in 1978-79, showed that nearly 20.5% of muskmelon fruits decay due to the association of several fungi. The extent of rotting warranted for devising suitable control measures to save the muskmelon fruits from fungal decay. An attempt, therefore, has been made to test the efficacy of two fungicides and wax-emulsion alone and in combination, for controlling various rots of muskmelon.

MATERIAL AND METHODS

Fresh and fully ripe muskmelon fruits of cv. Hara Madhu were coated with chemicals or washed with water by dipping for 2 min and allowed to dry for 2 h. Three cartons of fruits (4 kg per carton) were used per treatment and placed in a storage room (38±4°C).

Coating of fruits was done with wax emulsion Waxol-0-12 and fungicides viz., 500 ppm Thiabendazol and Roveral [Glycophene{1-isopropyl acarbamoyl-3-(3, 5 dicholorophenyl) hydantion}] with Waxol. The treated fruits were packed in vented cardboard cartons and placed in a storage room along with water dipped (control) fruits.

Observations for disease development were taken after 3 and 6 days of storage. The decay loss (%) was measured by the diameter of the lesions as suggested by Ogawa *et al.* (1963). Decaying fruits were taken out from each pack and the

organisms were isolated by standard methods (Riker and Riker, 1936).

RESULTS AND DISCUSSION

Thiabendazole and Thiabendazole+Waxol-0-12 protected the fruits for 3 days without developing any rotting (Table 1). Similar observations in controlling *Penicillium* rot of citrus have also been made by coating them with Thiabendazole and Thiabendazole+Wax-emulsion by Harding and Schade (1967). Roveral and Waxol-0-12+Roveral were ranked second and third, respectively, in order of their efficacy as protectants. These observations are similar to those reported by Singh and Gupta (1979). According to their findings Roveral alone or in combination with Waxol-0-12 protected the citrus fruits for the maximum period even after storage of 42 days. The fruits coated with Waxol-0-12 before storage tend to increase the loss significantly over fungicidal treated fruits. However, Singh *et al.* (1982) found that Waxol-0-12 emulsion retained the quality (total soluble solids and ascorbic acid) of muskmelon fruits for a longer period. This increase in the storage life due to Waxol-0-12 coated fruits appears to be physiological instead of any fungicidal effect (Pelser, 1975; Salih and Cengiz, 1976). The Waxol-0-12, a wax-emulsion seemed to be non-effective in arresting the decay of the fruits. But when it was used as emulsifier with fungicides the decay was reduced significantly even upto 6 days of storage.

Thielaviopsis paradoxa (de Seynes) Hoehn and *Trichothecium roseum* Link. were isolated more frequently (Table 2) in all the coated fruits and control (tap water) after 6 days of storage. The second group of fungi associated with muskmelon fruits on the basis of frequency of occurrence was *Fusarium semitectum* Berkeley and Ravenel. These two groups of fungi jointly caused a major decay of muskmelon fruits. The fungi which were isolated only occasionally in control and Waxol-0-12 treatments were *Aspergillus niger* Van. Tieghem and *Fusarium roseum* Link. ex Fries.

TABLE 1

Efficacy of different chemicals on muskmelon fruits affecting decay loss (%) during storage

Treatment	Days of storage	
	3	6
Control	5.37 (2.43)	69.85 (8.40)
Waxol-0-12	5.23 (2.42)	64.13 (8.04)
Thiabendazole	0.00 (1.00)	7.75 (2.87)
Roveral	0.57 (1.11)	13 73 (3.19)
Waxol-0-12+Thiabendazole	0 00 (1.00)	11.13 (3.35)
Waxol-0-12+Roveral	1.88 (1.69)	24.75 (4.91)
C. D. at 5%	0.65	1.46

Values in parentheses are transformed values of $\sqrt{n+1}$

TABLE 2

Fungi associated with decay of muskmelon fruits during storage

Fungi	Frequency of occurrence of fungi in different chemical coatings					
	Tap water	Waxol-0-12	Thiabenda-zole	Roveral	Waxol-0-12+Thia-bendazole	Waxol-0-12+Rove-ral
Aspergillus niger	+	+++	—	—	—	—
Thielaviopsis paradoxa	+++	+++	+	++	++	++
Fusarium roseum	+	—	—	—	—	—
Fusarium semitectum	++	+	—	+	—	+
Trichothecium roseum	+++	++	+	+	+	++

—=Nil; +=less common; ++=common; +++=very common.

Fungi, *Thielaviopsis paradoxa*, *Fusarium semitectum*, *Aspergillus niger* and *Trichothecium roseum* have already been reported in fruits by Rao (1964), Rao and Subramanium (1975) and Waraitch and Nandpuri (1975). Fruit rot caused by *Fusarium roseum* happened to be the first report on this host.

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YIELD LOSSES CAUSED BY THE APHID, *RHOPALOSIPHUM MAIDIS* (FITCH.) IN DIFFERENT VARIETIES/STRAINS OF BARLEY CROP

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ABSTRACT

Avoidable yield losses caused by the aphid, *Rhopalosiphum maidis* (Fitch.) in the barley varieties/strains, C 164, Wocus, EB 921, BP 462, BG 25, BG 105 and BG 108 were determined. The percentage of these losses varied from 2.3 (Wocus) to 17.1 (BG 105 and BG 108). The corresponding figures for EB 921, BP 462, C 164 and BG 25 were 3.4, 6.3, 13.4 and 16.9, respectively. Irrespective of the variety, the crop under protected condition (sprayed twice with 0.025% oxydemeton methyl) gave 10.9% higher yield than the unprotected crop. The mean avoidable loss in the recommended varieties worked out to 15.8 per cent.

Barley (*Hordeum vulgare* L.) occupies an important place amongst rabi cereals. This crop can be successfully grown in irrigated and unirrigated conditions, in areas of low fertility and in soils with problem of salinity and alkalinity. Even with low inputs it gives substantial economic returns. Of the various insect pests infesting this crop, the aphid, *Rhopalosiphum maidis* (Fitch.) (Hemiptera : Aphididae) is the most serious and often a limiting factor in the successful cultivation of this crop. It was, therefore, considered necessary to work out the yield losses caused by this pest in promising aphid resistant and recommended barley varieties under agroclimatic conditions of Hissar.

MATERIAL AND METHODS

The studies were conducted during the year 1978-79 at Haryana Agricultural University, Hissar. Seven barley entries viz., C 164, BG 25, BG 105, BG 108, EB 921, Wocus and BP 462 were sown on 19th November, 1978. All the recommended agronomic practices (Anonymous, 1978) were adopted to raise the crop. Each entry was replicated six times following the paired plot technique (Lecleng, 1971). Thus, for each entry there were 12 plots (6 pairs), each measuring 6×2.5 m (8 rows at a distance of 30 cm). Natural infestation of the aphid started during the first week at February. From every pair one random plot was kept unsprayed and the other was sprayed with 0.025% oxydemeton methyl on 2nd and 19th February 1979 (when the crop was 86 and 103 days old). The crop in each plot was harvested separately and the grain yield recorded. The yield data was analysed by paired 't' test method and the differences

were compared at 5% level of significance.

RESULTS AND DISCUSSION

The grain yield was always higher (4.4 to 8.2 kg/plot) under insecticide sprayed than under unsprayed (4.3 to 7.1 kg/plot) conditions. For the seven entries, the percentage avoidable losses varied from 2.3 to 17.1 being lowest in Wocus and highest in BG 105 and BG 108. Such values for the remaining entries, EB 921, BP 462, C 164 and BG 25, were 3.4, 6.3, 13.4 and 16.9, respectively. Irrespective of the variety, the crop under protected condition gave 10.9 % higher yield than under unprotected condition. The mean losses in the recommended barley varieties were worked out to 15.8% (Table 1).

Earlier workers have given quite diverse figures for the losses caused by *R. maidis* in the barley crop. These figures varied from 30 to 100 (Murty *et al*, 1968), 14.27 to 26.0 (Bhatia *et al*., 1973) and 2.1 to 67.5 (Bhatia and Singh, 1977) per cent.

As in present studies, Bhatia and Singh (1977) also observed the highest losses (67.5 %) in the variety BG 108. One of the reasons for relatively lower yield losses (17.1 %) in this variety in the present studies could be the optimal sowing time of the crop, the aphid infestation being more under late sown conditions.

ACKNOWLEDGEMENT

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TABLE 1

Avoidable losses by *R. maidis* in different barley entries

Barley entry	Mean grain yield (kg)/plot*		't' test	Avoidable yield loss (%)
	Protected condition**	Unprotected condition		
Recommended varieties				
C 164	8.2	7.1	Sig.	13.4
BG 25	7.7	6.4	Sig.	16.9
BG 105	7.6	6.3	Sig.	17.1
BG 108	7.6	6.3	Sig.	17.1
Promising aphid resistant strains				
EB 921	5.9	5.7	Sig.	3.4
Wocus	4.4	4.5	Sig.	2.3
BP 462	6.4	6.0	Sig.	6.3
Mean	6.8	6.0		10.9

*6 × 2.5 m

**Crop was sprayed twice with 0.025% oxydemeton methyl.

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EFFECT OF PLANT DENSITY AND SOWING TIME ON NITROGEN UPTAKE, YIELD AND YIELD ATTRIBUTING CHARACTERS OF HYBRID PEARL MILLET

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ABSTRACT

Maximum grain yield was obtained from the crop sown on 15th July with a significant reduction with each delayed sowing on 30th July and 15th and 30th August. Normal sown crop produced significantly taller plants with higher number of tillers, long ear-heads full of bold and heavy grains. Hybrid BJ-104 gave significantly higher grain yield and higher yield attributes except plant height over hybrid PHB-14. Yield and yield attributing characters were not much affected by planting density. With late sowing, reduction in grain yield was more with PHB-14 as compared to BJ-104. Total uptake of nitrogen by plants was decreased with delayed sowing, and by hybrids and plants population leavels remained unaffected during both the years. In 1976, higher grain yield was obtained as compared to 1977, owing to more favourable weather conditions.

Pearl millet (*Pennisetum americanum* (L.) K. Schum) is one of the major dual purpose grain and fodder crop of India, in general, and of Haryana State, in particular. It provides cheap staple food and comparatively more nutrients for poor masses, poultry birds, and dry and green fodder for the cattle. Among the various crops, hybrid bajra is the most efficient crop from the point of view of productivity and more total dry matter and grain yield per unit area and per unit time. In about 75 days, the crop is ready for harvesting with yield potential of 40 q/ha or more. Wherever bajra is grown, both human beings and cattle are comparatively hardier and healthier than their counterparts from rice and wheat growing areas. BJ-104 and PHB-14 are the promising cultivars. PHB-14 is shy in tillering as compared to BJ-104 and may require higher plant population than recommended one which is about 175,000 plants per hectare. In Haryana, yields are reduced to a great extent under late sown conditions due to poor grain setting because of low temperature at the time of grain setting (Tomer *et al.*, 1974). Sometimes sowing is delayed on account of late onset of monsoon and sometimes the crop fails to germinate with proper stand due to excess of rainfall.

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MATERIAL AND METHODS

Keeping in view the aforesaid objective, an investigation was conducted during **kharif** seasons of 1976 and 1977 at the Agronomy Farm of Haryana Agricultural University, Hissar. Three dates of sowing starting with normal (15th July) with two weeks interval; two hybrids viz., BJ-104 and PHB-14; with three planting densities, i.e., 330,000, 250,000 and 200,000 plants per hectare were tried in split plot design with four replications. Combination of sowing dates and hybrids were kept in the main plots and plant population in sub-plots. In 1976, due to lack of rainfall the third date of sowing was delayed till the end of August instead of second week of August in 1977. After 20 days of sowing, about 10 cm plant to plant distance was maintained. Phosphorus at the rate of 60 kg P_2O_5/ha through single super phosphate was drilled at the sowing time. Nitrogen at the rate of 80 kg/ha through urea (46%) was applied in three splits, 40 kg at sowing time, 20 kg at knee-high stage and 20 kg at earing stage. The soil of the experimental field was sandy loam in texture, poor in nitrogen, medium in phosphorus and high in potash and was slightly alkaline in reaction. The pre-sowing irrigation was not applied as adequate moisture was available due to timely rainfall. In late sown crop three irrigations during 1976 and two irrigations during 1977 were given.

RESULTS AND DISCUSSION

Perusal of grain yield data in Table 1 shows a significant reduction in yield with delay in sowing in both the years. The reduction in yield was 54.3 and 31 kg per hectare per day with six weeks and four weeks delayed sowing during 1976 and 1977, respectively. Hybrid BJ-104 gave significantly higher grain yield over that of PHB-14, however, both the hybrids were at par in stover production.

A reduction in plant height was observed. The variation in height due to hybrid and levels of plant population was not well marked upto harvest. Hybrid PHB-14 plants were taller than BJ-104 plants during both the years. It was noted that number of tillers was slightly decreased with each delayed sown condition upto 45th day, thereafter the variations were narrowed and non-significant. Hybrid BJ-104 produced more tillers at all the stages of crop growth as compared to PHB-14. The plant population treatments exerted marked influence in tiller production and a consistent increase in tiller number was recorded with corresponding decrease in plant population. Number of ears was not affected by date of sowing while length of ear was significantly decreased with late sown conditions. Low plant population produced significantly more number of ears per plant than higher level, however, length of ear was not affected much by plant population levels. Hybrid BJ-104 produced significantly higher number of ears per plant and lengthy ears as compared to PHB-14 during both the years. The variation in test weight brought about by hybrids and plant population levels was small and non-significant. Only during 1976, normal and two weeks late sown crop produced the grains of heavier weight than six weeks late sown

TABLE 1

Yield, yield attributes and nitrogen uptake of pearl millet as affected by different treatments

Treatments	Grain yield (q/ha)		Plant height (cm)		Number of tillers per plant		Number of ears per plant		Length of ear (cm)		1000-grain weight (g)		Grain yield per plant (g)		Total nitrogen uptake (kg/ha)	
	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977
Date of sowing																
Normal	26.4	24.4	198.3	201.2	2.21	2.16	1.3	1.3	27.2	26.4	6.7	6.6	23.7	22.2	46.9	43.7
2 weeks late	23.5	21.7	169.4	184.6	2.08	2.03	1.2	1.3	25.2	24.6	6.9	6.7	19.7	18.6	38.5	38.1
6/4 weeks late	3.6	8.3	152.1	168.5	2.96	2.44	1.2	1.3	24.2	21.9	6.1	6 3	8.0	12.5	8.2	21.4
s. e. m. ±	0.5	0.84	3.8	4.9	0.34	0.27	0.03	0.04	0.54	0.47	0.17	0.2	1.2	1.7	1.1	1.8
C. D. at 5%	1.6	2.54	11.6	14.94	NS	NS	NS	NS	1.6	1.4	0.52	NS	3.8	5.2	3.5	5.5
Hybrids																
BJ-104	19.0	18.2	172.3	178.2	2.83	2.61	1.3	1.3	20.6	21.5	6.4	6.5	17.4	16.9	31.5	30.2
PHB-14	16.6	15.9	174.3	185.1	2.00	2.04	1.2	1.2	30.5	31.4	6.7	6.6	17.0	16.3	30.9	28.5
s. e. m. ±	0.4	0.34	3.1	3.9	0.28	0.31	0.02	0.02	0.43	0.51	0.14	0.17	1.0	0.97	0.9	1.2
C. D. at 5%	1.3	1.04	NS	NS	NS	NS	0.07	0.07	1.3	1.6	NS	NS	NS	NS	NS	NS
Plant population																
330,000 plants/ha	18.4	17.5	177.5	186.0	1.83	1.71	1.2	1.2	25.4	23 8	6.6	6.5	18.0	17.7	32.4	31.8
250,000 plants/ha	17.6	16.8	170.8	181.5	2.29	2.13	1.2	1.3	25.4	24.2	6.6	6.5	17.2	17.0	30.9	29.8
200,000 plants/ha	17.4	16.7	171.4	178.4	3.12	2.98	1.3	1.3	25.8	24.5	6.6	6.5	16.2	15.9	30.3	30.5
s. e. m. ±	0.6	0.55	2.8	3.1	0.18	0.16	0.01	0.02	0.47	0.39	0.12	0.11	0.8	0.73	1.2	1.3
C. D. at 5%	NS	NS	NS	NS	0.53	0 49	0.05	0.07	NS	NS	NS	NS	NS	NS	NS	NS

TABLE 2

Effect of dates of sowing and hybrids on grain yield (q/ha)

Treatments	1976-77		1977-78	
	BJ-104	PHB-14	BJ-104	PHB-14
Normal	26.8	26.0	24.3	23.5
2 weeks late	25.9	21.1	22.8	19.3
6/4 weeks late	4.3	2.8	8.1	6.4
s. e. m. ±	0.76		0.93	
C. D. at 5%	2.30		2.84	

crop, whereas it was lower with BJ-104 as compared to PHB-14. Grain yield per plant decreased significantly with each delay in sowing, whereas it was not affected significantly by hybrids and plant population during both the years. These findings corroborated with the findings of Anjla (1967).

Total nitrogen uptake was significantly reduced with each delayed sowing. However, the uptake of nitrogen by hybrids and plant population was found non-significant, although, BJ-104 possessed slightly higher nitrogen content as compared to PHB-14.

Interaction

It is interesting to note that under late sown conditions the reduction in grain yield was more with PHB-14 as compared to BJ-104.

During 1976, with two weeks delay in sowing, the reduction was 4.9 and 0.9 q/ha, whereas with six weeks delay in sowing reduction was 23.2 and 22.5 q/ha with PHB-14 and BJ-104, respectively (Table 2). While during 1977 with two weeks delayed conditions, the yield reduction was 4.2 and 1.5 q/ha, whereas with four weeks delay, the reduction was 17.1 and 16.2 q/ha with PHB-14 and BJ-104, respectively. During both the years grain production was not affected by plant population levels. In 1976, higher grain yield was obtained as compared to 1977. This is because of higher yield attributes during 1976 as compared to 1977. Similar results were observed by Tomer *et al.* (1974) and Bhardwaj *et al.* (1971).

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RESEARCH NOTE

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STUDIES ON INHERITANCE OF APHID RESISTANCE IN BARLEY

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The corn leaf aphid, *Rhopalosiphum maidis* (Fitch.), is the major insect pest of barley in Haryana and often proves a limiting factor in the successful cultivation of this crop. The loss caused to the barley crop by this pest has been reported to vary from 30 to 100% (Murty *et al.*, 1968), 14.27 to 26.0% (Bhatia *et al.*, 1971), 2.8 to 67.5% (Bhatia and Singh, 1977) and 2.3 to 17.1% (Chhillar and Verma, 1982). As barley is grown mostly under low input conditions the use of insecticides, primarily because of high cost, does not find favour with the cultivators. The solution, therefore, lies in developing aphid resistant barley varieties. The present studies were, therefore, undertaken to study the mode of inheritance of resistance in barley to this aphid.

A total of 13 resistant and susceptible barley entries, reported earlier (Table 1), were sown on 29th November, 1976. Each entry was sown in four rows of one meter length. Three types of crosses viz., resistant × resistant, resistant × susceptible and susceptible × susceptible were made. Ear heads of each of these crosses were harvested separately at the maturity and the seeds of different crosses were kept in separate paper bags for use during next year. During 1977-78, the seeds of F_1 population of each cross were sown on 26th November, 1977 in four rows of one metre length with one line of one parent on one side and the other parent on the other side. Observations on the susceptibility of *R. maidis* were recorded when the crop was 65, 76 and 87 days old. First observation was recorded after 65 days because after 65 days enough aphid population appeared.

For recording the observations, the following six categories were made:

S_0—presence of winged adults but no nymphs;

S_1—winged adults plus few nymphs, colonies not developed;

S_2—very small colonies present;

S_3—conspicuous colonies only inside leaf whorls;

S_4—well developed colonies covering about 75% of the central leaf;

S_5—well developed colonies covering central leaf as well as other leaves.

There were 3 observations for F_1 population of each cross, and the mean

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TABLE 1

Ratings for susceptibility to *R. maidis* of F_1 populations of barley derived in a crossing programme

Crosses	Reaction of *R. maidis* (days after sowing)			Mean rating for susceptibility
	65	76	87	
(a) Resistant × Resistant				
EB 921 × Wocus	S_0	S_0	S_0	S_0
BP 462 × Wocus	S_0	S_1	S_1	S_0 to S_1
BP 464 × Wocus	S_0	S_0	S_0	S_0
BP 456 × Wocus	S_0	S_0	S_0	S_0
BP 454 × EB 921	S_0	S_0	S_0	S_0
BP 454 × BP 464	S_0	S_1	S_1	S_0 to S_1
BP 464 × BP 462	S_1	S_1	S_1	S_1
(b) Resistant × Susceptible				
EB 921 × C 164	S_1	S_1	S_1	S_1
Jyoti × EB 921	S_1	S_1	S_1	S_1
EB 921 × RD 103	S_0	S_1	S_1	S_0 to S_1
Ratna × Wocus	S_1	S_1	S_1	S_1
BG 25 × Wocus	S_1	S_1	S_1	S_1
BP 462 × RD 103	S_0	S_1	S_1	S_0 to S_1
BP 462 × Jyoti	S_1	S_1	S_1	S_1
BG 25 × BP 462	S_1	S_1	S_1	S_1
(c) Susceptible × Susceptible				
Ratna × Hiproly	S_5	S_5	S_5	S_5
Ratna × Jyoti	S_5	S_5	S_5	S_5
Ratna × C 164	S_5	S_5	S_5	S_5
Ratna × BG 25	S_5	S_5	S_5	S_5
K 125 × BG 25	S_4	S_5	S_5	S_4 to S_5
K 125 × Jyoti	S_5	S_5	S_5	S_5
C 164 × BG 25	S_5	S_5	S_5	S_5
C 164 × Hiproly	S_5	S_5	S_5	S_5
Dierella 102 × C 164	S_5	S_5	S_5	S_5
Jyoti × C 164	S_5	S_5	S_5	S_5
Hiproly × BG 25	S_5	S_5	S_5	S_5
BG 25 × Jyoti	S_5	S_5	S_5	S_5

susceptibility rating was based on 3 observations. In evaluating a population, the values of 0, 1, 2, 3, 4 and 5 were assigned, respectively, for the ratings S_0, S_1, S_2, S_3, S_4 and S_5. These values, for all the 3 observations were added and their mean worked out. If the mean value was found to be 0, its category was deemed to be S_0, and if the mean value was found to vary between 0 to 1.0 its category was deemed to be between S_0 and S_1. Likewise, for the mean values ranging between 1.1-2.0, 2.1-3.0, 3.1-4.0 and 4.1-5.0, the susceptibility categories were S_1-S_2, S_2-S_3, S_3-S_4 and S_4-S_5, respectively.

The data in Table 1 clearly show that F_1 barley population derived by crossing aphid-resistant line with aphid resistant and susceptible line was resistant to the aphid. The population derived by crossing two susceptible entries was found to be susceptible. It clearly indicates that the aphid resistance in barley is of dominant type. These findings are in confirmity with the findings of Bhatia and Singh (1977) and Gill and Metcalfe (1977). Dayani and Bakshi (1978) and Gulati *et al.* (1978) reported dominance for susceptibility.

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SALT TOLERANCE IN CHILLI (*CAPSICUM ANNUUM* L.) VARIETY NP-46A

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Salinity is a general problem in several arid and semi-arid regions of the world. It may further increase due to frequent use of brackish ground water and continuous rising of water table. The tendency to intensify land use by increasing the number of crops also increases the amount of irrigation water applied annually, thus, further accelerating salt accumulation in the soil even if the water quality is good to medium. A general suppression of growth is probably the most common plant response to salinity due to the presence of excessive soluble salts in the root zone. Na and Cl are among the more common ions found in excess in saline soils and some plant species are specifically sensitive to one or both of these ions (Bernstein and Hayward, 1958). Most of the vegetable crops are highly sensitive to salinity and their growth, yield and quality are affected adversely. Chilli is an important vegetable crop grown commercially in arid and semi-arid areas. It performs poorly on saline soils. Therefore, the present investigation was attempted to work out the safe limit of salinity level for the cultivation of chilli.

Six artificial salinity levels (0, 2, 4, 6, 8 and 10 mmhos/cm) were developed by adding equal quantities of calculated amount of mixture of NaCl, $CaCl_2$ and $MgCl_2$. The soil was drenched with calculated amount of salt solutions and left for five days for homogenous stabilisation of salts. Thereafter, the salt treated soils were thoroughly mixed several times and filled into cement pots (45^3 cm). The basic analysis of the soil and the actual salinity levels recorded during the experimental period are presented in Table 1. Two seedlings of chilli variety NP-46A were transplanted in third week of July in each pot during 1976, 1977 and 1978. Two pots per treatment were considered one replication and the experiment was replicated four times in completely randomized block design. One hundred mililitre of complete nutrient solution was applied five times, at an interval of 15 days. The plants were irrigated with canal water (ECe 0.25 mmhos/cm). The data were recorded on survival, growth and yield characters. The determination of N, P, K, Ca, Mg and Cl of leaves were made on dry weight basis (Richards, 1951). The chlorophyll a and b of fresh leaves were estimated by Maclachlan and Zalik (1963).

Data recorded on survival percentage (Table 2) showed that there was no

TABLE 1

Basic analysis of soil and salinity levels of the saturation extract from various salinized soils (average of three years)

A: Basic analysis of the soil

		Mechanical analysis
(a)	Sand (%)	82.6
(b)	Silt (%)	9.9
(c)	Loam (%)	6.6
(d)	Soil texture	Loamy sand
		Chemical composition
(a)	Organic carbon (%)	0.06
(b)	Available N (kg/ha)	164.4
(c)	Available P (kg/ha)	22.6
(d)	Available K (kg/ha)	219.8
(e)	Saturation (%)	26.0
(f)	pH (1 : 2 suspension)	8.1
(g)	ECe (mmhos/cm)	0.8
(h)	Cation exchange capacity (me/100 g)	4.6

B: Soil salinity levels in mmhos/cm

Desired	At transplanting time	At flowering time	At the end of experiment
0	0.8	0.9	0.9
2	2.0	2.0	2.1
4	3.9	4.0	4.1
6	6.0	6.1	6.2
8	8.1	8.1	8.2
10	10.1	10.1	10.2

effect of salt upto 4 mmhos/cm, but above this level there was progressive decreasing trend and the differences were significant. At ECe 10 mmhos/cm, the survival percentage was reduced to 25 per cent. Plant mortality at higher salinity levels may be due to the presence of Na and Cl ions in excess in the root zone which caused osmotic effect and disturbed the metabolic processes of plant (Bernstein and Hayward, 1958). Effect of salinity on seedling development may be both toxic and osmotic as reported by Prisco and O'leary (1970). Similar findings have been reported by Kaliappan and Rajagopal (1970). Height of plant and number of branches per plant also decreased significantly above 4.0 mmhos/cm. This may be due to the presence of harmful ions in excess which caused the physiological scarcity of water in root zone (Ayers and Eberhard, 1960)

TABLE 2

Effect of salinity levels on growth, yield and chemical composition of chilli (average of three years)

Characters	Salt concentration (E.C. mmhos/cm)						C. D. at
	Control	2	4	6	8	10	5%
Survival (%)	100	100	100	66.67	41.70	25 00	16.27
Height of plant (cm)	46.36	49.52	45.83	39.58	31.56	26.82	5 63
No. of secondary branches/ plant	10.43	11.00	9.97	6.72	5.81	2.45	0.88
Days to flower	68	69	61	66	71	74	3.12
No. of fruits/plant	121.47	130.26	116.86	86.14	58.26	42.38	11.96
Length of fruit (cm)	7.70	7.82	7.04	6.10	5.23	3.35	0.86
Yield/plant (g)	149.46	156.00	146.81	106.52	68.17	43.87	14.34
Chemical composition of foliage on dry weight basis (mg/100 g)							
N	831	835	807	732	671	592	31
P	492	484	446	345	262	217	39
K	252	260	247	213	181	167	12
Ca	293	299	287	261	239	215	15
Mg	310	316	299	245	209	185	23
Na	185	219	234	387	439	497	49
Cl	86	91	109	186	249	316	29
Chlorophyll a	26	29	24	17	13	11	8
Chlorophyll b	23	21	19	14	11	8	7

and specific ion effect in the plant metabolism (Kurian and Iyenger, 1967). Flowering was also delayed with the increased salinity levels, however, the differences were not significant upto 4 mmhos/cm (Table 2). Increased salinity levels not only delayed the flowering but reduced the number of fruits, length of fruits and yield per plant significantly above 4 mmhos/cm as compared to control. Similar results have been reported in tomato (Clay and Hudson, 1960; Geraldson, 1966). It was interesting that values for growth and yield characters were higher at 2 mmhos/cm as compared to control though the differences were not significant which suggested that lower salt concentrations had beneficial effect.

N, P, K, Ca and Mg content of leaves showed decreasing trend with increase in salinity level (Table 2). Workers like Ben-Zon *et al.* (1967), Fine and Curson (1954) and Lessani and Androcopular-Berand (1970) have also reported decrease in the uptake of N, P and K, respectively at higher salinity levels. Decrease in Ca and Mg levels at higher salinity levels may be due to higher uptake of sodium, which resulted in release of divalent cation like Ca and Mg

from the plant. Ayers and Eberhard (1960) also suggested that presence of Na in excess at higher salinity level reduced the uptake of K. The increase in the uptake of Na and Cl at higher salinity may be due to their increased concentration (Lunin and Gallatin, 1960). The data recorded on chlorophyll a and b content of fresh leaves showed 42 and 34% reduction at ECe 10 mmhos/cm as compared to control, respectively. The reduction in chlorophyll content at higher salinity levels may be due to the specific ion effect (Kurian and Iyenger, 1967). Similar findings have been reported by Kim (1958) and Nieman (1962). Thus, salinity caused nutrient imbalance not only in the soil but also in the plants which disrupted the normal metabolism of plants. From this study it can be concluded that chilli variety NP-46A can be grown successfully upto a salinity level of 4 mmhos/cm. Above this level the growth, yield and chemical composition of foliage were affected adversely. However, 70% yield was obtained at a salinity level of 6 mmhos/cm.

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COMPARATIVE EFFICACY OF SOME GRANULAR INSECTICIDES FOR THE CONTROL OF SUGARCANE TOP BORER, *TRYPORYZA NIVELLA* F.

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The sugarcane top borer, *Tryporyza nivella* F. is one of the most injurious borers of sugarcane in North India. Its first and second broods, appearing from March to May, although cause complete death of the affected shoots, yet the damage by these two broods is not very serious due to low borer incidence and compensation of attacked plants with enhanced tillering (Sandhu and Duhra, 1977). However, the 3rd and 4th broods, appearing in the beginning of July and in the end of August, respectively, cause tremendous loss to the sugarcane crop. Considerable efforts have been made in the past to control this borer. Kalra and Sidhu (1961) reported the control of third brood of top borer by the application of 3 to 5 pounds of gamma BHC per acre. Later on carbofuran @ 1.0 kg a.i./ha and phorate @ 3.0 kg a. i./ha were recommended for the control of this borer in Punjab (Sandhu and Duhra, 1977). Due to high cost of carbofuran (Rs. 500/ha) it was not possible for the small farmers to apply this insecticide. Keeping this in view, it was thought desirable to find out some other suitable substitute for carbofuran. In the present investigation, therefore, efficacy of mephosfolan, phorate, aldicarb and carbofuran granules all @ 1.0 kg a.i./ha were evaluated.

The experiment was conducted in a randomised block design, replicated four times with variety Co. 1148. Each insecticidal granule was applied only once in the root zone of plant against the third brood of top borer on 30.6.79. A light irrigation was given immediately after the insecticidal application. The incidence of top borer was recorded before the application of insecticides, one month after application and at harvest. The data on millable canes and yield were recorded at harvest and are presented in Table 1.

The incidence of top borer before insecticidal application was low, ranging from 0.8 to 4.0% (Table 1). However, one month after the application of insecticides, the incidence increased significantly in all the treatments except in mephosfolan in which case it was almost the same (2.1%) as was observed before the application of insecticides. Incidence in mephosfolan (2.1%) and carbofuran (5.1%) treated plots

TABLE 1

Effect of some granular insecticides on the top borer incidence, millable canes and yield of sugarcane

Treatments	Per cent incidence of top borer			Millable canes/ ha	Av. weight/ cane (g)	Cane yield (mt/ha)	Increase in yield over control (mt/ha)	Cost of insecti-cide+ labour charges (Rs.)	Benefit over control (Rs./ha)	C. C. S. (%)	Sugar produc-tion (mt/ha)
	Before applica-tion of insec-ticide (26.6.79)	One month after applica-tion (31.7.80)	At harvest								
Mephosfolan (Cytrolane 5 G) @ 1 kg a.i./ha	2.3	2.1 (7.8)	11.6 (19.91)	1,23,056	727	89.43	21.07	784	2683	11.19	10.01
Phorate (Thimet 10 G) @ 1 kg a.i./ha	1.3	14 9 (22.6)	27.7 (31.68)	1,22,083	680	83.04	15.28	202	2243	11.11	9.23
Aldicarb (Temik 10 G) @ 1 kg a.i./ha	4.0	16.9 (24.1)	34.1 (35.86)	1,18,889	675	80.21	12.45	308	1684	10.82	8.68
Carbofuran (Furadan 3 G) @ 1 kg a.i./ha	2.5	5.0 (12.6)	16.2 (23.58)	1,23,056	703	86.51	18.75	503	2497	11.45	9.91
Control (No treatment)	0.8	19.5 (26.0)	32.3 (35.26)	1,13,353	598	67.76	—	—	—	11.31	7.66
C.D. (p=0.05)	NS	(5.19)	(5.25)	NS	44	8.38	—	—	—	NS	—

Figures in parentheses are means of angular transformation.

was significantly lower than the control (19.5%). However, phorate (14.9%) and aldicarb (16.9%) treated plots were at par with the control.

The data recorded at harvest show that the incidence of top borer mephosfolan treated plots was again lowest (11.6%) followed by carbofuran (16.2%), however, both were at par. The incidence of borer in these two treatments was significantly lesser than the control, phorate and aldicarb treated plots (27.7-34.1%). Phorate and aldicarb treatments proved ineffective for controlling this borer as the differences in top borer incidence in these treatments and control were non-significant.

The number of millable canes in different treatments including control were almost similar indicating that these insecticides did not make favourable effect. However, yield data were significantly higher in all the insecticidal treatments than control. Among the various insecticidal treatments, highest yield (89.43 mt/ha) was obtained in mephosfolan treated plots. This yield was significantly higher than the yield obtained in aldicarb treatment (80.21 mt/ha). However, there was not significant difference in the yield recorded in mephosfolan, carbofuran and phorate treatments as well as in carbofuran, phorate and aldicarb treated plots. It was an interesting observation that although the top borer incidence in phorate and aldicarb treated plots was almost similar to that of the control, both one month after the application of insecticides and at harvest, yet yields in these treatments were significantly higher (83.04 and 80.21 mt/ha, respectively) than control (67.76 mt/ha). This shows that these insecticides, although ineffective in reducing top borer infestation, proved useful in improving cane yield by way of boosting cane growth as appeared from the data recorded on average weight per cane in different treatments (Table 1).

The cost of insecticide and labour charges for the application of insecticides although were highest in mephosfolan treated plots followed by carbofuran, aldicarb and phorate (Table 1) yet the maximum benefit over control due to increase in cane yield was in mephosfolan treatment (Rs. 2683/ha) followed by carbofuran (Rs. 2497/ha). In phorate and aldicarb treatments, the benefit over control was only Rs. 2243 and Rs. 1684/ha, respectively.

Application of insecticides did not give any favourable effect in improving Commercial Cane Sugar (CCS), however, low cane yield had its definite effect on the total sugar production per unit area (Table 1).

From the above study it may be concluded that mephosfolan which was found to be the most effective insecticide in reducing top borer incidence also gave highest cane yield/ha. The benefit over control due to the increase in cane yield was also highest in this treatment. This insecticide has already been reported to give very effective control of shoot borer, *Chilo infuscatellus* Snell., when applied at the time of planting of cane in February-March (Duhra and Sandhu, 1979; Krishan Prasad *et al.*, 1979). Carbofuran was the next best insecticide for reducing top borer incidence and also increasing cane yield.

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RESEARCH NOTE

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AN INSIGHT INTO THE POOR PRODUCTIVITY IN THOMPSON SEEDLESS GRAPES

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Thompson Seedless, a mid season cultivar of grapes, tops in quality not only for table purpose but forms excellent raisins also. However, shy bearing habit is an impedance for its commercial importance. With the advancement in age and under marginal climatic conditions of Haryana for grapes, this problem becomes aggravated. Similar was the case with this cultivar in the Vineyard of Department of Horticulture. The vines, though healthy, were producing negligible quantity of fruits. Therefore, the present study was undertaken to understand the underlying causes.

Twenty four Thompson Seedless vines aged eleven years, trained on double-wire-kniffin system, receiving all the recommended cultural practices (Anonymous, 1978) were selected for the study. These were uniformly pruned in the third week of January to have sixteen canes with eight buds per cane. Data were recorded on fruitfulness of buds, berry set and pollen germination. Bud sampling technique and the classification have already been described in our previous paper (Dabas *et al.*, 1980). Per cent berry set and berry drop were calculated by counting unopened flower buds, berries set and berries retained at harvest per bunch. Pollen viability was tested with 1% acetocarmine. Pollen germination was recorded in 20% sucrose solution *in vitro* by incubating the slides at 32±1°C for 6 h.

The perusal of data (Table 1) indicates that 25% of buds in the bearing zone of Thompson Seedless cultivar differentiated into flower buds while 50% remained vegetative and rest were killed due to one or the other reason. Similar observations on formation of limited number of flower buds and bud mortality were made by Bindra (1977) and Chundawat *et al.* (1977) who found that these factors accentuate the problem of poor productivity in this cultivar. Further, to find out the underlying causes of bud mortality, they could not found the involvement of any disease. They postulated that it may be due to excessive feeding of vines with N as girdling had been reported to reduce bud mortality (Dabas, 1979). However, Bindra and Chauhan (1976) speculated that under high N conditions some phyllosphere fungi may become parasitic causing bud mortality.

TABLE 1

Different parameters of yield in Thompson Seedless grapes

Parameters	Per cent	Remarks
Fruitful buds	25.09	Average of 432 buds
Vegetative buds	50.50	Average of 432 buds
Dead buds	25.41	Average of 432 buds
Berry set	11.53	Average of 36 bunches
Berry drop	31.30	Average of 36 bunches
Panicle drying	66.60	Average of 24 vines
Pollen viability	36.40	Average of 868 pollens
Pollen germination	3.20	Average of 564 pollens

Extremely poor berry set recorded in these vines (Table 1) might be due to excessive drop of unopened buds and flowers. Chundawat *et al.* (1979) also reported that in Gold and Thompson Seedless cultivars, excessive drop of buds and flowers resulted in poor set which in severe cases resulted into complete drying of panicles. In these studies also extremely poor set resulted into panicle drying. About two-third of the panicles dried. Further, low berry set was obvious as pollen viability and germination was also low in these vines (Table 1). Subsequent berry drop was also high. About one-third of the berries in bunches dropped and could not reach maturity. Similarly, Chundawat and Jindal (1978) also observed severe berry drop in a number of promising grape cultivars including Thompson Seedless.

Thus, it can be concluded that low fruit-bud-differentiation, bud mortality, heavy drop of unopened buds and flowers resulting into poor berry set, severe panicle drying and heavy subsequent berry drop aggravate the comparative low productivity potential of this cultivar.

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SOURCE CREDIBILITY PATTERN AMONG FARMING COUPLES FOR RATIONAL DECISION MAKING AND ADOPTION OF FAMILY PLANNING PRACTICES

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ABSTRACT

An integral part of knowledge transfer mechanism needs to be closely looked at so that rational decision making ability for adoption of planned parenthood could be promoted. Present study was an attempt to examine the differential source credibility pattern among farming couples in relation to their rational and adoption behaviour for family planning practices. The data revealed the differential source credibility patterns among farmers and farm women, which was found positively and significantly related with their rational and adoption behaviour.

The birth rate in rural area has shown a slow decline, particularly in the last one or two decades. Although the decline cannot be attributed to one single factor, but family planning research efforts need to be made expeditiously and extensively, for smooth transmission of knowledge in order to help rural parents to take rational decision for adoption of planned parenthood. The acceptability is heavily dependent on the source of transmission of technical knowledge. One of the principles of communication theory is that a message tends to be accepted more readily if the same is received from two or more different but highly credible sources. The multiple source approach obviously provides due validity and social acceptability to the message with spirit of confidence. Individuals are prone to seek information from sources which they feel are more credible (Simon, 1957). The role of source credibility in capsuling the adoption process was highlighted by Singh (1965). Similarly, Supe (1969) found that there existed a relationship between exposure to information sources and rational behaviour of farmers. However, under Indian conditions it has been found that the farmers tend to use personal localite sources of information at every stage of the adoption process (Singh and Jha, 1965; Sharma, 1966). This shows their source credibility preferences.

Therefore, it was postulated that source credibility would be associated with farming couples' rational and adop-

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tion behaviour. Credibility, as used here, refers to the degree of expertness and trustworthiness accorded to a source of information by the audience at a given time. Credibility of a source is not fixed and is flexible with the change in time or place.

Keeping the theoretical concepts into sharp focus, the present study was undertaken with the following objectives :

(i) To examine the differential source credibility pattern among farming couples for family planning practices; and

(ii) To find the relationship between rational and adoption behaviour with source credibility pattern of farming couples.

METHODOLOGY

The study was conducted on randomly selected 100 farming couples (husband and wife) of the three selected villages through probability proportionate to size sampling method from the Nagafgarh Development Block of the Union Territory of Delhi.

A modified Paired Comparison Technique (White, 1966) was used to find out the most credible sources of information. Rationality in decision making was measured by the following Rationality Quotient (R. Q.) Scale developed for family planning practices :

$$R.\,Q. = \sum_{i=1}^{N} \frac{ei}{pi} \times wi$$

Where,

N = number of decisions which are applicable to the situation of the respondents;

$\sum_{i=1}^{N}$ = summation over each of the N decisions of which any one is the i=i ith decision;

ei = extent of rationality of ith decision;

pi = potentiality for being rational in ith decision (which is considered as 3 in all cases);

wi = weightage to be given to ith decision based on the differential complexity weights for the decisions (1 to 8).

Similarly, adoption behaviour of farming couples for family planning practices was quantified by an Adoption Index (AI) especially evolved for the purpose. The AI for each respondent was calculated according to the formula :

$$AI = \frac{\Sigma(ta \times F)}{t} \times 100$$

Where,

ta = time of adoption (year);

t = period for which the couple is eligible to adopt family planning devices (here it would be 5 years);

F = factor taking into account the size of the family and effectiveness of the device in relation to its type, being used.

The source credibility scores were obtained by modified paired comparison technique.

For drawing inferences, Rank Order correlation and Zero Order correlation were applied in this study.

It would be noticed that based on their availability/frequency of use of these sources, the credibility scores were assigned and ranked.

RESULTS AND DISCUSSION

According to the farmers, the first, second and third credibility preference went to spouse, friends and clinic camps, in order of importance, whereas field/social workers, spouse and rural health centre personnel occupied the first, second and third position, respectively, by the farm women (Table 1).

These differences were tested by the rank order correlation coefficient which was calculated taking into account the common sources for the couples. The computed rank order correlation (P= 0.285) was not significant at 0.05 level of probability. This brought out the lack of agreement among farmers and farm women regarding their source credibility ranking. Hence, it could be visualized that a differential source credibility pattern existed among farming couples for family planning practices.

The pooled data indicated that spouse, friends and rural health centre personnel were the most credible sources in decreasing order of importance by farming couples.

TABLE 1

Ranking of source credibility for family planning practices by farming couples

S. No.	Sources	Farmers		Farm women		Pooled	
		Scores	Rank	Scores	Rank	Scores	Rank
1.	Spouse	68	I	64	II	66	I
2.	Friends	66	II	45	IV	56	II
3.	Clinic camps	59	III	29	VII	44	IV
4.	Private practitioners	53	IV*	—	—	27	IX
5.	Depot holders/motivators	47	V	10	VIII	29	VIII
6.	Neighbours	45	VI	41	V	43	V
7.	Rural Health Centre personnel	37	VII	59	III	48	III
8.	Relatives	30	VIII	37	VI	34	VI
9.	Radio	13	IX*	—	—	7	X
10.	Field/social worker	—	—	66	I*	33	VII
11.	Pamphlets	3	X*	—	—	2	XI
12.	Posters						
13.	Films						

*=Ranks not included for calculations.

P=0.285 not significant at 0.05 level of probability.

Source Credibility in Relation to Rational and Adoption Behaviour

The relationship between the rationality in decision making and adoption behaviour of farming couples with source credibility score was tested with the help of Zero Order correlation. The results are presented in Table 2.

The above highly significant observations have shown that source credibility has exerted its influence on rational and adoption behaviour of farming couples. Therefore, it can be concluded that farming couples' source credibility pattern significantly influence the rational and adoption behaviour regarding family planning practices.

Corollary to the assumption, the farming couples' rationality and adoption behaviour regarding family planning practices were found to be related with their source credibility pattern. A significant degree of association was assigned to spouse, field/social workers, friends, clinic camps and rural health centres personnel, as most credible sources by farming couples. Studies made by Mathai (1971) and Puri (1972) have also found these sources as important. As family planning involves joint decision of both the partners, the spouse have been ranked high. Moreover, their importance would be understood from the nature of innovation, as it involves higher degree of taboo element still in villages and information seeking behaviour.

The study revealed, the source credibility as a crucial variable that needs to be properly manipulated. The results have clearly revealed that personal localite sources were considered as highly credible ones. By and large, such localite sources are often found to lack in precise and technical information on the different aspects of the innovation. Since it is a guiding principle in communication strategy to effectively utilize existing channels of communication as much as possible to bring about technological changes, the obvious implication points out the necessity to give due attention to impart systematic training to the localite sources which can generally be identified in the village communities. Therefore, the knowledge transmitted through these credible sources would be expected to make a more pronounced and substantial impact.

TABLE 2

Relationship of source credibility with rationality in decision making and adoption of family planning practices

Independent variable :	Zero Order correlation (r)					
	Rationality in decision			Adoption		
	Farmers (N=100)	Farm women (N=100)	Pooled (N=200)	Farmers (N=100)	Farm women (N=100)	Pooled (N=200)
Source credibility	0.326*	0.450*	0.276*	0.461*	0.264*	0.438*

*Significant at 0.01 level of probability.

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JOB PREFERENCES OF HOME SCIENCE GRADUATES

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ABSTRACT

Studies on the job preferences of under-graduate home science students of Haryana Agricultural University, Hissar, revealed that students from middle and upper socio-economic stratum join this career. The levels of educational aspirations were fairly high. Teaching jobs were the most preferred and clerical the least. Students preferred mostly to serve in government organisations and have least liking for private organisations. As the distance of place of job from home increased, intensity of preference decreased. Village was least preferred for residence and independent colony nearby city most. There was no substantial difference of choices between urban and rural students and agricultural and non-agricultural occupations. Job preferences are changing with increasing employment opportunities and economic motivations. Present educational system could not inculcate the desired ideals in students.

Introduction of home science education in academic institutions in India is hardly three decades old. Only a few institutions offer graduate degree in home science. A number of new semi-government organizations and commercial concerns are coming forward to employ these graduates. Conventional outlets like government departments have also expanded the employment opportunities for this discipline. The job opportunities have considerably enlarged with the technological advancement and demand of trained people to meet the need for development. These graduates now have many careers to choose.

Traditional values of society are undergoing fast changes. The traditional conceptions regarding role and place of woman are slowly changing in contemporary Indian society. Increasing opportunities for modern education, greater geographical and occupational mobility and the emergence of new economic patterns are mainly responsible for this trend (Dube, 1963). Image of woman in Indian society is fast changing towards equality with man.

It is assumed that the students during the course of their studies have some plan to persue a career after getting the degree. They aspire in terms of some specific type of job, avenue of job, place of job and nature of place of residence. Preferences of students towards these aspects are of much practical significance for policy makers, planners and administrators of programmes of education, development programmes and commercial organizations. Moreover, all the

major roles of the future society are to be shouldered by this young generation. A study of this kind will help in understanding whether this generation is being adequately motivated to accept the socially desired ideals or they are still holding fast to the traditional values.

The specific objective of the study was (i) to know the intensity of job preferences according to (a) the nature of job, (b) avenue of agency in which job is preferred, (c) place of job, (d) nature of place of residence; and (ii) to know the association between background and family occupation of the respondents and the components of job preferences.

METHODOLOGY

Universe and Sample

The study was confined to B. Sc. (Home Science) final year students of Haryana Agricultural University, Hissar. There were 73 students in academic year 1978-79. Out of these, 60 students were available for response which formed the sample of study.

Stimulus Material

According to the nature of job, eight jobs: administrative, teaching, research, extension, clerical, social service, household and military were included.

According to the agency in which jobs were preferred, eight types of agencies: international, Central government, State government, semi-government, autonomous body, voluntary organization, private organization and personal business organizations were included.

Different places of work as per distance from home put forward were : anywhere in the world, neighbouring country, home country, neighbouring State, home State, home district, nearby home and the home village.

According to the nature of place of residence: metropolitan, city, town, village and independent colony nearby city were included.

The method of paired comparison was used in the study. The stimulus, nature of job, agency of job, distance of work place from home and nature of residence place were presented to the respondents in pairs in all possible combinations. In order to avoid space and time errors the pairs were so arranged that every stimulus appeared equally often on the right side and on the left, and maximum possible distance was kept between its appearances in pairs.

The total number of pairs were determined by the formula: $\frac{n\,(n-1)}{2}$

Total number of pairs presented to the respondents were 28 each as per nature of job, agency of job and distance of work place and 10 as per nature of residence place.

Respondents were instructed to put a tick mark against one stimuli in each pair and not to leave any pair unchecked. The standard procedure of pair comparison was followed. Scale values were solved with equations involving 'case V' of Thurstone (Edwards, 1969). Following steps were involved:

1. The observed frequencies of choices were arranged in the raw frequency matrix in which each column stimulus (i) was judged more favourable than the row stimulus (j). The diagonal entries involving a comparison of each statement with itself were 30 (N/2). This formed the F matrix.

2. From F matrix P matrix was constructed by dividing frequency of each cell by 60 (F/N). It gave the observed proportion of times. Stimulus i was preferred to stimulus j. All diagonal cells were 500. Stimuli were rearranged in rank order of the column sums of the P matrix with the stimulus with the smallest column sum at the left and that with the highest at the right. Pair of columns and corresponding pair of rows were interchanged accordingly.

3. From P matrix Z matrix was constructed, expressing P values into Z values which were unit normal deviates correspondent to the proportions. Proportions of above .977 and below .023 were not considered for this conversion, since Z values corresponding to these are large and give unreliable scale values. In such cases, the corresponding cells in the Z matrix were left blank.

Z values of each column were added (sums) and divided by number of stimuli (means). Means of Z values in columns expressed the scale values of respective stimuli in terms of their deviation from the mean of all the scale values. In this way, scale value of each stimulus in terms of its deviation from the mean scale value of all the stimuli was obtained. Scale values of some stimulus were negative and of others positive. Since origin, taken as the mean of the scale values of the stimulus on the psychological continuum, is arbitrary, a constant (largest negative deviation) was added to the deviation scale values to make them all positive.

This procedure was repeated for calculating the scale values of all groups of stimuli, i. e. as per nature of job, agency/avenue, distance of work place and nature of residence place, separately.

RESULTS AND DISCUSSION

Contextual Matrix of Respondents

What one is and what one to be is substantially influenced by his social and economic status and personal and psychological traits (Burchinal, 1961; Cormack, 1961; Harrison, 1969; Sharma, 1970; Pandey, 1974). This information about respondents was sought on some of the aspects closely related with main objective of the study.

An overwhelming majority (92.5%) of the students was Hindu. There was no student from Christianity and Islam. Different caste groups like agricultural (Jat, Rajput, Ror, Ahir, Saini and Gujjar), commercial (Bania and Arora), priestly (Brahmin) and artisan (Khati, Kumhar and Lohar) constituted 50, 40, 5 and 5 per cent of the respondents, respectively. As per type of family 72.5% were from nuclear families and 27.5% from joint families. As many as 57.5% of the students hailed from urban background and 42.5% from rural. Only 20% of the students were married and rest were

unmarried. Half of the students were from families with agriculture as the main occupation followed by profession and services (27.5%), and business and trade (22.5%).

Highest level of education in the family of respondents procreation was doctorate (5%), post-graduation (37.5%), graduation (52.5%) and matriculation (5%). When the education of respondents' father alone was considered only 12 5% were below matriculation. Only in 10% cases respondents' mother was above matriculation. Almost all the girls were in age group of 18-20 years, except three who were above twenty. Scholastic achievement at the time of entering present course, 80% were second divisioners (45 to 59% marks) and rest first divisioners (60% and above marks). Frequency of meeting tutor varied from fortnightly (52%) to once in a trimester. Educational aspirations were fairly high as none of the students aspired for job just after graduation. This might be because of no potential employment avenue in this State. Only 12.5% students aspired for B. Ed. for getting teaching job in schools. As many as 80% of the students aspired for post-graduation and 7.5% for doctorate degree.

Thus, the majority of the students in this course came from middle and upper social stratum of the society. Education in the family seems to have much bearing on the education of girls and their levels of aspirations. In general, levels of aspirations were fairly high.

Nature of Job

Data in Table 1 reveals that students preferred teaching jobs most followed by extension and social service. A similar trend was reported by Kaur (1961), Gupta and Sohal (1972) and Rao (1976) for under-graduate girl students. Chand and Sohal (1978) confirmed the general liking of girl students for teaching jobs. This trend is not a new one. Teaching jobs were also preferred by the maximum number of students of Land Grant Colleges (Getman and Chapman, 1933). Studies conducted by Sandhu and Sinha (1970), Singh *et al.* (1973) and Gupta and Sohal (1972) also found relatively higher preference for teaching jobs by agricultural under-graduate students, but in no case teaching was placed at first place. It was either extension or research which was preferred most. It is, thus, confirmed that the trend of preferring teaching job still continues but the intensity of preference by male students has decreased. It is because of the expanding employment opportunity avenues. But among home science graduates the trend has not shifted because of the non-expansion of employment opportunities outside teaching sector. Moreover, these jobs suit them most.

Clerical jobs were placed at lowest preference by all groups. Urban students preferred administrative jobs most followed by teaching and social service, whereas rural students preferred teaching most followed by extension and social service. Among the occupational groups, teaching was ranked first followed by research and social service by students from non-agricultural occupations. First preference altered to social service with equal weightage to teaching and household.

TABLE 1

Z-matrix, nature of job

	Clerical	Military	Research	Administrative	Household	Social service	Extension	Teaching
Clerical	.000	.524	.842	1.036	.935	1 150	1.150	0.935
Military	—.524	.000	—.063	.000	.253	.253	.189	.189
Research	—.842	.063	.000	.189	.000	.189	.063	.385
Administrative	—1.036	.000	—.189	.000	.000	.189	.319	.319
Household	—.935	—.253	.000	.000	.000	.000	.253	.253
Social service	—1.150	—.253	—.189	—.189	.000	.000	—.063	.000
Extension	—1.150	—.189	—.063	—.319	—.253	.063	.000	.000
Teaching	—.935	—.189	—.385	—.319	—.253	.000	.000	.000
Sums	—6.572	—.297	.053	.398	.682	1.844	1.911	2.081
Means	—.822	—.037	.007	.049	.085	.230	.238	.260
Means+.822	0	.785	.829	.871	.907	1.052	1.060	1.082

Clerical jobs were least preferred because these were not suiting to their field of specialisation. Moreover, girls from middle and upper socio-economic status families do not like these jobs. Employment opportunities suiting to their specialisation are meagre in other sectors. Therefore, they have given lower preferences to military and executive jobs. Research activities in home science have not taken a momentum in India. When the present findings were compared with that of Gupta and Sohal (1972) it appeared that changes in preferences are taking place.

Thus, it can be concluded that students prefer teaching jobs most and keep their field of specialisation as well as the employment opportunities in view while planning for a career.

Agency of Job

As evident from Table 2, most preferred agency of job was Central government followed by the State government. Preference for other agencies was much lower. Findings of Gupta and Sohal (1972) also confirm that education departments are most liked organisation for job. Even among the under-graduate agricultural students government departments were most preferred (Sandhu and Sinha, 1970; Singh *et al.*, 1973; Chand and Sohal, 1978). It was because of more employment opportunities. Differences between other agencies of jobs, as reported by above quoted studies, were not as wider as are in the present study. It reveals that in Haryana job opportunities for home science graduates are limited to government organisations only. Gupta and Sohal (1972) reported independent business as second most liked choice for home science graduates of Punjab. Difference in choice might be because of the background of respondents and employment opportunities in two States (Pandey, 1974).

TABLE 2

Z-matrix, agency of job

	Private firm	Autonomous organisation	Own business organisation	Voluntary agency	Semi Govt. agency	International organisation	State Govt.	Centre Govt.
Private firm	.000	—.126	.189	.253	.253	.253	.935	.825
Autonomous organisation	.126	.000	.000	.063	.319	.319	.674	.935
Own business organisation	—.189	.000	.000	.126	.253	.253	.524	.524
Voluntary agency	—.253	—.063	—.126	.000	.000	.126	.674	.935
Semi-Govt. agency	—.253	—.319	—.253	.000	.000	—.126	.674	.842
International organisation	—.253	—.319	—.253	—.126	.126	.000	.454	.598
State Govt.	—.935	—.674	—.524	—.674	—.674	—.454	.000	.189
Centre Govt.	—.935	—.935	—.524	—.935	—.842	—.598	.189	.000
Sums	—2.692	—2.436	—1.491	—1.293	—.783	—.227	3.746	4.848
Means	—.336	—.304	—.186	—.161	—.097	—.028	.468	.606
Means+.336	0	.032	.150	.175	.239	.308	.804	.942

First preference to Central government and second to State government was given by both with urban background as well as from non-agricultural occupations. Both preferences were reversed by students with rural background and agricultural occupations. Students with rural background gave last preference to private firm, whereas their counterparts with urban background gave fifth.

Thus, Central and State government departments are the most liked organisations and among different organisations, it is the department of education.

Place of Job

Scale values indicate that students preferred to serve nearer to their home villages (Table 3). It is also supported by the preferences of jobs according to nature of job and agency of job. The reason for this type of liking might be because of the social system. Girls are generally married in the same caste and nearby or within the State. Moreover, parents do not like to send their daughters at a distant place for education.

Students broughtup in rural background were more willing to work near

TABLE 3

Z-matrix, place of job

	Anywhere in the world	Neighbour State	Neighbour country	Home country	Home State	Home district	Nearby home village	Home village
Anywhere in the world	.000	.253	.319	.454	.755	.598	.598	.842
Neighbour State	—.253	.000	.063	.000	.524	.524	.755	.755
Neighbour country	—.319	.063	.000	.253	.385	.385	.454	.674
Home country	—.454	.000	—.253	.000	.454	.454	.674	.524
Home State	—.755	—.524	—.385	—.454	.000	.189	.189	.385
Home district	—.598	—.524	—.385	-.454	—.189	.000	.126	.319
Nearby home village	—.598	—.755	—.454	—.674	—.189	—.126	.000	.000
Home village	—.842	—.755	—.674	—.524	—.385	—.319	.000	.000
Sums	—3.819	—2.242	—1.895	—1.399	1.355	1.705	2.796	3.499
Means	—.477	—.280	—.236	—.174	.169	.213	.349	0.437
Means+.477	0	.197	.241	.303	.646	.690	.826	.914

TABLE 4

Z-matrix, place of residence

	Village	Metropolitan	Town	City	Independent colony nearby city
Village	.000	.253	.524	.935	1.036
Metropolitan	—.253	.000	.126	.842	.935
Town	—.524	—.126	.000	.755	.755
City	—.935	—.842	—.755	.000	.063
Independent colony nearby city	—1.036	—.935	—.755	—.063	.000
Sums	—2.748	—1.650	—.860	2.469	2.789
Means	—.549	—.330	—.172	.493	.557
Means+.549	0	.219	.377	1.042	1.106

TABLE 5

Internal consistency check (nature of job)

	Clerical	Military	Research	Administrative	Household	Social service	Extension	Teaching
Clerical	—							
Military	0.084	—						
Research	—.004	.043	—					
Administrative	—.042	.034	—.058	—				
Household	—.007	—.052	.031	.014	—			
Social service	—.028	.005	.013	—.003	.008	—		
Extension	—.020	.033	—.060	—.050	—.038	.028	—	
Teaching	.035	.042	.050	—.040	—.030	.012	.008	
$\lvert \Sigma \rvert$	.220	.209	.212	.107	.076	.040	.008	

Average discrepancy=.0311

TABLE 6

Internal consistency check (agency of job)

	Private firm	Autonomous organisation	Own business organisation	Voluntary agency	Semi-Govt. agency	International organisation	State Govt.	Centre Govt.
Private firm	—							
Autonomous organisation	0.063	—						
Own business organisation	—.015	.050	—					
Voluntary agency	—.030	.032	—.040	—				
Semi-Govt. agency	—.006	—.043	—.065	.026	—			
International organisation	.021	—.016	—.037	.003	—.077	—		
State Govt.	—.035	.030	.043	—.010	—.036	—.015	—	
Centre Govt.	.002	—.007	.086	—.040	—.041	.012	—.020	
$\lvert \Sigma \rvert$	0.172	.178	.268	.079	.154	.077	.020	

Average discrepancy=.0338

TABLE 7

Internal consistency check (place of job)

	Anywhere in the world	Neighbour State	Neighbour country	Home country	Home State	Home district	Nearby home village	Home village
Anywhere in the world	—							
Neighbour State	−.022	—						
Neighbour country	−.030	.043						
Home country	−.056	.002	−.075					
Home State	−.034	−.027	.007	−.041				
Home district	.030	−.011	.027	−.024	−.057			
Nearby home village	.071	−.040	.046	−.051	−.004	.004		
Home village	.020	−.012	.000	.029	−.041	−.036	.035	
$\lvert \Sigma \rvert$	.263	.135	.155	.145	.102	.040	.035	

Average discrepancy=.0312

TABLE 8

Internal consistency check (place of residence)

	Village	Metropolitan	Town	City	Independent colony nearby city
Village	—				
Metropolitan	.013	—			
Town	−.053	.013	—		
City	.026	−.005	−.028	—	
Independent colony nearby city	.016	−.012	.004	.001	—
$\lvert \Sigma \rvert$	.108	−.030	.032	.001	

Average discrepancy=.0171

the village as compared to those brought-up in urban environment, as former preferred to work in home village followed by nearby home village, home district, home State and country and later gave first preference to home district followed by nearby home village and home State. Both groups placed neighbouring country and anywhere as last preference. First and last two preferences of rural and urban students were same as those of agricultural and non-agricultural occupations, respectively.

Thus, students like to serve nearer to their home place, in the government agency as teachers.

Place of Residence

It is asserted that village environment does not attract students as their choice to reside in village was lowest (Table 4). On the other hand, city was highly preferred. Independent colony nearby city was valued most for residence. It might be because of the natural environment supplemented with comforts of city life. Students stay at campus might have contributed to this type of liking. Metropolitan might not be liked because of its hazards and rural background of 42.5% of the students.

Students with rural background gave first preference to independent colony nearby city followed by city, town, village and metropolitan, whereas those with urban background preferred city most followed by independent colony nearby city, metropolitan, town and village. As per occupation groups, agriculture group preferred independent colony most and village least. Those with non-agricultural occupations preferred city most and village least. Thus, the preference for village is the lowest in both occupation groups and urban students. It is also lower among those coming from villages.

Thus, the students like to reside in an environment which provides the comforts of city life and bounty of natural environment of village life.

Internal Consistency Check

Data in Tables 5-8 revealed that absolute average discrepancy for nature of job, agency of job and place of job were 0.0311, 0.0338 and 0.0312, respectively, for eight stimuli (28 pairs). Absolute average discrepancy for place of residence was 0.0171 with five stimuli (10 pairs). It reveals that the observed proportions are in agreement with those of expected in terms of derived scale values (Hevner, 1930; Saffir, 1937). Thus, the ordering of preferences is rational.

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ECONOMIC FEASIBILITY OF GRAPE CULTIVATION IN HARYANA

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ABSTRACT

The study reveals that investment in grape orchard is a profitable proposition as compared to field crops. The capital cost of a grape orchard is recovered in a period of seven years and grape provides regular net income of Rs. 5,000 per hectare. The benefit cost ratio shows that an investment of Re. 1.00 in a grape orchard unit fetches a return of Rs. 2.47. Grape orchard provides more stable income than field crops.

In Haryana State, grape cultivation was introduced in the early seventies. Since then its cultivation has gained momentum and now-a-days it is considered as one of the major fruit crops. Grapes are successfully grown in all the districts of the State except Ambala, Karnal and Kurukshetra. Its cultivation is most suited to sandy loam, well drained and fairly fertile soils containing a fair amount of organic matter. Such soils are also well suited to good crop cultivation. Although grape cultivation is profitable, it requires heavy initial investment in the form of capital, labour and skilled management. In this study, an attempt was made to appraise the investment in grapes. The specific objectives of the study were :

(i) to find out the average investment in establishing one hectare grape orchard;

(ii) to estimate the average production costs and returns;

(iii) to evaluate the profitability of grape cultivation as compared to field crops; and

(iv) to appraise the investment in grape orchard.

METHODOLOGY

For the purpose of this study Sirsa district was purposively selected. A list of all the grape growers having orchards was prepared. Eighteen grape growers were randomly selected from the district. The data were collected in June, 1980 by personally interviewing the grape growers. Out of 18 orchards, 11 had Perlette variety and 7 Thompson Seedless. Perlette is an early ripening and heavy bearer, whereas Thompson Seedless is a mid-season and comparatively

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shy bearer. Hence, data were compiled variety-wise for the analysis.

The cost of grape orchard consists of two parts viz., establishment cost and recurring and maintenance costs (Singh and Pandey, 1978). The former consists of all the expenditure on goods and services (excluding value of land) required for the establishment of grape orchard. These include preparation of land and layout, digging and filling of pits, cost of plant material, supporting structures, fencing and working capital (perishable dead stock). Recurring and maintenance expenses include upkeep of the establishment and working capital, manures and fertilizers, interculture, irrigation, plant protection, labour, interest on establishment cost and working capital, and opportunity cost of land (rental value of the land).

Data on the cost and returns of field crops were obtained from the Package of Practices (Anonymous, 1980).

Since, cost structures of both the varieties were more or less similar, appraisal of the investment was done only for Perlette variety as the area under this variety was more than that under Thompson variety. For calculating internal rate of return (IRR) and discounted cash flow (DCF), the tables given in Bierman and Smidt (1971) were used.

RESULTS AND DISCUSSION

Establishment and Recurring Costs

It is evident from Table 1 that the establishment cost of a grape orchard in

TABLE 1

Establishment cost of one hectare grape orchard

Elements of cost	Thompson variety	Perlette variety
A. Fixed cost :	Rs.	Rs.
1. Preparation of land and layout	250	250
2. Digging and filling of pits	1,023	1,000
3. Cost of plant material @ Re. 1.00	760	731
4. Supporting structures	17,845	17,910
5. Fencing	625	625
Total	20,503	20,516
B. Working capital :		
1. Spade (two) @ Rs. 10	20	20
2. Khurpi (four) @ Rs. 4	16	16
3. Bucket (four) @ Rs. 10	40	40
4. Secateur (four) @ Rs. 25	100	100
5. Mug (four) @ Rs. 5	20	20
6. Ropes	35	35
7. Dusting machine	125	125
8. Lantern (two) @ 10	20	20
9. Miscellaneous	50	50
Total	426	426
Establishment cost (A+B)	20,929	20,942
Say	21,000	21,000
C. Average plant stand	545	576

TABLE 2

Annual maintenance and recurring costs (Rupees per hectare)

Elements of cost	Thompson variety					Perlette variety				
	I	II	III	IV	V onward	I	II	III	IV	V onward
1. Upkeep @ 20% of establishment	410	410	410	410	410	410	410	410	410	410
2. Depreciation on establishment @ 5% per annum	1,025	1,025	1,025	1,025	1,025	1,026	1,026	1,026	1,026	1,026
3. Depreciation on working capital @ 20% per annum	85	85	85	85	85	85	85	85	85	85
4. Manures and fertilizers										
(i) FYM	140	10	10	10	10	129	10	10	10	10
(ii) N	27	122	146	153	186	39	142	161	177	191
(iii) P	248	148	64	91	113	215	147	57	95	125
(iv) K	45	73	37	48	49	48	58	39	45	45
5. Ploughing/Digging	—	212	256	327	292	—	191	238	300	295
6. Irrigation	540	575	650	600	600	540	585	645	645	645
7. Hoeing and weeding	130	145	219	186	209	130	141	224	203	187
8. Plant protection	25	260	79	100	104	25	82	74	102	109
9. Pruning	—	111	130	135	150	—	96	207	133	155
10. Labour (one permanent)	1,800	1,800	1,800	1,800	1,800	1,800	1,800	1,800	1,800	1,800
11. Interest on establishment cost and working capital @ 10% per annum	2,093	2,093	2,093	2,093	2,093	2,094	2,094	2,094	2,094	2,094
12. Opportunity cost of land	1,500	1,500	1,500	15,00	1,500	1,500	1,500	1,500	1,500	1,500
Total	8,068	8,569	8,504	8,563	8,626	8,040	8,366	8,569	8,624	8,676

Sirsa District during 1969-1972 was Rs. 21,000 per hectare. The largest single item of expenditure was supporting structures, followed by digging and filling of pits for grape vine. Bower system was most common type of training system found on the selected farms. The per year maintenance and recurring (operating) costs were between Rs. 8,100 and 8,700 (Table 2). Interest on investment, labour and opportunity cost of land (rental value of the land) accounted for the bulk of maintenance and recurring expenses. These costs increased as the age of the grape orchard advanced and started stabilizing after five years.

The establishment costs were more than 70% of the total costs while the maintenance and recurring costs accounted for 30 per cent. The total costs until the grape orchard started fruiting in the third year were Rs. 28,400 (including establishment cost, maintenance and recurring costs upto third year). Thus, a huge amount had to be invested in grape orchard before it started fruiting. In the first year (3rd year of establishment of grape orchard) the average yield of the Thompson variety was 24 q/ha and that of Perlette variety was 22 q/ha (Table 3). Average yield reached its maximum in the 5th year of fruiting (7th year of orchard establishment). Singh *et al.* (1972) observed that the average yield of grapes varied from 125 to 150 q/ha. Thus, grape growers of the district were able to obtain a satisfactory yield level. Income from grape orchard varied from Rs. 2,860 to 22,000 per hectare.

Discounted Cash Flow (DCF)

Costs and returns given in Tables 1 to 3 do not serve as true guides for making a decision to go in for grape orchard *vis-a-vis* other annual crops. This is mainly due to the fact that the costs incurred and returns obtained from grape orchard over time are not comparable with other annual crops grown in the area. While returns from investment in annual crops can be obtained within a year, three years must lapse after planting before any returns are obtained over

TABLE 3

Average annual yield and return from one hectare grape orchard

Year	Yield (q)		Value received from orchard auction (Rs.)	
	Thompson	Perlette	Thompson	Perlette
I	—	—	—	—
II	—	—	—	—
III	24	22	3,300	2,860
IV	52	54	7,300	7,750
V	83	86	12,000	12,200
VI	106	116	15.200	17,500
VII to XXX year	121	143	16,800	22,000

maintenance and recurring costs from grape orchards. This shows the need to estimate the deferred returns by discounting future returns. Hence, it is necessary to estimate the net present value (NPV) of future returns. The present worth of future returns can be obtained by discounting both the costs as well as returns at a required rate of return (RRR) or minimum acceptable returns which is an opportunity rate (generally prevailing rate of interest). Net present value is defined as the present value of all cash flows associated with the investment, including the outlay, this is :

$$NPV = \sum_{t=1}^{n} \frac{C_t}{(1+K)^t}$$

where C_t is the cash flow or net returns from grape orchard in period t and K is the RRR. Once the NPV is known the simple rule is to accept any investment opportunity whose NPV is greater than zero. The net present values thus obtained are shown in Tables 4 and 5. NPV_s of grape orchard have been estimated under two situations. In situation-I the entire establishment costs of the orchard have been included in the first year itself (Table 4), whereas in situation-II the establishment cost is spread over time during the life span of the orchard (Table 5). Average net returns per year* will be Rs. 5326 in the first situation (Table 4) and Rs. 5922 in the second situation (Table 5). These values represent constant annual net returns over the life of grape orchard.

Table 6 shows NPV of returns per hectare from the competing crops, grape orchards and cost-benefit ratio. It is evident that among the 10 possible crop rotations, none was superior to grape cultivation in terms of net income. This showed that grapes yielded much higher income than any other crop rotations, so long as the yield and price relationship did not change significantly. It is also evident from Table 6 that every rupee of investment in grape orchard would fetch a return of Rs 2.47 (both calculated at present value). Since this ratio is greater than one (above unity), the investment in grape orchard is considered to be economically justified. But farmers with severe scarcity of funds may prefer to invest in crop production due to quick turnover.

Pay Back Period

Another simple and much used method for analysing investment is the pay back or recoupment period i. e., how soon will the estimated cash flow benefits expected from given investment repay the initial outlay required for its implementation. In short, the pay back period measures length of time required to recover the initial outlay. For this the following relationship must be satisfied :

$$\sum_{i=n}^{n} R_i = K$$

*The average annual net return is determined by dividing discounted cash flow (DCF) or net present value (NPV) by the present worth of an annuity of Re. 1.00 for the life of grape orchard (30 years in the present case). Thus, at the discount rate of 10% present worth of one hectare grape orchard was estimated Rs. 50,204 or Rs. 55,829 for a life span of 30 years. The present worth of an annuity of Re. 1.00 for 30 years at 10% is Rs. 9.4269. Therefore, average annual net returns are Rs. 50,204÷Rs. 9.4269=Rs. 5326 or Rs. 55,829÷Rs. 9.4269=Rs. 5922.

TABLE 4

Net present values of estimated future costs and returns from one hectare grape orchard

(Discount rate 10%)

Year	Cost (Rs.)	Net returns (Rs)	Discount coefficient	Present value (Rs.)	
				Cost	Net returns
I	27,462*	—	0.9091	24,966	—
II	6,846	—	0.8264	5,658	—
III	4,189	—	0.7513	3,147	—
IV	701	—	0.6830	479	—
V	—	5,104	0.6209	—	3,169
VI	—	10,344	0.5645	—	5,839
VII to XXX	—	14,844	5.0825	—	75,446
Total	39,256	30,292		34,250	84,454

*Includes operating and establishment cost. Maintenance costs of first year i. e., Rs. 1520 (items 1-3 of Table 2) were not included.

TABLE 5

Net present values of estimated future costs and returns from one hectare grape orchard

(Discount rate 10%)

Year	Cost (Rs.)	Net returns (Rs.)	Discount coefficient	Present value (Rs.)	
				Cost	Net Returns
I	8,040	—	0.9091	7,309	—
II	8,366	—	0.8264	6,914	—
III	5,709	—	0.7513	4,289	—
IV	874	—	0.6830	597	—
V	—	3,604	0.6209	—	2,238
VI	—	8,824	0.5645	—	4,981
VII to XXX	—	13,324	5 0825	—	67,719
Total	22,989	25,752	—	19,109	74,938

Where R=net returns and K=the cost of grape orchard. It is evident that the investment would be more than fully recovered in 8 years in the first situation (Table 4) and in 7 years in the second situation (Table 5). Those farmers who have paucity of funds, prefer shorter pay back period despite lower returns. Such farmers may prefer to grow crops inspite of more net returns from grape orchards. However, as a criterion of judging the acceptability of an investment, the pay back period has a serious shortcoming as it ignores cash flows beyond the pay back period (Solomon and Pringle, 1978).

TABLE 6

Net present values (NPV) of returns from one hectare competing crop rotations

S. No.	Crop rotation	Total cost (Rs.)	Gross return (Rs.)	Net return (Rs.)	Cost benefit ratio (column 4÷3)
1	2	3	4	5	6
1.	Cotton (A)-Wheat (HYV)	5,148	6,875	1,727	1 : 1.35
2.	Cotton (D)-Wheat (HYV)	4,614	5,604	990	1 : 1.21
3.	Guar-Wheat (HYV)	3,695	4,711	1,016	1 : 1.27
4.	Guar-Wheat (Desi)	2,970	3,595	625	1 : 1.20
5.	Paddy (HYV)-Wheat (HYV)	5,895	7,577	1,682	1 : 1.20
6.	Paddy (Basmati)-Wheat (HYV)	5,440	7,928	2,488	1 : 1.46
7.	Cotton (D)-Gram	3,041	4,132	1,091	1 : 1.36
8.	Cotton (D)-Wheat (Desi)	3,916	4,488	572	1 : 1.15
9.	Cotton (D)-Mustard	3,541	5,441	1,960	1 : 1.15
10.	Sugarcane	5,116	6,468	1,352	1 : 1.26
11.	Bajra (Hyb)-Wheat (HYV)	3,795	4,535	740	1 : 1.19
12.	Grape orchard	3,633	8,959	5,326	1 : 2.47

Internal Rate of Return (IRR)

One of the important indicators for evaluating the desirability of the investment with long gestation period is IRR.** The IRR is the rate that discounts all the cash flows to exactly zero or to the lowest minimum. That is :

$$\sum_{t=0}^{n} \frac{C_t}{(1+r)^t} = 0$$

where C_t is cash in flow in each period. The IRR is the rate R that solves the above expression.

In estimating IRR, the investment costs, gross returns for each year and the life of grape orchard are set out (Table 7). The balance is obtained by subtracting each year's expenditure from gross return. The result is single value for each year in the life of grape orchard. These single yearly values have negative and positive signs depending on the quantum of costs and returns in each year. Finally, to find out DCF, an iterative method was employed until the difference between the sum of discounted streams of positive and negative values (C_t) is reduced either to zero or to the lowest minimum (Anonymovs, 1973). The IRR or earning power of one hectare grape orchard was found to be as high as 27 per cent.

Sensitivity Analysis

The rate of return from an investment is likely to be affected by changes with value of its basic parameters such as future yield, output prices and input costs, demand estimates and legs in output

**The IRR is also known by several other names, such as DCF rate of return, the investor's method rate, true yield to maturity, the marginal efficiency of investment, and the exact method.

TABLE 7

Internal rate of return from one hectare grape orchard

Year	Cost (Rs.)	Annual gross return (Rs.)	Net cash flow (Rs.)		Present value coefficient	Corresponding present value (Rs.)	
			(−)	(+)	r=27%	(−)	(+)
I	8,040	—	8,040	—	0.7874	6,331	—
II	8,366	—	8,366	—	0.6200	5,187	—
III	8,569	2,860	5,709	—	0.4882	2,787	—
IV	8,624	7,750	874	—	0.3844	336	—
V	8,676	12,260	—	3,584	0.3027	—	1,085
VI	8,676	17,500	—	2,824	0.2383	—	2,103
VII to XXX	8,676	22,000	—	13,324	0.8799	—	11,724
Total	59,627	22,370	23,989	25,752	—	14,641	14,912

(Anonymous, 1973). In the case of grapes unit prices and unit costs (until cost changes due to change in yield or input prices) are the sensitive parameters and they are likely to have greater impact on the rate of return. For the sensitivity analysis 20, 25 and 30 per cent fall in returns either due to change in grape yield or prices were considered. The discounted present value of future returns with negative (−) and positive (+) signs were found out as in case of IRR. The final discount rate is that which will make the sum of discounted stream of negative and positive values equal to either zero or to the minimum level.

It is evident from Table 8 that the IRR of grape orchard would go down to 20 per cent, i. e., 5% less when returns from grape orchard fall by 20% either due to fall in prices or yield. IRR would be 18 and 15 per cent, respectively when returns decline by 25 and 30 per cent. This rate of return sets the lower limit below which the farmer may not prefer to invest in grape cultivation or may even abandon the grape orchards.

Considering the above facts, it can be concluded that the cultivation of grapes even though capital intensive, is highly profitable. Most of the growers auction their orchards in the district. The returns could be substantially enhanced by direct sales in the market. Farmers prefer pre-harvest contracts as they are not well trained to handle complex problems of marketing. i. e., specialized training in grading, packing and transport. There is thus need to integrate production, marketing and processing before the cultivation of grape is further extended.

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TABLE 8

Sensitivity analysis : Internal rate of return from one hectare grape orchard when returns fall by 20, 25 and 30 per cent

Year	Cost (Rs.)	Gross returns (Rs.)	Net cash flow (Rs.)		Present value coefficients	Corresponding present values (Rs.)	
			(−)	(+)		(−)	(+)
			When returns fall by 20% r=20%				
I	8,040	—	8,040	—	0.8333	6,700	—
II	8,366	—	8,366	—	0.6944	5,809	—
III	8,569	2,288	6,281	—	0.5787	3,635	—
IV	8,624	6,200	2,424	—	0.4823	1,169	—
V	8,676	9,808	—	1,132	0.4019	—	435
VI	8,676	14,000	—	5,324	0.3349	—	1,783
VII to XXX	8,676	17,600	—	8,924	1.6534	—	14,754
Total	59,627	49,896	—	—	—	17,313	16,972
			When returns fall by 25% r=18%				
I	8,040	—	8,040	—	0.8475	6,814	—
II	8,366	—	8,366	—	0.7182	6,008	—
III	8,569	2,145	6,424	—	0.6086	3,910	—
IV	8,624	5,812	2,812	—	0.5158	1,450	—
V	8,776	9,195	—	519	0.4371	—	227
VI	8,676	13,125	—	4,449	0.3704	—	1,648
VII to XXX	8,676	16,500	—	7,824	2.0192	—	15,798
Total	59,627	46,277	—	—	—	18,182	17,673
			When returns fall by 30% r=15%				
I	8,040	—	8,040	—	0.8696	6,992	—
II	8,366	—	8,366	—	0.7561	6,326	—
III	8,569	2,002	8,567	—	0.6575	4,319	—
IV	8,624	5,425	3,199	—	0.5718	1,829	—
V	8,676	8,582	94	—	0.4972	47	—
VI	8.676	12,250	—	3,574	0.4323	—	1,545
VII to XXX	8,676	15,400	—	6,724	2.7815	—	18,703
Total	59,627	43,659	—	—	—	19,513	20,248

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SUPPLEMENTATION OF LEAF MEALS IN CEREAL BASED LAYING RATIONS TO ACHIEVE AN ACCEPTABLE EGG YOLK COLOUR

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ABSTRACT

Fifty five per cent yellow maize ration was found to produce most acceptable egg yolk colour with a pigmentation score of 12.6 and β carotene equivalent of 2.89 mcg/g of yolk. Yolk pigmentation score and β carotene equivalent were positively correlated ($r=0.722$). Yolk pigmentation and levels of leaf meals also had a positive correlation.

Leaf meal supplementation tended to depress egg production but was associated with increased feed intake except in case of ration supplemented with lucerne meal.

Jowar based laying ration supplemented with 4% carrot top meal and wheat based ration containing 6% lucerne meal could replace 55% yellow maize ration as far as yolk colour was concerned. Similarly other rations like white maize with 6% lucerne or 4% berseem meal, barley ration with 4 or 6% lucerne meal or 6% carrot top meal and wheat ration with 4 or 6% lucerne and carrot top meal, respectively could produce yolk colour comparable to control, i. e., 55% maize ration with slight but variable effect on egg production, egg weight and feed utilization.

Egg yolk colour is one of the important egg quality factors that influences consumer's preference and can be manipulated to the desired intensity by feeding.

The use of yellow maize is quite common in poultry rations as a source of energy and xanthophyll. High market rates and poor availability of yellow maize have necessitated efforts to replace it with other cereal grains deficient in yolk pigmenters. This deficiency is likely to be removed by the judicious use of various leaf meals.

MATERIAL AND METHODS

Two experiments were conducted. Experiment I was undertaken to know the most acceptable egg yolk colour obtained by feeding various levels of yellow maize ranging from 10 to 65% to egg type laying hens. Fifty hens were randomly divided into 10 groups of five each and assigned to one of the 10 treatments. The composition of rations used was as reported by Ribdawi (1980). Experimental period of 10 days was preceded and followed by 10 days of pre- and post experimental periods.

Acceptability of egg yolk was assessed by panel testing. Pigmentation score and β carotene equivalents were measured using yolk pigmentation meter (Cargill-Nutrena Farm, Cargill Inc.) and method of AOAC (1970), respectively. Effort was made to correlate the observations of panel testing with these two methods of yolk colour measurements.

Experiment II was conducted for one month on 148 hens randomly divided into 37 groups of four each. One of the groups was fed control ration containing 55% yellow maize (based on the result of first experiment) and the remaining 36 groups were given different rations based on combinations of 4 cereal grains (white maize, barley, jowar and wheat), at 55% three leaf meals (lucerne, berseem and carrot top) and three levels of leaf meals (2, 4 and 6%). These rations were kept as far as possible iso-nitrogenous and isocaloric using small amount of refined vegetable oils wherever needed. The composition of these rations has been reported by Ribdawi (1980). The chemical composition of leaf meals and yellow maize, used in this experiment, is given in Table 1.

Data for individual egg production, and feed intake on group basis were collected.

The data were subjected to analysis of variance (Snedecor and Cochran, 1968). Multiple Range Test (Duncan, 1955) was used to make comparisons of means of experiment I.

RESULTS AND DISCUSSION

The acceptability test of yolk colour was based on visual scoring conducted by a panel of 54 scorers and the results of the test are presented in Table 2. The effects of feeding various levels of maize on productive performance have been presented in Table 3.

It is evident from Table 2 that with the increase in the level of yellow maize in the ration the acceptability of egg yolk colour increased. The maximum acceptability was attained at 55% level of yellow maize when 79.6% scorers graded the colour as most acceptable. Egg yolk pigmentation score and β carotene equivalent of egg yolk corresponding to the eggs from hens fed 55% level of yellow maize were 12 6 and 2.89

TABLE 1

Chemical composition of leaf meals and yellow maize

Ration	β carotene equivalent (mcg/g)	Crude protein (%)	Crude fibre (%)	Ether extract (%)
Lucerne	38.4	21.70	29.40	3.44
Berseem	48.0	17.50	19.30	3.05
Carrot top	21.2	7.35	22.55	2.88
Yellow maize	1.0	10.00	2.40	2.40

TABLE 2

Effect of feeding various levels of yellow maize on acceptability of egg yolk colour

Ration No.	Level of yellow maize (kg/q)	Per cent acceptability			
		Most acceptable	Acceptable	Neither acceptable nor rejectable	Not acceptable
1.	10	—	—	13.0	87.0
2.	25	7.4	25.9	59.2	7.5
3.	30	5.6	29.6	40.7	24.1
4.	35	3.7	40.7	46.7	9.3
5.	40	16.7	63.0	20.3	—
6.	45	27.8	61.1	11.1	—
7.	50	20.4	55.6	20.3	3.7
8.	55	79.6	16.7	3.7	—
9.	60	75.9	18.5	3.6	—
10.	65	74.0	22.3	3.7	—

TABLE 3

Effect of feeding various levels of yellow maize on performance of hens

Ration No.	Level of yellow maize (kg/q)	Egg yolk pigmentation scores	β carotene equivalent (mcg/g yolk)	Hen housed egg production in 3 weeks	Egg weight (g)	Daily feed intake/hen* (g)
1.	10	4.4^{a}	1.78^{a}	12.8^{a}	60.38^{a}	102.4
2.	25	7.0^{b}	1.95^{ab}	8.4^{a}	58.82^{a}	99.4
3.	30	7.8^{c}	2.10^{ab}	12.4^{a}	58.15^{a}	103.4
4.	35	9.0^{d}	2.37^{ab}	9.6^{a}	55.10^{a}	92.2
5.	40	10.0^{e}	2.50^{ab}	8.6^{a}	57.12^{a}	105.2
6.	45	10.4^{e}	2.70^{b}	10.8^{a}	58.86^{a}	106.0
7.	50	10.8^{e}	2.83^{b}	10.2^{a}	60.36^{a}	105.2
8.	55	12.6^{f}	2.89^{c}	11.8^{a}	59.20^{a}	105.8
9.	60	13.2^{f}	3.83^{c}	10.0^{a}	58.27^{a}	91.2
10.	65	13.8^{f}	3.86^{c}	8.8^{a}	59.94^{a}	95.0

Figures in a column having same superscript do not differ significantly at $P<0.05$.

*Not subjected to statistical analysis.

mcg/g yolk, respectively (Table 3). These observations are in agreement with findings of Groot (1970), Hinton *et al.* (1974) and Raine (1980).

The correlation coefficients between different levels of yellow maize and β carotene equivalent in the feed with yolk pigmentation score and β carotene equivalent in egg yolk alongwith their regression equations were calculated. The levels of yellow maize had significant positive correlation with pigmentation scores and β carotene equivalents of yolk with correlation coefficients of 0.981 and 0.640, respectively. The regression equation, best fit for levels of yellow maize with yolk pigmentation score, was $y=2.72+0.173x$ and with β carotene equivalent in egg yolk was $y=1.022+0.04x$. These equations are useful in predicting the pigmentation score and β carotene equivalent value in yolk with known level of yellow maize in the ration. The correlations between β carotene in feed on one hand and β carotene content and pigmentation score in egg yolk on the other hand have also been calculated. The correlation coefficients were 0.585 and 0.798 with regression equations of $y=1.360+6.488x$ and $y=0.978+2.78x$, respectively. Such equations are useful in estimation of yellow colour of yolk against known values of β carotene in the whole ration.

Similarly, correlation and regression were also calculated for β carotene equivalent and pigmentation score of yolk. The correlation coefficient was 0.722 and the regression equation $y=9.72+0.227x$. With such a high correlation value between two methods of yolk colour measurement it can be said that any one of these two methods can be used for colour measurement. This observation agrees with the findings of Pino *et al.* (1962) and Mathur and Reddy (1974).

From Table 3, it is clear that levels of yellow maize varying from 10 to 65% in ration have no significant effect on egg production and egg weight in isocaloric and isonitrogenous diets. Feed intake varied from 91.2 to 106.0 g/hen/day but no consistent trend was in evidence.

The results of experiment II are presented in Tables 4 and 5. It is evident from these tables that, in general, a positive relationship existed between levels of leaf meals and the intensity of yolk colour. It means that the intensity of egg yolk colour is largely a function of carotenoids present in feed of birds. However, coming to specific leaf meal supplementation in various cereal based rations, it may be observed from Table 5 that incorporation of 6% lucerne meal in wheat ration, 4% berseem meal in white maize, **jowar** and wheat rations, 4% carrot top meal in **jowar** and 6% carrot top in barley and **jowar** rations produced yolk colour of similar intensity as produced by feeding 55% of yellow maize. But slightly different results were obtained when yolk colour intensity was measured in terms of β carotene equivalents. Supplementation of 4 and 6 per cent lucerne meal in all cereal rations under study, 2% berseem in barley and wheat rations and 4 and 6 per cent carrot top meal in barley, **jowar** and wheat rations resulted in similar yolk intensity as in case of control ration. It can be further concluded from these findings that yolk colour measured by β carotene equivalent is more sensitive

TABLE 4

Effect of supplementation of different levels of leaf meals in cereal based laying rations on yolk pigmentation scores

Leaf meal	Level (% of ration)	White maize	Barley	Jowar	Wheat
Lucerne	2	6.0**	8.0**	9.8**	11.0*
	4	9.6**	10.5*	10.5*	9.8**
	6	10.0**	10.0*	11.0*	13.0
Berseem	2	8.3**	9.0**	9.5**	11.0*
	4	11.6	14.0*	11.8	13.5
	6	14.5*	14.3*	13.3*	14.0*
Carrot top	2	7.0**	8.3**	8.0**	6.6**
	4	8.6**	10.8*	11.5	10.6*
	6	9.3**	12.3	11.5	10.3*
Control (55% yellow maize)		12.5	12.5	12.5	12.5

*,**Significant at 5 and 1 per cent, respectively.

TABLE 5

Effect of supplementation of different levels of leaf meals in cereal based laying rations on β carotene equivalent (mcg/g yolk)

Leaf meal	Level (% of ration)	White maize	Barley	Jowar	Wheat
Lucerne	2	0.77**	1.80*	2.33*	2.41*
	4	2.42*	2.74	2.62	2.84
	6	2.65	2.80	2.69	3.50
Berseem	2	1.93*	2.58	2.34*	3.14
	4	3.96*	4.55*	2.54*	3.33
	6	4.90*	4.91**	3.96**	5.03**
Carrot top	2	1.52**	1.83*	2.25*	1.09**
	4	2.23*	2.45	2.90	2.15*
	6	2.24*	3.64*	3.15	2.57
Control (55% yellow maize)		2.99	2.99	2.99	2.99

*,**Significant at 5 and 1 per cent, respectively.

than by pigmentation score. In general, lower levels of leaf supplementation have given the same intensity of yolk colour as found in control ration when measured by β carotene method compared to pigmentation score method.

Data on egg production, egg weight and feed intake of hens under each treatment were collected and have been presented in Table 6. The data of this table may be interpreted with caution as there were only four hens in each treat-

TABLE 6

Effect of leaf meal supplementation in cereal based laying rations on egg production (for 30 days), egg weight (g) and feed intake (g/hen/day)

Leaf meal	Level	White maize			Barley			Jowar			Wheat		
	(% of ration)	Egg production	Egg weight	Feed intake	Egg production	Egg weight	Feed intake	Egg production	Egg weight	Feed intake	Egg production	Egg weight	Feed intake
Lucerne	2	6.2**	53.7	81.8	16.0	53.8	107.8	9.7**	55.1	94.5	11.0**	59.2*	105.6
	4	9.7**	51.9	82.7	9.7**	53.9	104.3	10.5**	58.8*	113.0	11.7*	59.8*	97.3
	6	5.7**	52.6	85.7	10.2*	50.6*	102.0	14.7	57.6*	103.5	14.5	56.8*	93.9
Berseem	2	7.2**	55.6	101.7	11.7*	52.4*	78.4	14.2	55.0	102.9	9.2**	60.2	101.1
	4	7.2**	50.9*	82.8	6.7**	54.3	82.3	13.0*	59.0*	106.3	13.7*	57.6*	112.8
	6	9.0**	56.6	90.8	5 5**	56.1	93.0	12.5*	57.6*	97.9	12.0*	58.0*	97.6
Carrot top	2	7.2**	50.0	88.3	10.5*	57.1	122.9	8.2**	53.9	98.5	15.5*	55.8	106.6
	4	11.2*	54.1	89.1	10.5*	55.5	86.5	14.2	56.7	104.5	8.7**	54.3	92.2
	6	6.2**	53.4	86.3	16.0	57.1	93.6	9.2**	56.5	96.6	15.2	58.9**	109.9
Control (55% yellow maize)		15.2	55.1	92.5	15.2	55.1	92.5	15.2	55.1	92.5	15.2	55.1	92.5

*,**Significantly different from control at 5 and 1 per cent, respectively.

ment and those too were under late stage of laying. Egg production was significantly lower than that of control in white maize ration supplemented with various leaf meals. This may be due to small number of observations. No effect on egg weight was observed due to this treatment. Feed intake was usually less than the control group.

In barley based ration, egg production was significantly lower than control except in cases where 2% of lucerne and 6% carrot top meal supplementation was made. In general, no effect on egg weight was observed, but feed intake in all groups was higher than control.

In jowar rations, egg production decreased compared to control but in few cases like those having 6, 2 and 4 per cent lucerne and carrot top meal, respectively, no effect on egg production was discernible. No consistent effect on feed intake was observed. But there was a trend of increase in egg weight in most of the cases. In general, effect of wheat supplemented with various leaf meals was similar to that of white maize and barley.

A more elaborate experiment on larger number of birds fed various levels of leaf meals like berseem and lucerne may be undertaken to arrive at better practical conclusions.

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STUDIES ON THE REPLACEMENT OF MAIZE WITH HOMINY FEED IN GROWING-FINISHING SWINE RATIONS

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ABSTRACT

Replacement of maize with hominy feed resulted in increased digestibility of crude protein and nitrogen-free extractives in the diets. The average daily gain (ADG) and feed intake were not affected significantly by the inclusion of hominy feed but the efficiency of feed utilization as indicated by feed/gain ratio was better in pigs fed 40 parts of hominy feed as compared to those fed other levels. This was mainly due to significantly ($P<0.05$) less TDN intake/kg of gain. These observations indicated that hominy feed can successfully be incorporated upto 40% of the diet in growing-finishing swine diets.

Maize has been the ingredient of choice in the swine rations but its cost and availability as animal feed justifies the consideration of alternate feed ingredients. Hominy feed, a byproduct of maize meal industry consists of maize germ, bran and some starchy portion of the kernels. Although hominy feed is regularly produced for use in formula feed industry in Western countries (Pfost, 1976) its potentiality as pig feed has not been exploited in India. Paliwal *et al.* (1981) observed that hominy feed could successfully be used upto 30% in broiler rations without affecting growth and feed efficiency. Hanumantha Goud *et al.* (1979) suggested that hominy feed could be incorporated upto 45%, totally replacing maize with highly satisfactory growth response. Present investigations were, therefore, conducted to assess the possibility of replacing maize with hominy feed in growing-finishing pig diets.

MATERIAL AND METHODS

Twelve large White Yorkshire piglets, weaned at 8 weeks of age and weighing 12.9 to 13.3 kg were distributed into three comparable groups of 4 pigs each on the basis of their age and body weight. These pigs were assigned to different dietary treatments after deworming. The pigs under treatment T_1 were fed diet containing 60 parts of maize. Twenty and 40 parts of maize were replaced by the same amount of hominy feed (W/W) under treatment T_2 and treatment T_3, respectively. The detailed ingredient composition of diets has been depicted in Table 1.

The experimental pigs were housed in individual, partly covered pens having separate arrangements for feeding, watering and exercise. Weighed quantity of feed was offered to assure *ad lib.* intake

TABLE 1

Per cent ingredient composition of experimental diets

Ingredients	Diet*		
	T_1	T_2	T_3
Maize	60.0	40.0	20.0
Hominy feed	—	20.0	40.0
Wheat bran	16.5	16.5	16.5
Groundnut cake	15.0	15.0	15.0
Fish meal	6.0	6.0	6.0
Pig mindif	2.0	2.0	2.0
Common salt	0.5	0.5	0.5

*Each 100 kg of the diets were supplemented with 25 g Rovimix (Roche, India), 25 g Rovibe (Roche, India) and 25 g Vitamin B_{12} supplement.

and residues, if any, were recorded daily to find out actual feed intake individually. A digestion trial of 3 days duration was conducted using 2 pigs from each group after 81 days of experimental feeding. Aliquots from different diets, residues and faeces voided by each pig were composited and stored until analysed as per standard procedures (AOAC, 1970). The crude protein content of faeces was determined with fresh faecal samples. Statistical analysis of the data was performed according to the analysis of variance techniques as described in Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

The chemical composition of experimental diets and average digestibility coefficients of proximate principles contained in these diets are presented in Table 2. Replacement of maize with hominy feed resulted into an increase in the total ash and crude fibre contents while a marginal increase also occurred in crude protein content This could be ascribed to the difference in the proximate composition of maize and hominy feed. Hominy feed, on chemical analyses, was found to contain 91.47 dry matter, 16.49 crude protein, 7.93 ether extract, 6.91 crude fibre, 9.80 total ash and 58.87 per cent nitrogen-free extracts (Paliwal *et al.*, 1981). The digestibility coefficient of crude protein increased with increased level of hominy feed. Similar trend was also observed in case of nitrogen-free extracts. However, ether extract and crude fibre digestibilities declined with increased level of hominy feed. This might be due to increased crude fibre levels in the diets containing hominy feed. Such effect of crude fibre content of the diets on the digestibility coefficients of proximate principles has already been reported by various workers (Wahlstorm and Libal, 1979; Rao and Prasad, 1980). Higher nitrogen-free extract digestibility recorded in case of the diets containing more crude fibre was contrary to the findings of Ranjhan *et al.* (1971) and Dhudapker *et al.* (1971) who reported decreased nitrogen free extract digestibility with increased level of dietary crude fibre.

TABLE 2

Chemical composition, digestibility and nutritive value of experimental diets

Parameters	Diet		
	T_1	T_2	T_3
Chemical composition (% DM basis)			
Dry matter	93.00	93.00	92.66
Crude protein	18.06	21.07	19.95
Ether extract	3.87	3.75	4.16
Crude fibre	6.40	6.91	7.13
Nitrogen free extract	65.83	58.45	58.50
Total carbohydrates	72.23	65.36	65.63
Total ash	5.84	9.82	10.26
Digestibility coefficients (%)			
Dry matter	70.56	68.35	70 68
Crude protein	70.23	73.80	76.94
Ether extract	64.82	59.75	60.02
Crude fibre	27.52	28.80	25.51
Nitrogen free extract	76.78	75.85	78.96
Total carbohydrates	72.04	70.48	73.15
Nutritive value (% DM basis)			
DCP (%)	12.68	15.55	15.35
TDN (%)	70.62	66.91	68.98

TABLE 3

Mean nutrient intake and performance of pigs on experimental diets

Parameters	Diet		
	T_1	T_2	T_3
Initial body weight (kg)	12.83	13.25	13.35
	±0.83	±1.28	±1.63
Final body weight (kg)	62.13	62.37	60.75
	±4.16	±3.24	±5.85
Experimental period (days)	84	84	84
Daily gain (g)	583.75	584.75	564.25
	±23 33	±30.67	±52.00
Daily feed consumption (kg)	2.13	2.06	1.82
	±0.09	±0.12	±0.14
DCP intake/day (g)	270.40	319.93	279.43
	±12.01	±18.02	±21.56
TDN intake/day (g)	1505.95	1376.70	1255.45
	±66.95	±77.58	±97.10
Feed : gain	3.67^b	3.52^b	3.24^a
	±0.13	0.04	+0.07
DCP intake/kg gain (g)	465.63^a	546.93^b	497.50^a
	±16.83	±5.58	±11.25
TDN intake/kg gain (g)	2593.29^b	2353.49^a	2236.00^a
	±93.73	±24.08	±50.57

The figures having same superscript do not differ significantly ($P<0.05$) from each other.

Crude protein digestibility was much higher than the figures reported by Ranjhan *et al.* (1971) with Middle White Yorkshire pigs on similar diets employed in the present study. However, these digestibility figures were comparable with those reported by Chhabra *et al.* (1972). Lloyd and Crampton (1955) reported that apparent digestibility of crude protein increased with an increase in dietary crude protein level in growing pigs.

Performance of experimental pigs and their nutrient intake on different experimental diets have been presented in Table 3. It was observed that replacement of maize with hominy feed did not affect the average daily gain. The pigs fed diet containing 40 parts of hominy feed gained at a slower rate in comparison to those fed diets containing 0 and 20 parts of hominy feed. The diffrences among the treatment means were, however, not significant ($P<0.05$). Statistical analysis of the data revealed that pigs under treatment T_3 consumed significantly ($P<0.05$) less feed/kg gain in comparison to pigs under treatment T_1 and T_2.

On the basis of digestibility coefficients arrived at during the present experiment, digestible crude protein (DCP) and total digestible nutrient (TDN) content of the diets, and their intake daily as well as per kg of gain by experimental pigs were calculated (Table 3). It was observed that the pigs under treatment T_3 consumed highest amount of DCP while the TDN intake was maximum in case of pigs under treatment T_1. DCP intake/kg gain of the pigs under treatment T_1 was 465.63 g followed by 497.50 and 546.93 g under treatments T_3 and T_2, respectively. Statistical analysis of the data showed that DCP intake/kg gain was significantly ($P<0.05$) higher under treatment T_2 while there was no significant difference amongst treatments T_1 and T_3 in this regard. Significantly ($P<0.05$) higher TDN intake/kg gain was observed under treatment T_1 while no significant difference accrued amongst treatments T_2 and T_3.

These observations indicated that the pigs fed diets containing 40 parts hominy feed consumed significantly less TDN/kg gain while the DCP intake/kg gain was significantly less than the pigs fed diet containing 20 parts of hominy feed. This might be the reason for better feed utilization by the pigs fed diet containing 40 parts of hominy feed. Thus, it could be deduced that hominy feed could be successfully utilized to replace 66⅔% of maize in growing-finishing swine rations.

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EVALUATION OF WOOL TRAITS IN RAMBOUILLET, CHOKLA AND THEIR DIFFERENT CROSSBREDS

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ABSTRACT

Data on wool quantity and quality of Chokla, Rambouillet and their crosses were analysed to evaluate the effect of crossbreeding on the various wool traits. The crossbreds were significantly better than native with respect to overall performance. Exotic inheritance ranging between 1/2 to 3/4 performed almost similar with marginal superiority of 3/4 over other genetic groups. Thus, introduction of 1/2 Rambouillet exotic inheritance in Chokla improves the wool for its apparel properties besides increasing the total quantity clipped per sheep.

Crossbreeding of local sheep with exotic fine wool type sheep has been recognised as the quickest genetic technique for improving their production performance in respect of wool traits. In such an endeavour Chokla sheep were crossed with Rambouillet to produce different genetic combinations for assessing and evaluating the relative suitability of crossbreds under arid conditions of north-western India. This would help in making the choice as to which genetic combination will be an economically viable group in terms of wool production.

MATERIAL AND METHODS

Wool samples from 16 sq. cm mid side region were taken just prior to shearing during the autumn clip in the year 1976 from 213 adult ewes ranging between 3-4 years. These were maintained at CSWRI, Avikanagar (Rajasthan) under similar management conditions. These sheep were of F_1, F_2, 5/8th, $\frac{3}{4}$th Rambouillet inheritance and purebred Chokla and Rambouillet. The samples were preserved separately with identification card. The laboratory analysis of fleece traits was carried out in wool analysis laboratory of the Department of Animal Breeding, Haryana Agricultural University, Hissar. The following wool traits were measured.

Clean fleece weight per cent. The weighed quantity of wool was scoured according to the method suggested by Johnson (1934). The samples were dried and weighed again and this was taken as the clean fleece weight. The clean fleece per cent was calculated by routine method.

Staple length. The staple length of unscoured wool sample was measured by placing it unstretched on a black valvet board and measuring the length of the lock to the nearest fraction of 0.1 cm. An average of 10 random locks represented the average staple length.

Average fibre diameter. It was measured by standard technique given in Wool Sci. Rev. (1952). Two hundred fibre bits at random were measured in the whole sample.

Medullation percentage. Medullation percentage was calculated from the count of medullated fibre bits while measuring the fibre diameter.

Statistical analysis. Averages along with standard errors of the different genetic groups were calculated. The analysis of variance was computed using the linear model.

$yij = \mu + gi + eij$, where

yij is the jth observation in the genetic group, μ is the overall population mean, gi is the ith genetic group and eij is *random error* $(0, \sigma e^2)$.

RESULTS AND DISCUSSION

Grease Fleece Weight

Significant differences among different genetic groups were observed for this trait (Table 1). The multiple comparison (Table 2) among genetic group means revealed that Rambouillet produced significantly higher fleece than other groups. The F_1 and F_2 half-breds means did not differ and, thus, clustered in one group. The 5/8th and Chokla produced the lightest fleece and their *mean grease* fleece weights were not different significantly. The crossbreds, therefore, were found to produce more fleece than native purebreds. The results obtained are in agreement with the results of Gupta *et al.* (1976), who reported high grease fleece weight in Rambouillet crosses with Gaddi and Poonchi. The present findings also confirm the report of Acharya (1972) on Chokla, Malpura and their crosses with Rambouillet.

Clean Fleece Weight Per cent

Genetic group differences for clean *fleece per cent* were highly significant ($P<0.01$) and were in accordance with the findings of Gour (1975) and Gupta *et al.* (1976) on Indian sheep and their crosses with Corriedale and Rambouillet, respectively. The multiple comparison of genetic groups means showed that Chokla yielded the highest clean fleece per cent followed by 5/8th, $\frac{3}{4}$th, F_1, F_2 and purebred Rambouillet. The

TABLE 1

Between grade means squares for fleece characteristics

Traits	d. f.	M. S.
Fibre diameter	5	1662.53**
Grease fleece wt.	5	2.11**
Clean fleece (%)	5	726.04**
Medullation per cent	4	4276.23**
Fibre diameter	5	56.3 **

**Significant at 1% level.

TABLE 2

Multiple comparison for fleece characteristics

	R	RC	R_3C	RC_2	RC_5	C
Grease fleece wt.	1.64^a	1.35^b	1.32^b	1.22^c	1.17^{cd}	1.10^d
	±0.22	±0.04	±0.04	±0.03	±0.04	±0.02
Clean fleece (%)	45.90^c	49.94^b	50.53^b	48.98^{bc}	56.10^a	56.93^a
	±0.89	±0.98	±1.39	±1.26	±0.99	±2.47
Staple length	2.98^d	4.17^b	3.49^c	4.04^b	3.93^b	6.28^a
	±0.06	±0.10	±0.10	±0.08	±0.09	±0.09
Medullation per cent	0^d	13.37^b	6.08^c	11.99^b	11.66^b	30.19^a
		±0.52	±0.91	±0.59	±0.68	±0.84
Fibre diameter	15.28^d	25.63^{bc}	23.63^c	26.99^b	25.65^{bc}	31.33^a
	±0.16	±1.16	±0.31	±0.57	±0.63	±1.30

Means having similar superscripts do not differ significantly.

R=Rambouillet

RC=$\frac{1}{2}$ Rambouillet+$\frac{1}{2}$ Chokla (F_1)

R_3C=$\frac{3}{4}$ Rambouillet+$\frac{1}{4}$ Chokla

RC_2=$\frac{1}{2}$ Rambouillet+$\frac{1}{2}$ Chokla (F_2)

RC_5=$\frac{5}{8}$ Rambouillet+$\frac{3}{8}$ Chokla

C=Chokla

$\frac{3}{4}$th bred had lower value than 5/8th and Chokla, which is in line with the fact that finer wool had higher grease content and associated extraneous impurities.

Staple Length

The analysis of variance of the trait revealed significant genetic group differences (Table 1) and, thus, conforms with the results of Sule (1968) and Gour (1975). The Chokla had the longest staple which was significantly different from other genetic groups. The comparisons (Table 2) of crossbreds indicated that as the exotic inheritance increases, the staple length decreases. This would require treating the crossbred wool different from native wool and can be conveniently categorised among medium wools suitable for clothing manufacture.

Medullation Per cent

The genetic groups differed (Table 1) significantly ($P<0.01$) for this character and are in agreement with those of Chopra and Chopra (1972) and Gour (1975). The Chokla ewes had the maximum medullation per cent and Rambouillet were devoid of medullated fibres. There was appreciable decline in medullation per cent of crossbreds and values were significantly different from Chokla. Half-breds F_1 and F_2, and 5/8th breds almost constituted one group having medullation in the range of about 12 to 13 per cent. By increasing exotic inheritance to $\frac{3}{4}$ level, this defect was further removed by about 50 per cent. This suggested that Chokla lacked in genes for wooliness and these mostly acted in additive manner.

Average Fibre Thickness

The average fibre thickness among various genetic groups varied between 15 to 31 microns. The finest wool was in Rambouillet and coarsest in Chokla. The Rambouillet crossbreds with Chokla ranged from 23.63 to 26.99 microns. All the crossbreds except F_2 half-bred did not differ from each other. This indicated that all these crossbreds may be pooled together for the synthesis of new breed of finer wool producing sheep. This also suggested that attempts of introducing higher Rambouillet inheritance may not be fruitful in improving the fibre fineness further. This is contrary to Gupta *et al.* (1976) where Rambouillet inheritance when increased in combination with both Poonchi and Gaddi, the average fibre thickness decreased.

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TRIAL OF FROZEN *ANAPLASMA MARGINALE* INFECTED BLOOD AS PROPHYLAXIS AGAINST ANAPLASMOSIS IN CATTLE

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ABSTRACT

Frozen *Anaplasma marginale* infected blood proved to be a good agent for prophylactic immunization in crossbred *(Bos taurus × Bos indicus)* calves. The per cent parasitaemia after challenge in the intact vaccinated animals was negligible, whereas it was only 2 to 3% in the splenectomized vaccinated animals. The haematological changes regarding the packed cell volume and haemoglobin were less in the vaccinated animals. No undesired reactions including the parasitaemia were observed following administration of the frozen blood.

Anaplasmosis is a blood infectious disease of cattle caused by the rickettsia, *Anaplasma marginale*. Significant losses due to this disease occur among cattle in tropical and subtropical parts of the world. In India, the eradication of the vector ticks seems an uphill task if not impossible. A large number of *Bos indicus* (Zebu) cattle are carriers of anaplasmosis. The exotic pure bred *(Bos taurus)* and crossbred *(Bos taurus × Bos indicus)* animals are highly susceptible to anaplasmosis which causes considerable mortality in them. Immunoprophylaxis seems to be the right approach to control anaplasmosis in enzootic areas.

In the past, several attempts were made to immunize cattle against anaplasmosis. These include premunization, immunization with low virulent strain *(A. centrale)*, the use of irradiated (Simpson *et al.*, 1964; Gough and Dimopoullos, 1965), killed (Brock *et al.*, 1965) and attenuated (Ristic *et al.*, 1968) vaccines. But each had certain limitations.

In the present study attempt has been made to immunize cattle with frozen infective blood.

MATERIAL AND METHODS

Preparation of Frozen Blood Vaccine

Frozen blood vaccine was prepared in the following sequential steps :

(a) Blood from a splenectomized crossbred *(Bos taurus × Bos indicus)* male calf showing 70% parasitaemia was collected in 3.85% solution of sodium citrate, in the ratio of 10 : 1.

(b) Glycerin was added as 7% (V/V) in the blood and thoroughly mixed on magnetic stirrer at 4°C for 20 min.

(c) Infected blood-glycerin mixture was then distributed in 50 ml quantities and stored at 4°C for 5 h and subsequently at 0°C for 12 h and finally at −20°C for at least 30 days before using it as a vaccine. At the time of use it was first thawed at 4° C and then at room temperature (25°C).

Schedule of Immunization

Two splenectomized and four intact crossbred male calves, which were serologically negative to *A. marginale* infection were given the primary dose of 20 ml of the vaccine on day zero followed by the booster dose on 30th day. The 6 vaccinated and 3 control—one splenectomized and two intact unvaccinated crossbred calves were challenged on 66th day with 20 ml of infected blood, showing 50% parasitaemia. Clinical manifestations, changes in packed cell volume (PCV), haemoglobin (Hb), per cent parasitaemia, serological response to the indirect fluorescent antibody (IFA) test, were regularly studied during the vaccination period and after challenge.

Criteria of Immunization

(i) Less fall in levels of Hb and PCV in the vaccinated than in the unvaccinated animals after challenge.

(ii) Low levels of per cent parasitaemia in the vaccinated animals as compared to the unvaccinated controls after challenge.

(iii) Development of positive serological response after vaccination and challenge.

RESULTS AND DISCUSSION

The results are presented in Table 1. The prevaccination stage haematological values regarding PCV and Hb were lower in the splenectomized animals than in the non-splenectomized ones. The PCV and Hb values during the prevaccination stages were similar to those recorded during the vaccination stage. All the vaccinated animals were serologically positive to IFA test from day 7, post vaccination and onward. The control animals were found to be positive in IFA test on day 10, post challenge. After challenge with infected blood the splenectomized vaccinated calves (C-10 and C-65) showed a maximum parasitaemia of 2 and 3 per cent and recorded a fall of 11 and 24 per cent in PCV, and 15 and 19 per cent in Hb in comparison to the values recorded during the period of vaccination. The splenectomized control animal (C-80) developed a maximum of 35% parasitaemia and died on day 29 post challenge. Both the PCV and Hb values exhibited a fall of 7% in this animal. In non-splenectomized vaccinated animals the parasitaemia ranged from 0 to 0.5 per cent, during the observation period of 60 days after challenge. The fall in the PCV values was 7, 11, 9 and 12 per cent, whereas in the Hb it was 4, 9, 11 and 8 per cent, respectively. One of the non-splenectomized unvaccinated control animal died on day 40 post-challenge after showing a maximum parasitaemia of 20% and a fall of 15 and 16 per cent in the PCV and Hb values, respectively. The other control animal,

TABLE 1

Average PCV, Hb and serological reactivity of crossbred (*Bos taurus* × *Bos indicus*) calves following vaccination with frozen blood *A. marginale* vaccine and challenge with infected blood

Animal No.	Status	Pre-vaccination				During vaccination stage				Post-challenge			
		Observation period (days)	PCV (%) range & mean	Hb (g%) range & mean	IFAT	Observation period (days)	PCV (%)	Hb (g%)	IFAT	Observation period (days)	PCV (%)	Hb (g%)	IFAT
C-10	S*	35	15-23 (18.8)	5.2-7.8 (6.3)	Neg.	66	14-22 (18.1)	5.2-8.2 (6.3)	+	60	12-19 (16.2)	4.0-6.6 (5.4)	+
C-65	S	35	19-27 (24.0)	6.4-9.0 (8.0)	Neg.	66	18-26 (23.1)	6.2-9.0 (7.9)	+	60	16-25 (17.7)	5.0-9.2 (6.4)	+
C-80	S (unvaccinated)	35	21-24 (22.4)	7.2-8.4 (7.6)	Neg.	66	20-25 (23.1)	7.0-8.2 (7.6)	Neg.	29	18-26 (21.7)	6.0-6.6 (8.2)	+
C-47	NS**	35	18-29 (24.8)	6.2-9.8 (8.3)	Neg.	66	17-30 (24.0)	6.2-9.4 (8.0)	+	60	18-31 (22.4)	5.0-9.8 (7.5)	+
C-13	NS	35	28-33 (30.0)	9.4-11.0 (9.9)	Neg.	66	27-34 (30.2)	9.2-11.4 (10.3)	+	60	23-40 (31.1)	7.6-12.8 (9.9)	+
C-89	NS	35	27-33 (30.8)	8.6-11.2 (10.1)	Neg.	66	28-34 (30.5)	9.4-11.4 (10.3)	+	60	24-35 (27.4)	6.0-11.8 (9.4)	+
C-91	NS	35	26-31 (29.0)	8.4-10.2 (9.5)	Neg.	66	28-32 (30.2)	9.6-11.2 (10.2)	+	60	23-36 (27.5)	7.0-11.6 (9.1)	+
C-6	NS (unvaccinated)	35	27-31 (29.0)	9.0-10.2 (9.5)	Neg.	66	27-32 (29.7)	9.0-10.6 (9.6)	Neg.	60	20-31 (26.3)	6.5-10.8 (8.9)	+
C-96	-do-	35	31-34 (32.4)	10.2-11.8 (10.8)	Neg.	66	30-35 (32.7)	9.8-11.6 (10.6)	Neg.	40	15-35 (28.1)	4.0-12.0 (9.0)	+

*, **Splenectomized and non-splenectomized, respectively.

Two doses of frozen blood vaccine (20 ml each) were given subcutaneously 30 days apart. The vaccinated and unvaccinated control animals were challenged with *A. marginale* infected blood 66 days after vaccination.

however, survived showing a parasitaemia of 6 per cent.

The per cent parasitaemia, after challenge, in the intact and vaccinated animals was negligible, whereas it was only 2 to 3 per cent in the splenectomized animals. The haematological changes regarding the PCV and Hb were not significantly altered in the vaccinated animals and parasitaemia after challenge was very low. It appears that the organisms, when frozen at −20°C for 30 days, either die or get attenuated to such an extent that they could not produce parasitaemia after vaccination, although capable of inducing the immunological reactions in animals. The virulence of *A. marginale* following storage at −20°C seems to have gone down as parasitaemia after vaccination was negligible. Since the number of animals taken for the present study was small, and the dose of frozen *A. marginale* was almost arbitrary, further studies are needed to recommend whether this method of vaccination against anaplasmosis would be effective, practical and safe.

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EFFECT OF SUTURE MATERIALS ON HEALING OF EXPERIMENTAL INTESTINAL ANASTOMOSES IN CALVES

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ABSTRACT

Healing of intestinal anastomoses was studied using mechanical and biochemical techniques to evaluate the effects of absorbable and non-absorbable suture materials in calves. The anastomoses constructed with chromic catgut were weaker throughout the period of investigation than similar anastomoses accomplished with braided black silk. No appreciable difference was noticed in hydroxyproline concentrations in anastomotic margins of absorbable and non-absorbable suture groups.

Several studies have been made on intestinal anastomoses, most of them demonstrated the superiority of one technique of closure over another (Getzen *et al.*, 1966; Loeb, 1967; Bennett and Zydeck, 1970; Jiborn *et al.*, 1978; Singh *et al.*, 1979, 1980a, b). However, systematic studies to observe the effect of various suture materials are scanty, though such studies are available in relation to healing of skin and gastric wounds (Hastings *et al.*, 1975; Van Winkle *et al.*, 1975). To compare the healing pattern of wounds on the basis of rate of mechanical strength gain and the rate of collagenous protein synthesis in intestinal wounds in relation to commonly used absorbable and non-absorbable suture materials in calves, the present study was undertaken.

MATERIAL AND METHODS

The study was conducted on 12 clinically healthy cows calves in age group of $1\frac{1}{2}$–2 years, divided equally into two groups as per suture materials used. Thirty-six anastomoses were accomplished with each suture material at a rate of six anastomoses in each animal.

The overnight fasted animals were pre-medicated with siquil @ 60–80 mg about 20 min prior to surgical intervention. The right paralumbar fossa was prepared surgically after restraining the animal in lateral recumbency. Abdominal cavity was approached under local linear infiltration using 2% lignocaine hydrochloride. The ileum was exteriorized and delivered out of skin incision. The intestinal clamps were applied on either side of the proposed site of resection after milking away the intestinal content. The ileum was transected and the anastomosis of cut ends was accomplished by single layer inverting pattern made by continuous Connell's suture placed about 5 mm away from the cut

ends and about 5 mm apart in all the animals. In animals of group I, chromic catgut 3/0 was used to perform the anastomosis, while braided black silk was used in animals of group II.

The anastomotic site was sprinkled with combiotic powder and abdomen was closed in layers. All the animals received 2.5 g of combiotic intramuscularly on the day of operation and daily for four post-operative days.

Six biopsy materials of intestinal anastomosis of each group were collected on 3rd, 7th, 10th, 15th, 21st and 28th post-operative days. Bursting pressure of each anastomosis of either suture material was recorded as per the method of McAdams *et al.* (1969).

For collagen determination the intestine was dissected free of mesentry and then it was cut along the mesenteric border and smoothed over a paper. The two anastomotic segments of 0.5 cm length were cut. All specimens were dried in an oven at 100°C to constant weight and the dry weight was recorded. Hydroxyproline concentration was determined after hydrolysis in 6*N* HCl for 3 h at 130°C by the method of Amma and Tandon (1969). The hydroxyproline concentration was calculated as micrograms per milligram dry weight tissue. The mean value and standard error were calculated. The comparison between groups and intervals of anastomosis were carried out by student 't' test.

RESULTS AND DISCUSSION

Intestinal wound gained strength rapidly until 14th day of anastomoses in both the groups and thereafter gained little strength. The difference in gain of bursting strength was significant ($P<0.01$) when the values were compared between 3rd and 7th day of either group. When the bursting strength was compared in relation to suture materials used, anastomoses accomplished with non-absorbable sutures have greater strength than the anastomoses made with absorbable sutures at any given intervals. However, the difference was significant ($P<0.05$) only on 7th post-operative day (Fig. 1).

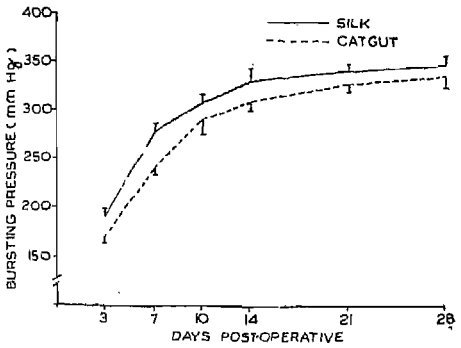


Fig. 1. Bursting pressure of anastomoses constructed with silk and catgut at different time intervals.

No significant difference in rate of collagen synthesis as indicated by hydroxyproline concentration was observed between anastomoses performed with absorbable and non-absorbable sutures. The hydroxyproline concentration decreased significantly in the intestinal tissues by approximately 36 and 46 per cent in anastomoses accomplished by non-absorbable and absorbable sutures on 3rd day as compared to hydroxyproline concentration in normal intestinal wall (25.03 ± 1.71 µg/mg). The decrease was significant even on 7th day in both the

groups and from day 14 through 28, the hydroxyproline began to return to normal limits. Moreover, slightly higher collagen content was noticed in anastomoses made with non-absorbable suture (Fig. 2).

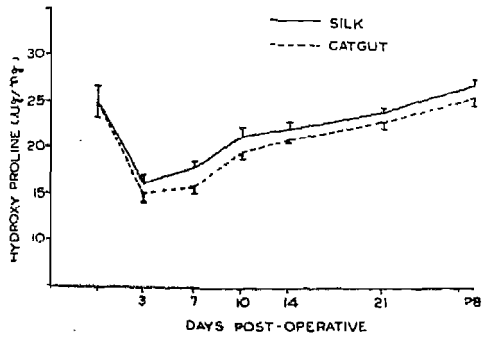


Fig. 2. Hydroxy prolin concentration of intestinal issue following anastomoses with silk and catgut at different time periods.

Two principally different methods could be used to determine the mechanical strength of anastomoses of intestine, namely breaking strength (Hastings *et al.*, 1975; Deveney and Way, 1977) and bursting pressure (Herrmann *et al.*, 1964; Wise *et al*, 1975; Singh *et al.*, 1980b). Measurement of bursting strength has been more widely used because it is considered to reflect the physiologic strain in the intestine more accurately. Bursting strength can be expressed as *bursting pressure, that is the intraluminal* pressure at leakage.

On the third day after operation all the anastomoses leaked irrespective of suture used. The values of bursting strength were low and there was no significant difference between the two groups. The greatest strength gain occurred from 3rd to 7th post-operative day. This finding is consistent with those of other reports (Nelsen and Anders, 1966; Yale and Van Gemert, 1971; Singh *et al.*, 1980a,b). The difference noted in the bursting strength of intestinal wounds closed with absorbable and non-absorbable sutures is difficult to explain. The presence of absorbable sutures may in some unexplained manner alter the strength of adjacent normal intestinal wall. Furthermore, absorbable sutures are digested by proteolytic enzymes secreted mainly by granulocytes and macrophages. It is conceivable that these enzymes can diffuse widely in the intestinal wall and can act to some extent on the tissue protein, however, no direct evidence is available to support this hypothesis.

Fellows *et al.* (1951), however, found no difference in the healing rate between intestinal wounds sutured with cotton and chromic catgut. Their period of observation was only 16 days, but rapid gain of bursting pressure in initial stages of healing was similar to our observations.

The collagen concentration of the anastomotic margin, using hydroxyproline as an index of collagen content decreased significantly in the intestinal specimen at the 3rd post-operative day regardless of sutures used for its construction. No appreciable differences in hydroxyproline concentration were recorded between the two groups at any given interval, though it was always slightly less in anastomoses constructed with chromic catgut. The early decrease in hydroxyproline concentration must be due to increased lysis. Cronin *et al.* (1968)

demonstrated that during the first five days of colonic anastomoses, collagen catabolism and synthesis occurred simultaneously, however, collagen catabolism ceased around the fifth day. The initial breakdown of collagen can so far not be clarified in detail. Mechanical, inflammatory, bacterial and possibly other factors might be responsible for such increased breakdown. Hawley *et al.* (1970) identified a collagenase enzyme at the anastomotic site and have shown marked increase in its activity which might be responsible for breakdown of collagen at initial stage of healing.

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INFECTIVITY OF *THEILERIA ANNULATA* INFECTED *HYALOMMA ANATOLICUM ANATOLICUM* ADULT TICKS INCUBATED AT 37°C AND 95% RH

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ABSTRACT

Infectivity of *Theileria annulata* infected *Hyalomma anatolicum anatolicum* adult ticks incubated for 0, 72, 96, 120, and 144 h at 37°C and 95% RH vis-a-vis *Theileria annulata* infected *H. a. anatolicum* adult ticks fed for 72 h on a calf against a control was studied on crossbred calves by injecting ground-up-tick-supernate (GUTS). All the five types of GUTS were found to be infective to susceptible calves though parasitaemia was low, pathogenic effect was minimum and none of the calves of those groups injected with inoculum of incubated ticks died except one calf of one group which developed clinical theileriosis. Calves which received GUTS of ticks fed for 72 h on a calf suffered severely and both of them died of acute theileriosis. It indicates that blood meal helps in the production of large number of infective particles in infected ticks in a way not known as yet.

Feeding of infected ticks on calves/rabbits for 72/96 h is an integral part in the process of infective tick stabilate preparation for transmission of *Theileria* infection to experimental calves. It involves considerable time and is a laborious process. Recently Samish (1977) reported that homogenate prepared from unfed *T. annulata* infected *H. excavatum* adult ticks incubated at 37°C and 95% RH caused lethal theileriosis in calves and confirmed the observations of Mazlum (1969) who was also able to transmit theileriosis through suspension prepared from unfed infected adult *Hyalomma dromedarii*. However, Young *et al.* (1979) observed that *T. parva* parasites infective to cattle could be induced by exposure of infected adult *R. appendiculatus* ticks at 37°C, the production of sporozoites of *T. parva* was not as efficient as by feeding ticks on rabbits. The present study was therefore, planned to observe the effect of incubation at 37°C and 95% RH on *T. annulata* infected *H. a. anatolicum* ticks with reference to their infectivity and immunogenicity in susceptible calves.

MATERIAL AND METHODS

Experimental Animals and Parasite. A total of 14 male, 2 to 3 months old crossbred calves (*Bos indicus* (Hariana) × *Bos taurus*) were used for

the present study. The calves were reared under tick-free conditions, with no known opportunities of *Theileria* infection. Before the animals were experimentally inoculated, serum samples were obtained and examined by complement fixation (CF) test (Dhar and Gautam, 1977) to verify freedom of infection. Only those animals whose sera did not show any CF antibody titre, were used.

A virulent strain of *T. annulata* isolated locally and maintained cyclically in *H. a. anatolicum* and susceptible calves was used.

Preparation of Inoculum. Nymphs from clean colonies of *H. a. anatolicum* maintained in this laboratory were allowed to engorge on *T. annulata* infected calves (having *T. annulata* erythrocytic forms). Following moulting the adult ticks were incubated at 37°C and 95% RH in an incubator for varying intervals.

The tick supernate was prepared according to the method of Singh *et al.* (1979). The supernate was so collected that each millilitre of it represented infective material from 25 ticks.

Experimental design. The experiment was conducted with 14 calves, allotted to 7 groups. Group A calves were infected by tick supernate prepared from unincubated ticks. Calves of groups B, C, D and E were injected tick supernate prepared from ticks incubated for 72, 96, 120 and 144h, respectively. Group F calves were injected tick supernate prepared from ticks fed for 72 h on a *T. annulata* carrier calf. All surviving calves (groups A through F) were challenge exposed with 30 infective adult *H. a. anatolicum* on post inoculation day 45 along with group G calves which served as challenge control.

Variables measured. Rectal temperature was recorded once each day and the prescapular lymph node was palpated for enlargement. Giemsa-stained biopsy material (smears) of lymph node tissue was obtained and examined for schizonts and peripheral blood smears prepared and examined for piroplasms. To assess antibody response CF antibody titres were examined by the method of Dhar and Gautam (1977). Necropsy was performed on all calves after death.

RESULTS

The reactions of the calves are summarised in Table 1. Only one calf of group A showed thermal reaction (39.5°C) on day 7 post inoculation which lasted for one day. Lymph gland enlargement was absent and schizonts could not be detected in lymph gland biopsy smears. Parasitaemia was less than 1% in both the calves and was detected on day 18 in one calf and on day 20 in the other calf. Mean maximum fall in haemoglobin (Hb) and packed cell volume (PCV) was 6.9 and 7.5 per cent, respectively. The complement-fixing (CF) antibody titre ranged from 1:5 to 1:40. One of two calves of group B (injected with GUTS prepared from ticks incubated for 72 h) developed clinical theileriosis (prepatent period 18 days, rectal temperature 40°C, two fold enlargement of prescapular lymph node, 2% schizonts in lymph node biopsy,

TABLE 1

Reaction of cross-bred calves inoculated with ground up tick supernate prepared from *H. a. anatolicum* ticks infected with *T. annulata* incubated at 37°C and 95% RH for various intervals

Particulars	Groups						
	A	B	C	D	E	F*	G**
Tick supernate inoculum, incubation time (h)	0	72	96	120	144	72	—
Prepatent period (days)	19	18	16	15.5	15.5	12.3	12.0
Day temperature	7	15	—	—	—	10.2	9.5
Maximum temperature (°C)	39.5	40.0	—	—	—	40.6	40.2
Duration of temperature (days)	1	4	—	—	—	8.25	9.0
Mean maximum parasitaemia (%)	<1	24	<1	<1	<1	29.75	34.5
Mean maximum haemoglobin decrease (%)	6.9	15.0	9.9	15.0	12.3	46.80	31.8
Mean maximum PCV decrease (%)	7.5	13.0	10.9	4.7	9.6	54.5	28.8
Deaths/number of calves	0/2	1/2	0/2	0/2	0/2	2/2	2/2
Result of infective tick challenge	Suscep-tible	Suscep-tible	Suscep-tible	Suscep-tible	Suscep-tible	—	Suscep-tible

*GUTS prepared from 72 h fed ticks was inoculated.

**Reactions as seen when challenge exposed.

mean peak parasitaemia 24%, mean decrease in PCV 13% and Hb 15%) and died on day 22 post-infection. Post-mortem examination revealed typical lesions of theileriosis. The other calf reacted very mildly. There was neither rise in temperature nor enlargement of lymph nodes. Parasitaemia was less than 1% and fall in PCV and Hb values was 14.0 and 18.8 per cent, respectively. The CF antibody titre was 1:40. In calves of group C prepatent period was 16 days. Temperature, lymph gland enlargement and schizonts in lymph node biopsy smears were not observed. Parasitaemia was less than 1 per cent. Mean maximum fall in PCV and Hb was 10.9 and 9.9 per cent, respectively. Maximum CF titre ranged from 1:5 to 1:20. Calves of group D had prepatent period 15 to 16 days even though thermal reaction, lymph gland enlargement and schizonts in lymph gland biopsy smears were not recorded. Parasitaemia was less than 1% and fall in PCV (4.7%) and Hb (15.0%) was seen only in one calf. Maximum CF titre varied from 1:5 to 1:80. Prepatent period was 15 to 16 days in calves of group E. Thermal reaction, lymph gland enlargement, and schizonts in lymph gland biopsy smears were not seen. Parasitaemia was less than 1% and decrease in PCV (9.6%) and Hb (12.3%) was observed only in one calf. Calves of group F showed typical symptoms of theileriosis (prepatent period 12.3 days, four-fold enlargement of prescapular lymph gland, maximum rectal temperature 40.6°C, 12.5% schizonts in lymph node biopsy smears, maximum parasitaemia 29.75%, mean decrease in PCV 54.5% and Hb 46.8%) and one of them died on day 21 and other on day 23 post-infection. Post-mortem examination revealed typical lesions of theileriosis.

All the surviving calves of groups A through F along with group G calves on challenge exposure to 30 ticks suffered severely having the clinical signs of theileriosis and died.

DISCUSSION

From the results it was evident that GUTS prepared from 0, 72, 96, 120 and 144 h incubated ticks were infective to susceptible calves. Gradual reduction in the prepatent period from group A to group E indicated that incubation of ticks might have resulted in the development of parasite in the salivary gland resulting in production of larger number of infective particles with increasing period of incubation. However, the pathogenic effects in all the groups (groups A to E) were very minimal. Parasitaemia was less than 1 per cent. Only one calf of group B showed high parasitaemia and died of theileriosis. It could have been probably due to individual susceptibility. Whereas, inoculation of GUTS prepared from similar number of ticks from same batch after feeding for 72 h resulted in severe reaction and death of both the calves of group F. Similar observation was made by Young *et al.* (1979) in *T. parva* infection. It, thus, indicates that probably blood meal helps in the production of large number of infective particles in the salivary gland of ticks in a way not known as yet.

The inability of the calves of groups A to E to withstand a severe challenge

might be because of the lack of optimal level of infection necessary to evince an optimal immune response. This observation is in conformity with that of Wilson (1950) who concluded that in East Coast fever the durability of immunity depended on the severity of original attack, being durable when attack was severe and transient and never solid when the attack was mild. Hashemi-Fesharki (1978) also observed that a minimal infection was necessary not only to establish infection, but also for development of resistance.

Since the GUTS used in this study caused only mild infection and not an optimal immune response, it would be interesting to study whether it is possible to increase the severity of the infection in order to elicit an immune response by increasing the number of ticks.

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RESEARCH NOTE

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TESTICULAR CHOLESTEROL AND ASCORBIC ACID CONCENTRATION IN DRAKES APPROACHING SEXUAL MATURITY

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High cholesterol concentration in the inactive, off-breeding season testes and its depletion at the recrudescence of spermatogenic and hormonal activity in breeding season has been reported in some birds (Hoffman, 1960; Hilton, 1961; Kanwar *et al.*, 1977). Direct relationship of ascorbic acid depletion and steroidogenesis in adrenal tissue (Coste *et al.*, 1953; Kitbachi, 1967) is well established. In ovarian tissue, both ascorbic acid (Parlow, 1958) and cholesterol (Bell *et al.*, 1964) depletions are powerful assay tools for luteinizing hormone activity, the inducer of steroidogenic activity. Taking advantage of this knowledge, Chand *et al.* (1978, 1979) in chicks and Arneja *et al.* (1980) in turkeys studied cholesterol and ascorbic acid changes in testicular tissue and found a dramatic drop in their level as sexual maturity approached. The present study was undertaken to see whether in drake testicular tissue also these relationships exist.

From a stock of 40 White Pekin drakes, batches of five birds were slaughtered from 70 days of age at an interval of 21 days. Midway between 133 and 154 days, an extra batch was also slaughtered at 143 days age. The testicular tissue was quickly removed, cleared of tissue debris and weighed. Tissues, upto 1 g from each bird, were used for lipid extraction in chloroform-methanol (2:1 v/v) mixture (Folch *et al.*, 1957) and suitable aliquot of this extract was made use of to estimate cholesterol concentration (Zlatkis *et al.*, 1953). Another similar portion of tissue was used for estimation of ascorbic acid (Dasgupta *et al.*, 1962). The results obtained were expressed per g testicular tissue (Table 1) and statistically analysed (Steele and Torrie, 1960).

The trend in both parameters was towards depletion as the age advanced and the change was significant ($P<0.05$). The values were significantly ($P<0.05$) and strikingly low at 154 days age and remained at that level thereafter. Microscopic examination of the testicular tissue at this time showed that all the seminiferous tubules contained sperma-

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TABLE 1

Age related changes in testicular size and cholesterol and ascorbic acid concentration of testicular tissue in drakes

Age (days)	Testis weight (g)	Testicular cholesterol (mg/g)	Testicular ascorbic acid (mg/g)
70	0.20	40.0±5.22a	1.55±0.136a
91	0.23	33.0±2.66b	1.34±0.115b
112	0.37	26.0±1.70c	1.34±0.029b
133	3.04	24.7±1.34c	1.11±0.025c
143	3.41	24.9±1.34c	0.93±0.068c
154	31.97	9.9±0.30d	0.16±0.015d
175	57.44	7.4±0.33d	0.17±0.009d
196	57.76	6.9±0.12d	0.16±0.006d

Values with the same superscript within a column do not differ from each other significantly ($P<0.05$)

tids in comparison to the picture at 143 days when only a few tubules showed spermatids (Goyal, 1981). Therefore, the age of active spermatogenesis in drakes, falling around 150 days, resulted in depletion in both cholesterol and ascorbic acid, probably due to a greatly enhanced steroidogenic activity of the testicular tissue at this time. Though steroidogenesis starts in gonads even at embryonal status (Sturkie, 1976), it is not until an actively spermatogenic state, a full scale steroidogenesis is sparked off. It is the cells in advanced stages of spermatogenesis that are implicated in depletion of cholesterol (Johnson *et al.*, 1970). This must be the critical age at which interstitial cell stimulating hormone (ICSH/LH) has reached the level required to induce steroidogenic activity. The testicular size continued to increase until the end of the study, though not much after 175 days age.

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A COMPARATIVE STUDY OF THE PERFORMANCE AND CARCASS QUALITY OF EXOTIC, CROSSBRED AND *DESI* PIGS FROM WEANING TO MARKET

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Aggarwala (1961) reported a very poor growth rate (281 g daily) for graded *desi* pigs. No information, however, is available about the performance of *desi* pigs crossed with exotic ones. Thus, the present study was undertaken to determine the relative performance and carcass quality of exotic (Middle White Yorkshire), *desi* pigs and their crosses under optimum managemental conditions.

Six Middle White Yorkshire, six *desi* and six crosses of *desi* with exotic weaned piglets were used in the present study. The exotic and crossbred pigs weighed 14 kg and *desi* 9.9 kg at the start of the experiment at 8 weeks of age. The pigs were dewormed and allowed an adjustment period of 7 days before being fed the experimental diets. The composition of different diets is presented in Table 1. The feed ingredients and diets were analysed by standard methods as described by AOAC (1970). The diets met the requirements of NRC (1968). All pigs were fed the grower diet for 92 days followed by the finisher diet for 21 days. The pigs were slaughtered at the end of the feeding trial as per procedure described by Satya Parkash *et al.* (1976). The data were analysed according to procedures laid down by Steel and Torrie (1960).

The performance and carcass traits of exotic, crossbred and *desi* pigs are presented in Table 2. On an average the daily gain of exotic, cross bred and *desi* pigs during the growing period was 492, 399 and 165 g, respectively. It was further revealed by the data that the three categories of pigs needed 3.11, 3.40 and 4.22 kg of feed, respectively, per kg of gain.

The differences among the treatment means were found to be statistically significant ($P<.05$). The same trend in these two important parameters of growth study of pigs was observed during the finishing and combined growing-finishing periods. These findings agree with those of Aggarwala (1961) and Sharda *et al.* (1981) in so far as the Middle White Yorkshire and *desi* pigs are concerned. No information, however, is available about the crossbred pigs.

The perusal of the data revealed that at the end of the feeding period the kill

TABLE 1

Per cent composition of diets

Ingredients	Diet identification	
	Grower	Finisher
Maize	80.2	86.2
Groundnut cake	11.3	5.3
Fish meal	6.0	6.0
Mindif pigs[a]	0.5	0.5
Ground limestone	1.0	1.0
Steamed bone meal	1.0	1.0
Rovimix[b]	15g	15g
Rovibe[c]	25g	25g
Crude protein %	16	14
ME Kcal/kg	3126	3129
Lysine %	0.73	0.50
Tryptophan %	0.14	0.12

[a]Mindif contained 25% calcium, 9% phosphorus, 30% sodium chloride, 0.5% iron, 0.05% iodine, 0.08% copper, 0.10% manganese, 0.15% cobalt, and 0.15% sulphur.

[b]Rovimix contained vitamin A 40,000 I. U., B_2 20 mg and D_3 5,000 I. U. per g supplement.

[c]Rovibe contained vitamins B_1 4 mg, B_6 8 mg, B_{12} 40 mg, niacine 16 mg, calcium pantothenate 40 mg and E 40 mg per g supplement.

TABLE 2

Performance and carcass traits of exotic, crossbred and *desi* pigs from weaning to market

	Exotic	Crossbred	*Desi*	CD ($P<.05$)
Growing period				
Av. daily gain (g)	492	399	165	50
Feed/gain ratio	3.11	3.40	4.22	0.84
Finishing period				
Av. daily gain (g)	638	482	134	84
Feed/gain ratio	4.09	5.27	7.42	2.02
Combined period				
Av. daily gain (g)	520	414	160	48
Feed/gain ratio	3.33	3.78	5.91	1.16
Carcass traits				
Kill weight (kg)	61.1	65.7	34.3	9.0
Dressing per cent	64.4	62.5	56.9	2.8
Length (cm)	64.8	61.0	49.3	4.0
Av. back fat thickness (cm)	3.07	3.67	1.34	0.47
Lean cut %	63.2	63.4	68.3	3.66
Primal cut %	76.3	78.1	81.4	2.24

weight of *desi* pigs was smaller (34.3 kg) as compared to that of exotic (61.1 kg) and crossbred (65.7 kg). The dressing percentage of the exotic and crossbred pigs was similar but significantly larger from that of *desi* pigs. The average back fat thickness was only 1.34 cm for the *desi* pigs, whereas it was 3.07 and 3.67 cm for the exotic and crossbred pigs, respectively. The differences among the treatment means were significant. The lean cut and primal cut per cent was also similar for the exotic and crossbred pigs but significantly smaller than those of *desi* pigs ($P<.05$).

The present study revealed the performance of *desi* pigs very poor as compared to that of exotic ones and that it could be improved by crossing these with exotic breeds of pigs.

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STUDIES ON OIL PREFERENCES IN INDIAN DESERT GERBIL–*MERIONES HURRIANAE* JERDON

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The present attempt was to sort-out, under confined conditions, the most preferred oil to be used for the control of Indian desert gerbil-*Meriones hurrianae* Jerdon. The oils used for evaluation were groundnut oil, mustard oil, coconut oil and gingely oil. Coarsely grounded gram, soyabean and maize, mixed in equal proportions, constituted the ingredients of food supplied (control diet). The food consisted of 90% of control diet plus 10% (w/w) of the adjuvant (oil). Recording of feed consumption was made every day for a period of 7 days. Ten rats (five males and five females) were used in each experiment. Individuals were kept in isolated cages following Durairaj and Rao (1975).

Preference Among Free Choice of Different Food Materials

The control diet without additive and with four different oils was tried independently. Five containers with 20 g of each food were kept in four corners and the centre of cage. The data (Table 1) on the mean values of food consumption showed linear preferential order in the following manner : Control diet>groundnut oil diet>mustard oil diet>coconut oil diet>gingely oil diet.

The mean values of food consumption between control diet and groundnut oil diet were subjected to 't' test and the results indicate significant differences (5%).

Paired Preference Test Between Control Diet and Groundnut Oil Diet

The two most preferred diets, i. e., control diet and groundnut oil diet, were subjected to paired preference test. The data (Table 2) revealed that the average consumption of diet without adjuvant definitely has an edge over the diet mixed with groundnut oil.

The specific influence of oil as the bait enhancing component was considered but it was found that the addition of vegetable oil did not increase the bait consumption in *M. hurrianae*. Of the four different oil components tried in the experimental diet, no oil was better preferred than the control diet.

TABLE 1

Preference among free choice of different food materials

	Mean food consumption per day (7 days average)									
	Control diet		Groundnut oil diet		Mustard oil diet		Coconut oil diet		Gingely oil diet	
	Diet (g)	Diet/kg of rat	Diet (g)	Diet/kg of rat	Diet (g)	Diet/kg of rat	Diet (g)	Diet/kg of rat	Diet (g)	Diet/kg of rat
Mean for males	7.44± 0.32	86.90± 9.06	4.69± 0.52	52.15± 3.19	3.58± 0.32	40.12± 1.53	2.83± 0.23	32.12± 0.49	1.84± 0.15	21.40± 2.62
Mean for females	5.82± 0.53	104.00± 12.16	4.84± 0.48	85.03± 8.42	3.92± 0.37	71.00± 10.40	2.75± 0.34	55.04± 13.89	1.54± 0.17	31.04± 8.00
Mean (Total)	6.63± 0.41	95.44± 8.07	4.75± 0.35	68.58± 6.88	3.74± 0.25	55.55± 7.17	2.79± 0.21	43.57± 7.90	1.68± 0.12	26.22± 4.48

TABLE 2

Paired preference test between control diet and groundnut oil diet

	Mean food consumption per day (7 days average)			
	Control diet		Groundnut oil diet	
	Diet (g)	Diet/kg of rat	Diet (g)	Diet/kg of rat
Mean for males	9.16±0.23	105.45± 6.55	6.30±0.71	70.59± 4.12
Mean for females	8.33±0.29	156.89±26.50	6.27±0.42	120.40±23.25
Mean (Total)	8.74±0.22	131.16±15.84	6.29±0.41	95.49±14.42

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STUDY ON THE PERFORMANCE OF TOMATO VARIETIES UNDER HIGH TEMPERATURE CONDITIONS

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ABSTRACT

Out of 60 tomato varieties evaluated during off season, to identify varieties suitable for raising a summer crop, varieties TAMU-saladette, HS-102 and HS-101 M_3 were found to give the early fruit set along with highest early and total yield during both the planting periods which was attributed to capacity of these varieties to set fruit at higher temperature conditions. Ox-heart was poorest for the characters. In general, varieties gave better yield performance in June planting than in March planting.

Under normal conditions in north Indian plains, tomato grown in autumn and early spring do not present any serious problem. However, when the crop is planted late in the spring or summer the fruit set is considerably reduced. Tomato plants are photo-periodically insensitive but high temperature during the day time coupled with warm nights cause the abscission of flowers and poor fruit set thereby reducing the yield considerably. Iwahori *et al.* (1963) also reported very poor fruit set at the high atmospheric temperature of 40-45°C. Moreover, Iwahori and Takahashi (1963) reported poor survival of transplants and poor fruit set in field under high temperature during summer season. Hence, there is a little production of tomatoes in this region during period ranging from June to beginning of October. A very little information is available regarding the production of tomatoes during summer season. Pandita *et al.* (1979) have reported that this objective can be partially achieved and period of non-availability of tomatoes during this period can be reduced by application of single foliar spray of 50 ppm PCPA at full blooming stage during hot summer months. Similarly Arora *et al.* (1981a) reported that a single foliar application of 50 ppm PCPA+25 ppm molybdenum at full flowering produced sizeable early and total yield of tomatoes during hot summer months. In addition to this, Arora *et al.* (1981b) reported highest early and total yield of tomato fruits by foliar application of 250 ppm ethrel (ripening agent) at mature green fruit stage under attached and detached conditions during hot summer months. Although a number of studies have been

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conducted to single out high yielding varieties of tomato in normal season yet information is not available regarding varietal behaviour with respect to growth, flowering, fruit set and yield during hot summer months. The present investigations were, therefore, undertaken with a view to screen available varieties of tomatoes suitable for producing crop during summer.

MATERIAL AND METHODS

The experiment was conducted at the Vegetable Research Farm, Haryana Agricultural University, Hissar. Sixty exotic and indigenous varieties of tomato were planted during summer season of the year 1976 on March 25 and June 20 in randomised block design with three replications having spacing of 60 and 45 cm between and within rows, respectively. The plot size was 3.6 × 1.2 m net having two rows with eight plants per row, giving a total of 16 plants per variety. The monthly mean maximum and minimum temperature during the periods of investigation is presented in Table 1.

The observations were recorded from 10 randomly selected plants on plant height, branches per plant, days to first flowering, number of fruit set 20 days after first flowering, flowers per inflorescence, fruits per truss, number and weight of fruits from early and total yield.

RESULTS AND DISCUSSION

Growth Characters

The mean performance of 60 tomato varieties for different characters has been presented in Table 2. The plant height recorded 10 weeks after transplanting has indicated significant differences among varieties in both the plantings. In March planted crop, maximum height was observed in variety Kalyanpur Angurlata while minimum in TAMU-Saladette. In June planting, maximum height was observed in Pritchard while minimum in TAMU-Saladette. In generel, the plants in all the 60 varieties were taller in June planted crop as compared to March planting.

TABLE 1

Average maximum and minimum temperature of Hissar for the experimental period of February to October, 1976

Month	Highest day temp. in the month (°C)	Mean max. temp. (°C)	Highest night temp. in the month (°C)	Mean min. temp. (°C)
Feb.	27.1	22.6	13.7	8.6
March	31.5	27.8	16.6	10.5
April	41.8	34.9	22.5	15.9
May	43.3	39.4	26.7	22.1
June	45.2	38.0	31.6	25.2
July	42.3	36.6	30.5	26.3
Aug.	36.3	32.5	26.1	24.6
Sep.	35.6	33.8	25.6	22.2
Oct.	37.1	34.4	20.0	16.1

TABLE

Mean value of tomato varieties for different characters under

S. No.	Varieties	Plant height (cm)		Branches per plant		Days to first flowering		Fruits per plant 20 days after first flowering	
		M	J	M	J	M	J	M	J
1	2	3	4	5	6	7	8	9	10
1.	Pusa Ruby	52.1	121.1	30.4	39.9	25.4	40.6	15.8	16.9
2.	TAMU-Saladette	35.4	60.5	20.6	29.3	20.1	41.1	22.7	18.7
3.	*Ox-heart*	64.3	121.3	35.0	31.0	30.2	50.3	1.1	1.8
4.	HS-102	46.7	74.4	21.1	25.5	19.6	39.1	17.6	24.4
5.	Panaco	55.7	91.0	16.6	26.8	24.3	44.2	9.3	8.9
6.	Pusa Lal Meeruti	57.1	127.3	23.1	29.5	29.3	42.3	12.4	13.3
7.	HS 101	39.6	85.9	22.3	30.2	24.2	42.0	11.5	16.6
8.	Pusa Early Dwarf	46.0	95.4	20.4	31.9	28.7	43.6	7.7	12.6
9.	Pusa Lal	65.5	104.7	22.0	26.3	27.7	44.2	9.8	11.3
10.	Cherry	53.6	109.1	26.2	33.5	30.2	44.1	7.5	13.3
11.	Kalyanpur Kuber	70.8	91.6	29.2	39.9	28.8	43.5	9.0	11.3
12.	Kalyanpur Type-1	64.5	125.1	25.3	27.2	27.5	44.1	7.5	9.9
13.	HS 101 M_3	48.6	102.5	25.7	28.2	22.5	38.8	17.5	20.8
14.	Pusa Ruby XS-12 F_1	56.3	119.1	16.7	34.9	26.5	42.4	9.7	11.6
15.	SI-120×HS-101	48.2	99.5	23.6	34.2	25.4	44.8	10.8	11.0
16.	Italian Red	48.0	109.4	22.1	30.3	29.4	44.3	8 6	9.9
17.	Kalyanpur Angur-lata	83.7	122.3	38.0	36.8	29.0	43.6	8.0	14.7
18.	Poosa Ruby (P)	46.6	125.1	25.9	32.9	28.4	43.1	9.5	12.4
19.	HS-103	50.6	93.5	26.5	29.1	24.4	41.5	11.9	15.9
20.	Marglobe standard	56.1	112.7	25.5	36.9	27.7	42.2	8.5	11.0
21.	63 VF-21	45.8	79.0	30.7	32.8	25.6	42.4	10.8	11.7
22.	Pritchard	56.4	142.8	23.5	40.0	29.3	44.6	5.8	10.6
23.	Resistant-2	54.6	90.1	28.8	30.7	27.2	41.8	6.9	11.2
24.	Tomato No. 1076	61.4	99.3	22.0	28.0	27.7	43.7	6.1	11.3
25.	Tomato No. 283	38.5	72.6	19.1	22.9	27.1	41.0	6.8	11.0
26.	Tomato No. 2972	56.4	111.1	28.4	30.3	29.4	41.8	5.1	10.1
27.	Tomato No. 232	45.9	69.9	20.1	17.2	25.6	42.0	7.8	15.6

2

two planting dates during summer (March=M June=J)

Flowers per inflores-cence		Fruits per truss		Fruits per plant (early yield)		Early yield per plant (kg)		Fruits per plant (total yield)		Total yield per plant (kg)	
M	J	M	J	M	J	M	J	M	J	M	J
11	12	13	14	15	16	17	18	19	20	21	22
3.5	4.8	2.2	3.4	22.8	32.1	0.60	0.98	44.7	52.0	1.25	1.64
5.6	6.0	3.1	3.7	29.8	41.9	1.29	1.55	46.1	58.3	1.86	2.29
4.1	4.5	1.0	1.8	1 3	4.3	0.05	0.21	2.6	7.1	0.08	0.31
3.7	4.3	2.9	4.2	31.1	46.5	1.25	1.50	53.9	62.9	1.56	2.15
5.2	5.5	1.6	2.9	11.9	17.4	0.20	0.50	16.1	28.6	0.37	0.89
3.1	5.0	1.9	4.2	21.3	24.7	0.52	0.91	40.4	45.6	1.09	1.61
4.0	4.8	1.9	3.9	19.9	30.5	0.48	0.90	35.3	50.5	1.01	1.44
3.7	4.3	1.7	4.0	10.9	24.5	0.33	0.77	23.6	38.0	0.68	1.18
4.1	4.6	2.2	3.9	14.9	24.5	0.32	0.75	32.6	40.8	0.71	1.31
3.5	4.0	2.0	3.9	13.8	21.8	0.35	0.68	28.4	38.3	0.75	1.21
3.9	4.5	1.7	3.1	12.9	24.8	0.28	0.77	28.2	44.2	0.70	1.32
4.1	5.4	2.3	3.9	15.6	24.6	0.34	0.69	31.3	43.3	0.71	1.24
4.1	5.4	3.1	4.7	31.9	42.4	1.16	1.31	48.8	68.0	1.30	1.90
4.0	4.8	2.6	4.6	16.7	19.7	0.40	0.55	27.1	35.7	0.73	1.04
3.1	4.1	1.9	3.7	14.9	24.0	0.38	0.74	30.7	37.3	0.84	1.20
3.3	3.3	1.7	3.0	11.1	23.2	0.26	0.71	27.3	35.0	0.78	1.14
5.3	7.3	2.9	6.4	15.5	29.1	0.27	0.68	32.5	58.8	0.72	1.39
4.2	4.3	2.2	4.0	14.3	26.4	0.32	0.72	27.7	41.7	0.69	1.15
4.1	4.5	2.5	4.1	18.4	33.4	0.49	1.09	38.8	48.1	1.14	1.72
3.7	5.2	1.7	3.5	13.4	20.7	0.32	0.71	27.3	41.8	0.69	1.42
4.1	4.4	2.4	4.1	17.7	24.1	0.43	0.77	38.5	43.9	0.95	1.33
3.9	4.8	1.9	3.4	12.3	25.1	0.30	0.70	29.7	37.3	0.79	1.15
3.4	4.5	2.1	4.4	13.0	29.8	0.39	0.74	30.3	41.8	0.79	1.24
6.2	8.4	2.1	4.6	9.5	23.6	0.17	0.71	20.0	41.0	0.41	1.14
4.9	6.4	2.2	3.3	15.3	24.5	0.47	0.80	29.0	37.7	1.08	1.43
3.6	9.5	2.0	7.4	10.3	26.8	0.22	0.71	19.2	43.8	0.41	1.20
4.6	5.6	2.0	3.5	9.5	20.8	0.15	0.57	19.5	39.5	0.37	1.20

1	2	3	4	5	6	7	8	9	10
28.	Tomato No. 3716	45.9	98.4	16.4	32.6	23.5	45.5	6.5	11.2
29.	Tomato No. 3693	66.3	94.7	23.4	30.7	25.2	44.4	6.2	11.1
30.	Tomato No. 226	29.4	107.8	10.0	19.4	25.9	42.6	6.3	23.0
31.	Tomato No. 3690	55.6	111.6	16.2	22.3	30.3	44.3	8.3	9.7
32.	Tomato No. 3692	61.7	90.4	21.6	29.1	28.4	44.4	4.0	13.1
33.	V-391	50.1	113.9	21.0	33.3	26.7	42.2	6.8	10.2
34.	Selection 4-1	52.0	114.7	21.2	32.4	25.1	44.0	12.1	15.1
35.	Red Pear	81.8	99.2	29.6	30.5	29.6	44.3	8.3	10.0
36.	Pantnagar Hybrid-14	51.7	92.7	31.9	36.7	26.7	42.1	10.0	11.3
37.	Sioux	43.0	121.8	32.4	27.8	25.0	43.2	7.0	11.5
38.	Best of All	54.6	127.4	25.9	30.3	28.4	43.5	5.7	12.1
39.	Hybride 42128	57.2	113.3	22.5	26.7	31.4	47.3	3.2	3.8
40.	Monarch	69.3	97.2	36.3	28.9	29.8	43.7	7.8	9.9
41.	Red Plum	65.5	115.1	22.9	33.1	30.6	43.3	11.2	11.5
42.	Monarch Ponderosa	61.2	118.3	24.4	35.5	29.1	44.4	9.2	11.1
43.	Mikado	60.6	87.7	22.9	25.3	29.4	44.4	8.0	9.0
44.	Sweet-72	52.3	112.5	24.9	30.3	25.7	44.1	6.9	13.6
45.	Improved Meeruti	58.8	105.1	28.0	27.6	25.8	43.5	8.8	12.8
46.	Marglobe Supreme	58.0	122.3	32.1	31.7	27.8	43.0	6.7	11.8
47.	Italian Red Pear	78.2	124.7	27.9	31.9	29.2	44.5	7.1	13.2
48.	S-12×73-1 F 1	45.3	102.9	27.2	29.8	28.2	44.6	7.8	11.4
49.	SL-120	43.9	118.8	28.0	32.1	27.4	44.6	9.6	10.8
50.	Bonny Best	56.6	100.8	27.4	31.6	28.3	45.0	6.3	9.4
51.	S-12	50.5	113.1	32.1	29.4	26.7	40.6	9.4	15.3
52.	Pb. Tropic×Imp. Meeruti	49.3	109.9	25.8	28.8	25.7	45.0	10.6	10.8
53.	HS 110	52.7	104.5	19.5	15.0	31.3	47.4	1.9	2.8
54.	SL 152	46.8	91.9	23.7	43.3	27.4	43.9	9.6	10.8
55.	104-S	49.4	96.9	23.1	30.0	28.4	44.1	6.9	10.5
56.	Grothens Globe	57.9	103.5	29.7	35.9	29.4	43.8	9 2	10.4
57.	Chameli Red Plum	67.2	114.3	34.7	35.2	28.7	43.0	8.1	10.8
58.	HS 104	43.1	103.8	30.1	29.3	25.8	40.8	8.7	15.3
59.	V-114	52.3	95.8	19.0	33.3	26.1	44.1	9.7	11.6
60.	Punjab Chhuhara	58.2	110.0	20.6	21.1	24.0	44.2	8.6	11.4
	C. D. at 5%	10.4	12.49	4.15	2.88	3.12	2.16	2.93	3.09

11	12	13	14	15	16	17	18	19	20	21	22
8.8	12.4	2.4	9.5	10.5	29.4	0.15	0.69	15.7	44.2	0.26	1.15
5.3	8.1	1.5	5.9	6.0	23.4	0.11	0.71	13.7	47.3	0.25	1.19
6.4	7.5	1.9	4.2	10.9	24.4	0.15	0.63	19.7	41.5	0.35	1.05
5.0	7.8	1.5	4.1	9.3	21.4	0.21	0.55	18.9	32.1	0.32	0.95
4.9	7.8	2.7	5.9	9.9	26.3	0.21	0.59	14.3	40.0	0.26	1.13
4.1	4.5	1.8	3.8	14.0	22.9	0.37	0.71	28.2	39.8	0.81	1.26
3.7	4.5	2.1	3.9	11.8	19.5	0.49	0.63	26.6	33.2	0.63	1.09
4.0	4.0	2.1	3.9	14.7	19.7	0.30	0.62	26.9	39.8	0.75	1.25
3.6	4.9	2.2	4.0	20.1	24.3	0.52	0.72	40.0	42.4	1.15	1.36
3.9	4.1	2.2	4.1	14.0	25.7	0.35	0.81	31.0	36.0	0.80	1.22
4.0	4.8	2.5	3.9	12.7	20.6	0.32	0.62	26.6	46.6	0.69	1.24
4.3	5.0	2.1	2.9	6.8	10.0	0.19	0.39	10.3	20.3	0.29	0.76
2.8	4.2	2.0	4.0	11.8	18.8	0.26	0.56	26.2	32.9	0.65	1.21
3.8	4.7	2.2	3.7	13.7	23.8	0.29	0.81	31.7	40.2	0.74	1.35
3.3	4.1	2.2	4.1	14.2	23.6	0.33	0.58	32.2	37.0	0.82	1.17
3.6	3.8	2.4	4.0	8.9	21.3	0.19	0.69	25.7	35.1	0.63	1.15
4.1	5.1	2.7	4.6	11.1	25.0	0.25	0.70	25.6	42.7	0.61	1.34
4.0	4.9	2.2	4.3	17.4	25.0	0.46	0.74	34.6	44.9	0.95	1.40
3.7	4.8	1.9	4.2	12.2	22.3	0.31	0.77	26.5	43.9	0.71	1.38
4.2	4.8	2.4	3.4	14.5	20.4	0.33	0.62	30.0	41.5	0.80	1.35
3.5	4.5	2.0	4.1	18.0	21.1	0.44	0.63	32.6	37.2	0.86	1.15
4.2	4.3	2.3	3.8	13.8	21.2	0.33	0.69	28.7	36.2	0.73	1.32
4.2	4.5	1.6	3.4	12.9	21.7	0.33	0.67	30.7	40.0	0.53	1.23
3.3	4.4	1.9	4.3	20.2	28.9	0.45	0.89	45.2	52.6	0.90	1.52
3.9	4.7	2.1	4.1	16.6	21.2	0.41	0.62	31.7	38.5	0.82	1.22
3.8	4.2	1.3	2.3	2.3	6.0	0.10	0.38	6.1	9.3	0.24	0.65
4.6	5.2	2.4	3.1	14.4	23.2	0.34	0.67	31.4	40.3	0.83	1.26
3.6	5.3	1.7	4.1	13.9	24.4	0.31	0.77	30.6	41.5	0.85	1.36
3.7	4.3	1.7	4.1	13.7	22.7	0.30	0.69	30.8	34.9	0.74	1.15
4.4	4.4	1.9	4.2	13.3	22.2	0.32	0.66	28.1	37.7	0.70	1.20
4.0	4.1	2.8	4.2	18.5	30.2	0.55	0.90	37.7	42.3	1.15	1.36
4.0	4.3	1.5	3.8	13.2	20.7	0.31	0.64	26.1	38.0	0.74	1.19
4.0	4.6	2.0	4.2	13.7	17.8	0.53	0.65	25.9	33.3	0.70	1.20
0.73	0.65	0.8	1.6	3.2	5.1	0.06	0.06	4.62	7.42	0.11	0.24

The differences in the number of branches among the varieties were found to be significant in both the planting dates. In March planting maximum number of branches were found in Kalyanpur Angurlata while minimum in Tomato No. 226. The responses of all the varieties were altogether changed in June planting when maximum number of branches were recorded in SI-152 and minimum in HS-110. The results further indicated that June planting favoured the production of branches while March planting depressed it. The findings showed that in March planting (semi-arid region) vegetative growth in all the varieties of tomato was poor while the same varieties had better vegetative growth during June planting. The reduction in vegetative growth was directly related to higher temperature during hot summer months (Critchfield, 1966). The poor growth during hot summer season was probably due to the physiological scarcity of water and increased rate of transpiration (Kramer, 1949). Another probable reason might be lack of hydration of protein and protoplasm (Levitt, 1956). Slatyer (1969) reported that there was a reduced mineral uptake in drought stressed plants grown under high temperature conditions. However, Livne and Vaadia (1972) reported that cytokinin activity was reduced, whereas abscissic acid (ABA) increased as a result of water deficit at high temperature which might have decreased growth of plants.

Flowering and Fruiting

There were significant differences (Table 2) in the number of days taken to first flowering of various varieties in both plantings. Minimum number of days to first flowering were taken by HS-102 while Hybride 42128 flowered very late in March planting. In June planting varietal responses varied and earliest flowering was noticed in HS-101 M_3, whereas Ox-heart was very late in flowering. In general, the flowering was earlier in March planted crop as compared to June planting which confirmed the earlier findings of Takahashi *et al.* (1973) who reported earliest flower bud differentiation at 30°C day temperature and latest at 17°C. Early flowering at high day temperature was probably because carbohydrates and nitrogen (Abdalla and Verkerk, 1967), and auxin and gibberellin like substances (Livne and Vaadia, 1972) attained their maximum content just before flower bud differentiation in the apical parts of the plants under high temperature condition (Saito and Ito, 1967) which induced earlier flower induction.

The data in Table 2 indicated significant differences in fruit set among varieties in both the plantings. In summer season, TAMU-Saladette had highest number of fruits 20 days after first flowering followed by HS-102 and HS-101 M_3. Similar trend was observed during June planting when HS-102, HS-101 M_3 and TAMU-Saladette gave the best fruit set. Very poor fruit set was observed in Ox-heart in March as well as in June planting followed by HS-110. Superiority of TAMU-Saladette, HS-102 and HS 101 M_3 in better fruit set might be due to earliest flowering in these varieties and their high degree of heat tolerance and resistance to heat injuries (Iwahori, 1965). These results agree with the earlier reports of Arora

et al. (1975) who obtained highest fruit set in HS-102 during summer season in the plains of north India while Leeper (1974) specifically mentioned Saladette to be more resistant to high temperature for fruit set. Minimum fruit set was observed in Ox-heart and Hybride 42128. However, Hoque *et al.* (1975) reported Ox-heart as promising variety under normal temperature conditions. In general, there was a poor fruit set in March planting than June planting. The reduced fruit set in various tomato varieties in March planting was due to very high temperature (Iwahori *et al.*, 1963), dormant fertilized ovaries (Johnson and Hall, 1953), reduction in auxin content after anthesis (Iwahori, 1966) and increased stigma length (Charles and Harris, 1972). Poor fruit set at higher temperature may also be due to dry functional pollen or the lack of respectivity of stigma (Charles and Harris, 1972), slow pollen tube growth because of severe inadequacy of substrate required for these processes (Abdalla and Verkerk, 1967) and abscission of flower under stress condition (Pratt and Goeschl, 1969). Moreover Arora (1977) has reviewed a good number of findings suggesting possible physiological barrier and reasons for reduced fruit set under high temperature condition. Better fruiting in tomato varieties HS-102 (a selection from cross of S-12 × P.E.D.) and HS-101 M_3 (a cross of Sel-2-3 × E. C. 15956 mutagenic treatment generation 3), might have been because of the earliest flowering and potential attained by continuous cultivation of parental lines and thereafter of the developed varieties under Hissar conditions. Tomato variety TAMU-Saladette (an introduction from Texas Agril. Expt. Station Texas, U.S.A) which was earlier reported to be a heat tolerant variety (Lepeer, 1974) also performed well under both the planting dates because of its early flowering habit during summer season.

It is clear from the present findings that TAMU-Saladette and HS-102 have potential of setting fruit at high night temperature when planted in the month of March. However, in the months of June, July and August, the mean monthly night temperature was not very high being around 25°C, but on some days the highest night temperature of 30 or 31°C has been recorded. Therefore, while evaluating different tomato varieties for their abilities to set fruit under extreme temperature conditions (either too high or too low), it would have been worthwhile to tag the individual flower cluster of different tomato varieties and correlate the day to day fruit set with the prevalent night temperature. Such studies would show real potential of varieties in relation to fruit set at higher night temperature which would be useful for development of a heat tolerant variety in tomato.

The data on the number of flowers per inflorescence (Table 2) have indicated significant differences among varieties. In march planting, Tomato No. 3716 *(Lycopersicon pimpinellifolium)* had the highest number of flowers per inflorescence while least number was recorded in Monarch. Tomato No. 3716 repeated its performance of highest number of flowers per inflorescence in June planting while least was observed in Italian Red. In general, number of flowers per inflore-

scence were more in June planting than March planting which is in agreement with the earlier findings of Lewis (1953) who reported reduced flower formation at high temperature regime of 45°C. The reduced number of flowers per inflorescence in March planting may be due to depletion of carbohydrates by increased respiration at high temperature (Hewitt and Curtis, 1948), abscission of flowers as a result of internal ethylene production induced by water stress (Mc Michael *et al.*, 1972) as compared to non-stress condition (Pratt and Goeschl, 1969), destruction of metabolites and production of the toxin under high temperature and more or less genetically controlled in a variety (Leeper, 1974) rather than an environmental effect (Clayberg *et al.*, 1966). The data on the number of fruits per truss presented in Table 2 have indicated significant differences among varieties. In March planted crop TAMU-Saladette, HS-101, HS-102 and Kalyanpur Angurlata had maximum number of fruits per truss, whereas least were observed in Ox-heart and HS-101. In June planting, maximum number of fruits were recorded from Ox-heart. Ox-heart had performed poorly under both the planting dates with respect to number of fruits per truss. In general, number of fruits per truss were higher in June planting than March planting. Reduced number of fruits per truss may be due to abscission of flowers as a result of internal ethylene production induced during high temperature condition (Stockton *et al.*, 1961).

Early and Total Yields

The number and weight of fruits from first three pickings made upto 3rd June, 1976 in March planting, and upto 4th September, 1976 in June planting was considered as early yield, whereas total number and weight of all the harvestings made upto 28th June, 1976 in March planting and 3rd October, 1976 in June planting was considered as total yield.

In March planted crop HS-101 M_3 gave the maximum number of fruits per plant from early yield followed by HS-102, and TAMU-Saladette (Table 2). Similarly in June planted crop HS-102 gave the highest number of fruits from early yield followed by HS-101 M_3 and TAMU-Saladette while least was recorded in Ox-heart during both the plantings. The differences in early yield among varieties, were significant during March and June plantings. Varietal performance during both the plantings showed highest early yield from TAMU-Saladette, HS-102 and HS-101 M_3 while least was found in Ox-heart in both plantings. This was mainly due to early fruit set in these varieties as reported in Table 2 (Leeper, 1974; Arora *et al.*, 1975). Several workers have also reported heat resistant varieties which set fruits under high temperature conditions (Nandpuri *et al.*, 1975; Arora *et al.*, 1975 and Nabos, 1976). Poor yield from early pickings were obtained in Ox-heart, Hybride 42128, Panaco and HS-110. Season also affected the response of varieties and it was found that March planting reduced the early yield of varieties as compared to June planting. Such a reduction in yield under high temperature conditions of 45°C were also reported by Thompson (1939), Iwahori and Takahashi (1963) and Iwahori *et al.* (1963); and was mainly due to poor fruit set in March planting due to higher tem-

perature. Poor early yield in tomato varieties namely Ox-heart, Hybride 42128, Panaco and HS-110 was due to delayed fruit set (Table 2). Increase in the early yield of fruits in tomato varieties TAMU-Saladette, HS-102 and HS-101 M_3 was mainly due to enhanced fruit set under unfavourable conditions of high temperature. Went (1944) suggested that poor yield of tomato varieties under high temperature conditions was due to decrease in fruit size with increase in temperature which had ultimately decreased the rate of sugar translocation. However, Smith (1932) reported poor yield of tomato varieties due to poor fruit set.

Data in Table 2 on the number of fruits per plant from total yield have indicated significant differences among varieties. In both the planting dates TAMU-Saladette, HS-102 and HS-101 M_3 gave the maximum number of fruits from total yield, whereas least number of fruits were harvested from Ox-heart, Hybride 42128, Panaco and HS-110. In general, varietal response was better in June planting than March planting. It was further observed that during both the planting periods TAMU-Saladette, HS-102 and HS-101 M_3 gave the highest yield of tomato. The results are in consistent with the findings of Arora *et al.* (1975) who found maximum total yield from HS-102 during summer, late spring and early autumn. The minimum total yield was recorded from Ox-heart, Hybride 42128, Panaco and HS-110. However, Ingner and Hancock (1970) and Hoque *et al.* (1975) reported that Ox-heart gave the highest yield of tomato fruit under favourable temperature. Higher yield in various tomato varieties under higher temperature conditions have been reported by few workers (Lindfors, 1966-68; Simonov, 1975). Increased yield in the above varieties was primarily due to their capacity to set fruit at higher temperature (Table 2). In general, yield responses were poor in March planting than in June planting. Smith (1932) reported that high temperature was a potent factor contributing to blossom drop.

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PHYSIOLOGICAL ANALYSES OF YIELD VARIATION OF SUGARCANE IN INTERCROPPING SYSTEM AT VARIOUS LEVELS OF N AND P

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ABSTRACT

A field experiment was conducted to study the physiological parameters causing the yield variation in sugarcane due to intercropping of *urd (Vigna mungo* (L.) Happer) at various levels of N and P. *Urd*, as an intercrop, depressed the shoot formation, leaf area index and intercepted the incoming radiation in sugarcane. The differences in dry matter production due to intercropping, which were conspicuous till the *urd* remained in the field, disappeared after *urd* harvesting. Intercropping of *urd*, though reduced the cane yield but considering per cent reduction in cane yield due to *urd* intercropping which was only 3.34% and over all economics of two cropping systems in which cane+*urd* gave Rs. 180/ha more gross profit, it could be concluded that growing *urd* as an intercrop of spring planted sugarcane would be more advantageous than growing cane alone.

Sugarcane *(Saccharum officinarum* Linn.) is a long duration crop and occupies the field for a period of 12 months or more in sub-tropical India. It is planted in rows at 75 to 90 cm distance. The initial growth of sugarcane is slow and lateral spread is poor as it germinates in 35-40 days and then grows slowly upto about 100 days (Singh and Kumar, 1977). During this period, the inter-row spaces remain unutilized where weeds grow and compete with the crop for light and nutrients. Availability of short duration varieties have helped in growing legumes as intercrops of sugarcane in north Indian conditions (Yadav and Srivastava, 1978). Since the legumes are grown for grain purpose their competition with sugarcane for light and nutrients is unavoidable. The behaviour of the crop grown in competition would be different than the crop grown free from it. This study was conducted to find out the physiological parameters which caused yield variation in sugarcane growing with *urd (Vigna mungo* (L.) Happer) as an intercrop.

MATERIAL AND METHODS

A field trial was conducted at the Indian Institute of Sugarcane Research, Lucknow, situated at 26.5°N latitude, 80.5°E longitude and at 120 m above mean sea level and is categorised in a semi-arid sub-tropical climatological

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zone. The soil of the experimental plots was sandy loam in texture, medium in fertility and neutral in reaction. Treatments, consisted of sugarcane pure, sugarcane+*urd*, N levels at 50, 100 and 150 kg/ha and P levels at 0 and 60 kg P_2O_5/ha, were randomised in a split plot design with 4 replications. Combinations of intercropping system and P levels were allotted to main plots and N levels to sub-plots. Sugarcane variety 'Co 1148' was planted in rows 90 cm apart on March 7, 1979. One row of *urd* variety 'T-9' was sown in between 2 rows of sugarcane on March 17, 1979. N and P were applied at the time of sugarcane planting in sugarcane rows below the cane setts through urea (46.4% N) and single superphosphate (16% P_2O_5), respectively.

Shoot population, leaf area index (LAI), light interception and dry matter accumulation were recorded at an interval of one month starting from May. Leaf area was calculated by the methods of Bathla and Sharma (1978) upto August and of Yadav and Sharma (1978) later on. The amount of light transmitted at the base of the sugarcane plants was measured by lux meter. From this, interception of incident radiation was worked out by deducting the transmitted light intensity from that recorded at the top of the crop canopy. At harvest, length and girth of millable canes were measured. Juice was analysed to determine its pol per cent.

RESULTS AND DISCUSSION

Canopy Formation and Light Interception

Canopy formation was studied in terms of shoot production and leaf area development (LAI) at different stages. Intercropping of *urd* depressed the shoot production (Fig. 1) and leaf area index (Fig. 2) of sugarcane, because the penetration of light into lower horizons of the canopy was adversely affected in intercropping system till late June, a period of maximum shoot production (Fig. 3). The shading, thus, caused due to intercropping reduced the tiller formation which ultimately resulted into lower LAI. Borden (1949) and Singh and Kumar (1977) have also reported poor tillering in sugarcane under shaded conditions. Application of P though helped in tiller formation but failed to show impact on the development of leaf area.

Dry Matter Accumulation and Crop Growth Rate

In general, dry matter accumulation followed a sigmoid path characteristics of any growth as described by Galston (1968). Plants accumulated nearly 5% of its total dry matter till June (Table 1). Dry matter increased at slow rate upto August and with a ever increasing rate afterwards upto September, in which 85% of the total dry matter was produced. The rate of increase declined later on. Dry matter, accumulated by pure crop, was significantly higher than the crop where *urd* was intercropped. After September, sugarcane where *urd* was grown also accumulated similar dry matter as that of the pure crop because after *urd* harvesting the light penetrated upto lower horizons, which made even lower leaves active to produce photosynthates.

The crop growth rate (dry matter produced kg/ha/day) which was slow (about 6 kg/ha/day) in June rose to

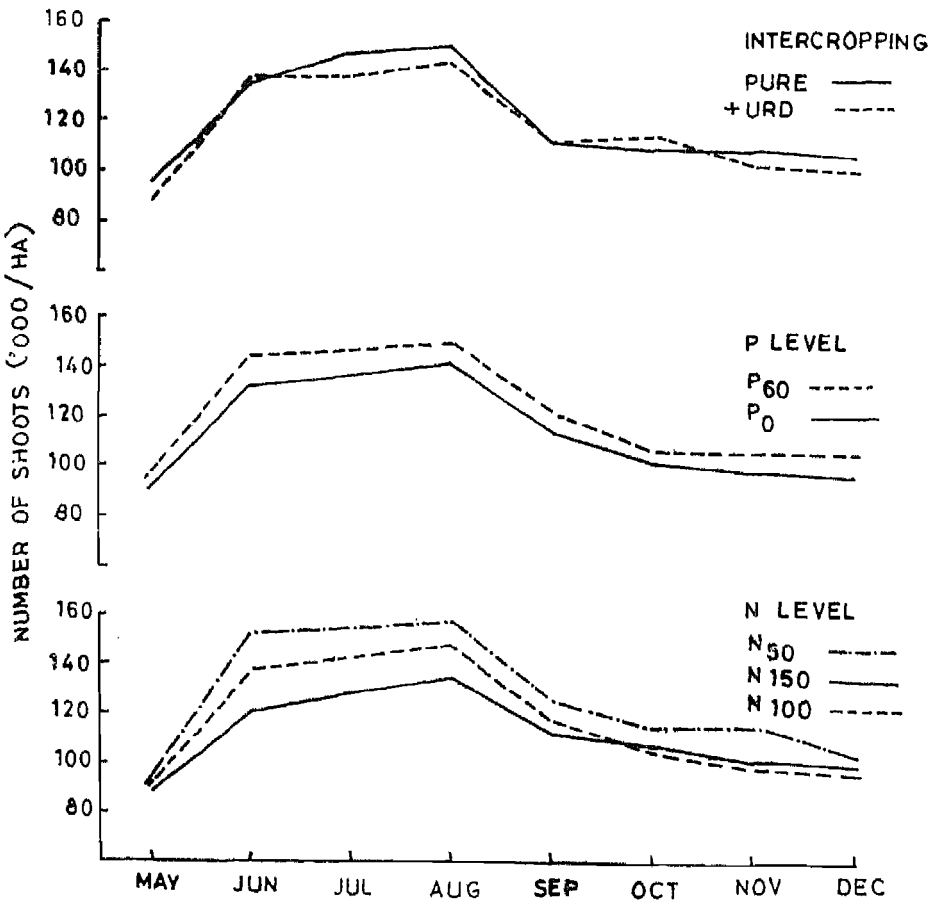


Fig. 1. Shoot production pattern of sugarcane as influenced by intercropping and N and P application.

about 420 kg/ha/day in September, and declined thereafter to reach a minimum value of 10 in December (Table 2). The rate of growth of pure sugarcane was on increasing trend in each month upto September while that of intercropped cane remained standstill in July and August. *Urd*, which reached to a maturity phase in last week of June, required more nutrients to fill up its grain (pod development), competed with sugarcane for light, nutrients and moisture, as a after effect of it the growth of sugarcane was slowed down in August and September.

Yield, Quality and Economics

Pure sugarcane produced significantly higher cane yield due to higher number of millable canes than the crop where *urd* was intercropped (Table 3). However, pure cane yielded only 3.34% more than

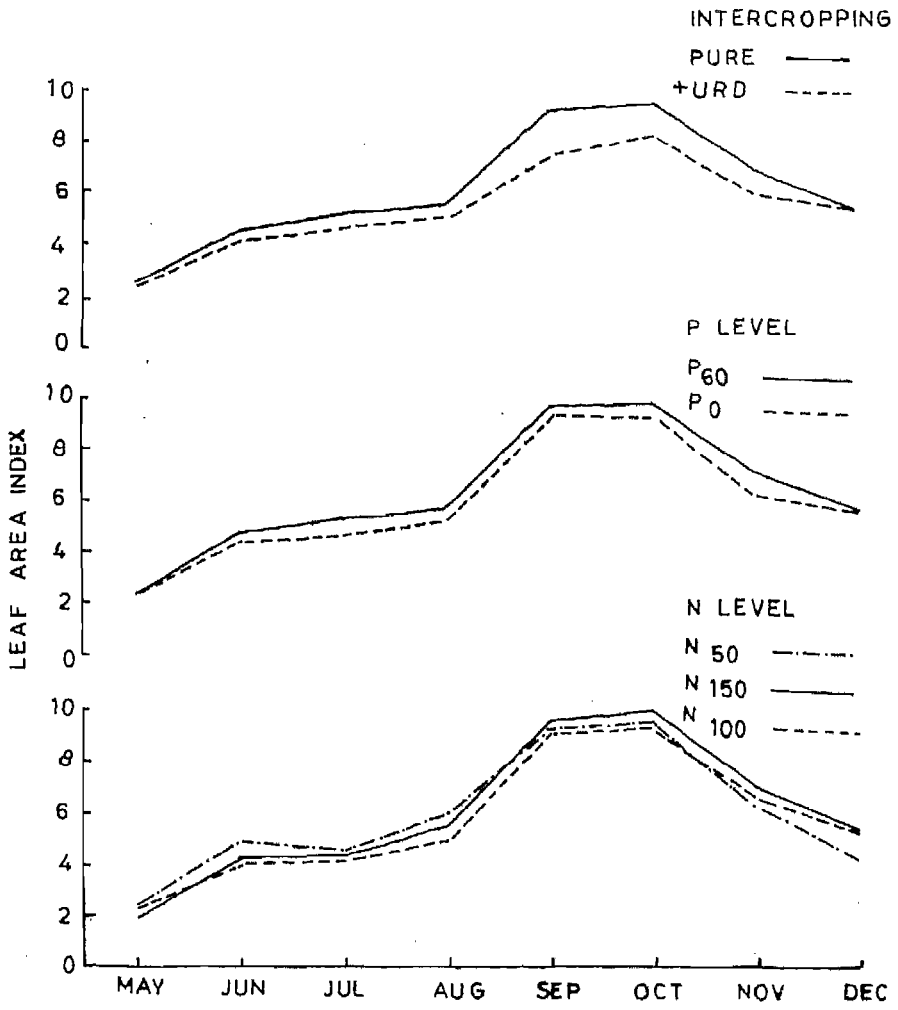


Fig. 2. LAI of sugarcane as influenced by intercropping and N and P application.

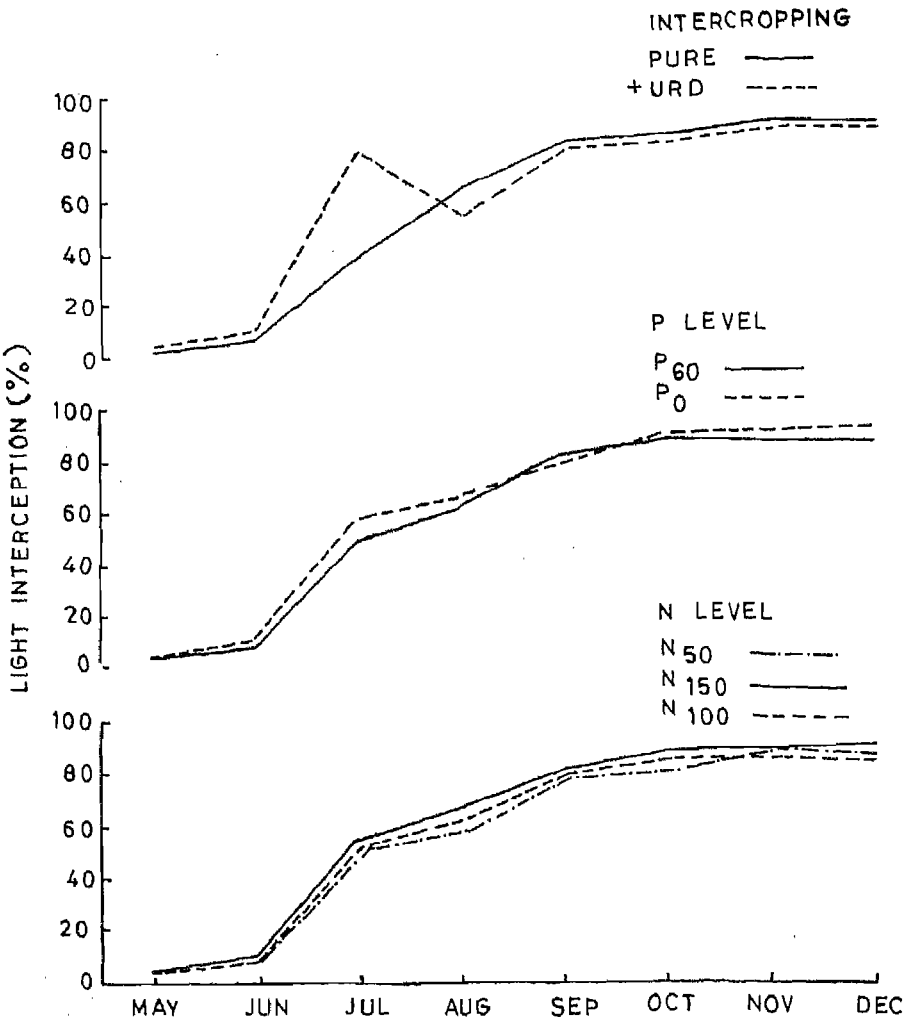


Fig. 3. Light interception in sugarcane canopy as influenced by intercropping and N and P application.

TABLE 1

Dry matter accumulation at different growth intervals of sugarcane as affected by various treatments

Treatment	Dry matter production (q/ha)							
	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Intercropping								
Pure cane	8.4 (4.5)	10.1 (5.6)	17.6 (9.8)	26.9 (15.0)	152 (85)	168 (94)	176 (98)	179
Cane+*Urd*	7.6 (4.3)	9.1 (5.2)	16.3 (9.3)	23.7 (13.5)	147 (84)	166 (94)	174 (99)	176
C. D. at 5%	NS	0.7	0.9	1.2	4	NS	NS	NS
P levels (kg/ha)								
0	7.6 (4.3)	9.3 (5.3)	16.4 (9.4)	24.3 (13.9)	144 (82)	163 (93)	173 (99)	175
60	8.0 (4.4)	9.9 (5.5)	17.6 (9.8)	26.2 (14.5)	155 (86)	172 (96)	177 (98)	180
C. D. at 5%	NS	NS	0.9	1.2	4	6	NS	NS
N levels (kg/ha)								
150	8.3 (4.3)	10.3 (5.4)	17.4 (9.1)	26.6 (13.9)	160 (83)	177 (92)	189 (98)	192
100	8.0 (4.4)	9.6 (5.3)	17.0 (9.3)	25.7 (14.1)	150 (72)	174 (82)	180 (99)	182
50	7.2 (5.2)	8.9 (5.7)	16.5 (10.5)	23.6 (15.0)	139 (88)	150 (89)	155 (99)	157
C. D. at 5%	NS	1.1	NS	2.4	9	12	10	8

Figures in parentheses indicate per cent of the ultimate dry matter production.

TABLE 2

Crop growth rate of sugarcane at different growth intervals as affected by various treatments

Treatments	Crop growth rate (kg/ha/day)						
	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Intercropping							
Pure cane	7.0	25.0	31.0	417.0	53.3	26.7	10.0
Cane+*Urd*	5.0	24.0	24.7	411.0	63.3	26.7	6.7
C. D. at 5%	1.6	NS	2.2	NS	8.2	NS	2.7
P levels (kg/ha)							
0	5.7	23.7	26.3	399.0	63.3	33.3	6.7
60	6.3	25.7	28.7	429.3	56.7	16.7	10.0
C. D. at 5%	NS	NS	2.1	10.7	NS	11.3	2.7
N levels (kg/ha)							
150	6.7	23.7	30.7	444.7	56.7	40.0	10.0
100	5.3	24.7	29.0	414.3	80.0	20.0	10.0
50	5.7	25.3	23.7	384.7	37.7	16.7	6.7
C. D. at 5%	NS	NS	4.8	20.2	15.6	19.2	NS

TABLE 3

Sugarcane yield and its contributing characters as affected by different treatments

Treatments	Cane yield (t/ha)	Millable canes ('000/ha)	Length of cane (cm)	Girth of cane (cm)	Pol % juice
Intercropping					
Pure cane	52.6	103.1	137.6	2.17	15.99
Cane+*urd*	50.9	96.4	134.3	2.17	16.45
C. D. at 5%	1.2	3.5	NS	NS	0.26
P levels (kg/ha)					
0	51.8	95.5	133.8	2.20	15.94
60	51.7	104.0	138.1	2.15	16.52
C. D. at 5%	NS	3.5	NS	NS	0.26
N levels (kg/ha)					
150	54.5	99.9	139.9	2.23	15.87
100	52.1	99.3	139.0	2.15	16.55
50	48.7	101.1	129.1	2.15	16.28
C. D. at 5%	3.6	NS	NS	NS	0.38

urd intercropped cane. Thus, considering over all economics of the cropping systems (the gross profit from pure cane was Rs. 6310/ha and from cane+*urd* was Rs. 6490/ha: Rs. 6108/ha from cane and Rs. 382/ha from *urd*) it could be concluded that growing *urd* as an intercrop of spring planted sugarcane would be more advantageous than growing sugarcane alone as the yield of *urd* crop would be an additional bonus (*urd* on an average yielded 153 kg/ha). Phosphorus application did not affect the cane yield. Application of 150 kg N/ha resulted into significantly higher yield than 50 kg N/ha.

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OXIDATION OF ELEMENTAL SULPHUR IN SOIL AND EFFECT OF ORGANIC MATTER, MOISTURE AND CALCIUM CARBONATE ON THE MINERALIZATION OF NATIVE SULPHUR

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ABSTRACT

The effects of added elemental S, $CaCO_3$, organic matter, moisture, and drying and wetting on mineralization of S to SO_4'' were studied in five texturally different soils. At field capacity 50 to 75% of added elemental S was oxidised to SO_4'' in 56 days of incubation at 28°C. The speed of oxidation in the beginning was faster. Oxidation of added elemental S in different soils was in the order : sandy soil > sandy loam soil > loam soil.

In clay loam soil, the addition of 3 and 6 per cent amorphous $CaCO_3$ increased the amount of SO_4—S significantly upto 42 days but in sandy loam soil significant increase was observed only at 42 days with 6% $CaCO_3$. The addition of 0.5, 1 and 2 per cent FYM oxidised native soil S into SO_4—S significantly in both sandy loam and clay loam soils.

The addition of 10 and 20 per cent moisture (w/w) in loam and clay loam soil increased SO_4-S upto 42 days of incubation. But 30% moisture showed less SO_4-S than 20% moisture at all incubation times. The addition of 40% moisture further decreased SO_4-S with advancement of time. In loam soil with 40% moisture, SO_4-S was less than control due to reduction of native SO_4-S under anaerobic conditions but this was not true in clay loam soil. The wetting and drying cycles increased SO_4-S in sandy loam and clay loam soils only but the increase with continuous moist condition (field capacity) was more.

The S is absorbed by plants in SO_4'' form. Therefore, the amount of SO_4-S present in the soil at a particular time is an index of its availability. Major amount of S is contained in organic fraction which is mineralized through various reactions. The chemical reactions widely differ under unsaturated and saturated soil conditions. In submerged soils the pressure of oxygen is very low and, therefore, the chances of reduction of SO_4-S are more. The addition of $CaCO_3$ increased the SO_4'' content in soils of all textural groups (Ellett and Hill, 1929;

White, 1959; Williams and Steinbergs, 1959). Li and Caldwell (1966) found high oxidation of S in presence of organic matter and inoculum, whereas, Nor and Tabatabai (1977) observed increase in oxidation rate of S with increasing incubation temperature (5-30°C) and increasing rate of added S.

The magnitude of effect on conversion of S to SO_4'' by several factors like added elemental S, FYM, $CaCO_3$ and moisture is not very well understood. Moreover, FYM has itself some SO_4-S, and some soils have lot of $CaCO_3$; some of the crops are grown with continuous high moisture content, whereas some can be grown with low moisture content. Under these variable conditions it was considered worthwhile to study the effect of FYM, $CaCO_3$, elemental S, and moisture content and alternate wetting and drying cycles on the mineralization of S in soils varying in texture.

MATERIAL AND METHODS

The study was conducted on five soils widely different in texture and other physico-chemical properties (Table 1). Four experiments were conducted :

1. The oxidation of elemental S was studied on soils A, B, C, D (Table 1) in 250 ml capacity incubation bottles. 200 g soil passed through 2 mm sieve, was taken in each bottle. Elemental S was mixed in each bottle at 0, 50 and 100 ppm and moisture was adjusted to 50% of saturation percentage which was kept constant throughout incubation period. Samples were incubated in duplicate at 28±1°C. The sampling was done after 3, 7, 14, 28, 42 and 56 days. The SO_4-S was extracted with KH_2PO_4 solution (500 ppm P) in 1 : 5 soil solution after shaking for 30 min (Ensminger, 1954).

2. The effects of $CaCO_3$ and FYM on the mineralization of native soil S were

TABLE 1

Physico-chemical characteristics of soils used for the experiment

Soil properties	Soils				
	A Sandy	B Sandy	C Loam	D Loam	E Clay loam
Sand (%)	93.20	64.00	48.00	46.50	37.20
Silt (%)	2.60	20.20	25.60	31.80	29.60
Clay (%)	4.20	15.80	26.40	21.70	32.80
$CaCO_3$ (%)	Traces	0.30	0.50	0.20	0.86
pH	8.30	8.40	8.00	8.20	8.25
EC mmhos/cm at 25°C	0.26	1.20	1.40	0.28	0.67
Organic carbon (%)	0.05	0.48	0.31	0.41	0.57
Available S (ppm) (SO_4-S)	4.20	17.50	20.00	8.00	24.10
Organic S (ppm)	40.20	145.00	115.60	195.00	224.00
CEC, meq/100g soil	4.50	8.75	11.30	10.50	14.60
Moisture (%) at 1/3 atm. (field capacity)	12.50	16.10	19.20	18.60	23.40

studied on sandy loam and clay loam soils. 200 g of soil was filled in 250 ml capacity incubation bottles. $CaCO_3$ was mixed at the rate of 0, 1.5, 3 and 6 per cent, and well crushed FYM at the rate of 0, 0.5, 1 and 2 per cent. Separate treatments were kept for $CaCO_3$ and FYM in triplicate. Moisture was adjusted to 50% of saturation percentage and kept constant throughout incubation period. Samples were incubated at 28±1°C. Sampling was done at 7, 14, 28 and 42 days and extracted with KH_2PO_4 solution (500 ppm P) in 1 : 5 soil solution ratio after shaking for 30 min. The added FYM had 250 ppm SO_4-S and 700 ppm of total S.

3. The effects of different moisture regimes were studied on loam and clay loam soils. 200 g soil was taken in 250 ml incubation bottles and moisture was adjusted at 10, 20, 30 and 40 per cent by weight of soil in both the cases. Moisture was maintained throughout and samples were incubated at 28±1°C. After 7, 14, 28 and 42 days samples were drawn and extracted with KH_2PO_4 (500 ppm P) in 1 : 5 soil solution ratio after shaking for 30 min.

4. Three of these soils were also passed through one and three wetting and drying cycles which were completed in 7 and 14 days. Samples were extracted with KH_2PO_4 (500 ppm P) in 1 : 5 soil solution ratio after shaking for 30 min.

Sulphur in all the extracts was estimated by Chesnin and Yien (1950) method, whereas Jackson (1958) methods were used for all other analyses.

RESULTS AND DISCUSSION

Effect of Elemental S

Out of four soils used for the study (Table 1), loam soil (C) had highest (20 ppm) SO_4-S followed by sandy loam (B) (17.5 ppm) and sandy soil (A) had lowest (4.2 ppm) SO_4-S. With the advancement in time of incubation upto 56 days, the SO_4-S of soil increased in all the soils (Table 2). When elemental S was applied at 50 and 100 ppm in all the soils the SO_4-S increased over control at all the times of incubation. The maximum oxidation of added S was observed in light soil though it had lowest native SO_4-S as compared to other soils. In case of added S, mineralization also continued till 56th day and highest SO_4-S in all the cases was observed at 56 days of incubation but rate of oxidation slowed down after 28 days of incubation. The highest oxidation of added S was observed in sandy (A) soil, which at 42 days had about 74% of added S. The decline in rate of oxidation of added S after 42 days (Table 2) indicated that it may not be possible to oxidise all the added elemental S into SO_4-S even if it is incubated for more than 56 days. In all these cases, the maximum oxidation of added S was between 50 to 60% of added elemental S except in sandy soil where oxidation was upto 74 per cent. Nor and Tabatabai (1977) reported for 100 μg S/g soil the rate of oxidation in ten Iowa soils ranged from 39 to 75 μg S/g soil after incubating at 30°C for 70 days. Even at 3rd day, oxidation of added S was maximum in sandy soil probably due to high porosity and more of soil gases. Abed (1976) found that oxidation of S changed according to soil type and was in the

TABLE 2

Effect of S levels and soil type on availability of S at different time intervals

Soils	S levels	Days after incubation (SO_4-S, ppm)						
		0	3	7	14	28	42	56
Sandy soil (A)	0	4.2	6.20	6.90	7.85	8.25	9.00	8.50
	50		15.60	29.40	41.00	45.40	46.50	48.00
	100		26.75	46.30	68.90	79.80	83.20	82.50
Sandy loam (B)	0	17.5	18.20	22.10	26.50	31.60	35.50	34.60
	50		22.80	37.87	55.20	64.90	67.80	69.00
	100		27.68	50.55	69.80	88.00	96.20	98.50
Loam (C)	0	20.0	21.50	23.60	25.00	29.00	35.75	39.60
	50		26.68	36.47	46.00	55.20	65.40	66.80
	100		30.65	49.50	70.50	78.50	90.20	92.10
Loam (D)	0	8.0	11.20	20.40	23.10	26.90	29.10	28.75
	50		16.00	28.40	41.50	50.20	55.80	57.30
	100		20.80	40.50	64.00	78.56	81.20	83.25
L. S. D. (0.05) S levels :			1.38	2 39	3.36	3.56	5.36	3.56

order : sandy soil⩾sandy loam soil⩾clay loam soil. The higher oxidation of added S in sandy soil and less oxidation in finer soils may also be related to the high native organic S in finer soils and less native organic S in sandy soil. The decline in rate of oxidation of S at longer incubation periods may be due to slowing down of microbial activity in later stages. Attoe and Olsen (1966) reported that rate of oxidation of S was fast in the beginning which became constant after sometime. It is also noted that wherever high amounts of native S are available, there will be slow and less oxidation of added elemental S. Starkey (1966) reported that SO_4-S is immobilized by microorganisms and the microbial activity is decreased at longer times of incubation.

Effect of $CaCO_3$

In this case two soils, sandy loam (B) and clay loam (E) were used (Table 1). In both the soils the rate of mineralization of S to SO_4'' was high upto 14 days of incubation after which it slowed down. When $CaCO_3$ was added at the rate of 1.5, 3 and 6 per cent, there was no significant increase in SO_4-S upto 28 days of incubation (Table 3). At 42 days of incubation too only 6% $CaCO_3$ increased the SO_4-S significantly over control. However, in clay loam soil 3 and 6 per cent $CaCO_3$ increased SO_4-S significantly over control upto 42 days of incubation. Ellett and Hill (1929) reported that application of liming material did not give marked increase in SO_4-S but increased the biological activity in the soil, whereas White (1959) found in incubation studies large increases in the sulphate content of Oxford soils by liming. Ruhal (1975) reported that addition of $CaCO_3$ increased mineralization of S which was rapid on soils having pH⩾7.5. He indicated chemical

TABLE 3

Effect of $CaCO_3$ levels on availability of S at different time intervals

Soils	$CaCO_3$ (%)	Days after incubation (SO_4-S, ppm)				
		0	7	14	28	42
Sandy loam (B)	0	17.50	20.10	28.50	32.10	37.80
	1.5		20.60	29.20	32.50	39.28
	3.0		21.86	29.90	33 20	39.87
	6.0		22.58	31.59	34.20	43.26
Clay loam (E)	0	24.10	38.20	49.35	55.70	61.20
	1.5		39.20	52.30	57.90	66.30
	3.0		40.50	55.70	60.50	66.80
	6.0		42.28	57.60	61.20	68.20
L. S. D. (0.05) $CaCO_3$ levels :			NS	NS	NS	3.51

hydrolysis or peptisation of organic matter as one of the reasons for increase in mineralization of S by the application of lime.

Effect of FYM

The addition of organic matter at 0.5, 1 and 2 per cent increased the SO_4-S significantly in both the soils at all the incubation times. Brown and Kellog (1914) reported that organic matter helped in the oxidation of native S. In clay loam soil the mineralization did not slow down even after 28 days of incubation and it continued at almost similar rates upto 42 days, whereas in case of sandy loam soil the mineralization slowed down after 28 days irrespective of addition of organic matter. The mineralization in all cases was higher with higher organic matter addition. Li and Caldwell (1966) found high oxidation of S in presence of organic matter and inoculum. Although, FYM contained as high as 250 ppm SO_4-S and 700 ppm total S but the total amount of S added through FYM was much less than the total amount mineralized (Table 4). It indicated that the application of FYM increased the oxidation of native soil S. The data even at 7 days incubation period in both the soils showed more SO_4-S than that could be produced by oxidation of total S added through FYM.

Effect of Moisture

The oxidation or reduction of S compounds in soils depends on the moisture content. Under aerobic conditions mineralization of S to SO_4'' form takes place, whereas in submerged soils anaerobic conditions are created and reduction of SO_4-S takes place. In loam and clay loam (C and E) soils, the addition of 10 and 20 per cent moisture (w/w) which was less and equal to field capacity increased mineralization of S to SO_4'' upto 42 days of incubation. When 30% moisture (w/w) was added, the SO_4-S decreased at all the intervals of sampling in comparison to 20% moisture, which could be because of increasing saturation of soil and setting of anaerobic conditions where aerobic microorganisms

TABLE 4

Effect of FYM levels on availability of S at different time intervals

Soils	FYM (%)	Days after incubation (SO_4-S, ppm) 0	7	14	28	42
Sandy loam (B)	0	17.50	21.80	28.20	32.75	35.00
	0.5	18.75	24.00	32.00	40.50	47.20
	1.0	20.00	25.50	38.10	51.48	48.80
	2.0	22.50	28.60	44.35	60.49	63.29
Clay loam (E)	0	24.10	36.80	52.00	58.20	63.00
	0.5	25.35	43.20	56.31	65.80	73.00
	1.0	26.60	44.50	51.30	74.36	87.00
	2.0	29.10	46.12	68.20	83.25	98.56
LSD (0.05) FYM levels :			5.18	4.90	5.24	5.34

The total S added through 0.5, 1 and 2 per cent FYM was 3.5, 7 and 14 ppm, respectively.

TABLE 5

Effect of different moisture levels on availability of S at different time intervals

Soils	Moisture (%)	Days after incubation (SO_4-S, ppm) 0	7	14	28	42
Loam (C)	10	20.00	21.50	23.10	27.15	32.70
	20		24.10	27.50	32.40	38.95
	30		23.76	24.90	27.50	28.10
	40		18.00	16.60	14.50	12.10
Clay loam (E)	10	24.10	33.15	46.50	50.20	53.50
	20		39.80	52.80	57.60	62.50
	30		36.20	47.60	52.00	55.48
	40		26.90	22.10	34.68	35.00
LSD (0.05) moisture levels :			3.88	4.04	4.79	4.00

might have been affected. With further increase in moisture to 40% where soil became fully saturated the SO_4-S decreased from 24.10 ppm with 20% moisture, to 18.00 ppm even at 7 days (Table 5). With further increase in time of incubation there was further decrease in SO_4-S in loam soil showing reverse trend in comparison to low moisture content (Table 5), probably mainly due to reduction in aerobic bacterial activity. With 20% moisture SO_4-S at 7 days to 42 days increased from 24.10 to 38.95 ppm, whereas with 40% moisture it decreased from 18.00 to 12.10 ppm. The situation in clay loam soil was still different. In this case, even at 10% moisture the maximum increase in SO_4-S was observed between 7 to 14 days and then the increase was slow between 14 to 28

days and between 28 to 42 days; SO_4-S tended to increase with moisture treatments up to 20 per cent.

The increase in SO_4-S at low moisture content was due to favourable conditions for aerobic microorganisms which are mainly responsible for the oxidation of S. Since, soils need to be on or near field capacity for best microbial activity the highest release of SO_4-S was observed at 20% moisture (w/w), with further increase in moisture to 30 and 40 per cent the oxygen supply in soil system would reduce and the activity of aerobic microorganisms would be curtailed drastically, which was more evident with decrease in SO_4-S at 40% moisture with increasing incubation time. Das (1971) observed reduction in water soluble SO_4-S in submerged soils with increase in time of incubation, whereas Haldar and Barthakur (1976) reported that reduction of SO_4-S was quite high in paddy soils upto 156 days.

Wetting and Drying of Soil

Once and thrice wetting at field capacity and drying of soils were accomplished in 7 and 14 days, respectively (Table 6). The continuous wetting at field capacity of all soils for such periods gave much higher SO_4-S than wetting and drying indicating that wetting and drying has significant effect on oxidation of S in sandy loam and loam soil but much less than continuous wetting. However, in clay loam soil there was not much difference in continuous moist for 14 days and wetted and dried for three times. So much so that there was practically no increase in SO_4-S by wetting drying cycles in loam soil. It indicated that wetting and drying sequences were of less practical significance for increasing mineralization of native soil S in comparison to continuous moist condition. Katzelson (1955) attempted to explain the stimulatory effects of air-drying on physical and chemical changes which cause an increase in the content of readily available nutrients. However, Williams (1967) found increase in SO_4-S content when dry soils were moistened and re-dried once and three times. Wetting and drying increased the mineralization of S in soils.

From the foregoing studies, it may be concluded that the added elemental S is oxidised in fine soils upto 60% and in light soils upto 74 per cent. High amounts of $CaCO_3$ may help oxidation of native soil S to some extent in light soils but more in fine soils. FYM application plays significant role in the mineralization

TABLE 6

Effect of alternate wetting and drying on availability of S in soils

Soils	Initial SO_4-S (ppm)	Continuous wet for 7 days	Alternate wetted and dried once	Continuous wet for 14 days	Alternate wetted and dried thrice
Sandy loam (B)	17.50	20.10	21.60	28.50	23.60
Loam (D)	8.00	20.40	8.68	23.10	8.90
Clay loam (E)	24.10	38.20	37.80	49.35	39.00

of native soil S. Highest mineralization of native soil S takes place under moist aerobic conditions. Wetting and drying of soils is not of much importance.

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EFFECT OF IRRIGATION INTENSITIES AND NITROGEN LEVELS ON GROWTH AND YIELD OF CAULIFLOWER (*BRASSICA OLERACEA* VAR. BOTRYTIS L.) VARIETY HISSAR-1

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ABSTRACT

Effect of irrigation intensities and nitrogen levels was studied on yield and curd characters in cauliflower variety Hissar-1. The yield was increased significantly under the treatment combinations of irrigation at 1.00 PEC and nitrogen of 150 kg/ha during both the years of experimentation. The plant weight, curd size and weight were also improved at irrigation intensity of 1.00 PEC and nitrogen 150 kg/ha in both the years.

Hissar-1 is a mid late variety of cauliflower and is gaining popularity in Haryana and Punjab. Once, the crop is transplanted and a reasonably good stand is established the growth, development and yield are perhaps directly related to soil, environment and cultural practices. Out of these factors, adequate irrigation and optimum dose of nitrogen are of great importance. Production of various vegetables like okra, tomato and onion is greatly influenced by moisture supply (Joshi, 1963; Sharma, 1970). The optimum dose of nitrogen under proper moisture supply would lead to the desired development of plant and optimum yield (Singh and Arora, 1976; Som *et al.*, 1976). However, very little information is available in this country on the effect of irrigation intensities and nitrogen application on growth and yield of cauliflower.

MATERIAL AND METHODS

The experiment was conducted at the Vegetable Research Farm, Haryana Agricultural University, Hissar during 1978 and 1979 on sandy loam soil of average and uniform fertility having pH 8.5, conductivity (mmhos/cm) 0.75, organic carbon (%) 0.43, available P_2O_5 (kg/ha) 37.0 and K_2O (kg/ha) 875.0. The studies were conducted in a split plot design with four main plot treatments of irrigation intensities, viz. 0.5, 0.75, 1.00 and 1.25 PEC and three sub-plot treatments of nitrogen (50, 100 and 150 kg/ha). There were twelve treatment combinations which were replicated four times.

The measured amount of irrigation water was applied to each plot. The depth of irrigation water was kept 50 mm

at each irrigation. The depth was considered while measuring the volume of water per plot. The details of irrigation schedules for various treatments during the two years are given in Table 1. Two common irrigations were given in each treatment before the schedule of irrigation was followed as per treatment.

A basal dressing of 50 kg P_2O_5/ha and half dose of nitrogen was applied as band placement at the time of planting. Remaining half dose of nitrogen was applied in two equal doses after 20 and 40 days of transplanting during both the years. Seedlings were transplanted on 18.9.78 and 10.10.79 in a plot size of 3×3 m at a spacing of 60×60 cm during 1978-79 and 1979-80, respectively. All cultural and plant protection measures were followed as and when required. The data were recorded on yield of curds, total weight of plant including leaves and stem but excluding roots, weight of individual edible curd and average diameter of individual curd.

RESULTS AND DISCUSSION

Yield

Significantly higher curd yield per plot was recorded under irrigation at 1.0 PEC during both the years in comparison to rest of the treatments (Table 2). Statistically there was no significant difference in curd yield harvested from the plots irrigated at 1.0 PEC and 1.25 PEC during both the years.

Curd yield per plot was also influenced by application of nitrogen. Highest yields, i.e., 48.98 and 47.56 kg/plot in respective years were obtained when nitrogen was applied @ 150 kg/ha. During 1978-79, there was no statistical difference in the yield harvested from plots receiving 50 and 100 kg N/ha. However, during 1979-80, yield was significantly higher under 100 kg N/ha as compared to 50 kg N/ha.

The interaction was found to be non-significant during 1978-79. However,

TABLE 1

Details of irrigation schedule

Treatments (PEC)	No. of irrigations given per treatment		Date of first irrigation		Date of last irrigation		Range of irrigation schedule (days)	
	1978-79	1979-80	1978-79	1979-80	1978-79	1979-80	1978-79	1979-80
0.50 (1.00 mm CPE)	2	2	24.10.78	23.10.79	14.12.78	8.12.79	7-19	8-18
0.75 (66.67 mm CPE)	3	3	26.10.78	25.10.79	14.12.78	8.12.79	10-20	10-20
1.00 (50 mm CPE)	4	4	30.10.78	29.10.79	12.12.78	29.12.79	14-25	14-23
1.25 (44 mm CPE)	6	6	8.11.79	7.11.79	2. 1.79	25.12.79	24-35	23-32

TABLE 2

Effect of irrigation intensities and nitrogen levels on curd yield per plot in cauliflower var. Hissar-1

Irrigation Intensities (PEC)	Year	Nitrogen dose (kg/ha) 50	100	150	Average
0.50	1978-79	37.55	40.25	42.95	40.25
	1979-80	40.33	40.26	40.88	30.37
0.75	1978-79	44.93	44.85	46.50	45.09
	1979-80	43 25	44.70	40.63	32.20
1.00	1978-79	50.93	50.22	54.20	51.78
	1979-80	45.00	49.35	52.63	36.75
1.25	1978-79	50.30	30.35	53.25	51.97
	1979-80	51.75	53 50	56.10	40.26
Average	1978-79	45.93	46.92	48.98	
	1979-80	45.06	46.95	47.56	

C. D. at 5% for	1978-79	1979-80
Irrigation (I)	1.35	4.32
Nitrogen (N)	1·85	1.26
Interaction (I×N)	NS	2.91

significantly higher curd yield was obtained during second year under the treatment combinations of irrigation at 1.25 PEC and nitrogen at 150 kg/ha.

Reduction in crud yield under irrigations at 0.75 and 0.50 PEC in comparison to irrigations at 1.0 PEC may be due to moisture stress which affected the normal growth and development. The plants having irrigations at 1.0 and 1.25 PEC appeared to have experienced no moisture stress and the various physiological processes went on smoothly resulting in better uptake of nutrients and better plant growth. Drew (1966) working on cabbage, pointed out that proper balance of moisture in plants not only increases the photosynthesis but also helps in higher uptake of nutrients to meet accelerated rate of growth and ultimately yield. These results are in conformity with the findings of Malinina (1971) and Molnar (1965).

Increased curd yield under 150 kg N/ha during both the years in comparison to lower doses may be because of higher rate of assimilation and ultimately more production of carbohydrates and their translocation to the storage organs like curd. Leonard (1962) has suggested a different theory that nitrogen favours the effective utilization of carbohydrates and other organic factors resulting in the enlargement of fruits/curd. The results are in agreement with the findings of Wilcox (1973) and Singh *et al.* (1982).

The best yield under the treatment combination of 1.25 PEC and 150 kg N/ha may be because of more conducive soil environment for the uptake of nutrients which were utilized by the leaves

with greater efficiency and resulted in assimilation of more food like carbohydrates and proteins which ultimately helped in better curd yield. Borna (1976) reported that irrigation and fertilization interaction had greater effect on marketable yield of cucumber.

Other Curd Characters

Maximum weight of curd was recorded under irrigation at 1.25 PEC followed by irrigation at 1.0 PEC during both the years (Table 3). Similarly highest dose of nitrogen, i.e., 150 kg/ha produced significantly higher weight of curd as compared to other treatments. The leaf weight was also significantly higher under irrigation at 1.25 PEC. Similarly the application of 150 kg N/ha produced significantly highest leaf weight as compared to other treatments. Average diameter of curd was also influenced by various moisture regimes. Curd diameter was significantly improved under irrigation at 1.25 PEC as compared to lower levels of irrigations (0.50). Nitrogen application did not produce any significant effect during both the years on curd diameter. However, it was slightly improved under highest dose of nitrogen only during 1978-79.

TABLE 3

Effect of irrigation intensities and nitrogen application on various plants and curd characters of cauliflower var. Hissar-1

Treatment	Year	Average weight of curd (kg)	Average weight of leaf (g)	Average diameter of curd (cm)
Irrigation intensities (PEC)				
0.50	1978-79	1.66	405.80	12.80
	1979-80	1.49	380.50	10.29
0.75	1978-79	1.96	504.30	15.46
	1979-80	1.63	450.60	13.56
1.00	1978-79	2.42	510.40	16.27
	1979-80	1.83	480.00	15.76
1.25	1978-79	2.73	652.80	17.89
	1979-80	2.01	550.60	17.89
C. D. at 5%	1978-79	0.142	43.61	2.86
	1979-80	0.102	38.30	1.96
Nitrogen dose (kg/ha)				
50	1978-79	2.06	480.22	15.25
	1979-80	1.52	380.55	14.37
100	1978-79	2.17	512.22	15.59
	1979-80	1.65	480.00	14.25
150	1978-79	2.33	562.59	15.98
	1979-80	2.06	530.20	13.85
C. D. at 5%	1978-79	0.105	25.85	1.53
	1979-80	0.130	21.30	0.64

Increased curd weight and diameter of the curd under irrigation at 1.0 PEC may be because of better soil environment for the uptake of nutrients and greater production of plant foods under this irrigation treatment. Higher curd weight and curd diameter under highest dose of nitrogen may be because of effective production and utilization of carbohydrates and other organic fractions under this treatment (Leonard, 1962). These results are in agreement with the findings of Karchi *et al.* (1977) and Singh *et al.* (1982).

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EFFECT OF SCHEDULING OF IRRIGATION ON THE YIELD AND UPTAKE OF N AND P BY SOME GENOTYPES OF WHEAT

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ABSTRACT

A field experiment was conducted to find out the critically sensitive stages of five genotypes of wheat, viz. HD 1941, HD 1949, HD 1977, WG 377 and Kalyan Sona for different irrigation schedules. When only one irrigation at crown root initiation was available, HD 1949 was the most suitable genotype, however, when two irrigations one each at C. R. I. and flowering stage were available then Kalyan Sona was the highest yielder. With four irrigations, maximum grain yield was recorded in case of Kalyan Sona and minimum in case of HD 1941. Total uptake of N and P was significantly increased as the frequency of irrigation increased.

Economic use of water is a vital problem which confronts farmers and agricultural scientists in irrigated areas. This problem is becoming more acute as the area of irrigated land throughout the world is increasing. A knowledge of the optimum time of application of limited amount of water for maximising yields of crops is quite essential.

Irrigation is one of the most important factors which governs the yield of crops. In India, 80% of crops are grown on stored moisture. This stored moisture is not always sufficient for getting the maximum yields. As plant grows, the demand for water increases. In drought years, this stored moisture cannot cope with the demand of the crop, so the supply of water through irrigation is the only means of moisture regulator which can push up the production.

Since water is a costly input, it is of paramount importance to select suitable genotypes which are most responsive to irrigation when applied at different stages of plant growth. The present study was carried out in order to understand the (a) effect of scheduling of irrigation on yield of 5 genotypes of wheat, (b) to find out the N and P removal by these genotypes, and (c) interaction between irrigation and nutrient uptake.

MATERIAL AND METHODS

The experiment was conducted in a fallow sandy loam field of Haryana Agricultural University Farm, Hissar. Some physico-chemical properties of soil are given in Table 1. Texture was determined by international pipette method (Piper, 1950). Bulk and particle densities

TABLE 1

Physico-chemical properties of soil

Soil depth (cm)	Sand (%)	Silt (%)	Clay (%)	Bulk density (g/cm³)	Particle density (g/cm³)	Texture class	pH 1 : 2	EC (mmhos/cm)	O. C. (%)	Available nutrients (kg/ha)		
										N	P	K
0—15	64.2	16.1	19.5	1.32	2.65	Sandy loam	8.50	0.38	0.32	180	10.4	379
15—30	60.8	17.5	21.1	1.40	2.61	Sandy loam	8.20	0.30	0.26	160	9.1	387
30—60	62.6	16.7	18.3	1.44	2.66	Sandy loam	8.30	0.24	0.22	136	7.8	350
60—90	58.7	20.6	18.2	1.55	2.63	Sandy loam	8.10	0.24	0.18	105	6.5	350
90—120	54.6	22.6	20.3	1.60	2.66	Sandy loam	8.40	0.18	0.12	90	8.3	320

were estimated by rubber coating method as outlined by Abrol and Palta (1968) and Pycnometer method as described in U. S. D. A. Hand Book No. 60 by Richard (1954), respectively. Organic carbon was determined by Walkley and Black's method (Piper, 1950). Available nitrogen was estimated by alkaline permagnate method (Subbiah and Asija, 1956). Available P_2O_5 was estimated by Olsen *et al.* (1954). Total N was determined by Nessler's Reagent (Jackson, 1967). Total phosphorus was estimated by Vanadomolybdo phosphoric acid yellow colour method of Koening and Johnson (1942). The irrigation water used was of 228 μmhos/cm E C. Leaving aside pre-sown irrigation of 10 cm, irrigations varying from zero to four were given to five genotypes of wheat at various stages of plant growth as given below :

(i) No irrigation (I_0)

(ii) One at crown root initiation (C.R.I.) stage (I_1),

(iii) One at flowering stage (I_2),

(iv) One at C. R. I.+one at flowering stage (I_3)

(v) One each at C. R. I., flowering and dough stages (I_4),

(vi) One each at C. R. I., tillering, flowering and dough stages (I_5).

The crop was sown in the 1st week of November and harvested in 2nd week of April. Seed @ 1 q/ha was used for sowing of crop. Each irrigation after germination of crop was of 8 cm and measurement was done with a partial flume. The genotypes selected were : HD 1941, HD 1949, HD 1977, WG 377 and Kalyan Sona.

A basal dose of 120 kg N, 60 kg P_2O_5 and 60 kg K_2O/ha in the form of urea, single superphosphate and murate of potash was applied. Half N and full dose of P and K was applied at the time of sowing and rest of N was applied at C. R. I. stage in all the treatments. The design of the experiment was split plot with irrigation in the main plots and varieties in sub-plots. Each plot was of 6×4 m. Both grain and straw samples were collected from each field at maturity for the estimation of N and P.

RESULTS AND DISCUSSION

Grain and Straw Yield

It is evident from the data in Table 2 that variety HD 1941 gave a yield of 20.99 q/ha and it outyielded all other varieties significantly except Kalyan Sona when no irrigation was applied after sowing. However, when one irrigation at C. R. I. was available, again this very variety gave the highest yield of 22.37 q/ha, but the differences among all these varieties though appreciable but were non-significant.

When one irrigation was applied at flowering, Kalyan Sona gave the highest yield of 27.00 q/ha and it was statistically superior to WG 377 and HD 1941 varieties of wheat. Variety Kalyan Sona and WG 377 yielded 31.55 and 29.05 q/ha, respectively, when two irrigations, one at C. R. I. and other at flowering stage were applied. Varieties HD 1941 and HD 1949 were significantly lower yielder than Kalyan Sona.

With the availability of three irrigations one each at C. R. I., flowering and dough stages, the lowest yield of 27.00

TABLE 2

Effect of number of irrigations on the grain and straw yield of different genotypes of wheat

Genotypes	I_0	I_1	I_2	I_3	I_4	I_5	Mean
				Grain yield (q/ha)			
HD 1941	15.93	21.76	23.30	26.20	27.00	31.30	24 33
HD 1949	20.99	22.37	24.55	28.75	31.35	36.25	27.67
HD 1977	16.57	22.02	24.55	27.90	32.90	37.55	26.62
WG 377	17.00	20.10	22.75	29.05	33.70	39.55	27.20
Kalyan Sona	18.79	20.10	27.00	31.55	33.50	40.70	28.11
Mean	17.86	21.47	24.43	28.67	32.10	37.17	—
C. D. at 5%	Irrigation : 1.228		Variety : 1.032	V×I : 2.525			
				Straw yield (q/ha)			
HD 1941	33.00	40.00	41.56	48.00	48.88	53.28	44.12
HD 1949	34.72	37.16	39.64	47.60	59.44	58.00	45.16
HD 1977	34.52	38.40	40.32	46.16	49.64	62.96	45.66
WG 377	37.72	37.20	43.28	50.28	55.28	61.48	47.73
Kalyan Sona	33.16	36.64	46.88	54.76	56.60	64.44	48.47
Mean	34.49	38.38	42.73	49.36	52.96	59.56	—
C. D. at 5%	Irrigation : 3.400		Variety : 3.007	V×I : 6.334			

q/ha of wheat was obtained in variety HD 1941 and the differences among rest of varieties were non-significant. When one extra irrigation was applied at tillering, the highest yield of 40.70 q/ha under variety Kalyan Sona and lowest yield of 31.00 q/ha in case of variety HD 1941 were recorded. The differences between WG 377 and Kalyan Sona were statistically non-significant, likewise HD 1949 and HD 1977 were also at par. These observations are in conformity with those of Modgal and Das (1963), Campbell (1968) and Day and Intalap (1970).

On an average basis Kalyan Sona was the highest yielder among all these varieties and it was followed by HD 1949, WG 377, HD 1977 and HD 1941. The differences among HD 1949, HD 1977 and WG 377 were non-significant. Similar results were also obtained by Sharma *et al.* (1975). As regard the effect of irrigation, average grain yield of 37.17 q/ha was obtained when four irrigations in all were applied as per treatment under I_5. Another interesting observation which emerges from yield data is the significant effect of one irrigation when applied at flowering stage over the irrigation at C. R. I. stage. The superiority of irrigation at flowering stage over C. R. I. is born out of the effect of fallow land in which sufficient moisture was available upto tillering stage, whereas the crop was under stress at flowering stage, therefore, the application of water at this critical stage gave higher yield by 3 q/ha over C. R. I. stage.

It is further evident that with every additional irrigation available there was on an average increase of about 4 q/ha of grain yield, because the average yield under treatments I_2, I_3, I_4 and I_5 was 24.43, 28.67, 32.10 and 37.17 q/ha, respectively. The highest yield of 48.67 q/ha of straw was recorded in the variety Kalyan Sona and it was followed by WG 377, HD 1977, HD 1949 and HD 1941 as shown in Table 2. Varieties HD 1977, WG 377 and Kalyan Sona were statistically at par but Kalyan Sona was significantly superior to other varieties.

Average effect of irrigation on straw yield of wheat almost followed the trend of grain yield and the total straw increased with the increase in number of irrigations. Taylor (1952) and Goel (1972) also made similar observations.

Nitrogen Uptake

Data in Table 3 revealed that total uptake of nitrogen was highest (71.49 kg/ha) in the variety HD 1949 followed by HD 1977 and Kalyan Sona. All the three varieties were statistically at par as regard to the total uptake of nitrogen but superior to HD 1941 and WG 377. Irrigation had a favourable effect in increasing the absorption of N and maximum uptake of 82.80 kg/ha of N was recorded when four irrigations in all were applied and average absorption due to three irrigations was 74.62 kg N/ha. This may be due to the dilution effect as stated by Chandnani *et al.* (1960), Sichkar and Volkova (1965) and Polz (1965).

When just one irrigation was applied at flowering stage than at C. R. I., the former increased the total removal by about 9.8 kg N/ha over the latter treatment. Interaction between irrigation and

TABLE 3

Effect of number of irrigations on the total uptake of nitrogen and phosphorus by grain straw of *different genotypes* of wheat

Genotypes	I_0	I_1	I_2	I_3	I_4	I_5	Mean
				Uptake of nitrogen (kg/ha)			
HD 1941	46.92	60.13	63.80	67.23	66.50	74.91	63.24
HD 1949	59.44	62.90	69.68	74.65	77.62	84.75	71.49
HD 1977	50.58	62.17	67.63	71.67	76.57	86.09	69.11
WG 377	*45.24*	*51.32*	57.34	66.97	73.80	80.35	62.91
Kalyan Sona	50.79	52.87	70.46	78.70	78.63	88.92	69.06
Mean	50.59	55.87	65.66	72.23	74.62	82.80	—
C. D. at 5%	Irrigation : 2.85		Variety : 3.53	V×I : 8.66			
				Uptake of phosphorus (kg/ha)			
HD 1941	12.31	14.66	15.26	16.37	15.26	16.05	15.14
HD 1949	12.38	13.19	14.37	15.48	16.01	16.09	15.06
HD 1977	11.68	14.03	15.17	14.48	17.13	17.80	15.25
WG 377	10.07	10.45	11.53	12.50	12.93	13.44	11.84
Kalyan Sona	13.44	13.65	18.14	19.25	18.00	18.29	16.78
Mean	12.05	13.18	14.89	15.81	15.83	16.51	—
C. D. at 5%	Irrigation : 0.632		Variety : 0.844	V×I : 2.065			

variety was also significant. Within the varieties, HD 1949 was the most efficient in total uptake of nitrogen when no irrigation was given. The varieties HD 1949 and Kalyan Sona responded very favourably to irrigation when applied at flowering than at C. R. I. stage. Application of irrigation at dough stage was very much conducive to the increase in nitrogen uptake in varieties HD 1977 and Kalyan Sona.

Phosphorus Uptake

Data presented in Table 3 indicated that on an average Kalyan Sona absorbed the highest significant amount of 16.78 kg P/ha followed by varieties HD 1977, HD 1941 and HD 1949. The lowest absorption of 11.84 kg P/ha was observed in variety WG 377. The differences between treatments I_3 and I_4 were statistically non-significant, but the highest absorption of 16.51 kg P/ha was recorded under the treatment I_5. Irrigation at flowering stage was more beneficial as regards the total uptake than at C.R.I. stage. The least absorption of P was observed when no irrigation was applied. Kilmer *et al.* (1960) also reported an increase in concentration of P with increasing moisture level. Interactions between irrigation and varieties were also significant. Application of only one irrigation to the wheat crop stimulated the phosphorus absorption in Kalyan Sona more than any other varieties when it was applied at flowering than at C. R. I. stages.

Relationship Between Water Applied and Total Uptake of N and P

Coefficients of correlation between water applied (in cm) and total uptake of N and P (kg/ha) by grain plus straw in different genotypes of wheat were worked out (Table 4). The relationship

TABLE 4

Coefficient of correlation between soil moisture and total uptake of nitrogen and phosphorus in different genotypes of wheat

Character		Correlation coefficient	Regression equation
		Nitrogen	
Soil moisture and N uptake by	HD 1941	0.92*	$Y=47.9+0.64x$
	HD 1949	0.96*	$Y=51.6+0.81x$
	HD 1977	—	—
	WG 377	0.88*	$Y=41.1+1.19x$
	Kalyan Sona	0.99*	$Y=34.6+1.14x$
		Phosphorus	
Soil moisture and P uptake by	HD 1941	0.83*	$Y=11.8+0.16x$
	HD 1949	0.92*	$Y=12.4+0.14x$
	HD 1977	NS	—
	WG 377	0.95*	$Y=8.7+0.14x$
	Kalyan Sona	0.87*	$Y=13.7+0.15x$

*Significant at 1%

between irrigation water applied and total uptake of nitrogen was highly significant in genotypes HD 1941, HD 1949, WG 377 and Kalyan Sona, the values of r being 0.91, 0.96, 0.99 and 0.88, respectively. However, such a relationship was not observed in HD 1977 variety of wheat. Relationship between irrigation water applied and total uptake of phosphorus was stronger in all the varieties except HD 1977. The values of r were 0.83, 0.92, 0.95 and 0.67 for varieties HD 1941, HD 1949, WG 377 and Kalyan Sona, respectively.

It may be concluded from these investigations that grain and straw yield of all the genotypes increased significantly with the increase in number of irrigations that varied from one to four. Amongst varieties, maximum of 31.80 q/ha in HD 1941 was recorded by applying four irrigations at different stages of plant growth. When only one irrigation was available at the time of flowering, genotype Kalyan Sona turned out to be the highest yielder. However, when only one irrigation at C. R. I. stage was available than HD 1949 was the best genotype. Genotype Kalyan Sona gave the highest yield when three or more irrigations were available. Total uptake of N and P increased with the increase in number of irrigations. A significant positive correlation was established between total uptake of N, P and amount of water applied in all genotypes except HD 1977.

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RESPONSES OF HYBRID PEARL MILLET *(PENNISETUM AMERICANUM* L., K. SCHUM*)* AND WHEAT *(TRITICUM AESTIVUM* L.*)* TO BALANCED FERTILIZATION AT CULTIVATORS' FIELDS

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ABSTRACT

Seventy seven experiments with hybrid pearl millet *(Pennisetum americanum* L., K. Schum) and 96 experiments with wheat *(Triticum aestivum* L.) crop were conducted at cultivators' fields in Jind district (Haryana) to study the impact of balanced fertilization under irrigated conditions. The highest grain yield of pearl millet (26.12 q/ha) and of wheat (53.52 q/ha) was obtained with the highest and balanced dose of nutrients ($N_{120}P_{60}K_{60}$+Zn) applied to both the crops. At low fertilizer level too, balanced dose of nutrients ($N_{60}P_{30}K_{30}$+Zn) proved superior to all the nutrients combinations comprising 120 kg nutrients per hectare. The following was the order of treatments with respect to grain yield of both the crops : $N_{120}P_{60}K_{60}$+Zn > $N_{120}P_{60}K_{60}$ > $N_{120}P_{60}$ > $N_{60}P_{30}K_{30}$+Zn > $N_{60}P_{60}$ > $N_{90}P_{30}$ > N_{120} > $N_{60}P_{30}K_{30}$ > $N_{60}P_{30}$ > N_{60} > $N_{30}P_{30}$ > $N_0P_0K_0$.

In stabilization of agricultural production, use of fertilizers coupled with irrigation, high yielding varieties and proper management has played a key role. The adequate supply of nutrients will be the king pin around which increase in food production will revolve. In the words of Dr. Norman Borlaug "Adequate fertilizers and new technology in the developing nations are essential to stay ahead of governing demands for food in the next two decades. Fertilizer shortage is the biggest bottleneck of all. Today the world is in the crisis on the fertilizer front". The crisis again has been aggravated by the shortage of power and limited availability of petroleum products.

Fertilizer being the costly input, every effort should be put forward to increase its efficiency. While all factors in the package of practices contribute to the improvement in the efficiency of fertilizer use, balanced fertilization continues to be among the foremost.

Balanced fertilization, demands the maintenance of an optimum balance between all essential nutrients considering the crop requirements of nutrients and their availability in the soil. Fertilizer consumption in the Haryana State has increased from 0.13 lakh tonnes in 1966-67 to 1.88 lakh tonnes in 1977-78. But the ratio of nitrogenous, phosphatic and potassic fertilizers used is near about

15 : 5 : 1 which is sufficiently wider than 2 : 1 : 1 ratio, recommended in package of practices. These figures clearly indicate selective preference of farmers for nitrogenous fertilizers and poor preference for phosphatic and potassic fertilizers. So, many times some farmers do not get expected returns from applied fertilizer to the high-yielding cultivars due to imbalanced fertilization.

Keeping in view the importance of balanced fertilization for farmers, a large number of experiments were conducted on cultivators' fields under All India Co-ordinated Agronomic Experiments Scheme in Jind district. The reason for selection of experiments on cultivators' fields was their greater suitability as they represent the typical management and soil fertility conditions.

MATERIAL AND METHODS

Seventy seven experiments with hybrid pearl millet and 96 experiments with wheat were laid out on cultivators' fields, continuously for 3 years from *kharif* 1974-75 to *rabi* 1976-77. The soils of experimental fields were loamy sand to loam in texture having no problem of salinity and sodicity. The average analysis showed that the soils were generally low in organic carbon and available nitrogen, low to medium in available phosphorus and medium to high in available potassium. The experiments were conducted throughout the whole district on randomly selected fields separately for both the crops. Each selected field was divided into 12 equal plots of 50 sq m each and the following 12 treatments including control were superimposed randomly at each site.

1. $N_0P_0K_0$
2. $N_{30}P_{30}K_0$
3. $N_{60}P_0K_0$
4. $N_{60}P_{30}K_0$
5. $N_{60}P_{30}K_{30}$
6. $N_{60}P_{30}K_{30}$+Zn
7. $N_{60}P_{60}K_0$
8. $N_{90}P_{30}K_0$
9. $N_{120}P_0K_0$
10. $N_{120}P_{60}K_0$
11. $N_{120}P_{60}K_{60}$
12. $N_{120}P_{60}K_{60}$+Zn

The N, P, K and Zn were supplied through calcium ammonium nitrate (25% N), single superphosphate (16%P_2O_5) and muriate of potash (60%K_2O) and zinc sulphate of commercial grade, respectively.

All of the P, K and half of N was drilled at the time of sowing and rest of N was top-dressed after 3 weeks in both the crops. Zinc sulphate (25 kg) was broadcasted at the time of sowing. Hybrid pearl millet cultivar HB 3 and wheat cultivar HD 2009 were grown as test crops under assured irrigation. All agricultural operations were kept uniform at each site. Both the crops were sown at appropriate time and were harvested at maturity. The grain yield data observed were analysed statistically by treating different sites as replications for each treatment in a randomised block design. A pooled analysis was done for all the three years (Tables 1 and 2). Responses to per kg applied in combination and alone was also calculated by dividing the additional yield with applied nutrients.

RESULTS AND DISCUSSION

Pearl millet

Data in Table 2 show that lowest grain yield (11.03 q/ha) was recorded from control treatment ($N_0P_0K_0$) and the highest grain yield (26.12 q/ha) was obtained with highest and balanced fertilizer

TABLE 1

Yield and responses of pearl millet to N, P and K and Zn fertilization

Treatments	Yield (q/ha)	Additional yield (q/ha)	Increase over control (%)	Response per kg of nutrients (kg)	Response per kg of N/P/K/ $ZnSO_4$ (kg)
$N_0P_0K_0$	11.03	—	—	—	—
$N_{30}P_{30}K_0$	15.83	4.80	43.61	8.00	—
$N_{60}P_0K_0$	16.19	5.16	46.78	8.60	8.60
$N_{60}P_{30}K_0$	17.74	6.71	60.83	7.46	5.17
$N_{60}P_{30}K_{30}$	18.69	7.66	69.45	6.38	3.17
$N_{60}P_{30}K_{30}$+Zn	21.05	10.02	90.84	8.02	9.14
$N_{90}P_{60}K_0$	19.90	8.96	81.23	7.47	6.33
$N_{90}P_{30}K_0$	19.87	8.84	80.14	7.37	—
$N_{120}P_0K_0$	19.66	8.63	78.24	7.19	7.19
$N_{120}P_{60}K_0$	23.30	12.27	111.24	6.82	6.07
$N_{120}P_{60}K_{60}$	24.59	13.56	122.94	5.65	2.15
$N_{120}P_{60}K_{60}$+Zn	26.12	15.09	136.81	6.16	6.12
C. D. at 5%	1.84				

TABLE 2

Yield and responses of wheat to N, P, K and Zn fertilization

Treatments	Yield (q/ha)	Additional yield (q/ha)	Increase over control (%)	Response per kg of nutrients (kg)	Response per kg of N/P/K/ $ZnSO_4$ (kg)
$N_0P_0K_0$	21.53	—	—	—	—
$N_{30}P_{30}K_0$	31.62	10.09	48.86	16.82	16.82
$N_{60}P_0K_0$	32.49	10.95	50.91	18.27	18.27
$N_{60}P_{30}K_0$	37.45	15.92	73.94	17.69	16.53
$N_{60}P_{30}K_{30}$	39.16	17.63	81.88	14.69	5.70
$N_{60}P_{30}K_{30}$+Zn	42.20	20.67	96.00	16.54	10.16
$N_{90}P_{60}K_0$	41.16	19.63	91.18	16.36	12.37
$N_{90}P_{30}K_0$	41.65	20.12	93.45	16.76	—
$N_{120}P_0K_0$	40.33	18.80	87.32	15.66	15.67
$N_{120}P_{60}K_0$	48.35	26.82	124.57	14.80	13.36
$N_{120}P_{60}K_{60}$	51.55	30.02	139.43	12.50	5.33
$N_{120}P_{60}K_{60}$+Zn	53.92	32.39	151.83	13.22	9.48

level ($N_{120}P_{60}K_{60}$+Zn). Kanwar *et al.* (1972, 1973), Bhumbla (1976), Roy and Kanwar (1979) and Sekhon (1979) have also reported the importance of balanced fertilization for the maximisation of yields.

Application of 60 and 120 kg N/ha gave 5.16 and 8.63 q/ha additional grain yield which comes to be 47 and 78% response over control. The responses of N application were 8.60 and 7.19 kg grain/kg of applied N at the rate of 60 and 120 kg N/ha, respectively. The results are in confirmation with findings of Sharma and Verma (1975).

Application of 30 kg P_2O_5/ha alongwith 60 kg N/ha produced 6.71 q/ha additional grain yield. Application of 30 kg P_2O_5 gave 1.55 q/ha extra yield, which is equal to 5.17 kg grain/kg of applied P_2O_5. But when P dose was enhanced to 60 kg P_2O_5/ha alongwith 60 kg N/ha, it produced 8.96 q/ha additional yield which was equal to 81% response over control. The contribution by 60 kg P_2O_5 was 3.80 q/ha. The second increment of 30 kg P_2O_5/ha gave 2.25 q/ha additional yield or 6.33 kg grain/kg of applied P_2O_5. Results clearly indicate that there was slight enhancement in the magnitude of P responses at its higher level.

But when 60 kg P_2O_5 was applied alongwith 120 kg N/ha, it produced 3.64 q/ha additional grain yield and application of 1 kg of P_2O_5 gave 6.07 kg grain which clearly indicate that degree of response to 60 kg P_2O_5 was almost same at both the N levels.

Application of 30 and 60 kg K_2O alongwith $N_{60}P_{30}$ and $N_{120}P_{60}$ contributed 0.95 and 1.29 q/ha additional yield and the magnitude of response to per kg of applied K_2O was reduced from 3.17 to 2.15 kg grain with the increase in the K dose from 30 to 60 kg. This non-significant increase in the yield clearly indicate poor response due to K application in these soils, being high in native K.

Application of 25 kg $ZnSO_4$/ha produced 2.36 and 1.53 q/ha additional yield when applied with both the fertilizer levels, i. e., $N_{60}P_{30}K_{30}$ and $N_{120}P_{60}K_{60}$, respectively; which conclusively showed that application of Zn improved the response to NPK. Anonymous (1976), Katyal and Sharma (1979) and Singh *et al.* (1979) also observed that application of zinc with N, P and K enhanced the efficiency of response. The slightly lower magnitude of response at higher fertilizer levels may be due to more mining of native zinc by better root system provided by higher fertilization.

Application of 60 kg nutrients in the form of $N_{30}P_{30}$ or N_{60} alone yielded almost equal grain, indicating that both the N and P are equally important when they are limiting. This fact was again confirmed when 120 kg nutrients applied as $N_{120}P_0K_0$, $N_{90}P_{30}K_0$ and $N_{60}P_{60}K_0$ produced almost equal yields. Phosphorus fertilization is not economical in pearl millet due to lower response to per kg of applied P, lower rates of pearl millet grain produced and higher rates of P fertilizers. The lower responses to applied P in pearl millet may be attributed to the higher availability of native P due to high temperature and moisture conditions.

Application of balanced fertilizers at lower level ($N_{60}P_{30}K_{30}$+Zn) seems to be

more remunerative than the higher fertilizer level (Table 1). The results conclude that balanced dose of fertilizers is superior than the imbalance fertilization at both the fertilizer levels. The following was the order of treatments with respect to grain yield :

$N_{120}P_{60}K_{60} + Zn > N_{120}P_{60}K_{60} > N_{120}P_{60} > N_{60}P_{30}K_{30} + Zn > N_{60}P_{60} > N_{90}P_{30} > N_{120} > N_{60}P_{30}K_{30} > N_{60}P_{30} > N_{60} > N_{30}P_{30} > N_0P_0K_0$.

Wheat

In wheat lowest grain yield (21.53 q/ha) was obtained in control ($N_0P_0K_0$) and the highest (53.52 q/ha) in the highest fertilizer level $N_{120}P_{60}K_{60}$ + Zn (Table 2).

Application of 60 and 120 kg N/ha produced 10.96 and 18.80 q/ha additional yield over control. Application of 60 and 120 kg N/ha gave 18.27 and 15.67 kg grain/kg of applied N, respectively. It indicates that wheat crop was highly responsive to applied N in comparison to pearl millet.

Application of 30 kg P_2O_5 alongwith 60 kg N/ha produced 15 92 q/ha additional grain yield over control, in which 4.96 q/ha was contributed by 30 kg P_2O_5 alone which comes to be 16.53 kg grain/ha of applied P_2O_5. But when P dose was increased to 60 kg P_2O_5 alongwith 60 kg N/ha it gave 19.63 q/ha additional yield over control. The second increment of 30 kg P_2O_5/ha showed comparatively lower impact on the grain yield producing 3.71 q/ha more yield over $N_{60}P_{30}$. The magnitude of response to per kg of applied P was declined to 12.37. The lower response to 60 kg applied P_2O_5 might be due to limited availability of N. But when 60 kg P_2O_5 was applied alongwith 120 kg N/ha it gave 8.02 q/ha additional yield over $N_{120}P_0$ and the degree of response to per kg of applied P was slightly increased to 13.36 kg grain/kg of applied P_2O_5 which may be due to maximum yield obtained at this level of N and P. Application of 30 and 60 kg K_2O/ha alongwith $N_{60}P_{30}$ and $N_{120}P_{60}$ produced 2.00 and 3.20 q/ha additional yield, respectively. But the magnitude of response to per kg of applied K_2O remained the same at both the fertilizer levels (Table 2). Results clearly show that wheat crop was having some hidden hunger for K, hence K application is must in high-yielding varieties.

Application of 25 kg $ZnSO_4$/ha produced 2.54 and 2.37 q/ha additional yield at both fertilizer levels which indicated that application of zinc improved the response to N, P and K. Anonymous (1973, 1976), Katyal and Sharma (1979) and Singh *et al.* (1979) also reported that application of zinc with N, P and K enhanced the magnitude of response.

Application of 60 and 120 kg nutrients in different proportions of N and P produced almost equal yields, emphasizing the equal importance of N and P in wheat fertilization. The N, P, K and Zn complements regulates the functions of each other in plant metabolism and maximum yield and profits were obtained through balanced fertilization. The following was the order of treatments with respect to grain yield :

$N_{120}P_{60}K_{60} + Zn > N_{120}P_{60}K_{60} > N_{120}P_{60} > N_{60}P_{30}K_{30} + Zn > N_{60}P_{60} > N_{90}P_{30} > N_{120} > N_{60}P_{30}K_{30} > N_{60}P_{30} > N_{30} > N_{30}P_{30} > N_0P_0K_0$.

level ($N_{120}P_{60}K_{60}$+Zn). Kanwar *et al.* (1972, 1973), Bhumbla (1976), Roy and Kanwar (1979) and Sekhon (1979) have also reported the importance of balanced fertilization for the maximisation of yields.

Application of 60 and 120 kg N/ha gave 5.16 and 8.63 q/ha additional grain yield which comes to be 47 and 78% response over control. The responses of N application were 8.60 and 7.19 kg grain/kg of applied N at the rate of 60 and 120 kg N/ha, respectively. The results are in confirmation with findings of Sharma and Verma (1975).

Application of 30 kg P_2O_5/ha alongwith 60 kg N/ha produced 6.71 q/ha additional grain yield. Application of 30 kg P_2O_5 gave 1.55 q/ha extra yield, which is equal to 5.17 kg grain/kg of applied P_2O_5. But when P dose was enhanced to 60 kg P_2O_5/ha alongwith 60 kg N/ha, it produced 8.96 q/ha additional yield which was equal to 81% response over control. The contribution by 60 kg P_2O_5 was 3.80 q/ha. The second increment of 30 kg P_2O_5/ha gave 2.25 q/ha additional yield or 6.33 kg grain/kg of applied P_2O_5. Results clearly indicate that there was slight enhancement in the magnitude of P responses at its higher level.

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Application of 25 kg $ZnSO_4$/ha produced 2.36 and 1.53 q/ha additional yield when applied with both the fertilizer levels, i. e., $N_{60}P_{30}K_{30}$ and $N_{120}P_{60}K_{60}$, respectively; which conclusively showed that application of Zn improved the response to NPK. Anonymous (1976), Katyal and Sharma (1979) and Singh *et al.* (1979) also observed that application of zinc with N, P and K enhanced the efficiency of response. The slightly lower magnitude of response at higher fertilizer levels may be due to more mining of native zinc by better root system provided by higher fertilization.

Application of 60 kg nutrients in the form of $N_{30}P_{30}$ or N_{60} alone yielded almost equal grain, indicating that both the N and P are equally important when they are limiting. This fact was again confirmed when 120 kg nutrients applied as $N_{120}P_0K_0$, $N_{60}P_{30}K_0$ and $N_{60}P_{60}K_0$ produced almost equal yields. Phosphorus fertilization is not economical in pearl millet due to lower response to per kg of applied P, lower rates of pearl millet grain produced and higher rates of P fertilizers. The lower responses to applied P in pearl millet may be attributed to the higher availability of native P due to high temperature and moisture conditions.

Application of balanced fertilizers at lower level ($N_{60}P_{30}K_{30}$+Zn) seems to be

more remunerative than the higher fertilizer level (Table 1). The results conclude that balanced dose of fertilizers is superior than the imbalance fertilization at both the fertilizer levels. The following was the order of treatments with respect to grain yield :

$N_{120}P_{60}K_{60} + Zn > N_{120}P_{60}K_{60} > N_{120}P_{60} > N_{60}P_{30}K_{30} + Zn > N_{60}P_{60} > N_{90}P_{30} > N_{120} > N_{60}P_{30}K_{30} > N_{60}P_{30} > N_{60} > N_{30}P_{30} > N_0P_0K_0$.

Wheat

In wheat lowest grain yield (21.53 q/ha) was obtained in control ($N_0P_0K_0$) and the highest (53.52 q/ha) in the highest fertilizer level $N_{120}P_{60}K_{60} + Zn$ (Table 2).

Application of 60 and 120 kg N/ha produced 10.96 and 18.80 q/ha additional yield over control. Application of 60 and 120 kg N/ha gave 18.27 and 15.67 kg grain/kg of applied N, respectively. It indicates that wheat crop was highly responsive to applied N in comparison to pearl millet.

Application of 30 kg P_2O_5 alongwith 60 kg N/ha produced 15 92 q/ha additional grain yield over control, in which 4.96 q/ha was contributed by 30 kg P_2O_5 alone which comes to be 16.53 kg grain/ha of applied P_2O_5. But when P dose was increased to 60 kg P_2O_5 along with 60 kg N/ha it gave 19.63 q/ha additional yield over control. The second increment of 30 kg P_2O_5/ha showed comparatively lower impact on the grain yield producing 3.71 q/ha more yield over $N_{60}P_{30}$. The magnitude of response to per kg of applied P was declined to 12.37. The lower response to 60 kg applied P_2O_5 might be due to limited availability of N. But when 60 kg P_2O_5 was applied alongwith 120 kg N/ha it gave 8.02 q/ha additional yield over $N_{120}P_0$ and the degree of response to per kg of applied P was slightly increased to 13.36 kg grain/kg of applied P_2O_5 which may be due to maximum yield obtained at this level of N and P. Application of 30 and 60 kg K_2O/ha alongwith $N_{60}P_{30}$ and $N_{120}P_{60}$ produced 2.00 and 3.20 q/ha additional yield, respectively. But the magnitude of response to per kg of applied K_2O remained the same at both the fertilizer levels (Table 2). Results clearly show that wheat crop was having some hidden hunger for K, hence K application is must in high-yielding varieties.

Application of 25 kg $ZnSO_4$/ha produced 2.54 and 2.37 q/ha additional yield at both fertilizer levels which indicated that application of zinc improved the response to N, P and K. Anonymous (1973, 1976), Katyal and Sharma (1979) and Singh *et al.* (1979) also reported that application of zinc with N, P and K enhanced the magnitude of response.

Application of 60 and 120 kg nutrients in different proportions of N and P produced almost equal yields, emphasizing the equal importance of N and P in wheat fertilization. The N, P, K and Zn complements regulates the functions of each other in plant metabolism and maximum yield and profits were obtained through balanced fertilization. The following was the order of treatments with respect to grain yield :

$N_{120}P_{60}K_{60} + Zn > N_{120}P_{60}K_{60} > N_{120}P_{60} > N_{60}P_{30}K_{30} + Zn > N_{60}P_{60} > N_{90}P_{30} > N_{120} > N_{60}P_{30}K_{30} > N_{60}P_{30} > N_{30} > N_{30}P_{30} > N_0P_0K_0$.

On the basis of these experiments, it may be concluded that both the crops responded well to balanced fertilization. But among both the genotypes, comparatively wheat crop was found more responsive to per kg of applied nutrients.

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GENETICS OF EARLINESS AND QUALITY IN OKRA *(ABELMOSCHUS ESCULENTUS* (L.) MOENCH.*)*

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ABSTRACT

A seven parent diallel set consisting 28 okra genotypes was evaluated for study. First fruiting node and days to 50% flowering were under the control of additive gene action; disease incidence, crude fibre content and sugar content were controlled by non-additive gene action; and for fruits and yield per plant both additive and non-additive gene action played their role. Complete to over dominance except first fruiting node and days to 50% flowering was observed for all the characters. Asymmetrical distribution of positive and negative homozygotes and dominance and recessive genes was found among the parents for all the characters. High heritability coupled with additive gene action for first fruiting node and days to 50% flowering indicated that simple selection would be effective for their improvement; for fruits and fruit yield per plant recurrent selection would be desirable while variation of disease incidence, sugar and crude fibre content could be exploited by developing F_1 hybrids.

Okra *(Abelmoschus esculentus* (L.) Moench.) occupies an important place among vegetable crops of tropical and subtropical regions. This crop remains to be explored for a genotype with high yield, quality fruits and disease resistance. To improve its yield potential and quality, an understanding of genetic basis of yield and quality characters is essential. Genetic variation in quantitative characters would arise from additive, non-additive and/or epistatic gene effects. Some information is available on yield components but for quality attributes like crude fibre and sugar content information on such aspects is lacking in the literature. Therefore, the present investigation was undertaken to furnish informations on genetic nature of early yield and quality characters which would be helpful in devising specific breeding programme for achieving the desired results.

MATERIAL AND METHODS

The material for the present study consisted of 21 possible single crosses among seven parental lines, viz. IC 6653, IC 12930, IC 6316, Pusa Sawani, Narnaul Collection, Dwarf Green Smooth and Selection 2. The parental lines along with the crosses were sown at the Vegetable Research Farm of Haryana Agricultural University, Hissar during rainy season, 1977 in a randomised block

design with three replications, spacing 60 and 30 cm between and within rows, respectively. Randomly selected five competitive plants per treatment per replication were observed for first fruiting node, days to 50% flowering, per cent disease incidence (Yellow Vein Mosaic Virus affected plants as a per cent of total plant population per treatment), number of fruits per plant and fruit yield per plant. Randomly selected five marketable fruits of these plants each at early, mid and last pickings were sampled out to analyse per cent crude fibre and per cent sugar content (dry wt. basis). Data were subjected to genetic analysis using diallel techniques of Hayman (1954a, b) and Jinks (1954).

RESULTS AND DISCUSSION

Treatment variances for the six traits studied are presented in Table 1. Highly significant differences were recorded among the genotypes for all the characters under investigation indicating further scope of improvement. Least square estimates of the genetic variance and covariance, proportions of genetic parameters, heritability in narrow sense and regression coefficients of variance and covariance are also given in Table 1. The additive (D) variance was highly significant for all the characters except disease incidence and sugar content. Both the dominance components (H_1 and H_2) were also highly significant for all the characters under study. This indicated the importance of both gene actions in the inheritance of these characters. However, the magnitude of dominance components was higher than additive for all the characters except first fruiting node and days to 50% flowering. Ramu (1976) found high additive and non-additive components of variation for number of fruits and fruit yield per plant and low values of these components for days to flowering. Rao and Sathyavathi (1977) stated that additive gene action was important for number of fruits per plant and days to flowering. Kulkarni and Virupakashappa (1977) reported non-additive gene action for days to flowering and number of fruits per plant. Erikson and Couto (1963) reported that early bearing in okra was controlled by single dominant gene P, its allele p conditioning late bearing. Positive values of h^2 for all the characters suggested that the dominance was in positive direction. The estimates of F were significant for first fruiting node, days to 50% flowering and number of fruits per plant while positive for all the characters except crude fibre and sugar content. This indicated excess of dominant factors (Povilaitis, 1956) present in the parents for these characters.

The estimates of degree of dominance $(H_1/D)^{\frac{1}{2}}$ were more than unity for all the characters except first fruiting node and days to 50% flowering which, thus, showed complete to over-dominance for these characters (Partap and Dhankhar, 1980). Kulkarni (1976) observed over dominance for the number of fruits per plant and days to flowering. The ratio $H_2/4H_1$ which was far from 0.25 in case of all the characters except sugar content indicated asymmetrical distribution of positive and negative homozygotes among parents. The ratio KD/KR (i.e. $(4DH_1)^{\frac{1}{2}} + F/(4DH_1)^{\frac{1}{2}} - F$), a measure of relative value of the dominance and recessive genes was higher than

TABLE 1

Components of variance and genetic proportions for seven characters

Parameters	First fruiting node	Days to 50% flowering	No. of fruits/ plant	Fruit yield/plant	Disease incidence (%)	Crude fibre (%)	Sugar content (%)
Treatments	6.98**	31.51**	27.58**	9649.81**	232.00**	0.061**	60.02**
D	4.74**	27.02**	10.79**	2502.50**	3.16	0.011**	2.71
H_1	3.27**	20.80**	12.90**	5584.00**	264.50**	0.029**	71.86**
H_2	3.01**	11.27**	10.77**	4803.00**	165.90**	0.028**	70.31**
h^2	0.17	0.85	20.18**	6604.49**	72.89**	0.006	4.56
F	2.17**	25.86**	5.06*	1044.00	42.95	—0.013	—2.86
$(H_1/D)^{\frac{1}{2}}$	0.83	0.88	1.09	1.49	9.14	1.632	5.15
$H_2/4H_1$	0.23	0.14	0.21	0.22	0.16	0.236	0.25
KD/KR	1.76	3.40	1.55	1.33	6.76	0.459	0.89
h^2/H_2	0.06	—0.08	1.87	1.38	0.44	0.217	0.07
Heritability narrow sense	72.36	91.55	32.56	19.09	—0.87	14.891	2.77
b	1.05	1.38	1.10	1.27	0.06**	0.348**	—0.11**

*, **Significant at 5 and 1 per cent level, respectively

unity for all the characters except crude fibre and sugar content indicating asymmetry of genes distribution among the parents. The ratio h^2/H_2 indicated that the number of genes or gene group showing dominance was low in proportion as compared to the total number of loci involved for all the characters. However, for number of fruits and fruit yield per plant, groups of genes or factors involved were one or more than one. Kulkarni (1976) reported that days to flowering and number of fruits per plant in okra were controlled by one to three groups of dominant genes. The estimates of heritability in narrow sense were high for first fruiting node and days to 50% flowering; moderate to low for number of fruits per plant and fruit yield per plant and very low for disease incidence, sugar and crude fibre contents. The expression of over-dominance for

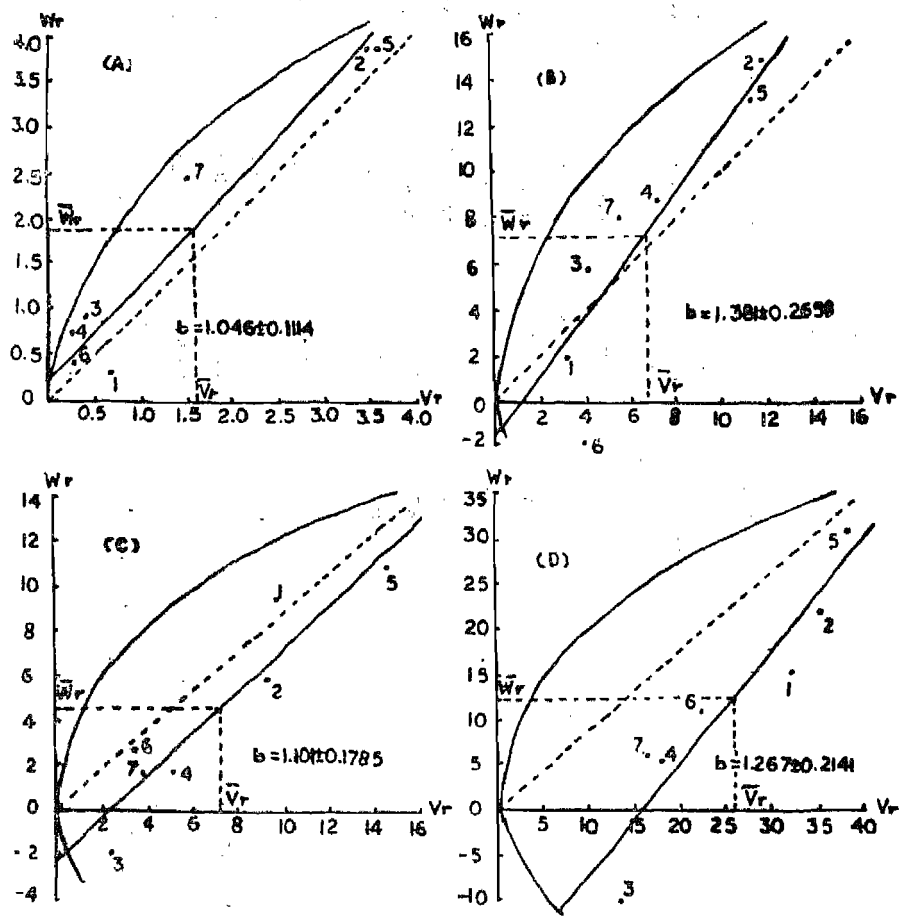


Fig. 1. Wr, Vr, graphs showing regression pattern of arrays for the characters (A) first fruiting node, (B) days to 50% flowering, (C) number of fruits per plant, and (D) fruit yield per plant; 1=IC 6653, 2=IC 12930, 3=IC 6316, 4=Pusa Sawani, 5=Narnaul Collection, 6=Dwarf Green Smooth, and 7=Selection-2.

these characters was due to the combined effect of epistasis and over-dominance at individual loci which was further confirmed by mean degree of dominance as obtained from the components of phenotypic variance, where the preponderance effect of dominance was exhibited and there were significant values of regression coefficient (b).

The graphical analysis carried out for four of the seven characters (Fig. 1) showed partial dominance for first fruiting node and over-dominance for days to 50% flowering, number of fruits and fruit yield per plant. The position of array points suggested that IC 6653, IC 6316 and Dwarf Green Smooth possessed more of dominant genes and Narnaul Collection and IC 12930 had maximum recessive genes for first fruiting node and days to 50% flowering. However, Pusa Sawani contained more dominant genes for first fruiting node but equal dominant and recessive genes for days to 50% flowering; and Selection 2 had more of dominant genes for days to 50% flowering and more of recessive genes for first fruiting node. For number of fruits and fruit yield per plant IC 6316, Pusa Sawani, Dwarf Green Smooth and Selection-2 possessed more of dominant factors and IC 6653, Narnaul Collection and IC 12930 had maximum of recessive genes.

For the characters first fruiting node and days to 50% flowering high heritability coupled with additive genes action indicated that simple selection would be effective to select early genotypes. Low heritability estimates for disease incidence, crude fibre and sugar content further substantiated that non-additive and environmental variation constitute the major portion of phenotypic variation of genotypes and this variation should be exploited by developing F_1 hybrids. For number of fruits and fruit yield per plant involvement of both gene action suggested the use of recurrent selection for their improvement.

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LINE X TESTER ANALYSIS IN MUNGBEAN

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ABSTRACT

Line × tester analysis in mungbean was carried out in respect of nine quantitative characters using seven females and three testers. Among the testers, K 851 for yield and yield components, P. S. 16 for earliness, and H 70-16 for bold seeds were found good general combiners. Among the females, ML-1 and CES-55 were found good combiners for yield and other characters. The cross ML 1 × H 70-16 for five characters, No. 239 × P. S. 16 for four characters, and ML 1 × K 851 for three characters showed significant specific combining ability effects.

Mungbean is an important grain legume grown under diverse situations throughout the country. The farmers hardly raise this pulse as sole crop owing to its low yield potential. It is, therefore essential to breed varieties having high yield potential so that this crop can stand competition with other crops. In a sound breeding programme the choice of the suitable parents is the most important pre-requisite and it should be based on the ability of a particular variety to combine well and produce superior segregates. A very little information is available on this aspect. Therefore, an attempt has been made to derive information on combining ability of 10 lines through line × tester technique for nine quantitative characters.

MATERIAL AND METHODS

Twenty one crosses, following line × tester method with seven females viz., ML 1, ML 3, S 8, No. 239, CES-55, G 65 and P 426 and three testers viz., K 851, P. S. 16 and H 70-16, were made during 1976. All the selected lines and testers were observed genetically diverse. The crosses alongwith their parents were grown in a randomized block design with three replications. Each population was represented by 5 m long single row plot. The spacing between the plants and between the rows was kept 10 and 50 cm, respectively. The observations in each population or genotype were recorded on five randomly chosen plants in respect of plant height, maturity, number of clusters per plant, number of pods per cluster, number of pods per plant, pod length, number of seeds per pod, weight of 100 seeds and grain yield per plant. The data collected on the above characters were analysed for combining ability variance and effects according to the procedure developed by Kempthorne (1957).

RESULTS AND DISCUSSION

Analysis of Variance

The analysis of variance showed significant differences among various genotypes or populations in respect of all the characters (Table 1). The total variance due to genotypes was further partitioned into parents, hybrids or crosses and parents vs. crosses components. The significant variance each among the parents and F_1 crosses was observed for all the characters, except number of pods per cluster for parents. However, the component of variance due to parents vs. crosses was significant for all the characters except maturity and plant height. Thus, the significance of parents vs. crosses indicated the prevalence of heterosis for the characters; and testers as well as lines were found differing among themselves for majority of the characters except number of pods per cluster. The mean squares due to male × female interaction were found significant for all the characters (except number of pods per cluster) indicating the importance of specific combining effects for these characters.

The relative estimates of variance due to general combining ability and specific combining ability indicated that the latter played greater role than the former for most of the characters (Table 1) except number of seeds per pod and 100 seed weight. Similar findings were reported by Singh and Jain (1971), Singh and Singh (1972, 1974), Tiwari and Ramanujam (1974), Gupta *et al.* (1978) and Luthra *et al.* (1979) in mungbean. Thus, the higher magnitude of specific combining ability variances revealed the predominant role of non-additive gene action. The translocation of the statistical components into genetical components showed the similar trend.

General Combining Ability Effects

The gca effects of the males and females have been given in Table 2. Among the males, K 851 was found to be the best general combiner as it exhibited significant gca for almost all the yield components and yield, except number of pods per cluster and 100-seed weight. On the other hand, P. S. 16 gave negative estimates of gca effects for most of the characters including the yield. Since it has given significant and negative estimate for maturity, thus, this variety may be used for breeding early maturing lines. The bold seeded variety H 70-16 gave significant and positive gca effects for 100-seed weight and pod length. Therefore, this variety may be used for improving these two characters.

Among the females, ML 1 and CES 55 were found good general combiners as they gave significant values of gca effects for four and five characters, respectively, including the yield. However, both these lines gave significant gca effects for late maturity. Similar to P. S. 16 which was used as male, G 65 and P 426 gave negative estimates of gca for maturity and other characters including the yield. Therefore, these varieties may also be used for breeding early maturing varieties.

Specific Combining Ability Effects

The estimates of sca effects of 21 crosses are given in Table 3. Out of

TABLE 1

Analysis of variance for combining ability in a line × tester of mungbean for nine characters

S. No.	Source of variation	d.f.	Maturity (days)	Plant height (cm)	No. of clusters/ plant	No. of pods/ cluster	No. of pods/plant	Pod length (cm)	No. of seeds/pod	Weight of 100 seeds (g)	Grain yield/ plant(g)
1.	Replications	2	2.59	0.08	0.09	0.08	9.46	0.02	0.03	0.01	0.14
2.	Progenies	30	50.21**	117.08**	52.07**	0.23**	309.52**	2.05**	1.72**	2.51**	34.91**
3.	Parents	9	59.32**	200.43**	16.45**	0.08	188.29**	1.97**	1.30**	4.20**	6.69**
4.	Crosses	20	48.62**	84.25**	37.61**	0.17*	307.11**	2.07**	1.96**	1.80**	33.47**
5.	Parents vs. crosses	1	0.06	23.58	61.79**	2.06**	1448.74**	2.35**	0.58**	1.40**	317.64**
6.	Males	2	11.49	134.73	14.48	0.13	80.11	15.50**	10.43**	12.48**	51.05
7.	Females	6	150.54**	62.21	213.93**	0.14	611.52*	1.13*	2.42*	1.64**	50.56
8.	Males × Females	12	3.45**	82.31**	24.64**	0.19*	192.52**	0.29**	0.68**	0.21**	21.97**
9.	Error	60	0.94	5.97	0.81	0.09	7.29	0.06	0.07	0.02	0.57
Estimated variances											
1.	σ^2gca (Males)		0.38	2.49	−0.48	−0.003	−5.35	0.72	0.46	0.58	1.39
2.	σ^2gca (Females)		16.34	−2.23	21.02	−0.005	46.56	0.09	0.19	0.16	3.18
3.	σ^2gca (Average) or $\frac{1}{2}\sigma^2$A		1.17	−0.37	0.34	0.000	2.76	0.05	0.04	0.04	0.29
4.	σ^2sca or σ^2D		0.53	25.45	7.94	0.030	61.75	0.08	0.20	0.06	7.13
5.	σ^2D/σ^2A		0.23	—	11.78	—	11.19	0.80	2.60	0.75	11.93

*, **Significant at 5 and 1 per cent level, respectively.

TABLE 2

General combining ability effects of females and testers in a line × tester cross of mungbean

S. No.	Genotypes	Maturity (days)	Plant height (cm)	No. of clusters/ plant	No. of pods/ cluster	No. of pods/ plant	Pod length (cm)	No. of seeds/ pod	Weight of 100 seeds (g)	Grain yield/ plant (g)
Testers										
1.	K 851	0.00	2.76*	0.92*	−0.09	1.71*	0.158*	0.80*	−0.32*	1.50*
2.	H 70-16	0.74*	−0.56	−0.68*	0.03	−2.13*	0.78*	−0.25*	0.88*	0.10
3.	PS 16	−0.74*	−2.21*	−0.25	0.05	0.40	−0.92	−0.55*	−0.55*	−1.61*
Females										
4.	ML 1	2.09*	−1.29	5.44*	3.12*	16.29*	−0.16	0.03	−0 17*	4.76*
5.	ML 3	2.29*	−2.66*	−0.18	3.22*	0.15	0.16	0.07	0.22*	−0.66
6.	S 8	3.09*	3.91*	1.12*	3.09*	2.09	−0.13	0.60*	−0.29*	0.67
7.	No. 239	1.09*	−0.86	−0.18	3.11*	−1.18	0.60*	0.13	0.60*	−0.32
8.	CES 55	1.32*	−0.52	−1.80*	3.44*	−2.78*	0.38*	0.53*	0.48*	2.48*
9.	G 65	−8.78*	−2.09	−3.56*	2.19*	−10.65*	−0.32*	−0.60*	−0.39*	−2.96*
10.	P 426	−1.11*	3.48*	−0.85*	3.07*	−3.95*	−0.43*	−0.77*	−0.44*	−1.04*
	$S.E.(\hat{gi})$ females	0.32	0.82	0.30	0.10	0.89	0.08	0.09	0.04	0.25
	$S.E.(\hat{gi})$ testers	0.21	0.53	0.19	0.07	0.58	0.06	0.06	0.03	0.17
	$S.E.(\hat{gi}\text{-}\hat{gj})$ females	0.46	1.15	0.42	0.15	1.27	0.12	0.13	0.06	0.36
	$S.E.(\hat{gi}\text{-}\hat{gj})$ testers	0.29	0.75	0.28	0.09	0.83	0.08	0.08	0.04	0.23

*Significant at 5% level.

TABLE 3

Specific combining ability effects of crosses in mungbean

S. No.	Cross	Maturity (days)	Plant height (cm)	No. of clusters/ plant	No. of pods/ cluster	No. of pods/ plant	Pod length (cm)	No. of seeds/ pod	Weight of 100 seeds (g)	Grain yield/plant (g)
1.	ML 1×K 851	0.27	2.01	3.31*	−0.05	8.89*	0.07	−0.26	0.09	2.05*
2.	ML 3×K 851	−1.33	1.38	0.73	−0.35	−2.47	0.02	0.40	−0.10	0.55
3.	S 8×K 851	0.57	2.71	−2.13*	0.28	−2.61	0.15	−0.43*	0.08	−0.56
4.	No. 239×K 851	−0.73	−6.12*	−1.07*	−0.11	−4.54*	−0.12	−0.06	−0 08	−1.55*
5.	CES 55×K 851	0.66	−0.66	0.29	−0.22	−1.14	0.48*	0.34	0 04	−1.14
6.	G 65×K 851	1.44	−0.29	−0.12	0.16	1.43	−0.45*	−0.13	0.01	0.85
7.	P 426×K 851	0.00	1.04	−0.96	0.29	0.53	−7.74*	0.14	−0.04	−0.17
8.	ML 1×H 70-16	−0.66	7.73*	1.28	0.01	7.23*	−0.10	0.89*	−0.31*	3.36*
9.	ML 3×H 70-16	0.93	−4.00*	−1.77*	0.29	−2.73	−0.21	−0.75*	−0.06	−2.85*
10.	S 8×H 70-16	0.83	2.13	3.87*	−0.37	−2.73	−0.03	0.22	−0.05	1.46*
11.	No. 239×H 70-16	0.13	−1.00	−2.87*	0.05	−8.40*	−0.08	−0.11	0.42*	−2.30
12.	CES 55×H 70-16	0.60	−0.34	−0.88	0.21	−0.70	0.14	−0.21	0.31*	0.56
13.	G 65×H 70-16	−1.60*	−1.47	−0.19	−0.13	−1.53	0.30	−0.08	−0.19	−0.65
14.	P 426×H 70-16	0.03	−3.04	−0 13	−0.03	−0.53	−0.02	−0.09	−0.10	0.48
15.	ML 1×P. S. 16	0.61	−9.72*	−5.28*	0.05	−16 10*	0.03	−0.61*	0.22*	−5.40*
16.	ML 3×P. S. 16	0.41	2.65	1.07	0.08	5.24*	0.19	0.35	0.17	2.31*
17.	S 8×P. S. 16	−1.39	−4.82*	−1.73*	0.10	−4.10	−1.09	0.22	−0.02	−0.89
18.	No. 239×P. S. 16	0.61	7.15*	3 94*	0.06	12.97*	0.20	0.19	−0.35*	3.88*
19.	CES 55×P. S. 16	0.08	1.01	0.62	0.01	1.87	−0.62*	−0.11	−0.36*	0.59
20.	G 65×P. S. 16	0.18	−0.02	0.32	−0.01	0.14	0.14	0.22	0.18	−0.19
21.	P 426×P. S. 16	−0.49	2 01	1.11	−0.25	0.04	0.15	−0.21	0.13	−0.29
	S. E.$(\hat{S}_{ij})$	0.56	1.41	0.52	0.18	1.56	0.15	0.15	0.07	0.44
	S. E. $(\hat{S}_{ij}-\hat{S}_{kl})$	0.79	1.99	0 74	0.25	2.20	0.21	0.21	0.10	0 62

*Significant at 5% level.

these 21 crosses, as many as 12 gave either non-significant or negative estimate effects, and five crosses exhibited significant and positive sca effects for yield. However, the crosses ML 1 × H 70-16 and No. 239 × P.S. 16 gave significant and positive sca effects for five and four characters, respectively, including the yield. The next best cross was ML 1 × K 851 which showed such performance for three characters. Among these crosses, ML 1 × K 851 involved both the high combiners; ML1 × H 70-16, one high and another medium combiners; and No. 239 × P. S. 16 both the poor combiners. In the last case high sca may be because of non-additive type of gene action. The crosses involving one or both the parents having high combining ability may be exploited for breeding high yielding varieties.

For early maturity, the cross G 65 × H 70-16 gave significant and desirable sca effect. The cross involved G 65 as high combiner for early maturity. For pod length, the two best general combiners involved in the cross CES 55 × K 851 gave significant and positive sca effects. Contrary to this Singh and Jain (1971) found the cross between best general combiners resulting in poor specific combination in mungbean. However, they reported that high sca effects involved at least one parent with high gca. For seed size the cross ML 1 × H 70-16 exhibited significant sca effects.

The study further, revealed that both additive and non-additive types of gene actions were present in the material studied. For yield and its component the major portion of genetic variability was contributed by non-additive gene action. Under situation where both additive and non-additive types of gene actions were involved, the population improvement programme as suggested by Jensen (1970) may be taken up.

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CONTENT AND DISTRIBUTION OF DIFFERENT FORMS OF PHOSPHORUS IN SOME REPRESENTATIVE SOIL PROFILES OF HARYANA

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ABSTRACT

Five representative soil profiles were exposed at different places in Haryana. Soils varied from saline to alkaline in reaction, nil to high in $CaCO_3$ accumulation, low in organic carbon and sandy to loam in texture. Total phosphorus ranged from 31.4 to 860.3 kg P/ha, organic phosphorus from 1.8 to 215.7 kg P/ha and calcium phosphate from 7.9 to 762.5 kg P/ha. These attributes invariably decreased with depth. Iron and Al-bound phosphorus formed a significant fraction of inorganic phosphorus, but no definte trend in depthwise distribution was observed. Iron, aluminium and organic bound P were positively correlated with organic carbon.

Native soil phosphorus exists largely as calcium, magnesium, iron and aluminium phosphates and also in combination with organic compounds. There is a dynamic equilibrium between various forms and the dominance of one over the other is controlled by various physico-chemical characteristics of the soil. The present investigation was, therefore, taken up with a view to determine the various phosphorus fractions under different soil situations in Haryana State.

MATERIAL AND METHODS

Five different soil profiles were exposed at Rohtak, Karnal, Sirsa, Hissar and Gagarwas. The soils were saline in salt content and tested alkaline in reaction. They contained nil to high $CaCO_3$, low organic carbon and were sandy to loam in texture. The samples were analysed for physico-chemical characteristics (Table 1) adopting usual methods as described by Piper (1950).

Phosphorus fractionation was carried out by the method described by Chang and Jackson (1957) as modified by Fife (1959). Total phosphorus and organic phosphorus were determined according to Mehta *et al.* (1954) and available phosphorus by the method of Olsen *et al.* (1954).

RESULTS AND DISCUSSION

Total Phosphorus

A perusal of data in Table 2 indicate that total phosphorus varied from 31.4 to 860.3 kg P/ha. A large variation in different soils may be due to different physico-chemical characteristics of the

TABLE 1

Physico-chemical characteristics of different soils of Haryana

Location	Depth (cm)	pH	EC (mmhos/cm)	O. C. (%)	$CaCO_3$ (%)	Textural class
Karnal	0–12	10.2	4.6	0.3	1.2	Loam
	12–42	10.0	2.8	0.2	1.8	Loam
	42–75	9.9	2.2	0.2	2.5	Loam
	75–145	9.8	1.2	0.4	9.0	Loam
	145–175	9.7	1.1	0.5	7.6	Silt loam
Rohtak	0–15	7.7	0.19	0.3	A*	Loam
	15–42	7.6	0.55	0.3	A	Loam
	42–82	8.3	0.78	0.2	1.8	Loam
	82–127	9.0	0.90	0.3	9.8	Loam
Sirsa	0–20	7.9	0.90	0.5	1.5	Sandy loam
	20–70	8.1	0.28	0.3	8.5	Sandy loam
	70–120	8.1	0.24	0.2	5.8	Sandy loam
	120–150	8.1	0.30	0.1	5.3	Sandy loam
	150–180	8.1	0.20	0.1	1.6	Sandy clay loam
Hissar	0–20	8.2	0.98	0.3	2.0	Loam
	20–60	8.2	0.70	0.3	5.4	Loam
	60–110	8.1	0.65	0.2	11.0	Sandy loam
	110–150	8.0	0.32	0.2	3.0	Sandy loam
	150–200	7.5	0.20	0.1	2.3	Loam
Gagarwas	0–25	7.8	0.31	0.2	3.8	Sandy
	25–60	8.2	0.28	0.1	9.6	Sandy
	60–100	8.1	0.92	0.1	36.0	Loamy sand
	100–145	Pebbles band				
	145–175	8.2	0.76	0.2	18.7	Loamy sand

*A—Absent.

soils. Raychaudhury and Datta (1964) also reported such variation in total phosphorus content (0.03–0.3%) in different soils of India. Of the various profiles exposed, Sirsa profile contained the highest amount of total phosphorus (860.3 kg P/ha), whereas Gagarwas profile had the lowest (31.4 kg P/ha). This may be due to the fact that inorganic phosphorus accounted for major part of total phosphorus and Sirsa profile was found to be richer in inorganic phosphorus as compared to that of Gagarwas. Moreover, the soils of Gagarwas were sandy in texture. Such a wide variation in total P content in erstwhile Punjab soil has also been reported by Kanwar and Grewal (1959).

Total phosphorus invariably decreased with depth in all the profiles and the decline was more marked in Gagarwas profile, where the content of total phosphorus in the bottom horizon was almost half of that present in the surface horizon. The low phosphorus content in lower horizons apparently results from the continuous removal of

TABLE 2

Different forms of phosphorus in various soil profiles

Location	Depth (cm)	Forms of phosphorus (kg P/ha)						
		Olsen's P	Al-bound P	Fe-bound P	Ca-bound P	Total inorganic P (cols. 4+5+6)	Organic P	Total P
1	2	3	4	5	6	7	8	9
Karnal	0-12	26.2	34.9	47.2	69.9	151.9	131.0	286.5
	12-42	29.7	38.0	53.3	70.8	162.1	188.8	292.6
	42-75	13.1	40.2	42.8	40.2	123.2	118.8	251.5
	75-145	3.5	19.2	41.1	31.4	91.7	125.8	223.6
	145-175	2.6	30.6	27.9	29.7	88.2	157.2	247.2
Rohtak	0-10	8.7	47.2	75.1	158.1	280.4	215.7	498.7
	10-42	7.9	45.4	42.8	124.9	213.1	155.5	441.9
	42-82	5.2	42.8	27.9	118.8	189.5	92.6	366.8
	82-127	7.9	71.6	24.5	120.5	216.6	106.6	332.8
Sirsa	0-20	15.7	157.2	5.2	600.0	762.5	45.2	860.3
	20-70	6.1	106.6	7.0	586.9	700.5	94.3	795.6
	70-120	5.2	161.2	2.6	422.7	596.5	79.5	676.9
	120-150	3.5	168.6	1.8	432.3	602.6	76.0	679.5
	150-180	1.8	151.9	1.8	316.2	469.9	77.7	633.2
Hissar	0-20	12.2	78.6	9.6	514.4	602.7	97.8	703.9
	20-60	8.7	65.5	7.0	464.6	537.2	80.4	620.1
	60-100	5.2	81.2	5.2	363.3	449.8	55.9	490.8
	100-150	5.2	83.9	4.4	266.4	354.6	44.5	366.8
	150-200	2.6	82.9	2.6	248.9	334.5	43.7	336.3
Gagarwas	0-25	4.4	11.4	12.2	30.6	54.2	22.7	81.2
	25-60	3.5	6.1	1.8	18.3	26.2	1.8	31.4
	60-100	1.8	7.0	2.6	9.6	19.2	1.8	31.4
	100-145	Pebbles band						
	145-175	1.8	5.2	3.5	7.9	16.6	2.6	31.4

phosphorus by plant roots from lower depths without subsequent replenishment through organic matter or fertilizers which, in general, are added in surface soils.

Organic Phosphorus

Organic phosphorus varied from 1.8 to 215.7 kg P/ha (Table 2), the highest being in surface horizon of Rohtak profile and the lowest in 25 to 60 cm horizon of Gagarwas profile. Organic phosphorus, being a part of organic matter, tends to follow a pattern of accumulation and losses similar to that of organic matter. Correlation coefficient between organic phosphorus and organic matter was calculated to be 0.835 (significant at 1%) which is of the same order as reported by Black and Whitney (1966) and Khan and Mandal (1973).

Depthwise, there was a decrease in organic phosphorus, the highest amount (22.7 to 215.7 kg P/ha) being in surface horizons and the lowest (2.6 to 157.2 kg P/ha) in the lower most horizons. The only exception was Karnal profile, where it increased with depth which may be attributed to higher organic matter accumulation in lower horizons of that soil. A similar trend regarding the vertical distribution of organic phosphorus has been reported by Mehta *et al.* (1979) in deep black soils of Gujarat. They attributed it to the soil maturity level and distribution pattern of organic matter and roots in the profile.

Aluminium and Iron Phosphates

Aluminium and iron phosphates varied from 5.2 to 171.2 kg P/ha and 1.8 to 75.1 kg P/ha, respectively (Table 2) exhibiting a variation of 13.9–28.0 and 0.5–34.6 per cent of inorganic phosphorus. The low content of aluminium and iron phosphates may be attributed to high pH of these soils as phosphate ions combine readily with aluminium and iron ions under acidic conditions as compared to alkaline soils, because of their solubility in acidic range. As already stated the soils of Haryana are alkaline in reaction having a pH value of 7.6-10.2 which results in lower content of aluminium and iron phosphates. The results are in close agreement with those of Scheffer *et al.* (1960) who had reported that iron and aluminium phosphates dominated in acid soils and calcium phosphate was prevalent in calcareous soils of South Dakota. Dhaliwal (1966) also reported that Al and Fe bound P was low as compared to Ca-P in Hissar soils of Haryana State.

Vertically, aluminium phosphate did not follow any general trend, whereas iron phosphate gradually decreased with depth. The latter, ranged from 5.2 to 75.1 kg P/ha in surface horizons. and 1.8 to 27.9 kg P/ha in the lowest horizons. Movement and accumulation of clay in some horizons may account for the differential distribution of aluminium and iron phosphates in soil profiles. A positive significant correlation between silt and Al-P and Fe-P has been reported by Balasubramanian and Raj (1969). Such a correlation, however, was not observed in the present study.

Calcium Phosphate

A perusal of the data in Table 2 indicates that Ca-P formed the largest fraction (84.7%) of total inorganic phosphorus and varied from 7.9 to 600 kg P/ha. The calcium ions which hold phosphate ions in soils may be calcium ions in soil solution and/or exchangeable calcium forming calcium phosphate on the surface of clay particles or anchored on the surface of $CaCO_3$ crystals. This explains the presence of larger quantity of calcium phosphate in alkaline and calcareous soils of Haryana which is in line with the work reported by Kanwar and Grewal (1959) and Dhaliwal (1966).

Depth wise, calcium phosphate decreased gradually in all the soils and varied from 30.6 to 600 kg P/ha in surface and 7 9 to 29.7 kg P/ha in bottom horizons. Scheffer *et al.* (1960) had also observed that calcium phosphate decreased with depth.

Olsen's-P

The sodium bicarbonate (pH 8.5) extractable phosphorus varied from 1.8

to 29.7 kg P/ha, i. e., from very low to high in status. Surface soils were found to be comparatively richer in available phosphorus as compared to sub-soils. Patel and Mehta (1962) had also observed that surface soils of Gujarat were relatively richer in available phosphorus than sub-soil layers. The high content of available phosphorus in surface horizons may be attributed to high organic matter content (Table 1) and addition of inorganic P fertilizers in surface soils. Carbon dioxide evolved during organic matter decomposition forming carbonic acid may dissolve various fractions and render them in available form.

Association Between Inorganic and Organic Forms of Phosphorus

A perusal of data in columns 7 and 8 of Table 2 reveals that total content of inorganic phosphorus was invariably higher than the organic phosphorus in all the profiles except in Karnal where horizons below 75 cm contained higher content of organic phosphorus. On an average, organic phosphorus varied from 6.6 to 56% of the total phosphorus. The ratio of inorganic phosphorus to organic phosphorus was the highest (8 : 1) in Sirsa and lowest (1 : 1.7) in Karnal profile. This may be due to the fact that aluminium and calcium bound phosphates were comparatively higher in Sirsa than in Karnal profile. Moreover, Karnal profile had higher organic phosphorus content than Sirsa profile. Both inorganic and organic phosphorus contents were, in general, low at the bottom as compared to the top horizons. Black and Whitney (1966) reported a comparatively lower organic phosphorus content in the bottom horizons of the soils studied by them.

Association Between Different Forms of Inorganic Phosphorus

In general, the calcium phosphate content was higher than the sum of aluminium and iron phosphates. However, in Karnal profile, aluminium and iron phosphates taken together were more than calcium phosphate content especially in the surface and sub-surface horizons. In strong alkaline soils of Karnal, sodium is a dominating cation and, therefore, the calcium bound phosphorus is less as compared to Sirsa profile. In Rohtak soils, the sum of aluminium and iron phosphate was slightly less than calcium phosphate but in Sirsa profile calcium bound phosphorus was much higher than the sum of aluminium and iron phosphates. Aluminium bound phosphorus was higher than iron bound phosphorus in all the profiles except Karnal which may, however, be ascribed to its high pH. Dominance of Ca-P has also been reported by Ram Deo and Ruhal (1972) in calcareous soils of Rajasthan.

Regarding the relative percentage of various phosphatic forms, calcium phosphate, on an average, varied from 37.4 to 84.7% of the total phosphorus, whereas iron phosphate varied from 0.5 to 34.6 per cent. This indicates that calcium phosphate contributed the highest and the iron phosphate the lowest amount towards total inorganic phosphorus. This observation finds support from the work of Singh and Pathak (1973).

Correlation Coefficients

Iron, aluminium and organic bound phosphorus was significantly correlated with organic carbon, viz. Fe-P (+0.554), Al-P (+0.700) and organic-P (+0.835), respectively, at 1% level of significance. Al-P was also correlated with pH (+0.519) at 5% level of significance. No correlation of $CaCO_3$ and silt+clay contents with any form of phosphorus could be observed. The results are in conformity with the findings of Singh and Pathak (1973).

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EFFECT OF VARYING MOISTURE REGIMES, LEVELS OF NITROGEN AND SPACING ON QUALITY AND CHEMICAL COMPOSITION OF SEEDS OF OKRA *(ABELMOSCHUS ESCULENTUS* (L.) MOENCH.*)*

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ABSTRACT

Out of four moisture regimes (40, 60, 80 and 120 mm CPE), four nitrogen levels (0, 50, 100 and 150 kg/ha) and three spacings (45×15, 45×30 and 45×45 cm) on the soil of medium fertility level, the irrigation at 60 mm CPE and nitrogen at 100 kg N/ha under the spacing of 45×30 cm produced better quality seeds from the view point of boldness, acceptability and germination. The protein content of seeds was markedly improved by the irrigations at 60 mm CPE and nitrogen at 150 kg N/ha under spacing of 45×30 cm. The starch and phosphorus contents of seeds were not influenced significantly by either of the moisture regimes, nitrogen levels or spacings.

The quality of seed plays an important role in improving the crop yield. Besides the genetic purity, the quality of seed is usually judged by their boldness and germination capacity. The bold seeds resulted in better germination and yield performance of crop (Sandhu *et al.*, 1965). The protein, starch and phosphorus contents of seeds are influenced by moisture conditions, nitrogen application and plant population in the crop (Sarkisyan, 1970). Because of paucity of scientific literature in vegetable seeds on the above aspects, the proposed studies were conducted to find out the effect of moisture regimes, nitrogen levels and plant spacings on the quality and chemical composition of seeds of okra.

MATERIAL AND METHODS

The experiment consisting of three moisture regimes (120, 80 and 60 mm CPE in 1976 and 80, 60 and 40 mm CPE in 1977), four nitrogen levels (0, 50, 100 and 150 kg/ha) and three plant spacings (45×15, 45×30 and 45×45 cm) under split plot design was conducted from March to June each year at the experimental Farm of R. B. S. College, Bichpuri, Agra. A total of 36 treatments were arranged in three replications. The soil of the experimental field had the organic carbon 0.41%, total nitrogen 0.042%, available P_2O_5 22 kg/ha, available K_2O 350 kg/ha, pH 8 and electrical conductivity 0.65 mmhos/cm. The foundation

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seed of Pusa Sawani variety of okra was used in the experiment. The moisture regimes were decided on the basis of Cumulative Pan Evaporation (CPE) by U. S. open pan and accordingly the measured quantity of irrigation water was applied to the crop. In 1977, the irrigation schedule based on 120 mm CPE was dropped because of poor crop survival under this irrigation. In its place another irrigation schedule based on 40 mm CPE was added to the irrigation treatments. Thus, total number of irrigations applied in 1976 were 9, 12 and 15 under irrigation treatments at 120, 80 and 60 mm CPE, respectively, whereas in 1977 the applied irrigations were 10, 12 and 17 under irrigation treatments at 80, 60 and 40 mm CPE, respectively. Nitrogen in the form of calcium ammonium nitrate was applied in two splits, i.e., first half dose at the sowing time and the second half dose at 45 days after sowing. All the due cultural operations and plant protection measures were followed to grow the crop successfully. Acceptable percentage of seed was calculated as per minimum seed certification standards (Anonymous, 1971), weight of randomly sampled acceptable 1000 seeds from each treatment was recorded to express the boldness of seeds. One hundred seeds from each treatment were used for germination by towel paper test at 20°C in a germinator and the number of seeds germinated upto 10 days when the germination became constant, were recorded as percentage of germination. Protein content of seeds was worked out by estimating per cent content of nitrogen in the seed and then multiplying it by 6.25 (AOAC, 1970). The starch content of seed was estimated by direct acid hydrolysis method (AOAC, 1970). The percentage of phosphorus in the seeds was determined by Vanado molybdophosphoric yellow colour method (Koeing and Johnson, 1942).

RESULTS AND DISCUSSION

Weight of 1000 Seeds

Irrigations at 60 mm CPE during both the years showed the weight of 1000 seeds significantly higher (58.6 g in 1976 and 60.4 g in 1977) than the rest of moisture regimes (Table 1). Irrigations at 120 mm CPE in 1976 resulted in the lowest weight of 1000 seeds (16.7 g). Increasing the level of nitrogen upto 100 kg/ha increased significantly the weight of 1000 seeds during both the years. Further increase in the level of nitrogen from 100 to 150 kg/ha reduced the weight of 1000 seeds. However, significant reduction was recorded in 1977 only. Thus, the highest weight of 1000 seeds, which was 45.9 g in 1976 and 62.3 g in 1977 was obtained with 100 kg N/ha. Medium spacing of 45×30 cm resulted in significantly bolder seeds than closer or wider spacings during both the years.

Irrigations at 60 mm CPE produced bolder seeds probably because of greater production of plant food like carbohydrates and proteins which were spared in more quantity for storage in seeds. The present findings confirm the observations of Singh and Cheema (1972) and Stoker (1975) who working with different vegetable crops reported the production of bolder seeds under medium irrigations. The boldest seeds expressed in terms of highest weight of 1000 seeds

TABLE 1

Weight of seeds, acceptable seeds and germination of seeds as influenced by varying moisture regimes, levels of nitrogen and spacings

Treatment	Weight of 1000 seeds (g)		Acceptable seeds (%)		Germination (%)	
	1976	1977	1976	1977	1976	1977
Moisture regimes (mm CPE)						
120	16.7	—	13.2	—	50 6	—
80	49 2	50.6	66.2	67.3	88.3	89.0
60	58.6	60.4	76.1	77.2	91.0	90.7
40	—	54.0	—	71.9	—	89 7
C.D. at 5%	0.23	0.27	0.19	0.48	2.81	NS
Nitrogen levels (kg/ha)						
0	32.8	42.8	47.5	67.4	89.3	87.6
50	41.6	54.3	53.0	72.3	89.4	88.3
100	45.9	62.3	54.1	74.5	83.6	88.6
150	45.8	61.5	52.8	74.3	83 6	88.6
C.D. at 5%	0.32	0.21	0.16	0.12	NS	NS
Intra row spacings (cm)						
15	41.8	53 8	52.0	70.8	73.7	86.6
30	43.2	56.7	53.9	74.6	74.8	87.7
45	39.6	55.2	49.6	70.9	74.3	87.6
C.D. at 5%	0.28	0.17	0.14	0.10	NS	NS

under 100 kg N/ha were observed because of this being better helpful in synthesis of more food material and its translocation to the seeds making them bolder than rest of nitrogen levels. At lower levels of nitrogen perhaps due to lesser storage of food, the seeds were shrivelled and undersized resulting in reduction in their weight. Under spacing of 45 × 30 cm it appears that supply of water and nutrients and the synthesis of food were more favourable for greater translocation to the seeds making them more plump and bold than under closer spacings while under wider spacing of 45 × 45 cm unfavourable microclimate associated with free movement of air resulted in shrivelling of seeds reducing their size and weight.

Acceptable Seeds

The perusal of the data in Table 1 reveals that irrigating the crop at 60 mm CPE produced the highest percentage of acceptable seeds (76.1 in 1976 and 77.2 in 1977) which was significantly superior to those recorded at other moisture regimes. Increasing the level of nitrogen upto 100 kg/ha significantly increased the percentage of acceptable seeds. Further increase in the level of nitrogen to 150 kg/ha significantly reduced the percentage of acceptable seeds in both the years. Thus, highest percentage of acceptable seeds (54.1 in 1976 and 74.5 in 1977) was recorded with 100 kg N/ha. Due to variations in spacing, significant differences in per-

centage of acceptable seeds were produced in both the years. The crop raised with medium spacing of 45 × 30 cm recorded the highest percentage of acceptable seeds (53.9 in 1976 and 74.6 in 1977) which was significantly higher than the wider and closer spacings.

The reasons accounted for bolder seeds expressed in terms of weight of 1000 seeds are also directly responsible for producing highest percentage of acceptable seeds.

Germination Percentage

Maximum germination (91.0% in 1976 and 90.7 % in 1977) was with the seeds produced under irrigations at 60 mm CPE during both the years. However, the differences were significant in 1976 only. Variations in the level of nitrogen as well as spacing between plants did not produce any significant effect on the germination of okra seeds. Irrigations were also observed not affecting materially on the germination of seed in radish (Singh and Cheema, 1972). The present studies with regard to nitrogen application on germination of seeds were in agreement with the findings of Sandhu *et al.* (1965) who also could not find the significant effect of nitrogen application on the germination of turnip seeds.

Chemical Composition of Seeds

In both the years, the seeds produced with irrigations at 60 mm CPE contained significantly higher protein (12.5% in 1976 and 11.8% in 1977) than that obtained under the rest of moisture regimes (Table 2). Nitrogen application at 100 kg/ha resulted in highest percentage

TABLE 2

Protein, starch and phosphorus contents in seeds as influenced by varying moisture regimes, levels of nitrogen and spacings

Treatment	Protein (%)		Starch (%)		Phosphorus (%)	
	1976	1977	1976	1977	1976	1977
Moisture regimes (mm CPE)						
120	9.3	—	48.1	—	0.43	—
80	10.8	10.3	48.2	49.0	0.44	0.48
60	12.5	11.8	49.0	49.1	0.45	0.49
40	—	10.6	—	49.1	—	0.48
C.D. at 5%	0.12	0.06	NS	NS	0.3	NS
Nitrogen levels (kg/ha)						
0	6.2	7.6	48.1	49.2	0.43	0.48
50	8.5	10.5	48.1	48.9	0.43	0.48
100	10.9	12.5	48.0	48.9	0.43	0.48
150	10.5	13.1	48.0	48.9	0.44	0.48
C.D. at 5%	0.07	0.11	NS	NS	NS	NS
Intra row spacings (cm)						
15	8.9	10.4	48.0	49.0	0.43	0.48
30	9.5	11.6	48.1	49.0	0.44	0.48
45	8.6	10.8	48.1	49.1	0.43	0.48
C.D. at 5%	0.06	0.08	NS	NS	NS	NS

(10.9) of protein in seeds during 1976, whereas in 1977 it was 13.1 with 150 kg N/ha. These values were significantly higher than those recorded under other levels of nitrogen. Medium spacing of 45×30 cm produced highest percentage of protein (9.5 and 11.6) in 1976 and 1977, respectively.

The highest protein content under irrigations at 60 mm CPE during both the years might be due to more nitrogen accumulation in seeds under this moisture regime than other moisture regimes (Table 2). Sharma and Prasad (1973) also observed increased protein in green okra pods with medium and decreased protein with higher or lower moisture regimes. They also observed that protein content of green pods of okra increased with the increase in the level of nitrogen. The plant spacing of 45×30 cm showed significantly higher protein content than either under closer or wider spacings because of higher percentage of nitrogen in plants under this spacing which was diverted towards seeds at the maturity of the crop. The results are in agreement with the statement of Sutcliffe and Baker (1974) that considerable amount of nitrogen migrates from different plant organs to the seeds at maturity of the crop and increases the protein content.

The starch content in seeds was not influenced significantly by any of the treatment. However, the percentage of starch was more in seeds produced under wettest moisture regimes and wider plant spacings. The nitrogen application did not show a marked variation in starch content of seeds. Maranvill and Paulsen (1970) also observed decreased starch concentrations under moisture stress due to accelerated hydrolysis because of depressed synthesis.

In both the years, maximum phosphorus content in seeds (0.45% in 1976 and 0.49 % in 1977) was recorded in the crop irrigated at 60 mm CPE, though the significant differences were noted in 1976 only. The irrigations applied at 120 mm CPE appeared to have restricted the uptake of phosphorus from soil. Hibbard (1959) also observed low phosphorus content in various crops as the moisture stress increased. The phosphorus content of seeds remained unaffected due to varying levels of nitrogen and plant spacings.

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STORAGE STUDIES ON DIFFERENT MUSKMELON CULTIVARS

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ABSTRACT

Seven muskmelon cultivars were studied for their storage behaviour under room and low temperature conditions. Physiological loss in weight was significantly less in cvs. Arka Jeet, Punjab Sunheri and Punjab Hybrid. In the organoleptic assessment Punjab Sunheri, Punjab Hybrid and Hara Madhu were rated to be above average. The acceptability of fruits was upto 8 and 25 days at room and low temperature, respectively. TSS increased in all the cultivars during early period of storage.

Muskmelon is commercially grown for fresh consumption during summer in the plains of Northern India. In the peak period of production, there is a glut in the market, which causes economic loss to the growers, because muskmelon is not generally stored. However, muskmelon fruits behave differently under different storage conditions (Platenius *et al.*, 1934; Wiant, 1938). Hence, present studies were undertaken to evaluate different muskmelon cultivars for their storage behaviour at room and low temperature conditions.

MATERIAL AND METHODS

The experiment was conducted in the post-harvest laboratory of Horticulture Department, during 1977-78 and 1978-79. Fully mature fruits from seven muskmelon cultivars viz. Arka Jeet, Durgapura Madhu, Hara Madhu, Punjab Hybrid, Punjab Sunheri, S-445 and Selection-1 were selected. The fruits were packed in bamboo baskets taking 5 kg fruits per pack using paper cuttings as cushioning material. Four packs were used for each cultivar and kept at room temperature (32±8°C) and low temperature (4±1°C) conditions.

Observations on weight loss, TSS and organoleptic quality of fruits were recorded at an interval of 2 and 4 days for room and low temperature, respectively. Organoleptic rating of the fruits was done by a panel of six judges and was based on various factors like general appearance, skin and flesh texture, aromatic flavour and taste. The data on fruit-size and flesh-thickness were also recorded on 10 fruits for each cultivar.

RESULTS AND DISCUSSION

The physiological loss in weight was significantly less at low temperature as compared to room temperature (Table 2). This might be due to slow rate of respiration and transpiration at low temperature. Minimum weight loss was

TABLE 1

Fruit size and flesh thickness of various muskmelon cultivars

Cultivars	Fruit size (Diameter in cm)	Flesh thickness (cm)	Skin texture
Arka Jeet	8.33	1.09	Smooth & waxy
Durgapura Madhu	13 08	2.72	Smooth & waxy
Hara Madhu	11.96	2.04	Smooth & waxy
Punjab Hybrid	11.40	3.09	Netted
Punjab Sunheri	12.22	3.99	Netted
S-445	10.22	2.18	Smooth
Selection-1	12.11	2.00	Smooth
C. D. at 5%	2.44	0.68	

recorded in cvs. Arka Jeet, Punjab Sunheri and Punjab Hybrid under both the temperature conditions. This difference in weight loss might be attributed to the variability in the size, surface and flesh thickness of the fruits (Table 1). Similar results were also reported by Bhatnagar *et al.* (1980) in tomato.

Organoleptic quality of the fruits as influenced by storage conditions is presented in Table 3. The fruits of the cultivars Punjab Sunheri and Punjab Hybrid were rated to be above average as compared to other cultivars. The acceptability of the fruits was upto 8 and 25 days at room and low temperature conditions, respectively.

However, the fruits of Hara Madhu were equally good upto six days at room temperature, inspite of higher weight losses. The colour, taste and flavour of the fruits were improved slowly in all the cultivars at low temperature because of the suppression of respiration but were normal at room temperature. Similar results were also reported by Chace *et al.* (1924) and Rosa (1928).

The data presented in Table 4 shows an increase in TSS in all the cultivars during early period of storage. This increase was recorded upto 6 and 16 days of room and low temperature, respectively. However, the fruits stored at low temperature could not reach the value attained by the fruits at room temperature.

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TABLE 2

Per cent loss in weight in various muskmelon cultivars during storage

Cultivars	Room temperature				Total weight loss after 6 days	Low temperature						Total weight loss after 16 days
	Days in storage					Days in storage						
	2	4	6	8		4	8	12	16	20	25	
Arka Jeet	0.80	3.00	1.61		5.41	1.24	1.16	1.70	2.88			6.98
Durgapura Madhu	8.55	7.28	3.17		19.00	1.04	2 32	4.12	6.01			13.49
Hara Madhu	4.60	6.85	8.73	4.71	20.18	0.58	1.59	2.76	3.84	3.21		8.77
Punjab Hybrid	5.90	5.74	3.57	4.36	15.21	0.42	1.89	2.89	3.36	2.34	1.82	8.56
Punjab Sunheri	4.61	3.00	3.57	4.62	11.18	0.45	1.21	2.65	3.42	2.34	1.89	7.73
S-445	6.90	5.98	7.18		20.06	0.33	1.25	2.90	4.94			9.42
Selection-1	4.70	7.94	9.59		22.23	0 53	1.81	3.42	4.62			10.38

C. D. at 5%
Cultivars=1.82
Days =0.66

C. D. at 5%
Cultivars=1.08
Days =0.92

TABLE 3

Organoleptic rating of various muskmelon cultivars during storage

Cultivars	Room temperature					Low temperature					
	Days in storage					Days in storage					
	0	2	4	6	8	4	8	12	16	20	25
Arka Jeet	8.2	6.4	4.8	3.6	2.0	8.0	7.6	6.8	4.3	3.4	2.0
Durgapura Madhu	7.0	5.4	4.8	3.0	1.5	6.8	6.5	6.0	4.0	3.0	1.8
Hara Madhu	9.5	8.0	6.5	5.0	3 2	9.2	9.0	8.6	7.0	5.1	3.8
Punjab Hybrid	9.2	8.0	7.0	6.2	5 1	9.0	8 8	8.4	8.0	7.5	6.2
Punjab Sunheri	9.8	9.0	7.0	6.0	4.8	9.6	9.0	8.5	7 2	6.4	5.5
S-445	9.0	8.1	5 6	3 0	1 8	8.4	7.6	6.8	4.5	3.7	2.0
Selection-1	7.6	6.8	4.2	2 8	1.2	7.4	6.6	5.8	4.5	3.8	2.6

Grading :

below 3 = Discarded
3—4 9 = Acceptable
5 - 7.9 = Good
8—10 = Excellent

TABLE 4

Total soluble solids (%) of various muskmelon cultivars during storage

Cultivars	Room temperature					Mean upto 6th day	Low temperature						Mean upto 16th day
	Days in storage						Days in storage						
	0	2	4	6	8		4	8	12	16	20	25	
Arka Jeet	5.0	6.5	7.0	7.0	—	6.35	5.0	6.0	6.5	6.5	—	—	6.00
Durgapura Madhu	4.5	5.0	6.5	7.0	—	5.75	4.5	5.0	6.0	6.0	—	—	5.37
Hara Madhu	6.0	7.0	8.5	9.0	10.0	7.88	6.5	7.0	7.5	8.0	8.5	8.5	7.25
Punjab Hybrid	8.0	9.0	10.5	11.0	11.0	9.62	8.0	9.0	9.5	9.5	10 0	10.0	6.50
Punjab Sunheri	8.0	9 5	11.0	12.0	12.0	10.12	8.5	9.0	9.0	10.5	11.0	11.0	9.27
S-445	7.0	8.5	10.0	10.5	—	9.00	7.0	8.5	9.5	9.5	—	—	8.32
Selection-1	6.0	8.0	9.0	9.0	—	8.00	6.5	7.5	8.0	8.0	—	—	7.50
C. D. at 5% Days=0.67							C. D. at 5% Days=1.08						

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FEEDING BEHAVIOUR AND LARVAL POPULATION LEVELS OF *HELIOTHIS ARMIGERA* (HUBNER) CAUSING ECONOMIC THRESHOLD OF DAMAGE TO THE GRAM CROP

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ABSTRACT

Studies on feeding behaviour of *Heliothis armigera* (Hubner) on gram crop revealed that during reproductive phase of the crop (March-April), about 87% of young larvae fed on green leaves for about 5 days while the remaining 13% larvae continued feeding on leaves upto 10 days. After becoming 5 days old, the larvae shifted on pods where they fed for another 3-10 days. In its larval stage, a caterpillar was able to damage 7-16 pods. Studies on larval population, to estimate economic injury level, showed a direct correlation between the increase in the number of larval population/unit area and per cent pods and grains damaged and loss in yield of the crop. Continuous presence of even a single larva per meter row length of gram crop, during its pod formation stage, caused about 5.4 % loss in yield and damaged 6.9 % pods and 6.2% grains. The population of 10 larvae/meter row length caused a damage of 24.6, 23.5 and 21.5 per cent to pods, grains and yield, respectively.

The gram pod borer, *Heliothis armigera* (Hubner) is a serious pest of gram crop in almost all the gram producing states in the country. During 1964 even when the infestation of *H. armigera* was not considered to be high, the loss in yield by the pest in Madhya Pradesh was 40 to 50% (Bindra, 1968). Singh and Singh (1975) reported 6.6 to 10.7% pod damage by this borer in the Punjab. This pest was reported to damage 5 to 32% pods during 1977 in different agro-climatic zones of Haryana State (Chaudhary *et al.*, 1980). *H. armigera*, although, is a major pest of gram crop, yet a little information is available on the number of pods of gram a caterpillar can damage during its larval stage, population levels causing economic injury and also on the feeding behaviour of the borer during reproductive phase of the crop, which is very essential for the proper management of *H. armigera* on this important pulse crop.

Considering the importance of gram crop in the country, studies on the above aspects in respect of *H. armigera* on gram crop were carried out during 1978.

MATERIAL AND METHODS

Feeding behaviour of the larvae of *H. armigera* on gram plants during its pod formation stage and estimation of number of pods a larva can damage

during its larval duration were studied by giving gram twigs bearing green leaves and pods on them. Supply of such twigs to the larvae was started from the moment they hatched from the eggs and continued until they pupated. Each larva was fed on separate twigs confined in separate jars (size 15×5 cm). Fresh twigs in the jars were replaced after every one or two days, i. e., much before their complete consumption. Observations on the feeding behaviour on leaves as well as on pods by different larval stages and also on number of pods eaten by a larva during its larval stage were recorded.

For the determination of the minimum larval population level of *H. armigera* causing economic threshold of damage to the gram crop, an experiment was carried out at the farm of Haryana Agricultural University, Hissar during March-April, 1978 on **desi** gram variety-G 130. As soon as pod formation started, five plants of gram, grown in one metre row length, were enclosed in rectangular cages (size 1×0.5×1m). The frames of the cages were made with iron bars (thickness 13 mm) and these were covered with white synthetic nettings of 24 mesh. In each cage, 0, 1, 2, 3, 4, 6, 8 and 10 larvae of second instar were released. The experiment was replicated thrice and in this way a total of 24 cages were used. In each cage desired number of caterpillars were maintained upto the maturity of the crop. The plants which were to be kept for the control treatment were sprayed with 0.07% endosulfan before caging them to avoid the risk of presence of caterpillars of *H. armigera* on them. On maturity, plants were harvested and total number of healthy and damaged pods were counted. Percentage of damaged pods, damaged grains and loss in yield due to different levels of larval population were calculated and correlation and regression for per cent pods and grains damaged and loss in yield were worked out.

RESULTS AND DISCUSSION

Feeding Behaviour of *H. armigera* Larvae During Pod Formation Stage

The data in Table 1 show that all the early stage larvae of *H. armigera* after hatching from the eggs fed on green leaves. Out of the 23 larvae observed for this purpose, 87% larvae fed on leaves for about 5 days, while the remaining 13% continued feeding on leaves for 8-12 days (av. 10 days). For the above study, although, larvae were provided with gram twigs containing both leaves and pods on them, they were never observed feeding on pods unless they became 5 days old. This indicates that the larvae in their early instars (I and II) were incapable of boring into the green pods of gram. The third instar larvae, however, shifted on pods, on which they continued their feeding until they became fully mature. The duration of feeding on green pods varied from 3 to 10 days (av. 7.4 days) during March-April when the crop was in fruiting phase. During the period of feeding on pods, a larva was observed to damage 7-16 pods (av. 12 pods). However, according to Chaudhary and Chaudhary (1975), a larva of *H. armigera* was capable of damaging 30 to 40 pods in its life time. Such a higher number of pod damage was never observed in the present study.

TABLE 1

Duration of larval feeding of *H. armigera* and number of pods damaged in its larval period during March-April, 1978 (Based on 23 observations)

Particulars	Average	Range
Duration of larval feeding (days)		
(a) On leaves	5.7	5–12
(b) On pods	7.2	3–10
Number of pods damaged by a caterpillar in its total larval duration	12.0	7–16
Laboratory temperature (0°C)		
(a) Maximum	34.5	32.4–36.8
(b) Minimum	30.0	28.2–31.6
Relative humidity (per cent)	70.0	66–73

TABLE 2

Effect of different population levels of *H. armigera* on number of pods damaged, per cent pods and grains damaged ar d loss in yield

No. of larvae/ m row length	No. of pods damaged*	Pods damaged** (%)	Grains damaged** (%)	Loss in yield** (%)
0	0.0 (1.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)
1	55.0 (7.48)	6.9 (15.12)	6.2 (14.30)	5.4 (13.44)
2	80.0 (9.00)	10.0 (18.43)	9.7 (18.15)	8 5 (16.55)
3	111.0 (10.58)	13.9 (21.81)	13.3 (21.30)	11.8 (20.09)
4	121.3 (11.06)	15.2 (22.87)	15.8 (23.34)	14.0 (21.97)
6	141.6 (11.94)	17.7 (24.88)	17.1 (24.35)	15.7 (23.26)
8	150.6 (12.32)	18.9 (25.70)	18.1 (25.18)	16.5 (23.97)
10	196.3 (14.05)	24.6 (29.67)	23.5 (28.93)	21.3 (27.49)
S.Em.±	(0.62)	(1.34)	(1.49)	(1.27)
C. D. at 5%	(1.88)	(4.08)	(4.52)	(3.84)

*Figures in parentheses are means of $\sqrt{n+1}$

**Figures in parentheses are means of angular transformation of percentages.

Minimum Population Level of *H. armigera* Larvae causing Economic Threshold of Damage

The data in Table 2 reveal that there was a regular increase in the per cent pods damage, per cent grain damage and per cent loss in yield with the increase in the number of larvae per unit row length of the crop. Also there was a positive correlation between the number of larvae per unit row length and the above mentioned factors (Fig. 1).

Presence of even one larvae per metre row length caused about 5.4% reduction in the yield of the crop which is considerably higher than the level of economic injury. Singh and Reddy (1976), on the other hand reported that there was not significant reduction in yield till one larva was fed on a metre row length of the gram crop, but any population beyond that caused considerable loss in yield. The above workers recommended control operation of the crop soon after the appearance of a larva in a metre row length of the crop. They have further reported that presence of 8 larvae on 10 plants of gram, grown in a metre row length, caused 31 to 39% loss in yield, whereas in the present study, presence of 10 larvae on 5 plants, grown in a metre row length, caused only 21.3% loss in yield. Almost similar results were also obtained by Odak and Thakur (1977) in their trial conducted at Jabalpur.

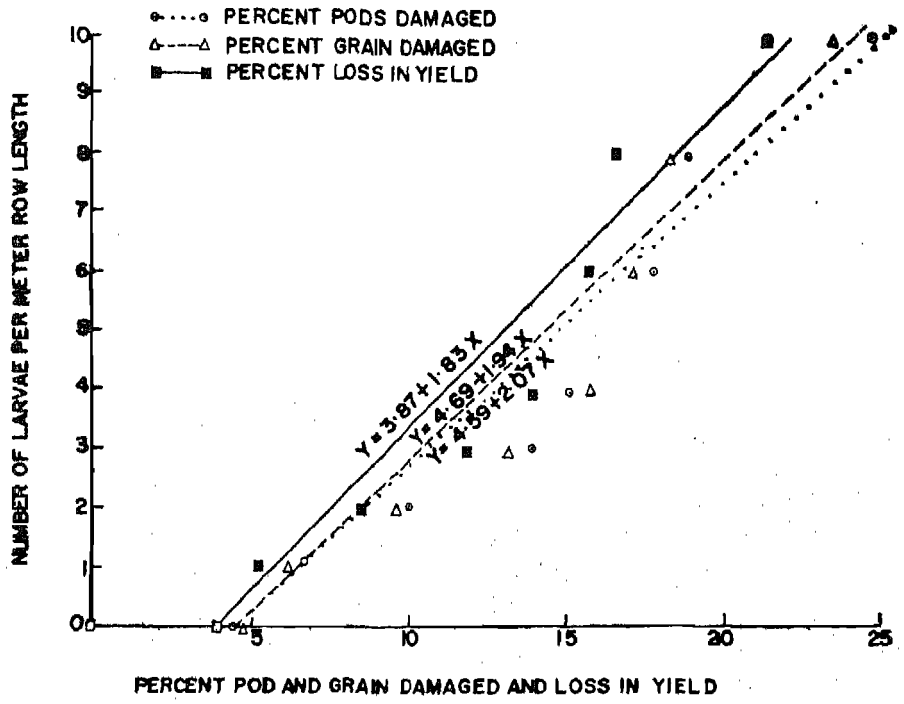


Fig. 1. Correlation between number of larvae of *H. armigera* per metre row length of the gram crop and the percentage damage to pods and grains and losses in yield.

Regular increase in the larval population in a unit of row length of the crop did not give the same trend of increase in the damage to the pods and grains and loss in yield as was observed under the low population levels. In nature, it was noticed that due to competition under the conditions of higher larval density, some of the larval population prolonged their feeding duration on leaves even when large number of healthy pods were present on plants. This seems to be the probable factor responsible for the improportionate increase in damage of pods with the increase in the larval population, which ultimately was the factor responsible for proportionately low grain damage and per cent loss in yield.

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GENETIC ANALYSIS OF PLANT HEIGHT IN CASTOR (*RICINUS COMMUNIS* L.)

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ABSTRACT

Analysis of an 8×8 diallel cross (excluding reciprocals) of dwarf, medium and tall inbreds of castor revealed that the plant height was under the control of both additive and non-additive type of genetic variances with more preponderance of the former. Dwarf plant height was governed by a single recessive gene group with a very high narrow sense heritability (86.97%). There was partial dominance and no epistasis for the expression of this attribute. These facts were also confirmed from covariance and variance graph analysis. CH_1, dwarf variety of castor possessed recessive gene for dwarfing and, hence, could be a worthwhile source for reducing the height of the plant without sacrificing the seed yield.

In the Northern part of the country, one of the main reasons for the smaller area under castor is the availability of the varieties which are very tall and late in maturity. Tall height creates problems in harvesting and cultural operations. Recently, new plant types in castor have been evolved which are early and some are also dwarf (Yadava *et al.*, 1976) as compared to old varieties. However, the genetics of plant height has not been worked out to formulate a suitable breeding procedure for developing the dwarf varieties of castor. The present study is an attempt towards this direction.

MATERIAL AND METHODS

The study comprised of 28 one way F_1s of an 8×8 diallel cross and eight parental inbreds. These inbreds were developed from Aruna, PC No. 1, CH_1, VHB 44, RC 1377, RC 1379, RC 7 and JI 44 which represented larger differences in plant height. These 36 entries (28 F_1s and 8 parental inbreds) were grown in a randomized block design with three replications. Each entry consisted of one row of 6 m length. Row to row and plant to plant distances within row were kept at 60 and 30 cm, respectively. All the recommendations were followed to raise a good crop. The data on plant height was recorded at the maturity on five randomly tagged plants in each entry. Hayman's (1954) genetic components of variances such as D, H_1, H_2, h^2, F and E were calculated. With these statistics various ratios were also computed as per Aksel and Johnson (1963).

RESULTS AND DISCUSSION

The analysis of variance for plant height (Table 1) revealed significant differences among the progenies for this attribute. The analysis of various genetic components has been presented in Table 2. The 'b' value was significant from zero (4.19) and non-significant from unity (0.346). This revealed that no epistasis was involved in the expression of the plant height. It also signified the validity of the genetic analysis of this attribute for the present study following the method of Hayman (1954). Both, additive genetic variance (D) and dominance variance (H_1) were highly significant indicating the importance of both D and H_1 genetic components for the expression of plant height. However, by comparing the relative magnitude of D and H_1 it was evident that there was preponderance of additive genetic variance. H_2, another measure of dominance was also significant. The estimation of the degree of dominance from the ratio $(H_1/D)^{\frac{1}{2}}$ indicated the partial dominance for this character. F component which measures the covariation of the additive and dominance effect was found to be positive and highly significant indicating thereby an excess of dominant genes (Crumpacker and Allard, 1962). The statistic h^2 measures the net dominant effect expressed as an algebraic sum over all the loci in heterozygous phases. In our study it was negative and significant which indicated that mean direction of dominance was negative for plant height. $H_2/4H_1$ is an estimate of average frequency of positive versus negative alleles in the parents. It can attain a maximum value of 0.25 when frequency of positive and negative alleles is equal. The value of this ratio (0.22) deviated from 0.25 in

TABLE 1

Analysis of variance for plant height in castor

Source	d f.	MS
Replications	2	2415.16
Progenies	35	7102.87**
Error	70	595.10

**Significant at 1% level.

TABLE 2

Estimates of genetic components of variance for plant height in castor

Components	D	H_1	H_2	F	h^2	E	t
	5054.54** ± 436.01	3272.35** ± 1006.78	2874.00** ± 875.92	2553.21** ± 1034.84	—85.48 ± 587.44	198.37 ± 145.99	1.09

Ratios	$(H_1/D)^{\frac{1}{2}}$	$H_2/4H_1$	$\frac{(4DH_1)^{\frac{1}{2}}+F}{(4DH_1)^{\frac{1}{2}}-F}$	$\frac{h^2}{H_2}$	Heritability narrow sense (%)
	0.80	0.22	1.09	—0.029	87.96

**Significant at 1% level.

the present study indicating an unequal proportion of positive and negative alleles in the parents.

The negative value of the ratio $(4DH_1)^{\frac{1}{2}}+F/(4DH_1)^{\frac{1}{2}}-F$ (which provides estimates of the proportion of total number of dominant to recessive genes in the parents) indicated that no dominant gene group is responsible for the expression of dwarfing in castor. The ratio of h^2/H_2 estimates the number of gene groups which control a character and exhibit dominance. In the present study this ratio was below unity and negative which indicated that the gene responsible for dwarfing had no dominance. The low value (below unity) of this ratio envisaged that there was under estimation of this value. Nevertheless for practical purposes it could be assumed that atleast one recessive gene group is involved for dwarf plant height. This is also evident from the correlation coefficient ($r=-0.013$) between parental order of dominance (Wr+Vr) and parental measurement (Yr) which indicates that the positive genes for increased plant height are mostly dominant. The narrow sense heritability was very high (87.96%) which indicated that selection would be most effective to develop dwarf varieties of castor.

The graphical analysis (Fig. 1) indicated the partial dominance, no epistasis,

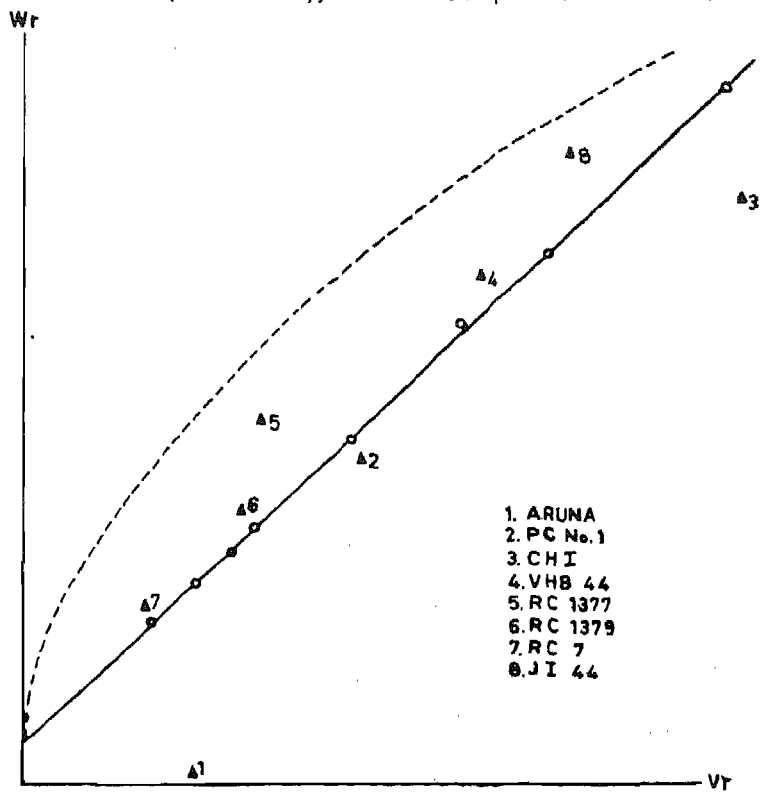


Fig. 1. Covariance (Wr) and variance (Vr) graph for plant height in castor.

wide differences among the parents for plant height, parents Aruna and RC 7 having mostly dominant genes, and parent CH 1 having the recessive gene. Variety CH 1 is very dwarf (100 cm) and could be a worthwhile source for dwarfing. This variety also possesses the yield potential fairly comparable with the tall varieties (Yadava *et al.*, 1976). The graphical analysis confirmed the results obtained by various ratios described in the present study.

The two important findings i. e., high narrow sense heritability and a lower number of recessive genes involved for dwarfing plant height indicated the prospects of breeding dwarf varieties of castor. CH 1 which possesses one recessive gene and high yield potential like taller varieties would be a worthwhile source for dwarfing in castor without much sacrifice in yield.

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GENETIC COMPONENTS AND COMBINING ABILITY EFFECTS IN URDBEAN (*VIGNA MUNGO*(L.) HEPPER)

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ABSTRACT

A diallel analysis of plant height, pod number, cluster number and seed yield of eight cultivars of *Vigna mungo* (L.) Hepper was studied. The gca and sca mean squares indicated that both additive and dominance variances were important, except for seed yield where variance due to dominance was more important. However, the partitioning of genetic components of variation, the degree of dominance and heritability indicated that dominance component (H_1) was more pronounced than additive (D).

Analysis of the inheritance of polygenic or quantitative traits as distinct from those determined by one or a few genetic factors is complex. Because segregation may be affected by linkage, and individual gene pairs have relatively small effects, such analysis required special technique.

The present study deals with the genetic components from a 8×8 diallel on urdbean to know the genetic basis of yield and some of its components.

MATERIAL AND METHODS

Eight cultivars were chosen on the basis of their plant height, number of pods per plant, number of clusters per plant and seed yield per plant. The parents were crossed in all possible combinations to produce a diallel set without reciprocals, and the 28 F_1 hybrids with their parents were grown in three replications at Research Farm in **kharif** 1979. Each genotype was represented by single row plot of 5 m length. Five plants were randomly chosen for recording the observations on plant height (cm), number of pods per plant, number of clusters per plant and seed yield per plant (g).

The genetic components were determined by Hayman's method (1954). Model-1 and method-2 of Griffing (1956) was followed for diallel analysis. Heritability in narrow sense was estimated from the mean variance of arrays according to Crumpacker and Allard (1962).

RESULTS AND DISCUSSION

The analysis of variance (Table 1) revealed significant variation among the parents for all the characters. It, thus, indicated adequate amount of variability present in the parental material. The

TABLE 1

Analysis of variance in 8×8 diallel of urdbean

Source of variation	d f.	Plant height	No. of pods/ plant	No. of clusters/ plant	Seed yield/ plant
1. Replications	2	194.25**	834.48	133.43	7.59
2. Genotypes	35	134.68**	3243.66**	718.45**	355.59**
3. a. Parents	7	187.53**	1266.12*	360.59**	202.83**
b. Hybrids	27	124.50**	3081.48**	722.29**	362.16**
c. Parents vs Hybrids	1	39.46**	21444.39**	3119.68**	1247.71**
4. Error	70	9.01	429.16	50.21	18.90
5. gca	7	133.88**	1136.43**	417.34**	121.93**
6. sca	28	47.32**	1073.70**	194.70**	31547.61**
7. Error	70	3.005	143.05	16.74	6.30

*, **Significant at 1 and 5 per cent, levels, respectively.

TABLE 2

Genetic components, standard errors and ratios between components from a 8×8 diallel in urdbean

Components	Plant height	No. of pods/plant	No. of clusters/ plant	Seed yield/plant
D	57.77±28.40	278.08±393.03	102.69± 96.41	61.49± 83.48
H_1	184.11±67.40	3463.88±907.54	691.88±222.62	493.21±192.77
H_2	172.24±65.57	3317.14±789.58	656.42±183.68	390.16±167.71
h^2	89.65±57.05	27880.53±529.53	4270.45±129.23	310.20±198.14
F	16.50±38.26	−114.54±932.84	−21.66±228 82	102 72±112.47
$(H_1/D)^{1/2}$	1.785	3.529	2.590	2.830
$H_2/4H_1$	0.223	0.230	0.237	0.197
KD/KR	1.160	0.889	0.922	1.836
h^2/H_2	0.520	8.405	6.505	0.795
Heritability	23.64	6.25	11.58	12.89

gca and sca mean squares were found to be significant which indicated that both additive and non-additive variances were involved in the expression of the traits.

Component Analysis

The genetic components, standard error and ratios between components are presented in Table 2.

Plant height. Higher values of H_1 and h^2 than that of D indicated greater effects of dominance than additive gene effects The $(H_1/D)^{1/2}$ measures mean degree of dominance over all loci. The value was greater than unity and H_1 and H_2 were of comparable magnitude, thus, indicating over dominance. The quantity $(H_2/4H_1)$ estimates the relative aver-

age frequency of positive and negative alleles in the parental lines. Apparent asymmetry of positive and negative alleles was indicated as $H_2/4H_1$ was not equal to 0.25. The positive F value, though not significant and the ratio KD/KR being more than one suggests that there may be a slight excess of genes with positive effects. Low values of heritability (23.64%) suggest that non-additive gene effects were more important.

Number of pods per plant. Dominance components (H_1 and h^2) seem to be more important than additive component (D). This was further supported by a low heritability estimate (6.25%). Apparent over dominance was operating because $(H_1/D)^{1/2}$ was greater than unity. Asymmetry of positive and negative genes was indicated from the facts that the quantity $(H_2/4H_1)$ was not equal to 0.25. The negative and non-significant value of F and the ratio KD/KR was less than one implied more recessive than dominant genes. The h^2/H_2 ratio indicated that at least eight gene groups showing recessive behaviour controlled pod number.

Number of clusters per plant. Again for cluster number, the dominance components (H_1 and h^2) seemed to be more important than the additive one (D), as further indicated by a low heritability estimate (11.58 %). Over dominance was operating as $(H_1/D)^{1/2}$ was greater than one. Asymmetry of positive and negative genes was indicated by the ratio $H_2/4H_1$ which was not equal to 0.25. The value of F, though negative but was non-significant. The ratio KD/KR was almost equal to one, suggesting an equal ratio of dominant and recessive alleles in the parents. At least six groups of genes were found dominant for this character.

Seed yield per plant. Non-significance of D, high level of significance of H_1, H_2 and h^2 and low heritability estimate (12.80%) confirmed that mostly dominance gene effects were involved in the inheritance of yield and that additive genetic variation constituted only a small portion of the phenotypic variation. The ratio $(H_1/D)^{1/2}$ suggested over dominance. The ratio $H_2/4H_1$, was not equal to one, indicating asymmetry of positive and negative genes. Dominant alleles were more than recessive alleles in the parents, because the ratio KD/KR was more than one. The ratio h^2/H_2 was 0.79, indicating slight excess of recessive genes controlling seed yield, but this ratio is under-estimated if the dominance effects of all genes concerned are not equal in size and direction (because effects are cancelled) or if the distribution of the genes is correlated (Jinks, 1954).

The partitioning of genetic components for variation, the degree of dominance and heritability indicated that dominance components (H_1) were more important than additive one (D). These facts confirm that plant height and cluster number, though showing additivity were also strongly influenced by dominance, which was also a part of the gca. The role of dominance in gca was emphasized by Jinks (1955), and the difficulty of determining the relative magnitude of additive and dominance variances was reviewed by Matzinger (1963). The lack of a significant and consistent additive

gene effect for yield indicated that there will be no effective advance by direct selection for yield itself, and that improvement in yield must be achieved indirectly through its components. The present study further suggested that selection should be delayed to F_4 generation as compared to F_2 generation so that the additive variances though small can be utilized more effectively.

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MINERALOGY OF FINE SAND FRACTION IN RELATION TO LANDFORMS IN A PART OF INDO-GANGETIC PLAIN IN HARYANA

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ABSTRACT

The 15 soils developed on different landforms of a part of Haryana have been studied for the sand mineralogical composition, which indicated the predominance of quartz followed by muscovite and albite as the light fraction minerals. Calcite was present, either in crystalline or amorphous form in all the pedons and its content was higher in salt-affected pedons. The heavy minerals present were hornblende, chlorite, iron ores (haematite, magnetite), biotite, tourmaline and zircon. Mineralogical distribution showed an advanced stage of weathering in pedons on upland with a wedge, relict bowl and upland water divide landforms as compared to pedons on low land, horst land and relict course landforms.

Knowledge of the nature and quantity of mineral in sand fraction provides information on the source of parent material, in the presence of lithological discontinuties and on the degree of soil development. Although, several attempts have been made to study the mineralogy of salt-affected soils (Khera, 1964; Sehgal *et al.*, 1973), a little is known about the geomorphological conditions and the distribution of minerals in these soils. Present study has been aimed at studying the mineralogy of representative pedons in relation to geomorphology and salt accumulation.

MATERIAL AND METHODS

The study area forms a part of Karnal, Kurukshetra, Jind and Hissar districts of Haryana State. It lies between latitude of 29°6'30" to 29°32'43"N and longitude of 76° to 77°E. The area is a part of the Indo-Gangetic alluvial plain with the plain belonging to the Pleistocene as well as Sub-Recent times. The topography is fairly level to very gently undulating. Vast stretches of barren land with conspicuous salt encrustations at the surface occur in the region. The climate of the area can broadly be referred to as sub-tropical and semi-arid.

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Based on the study of aerial photographs in the scale of 1:25,000 and field studies of major and sub-land types, 15 representative profiles were selected for detailed studies (Fig. 1). The details of pedons exposed in each landform are given in Table 1.

Soil profiles in the field were described following the FAO (1966) guidelines for soil profile description and classified according to soil taxonomy (Soil Survey Staff, 1975). Fine sand was separated and permanent slides were prepared for heavy and light mineral crop.

The following steps were involved for the preparation of a specimen: (1) crushing, (2) disaggregation, (3) sizing, (4) cleaning, (5) separation, and (6) mounting. The first two steps were achieved through mechanical analysis. Grains between 80 and 100 mesh size were used for mounting. Coatings of ferruginous or other material were removed by boiling in 50% HCl with stannous chloride. Bromoform (sp. gr. >2.85) was used for separation and then washed with acetone. Permanent slides were prepared separately for heavy and light fraction with Canada balsum. The slides were studied under a polarizing microscope and their relative abundance was recorded (Brewer, 1964).

RESULTS AND DISCUSSION

A study of the light and heavy mineral suites of the fine sand fraction was con-

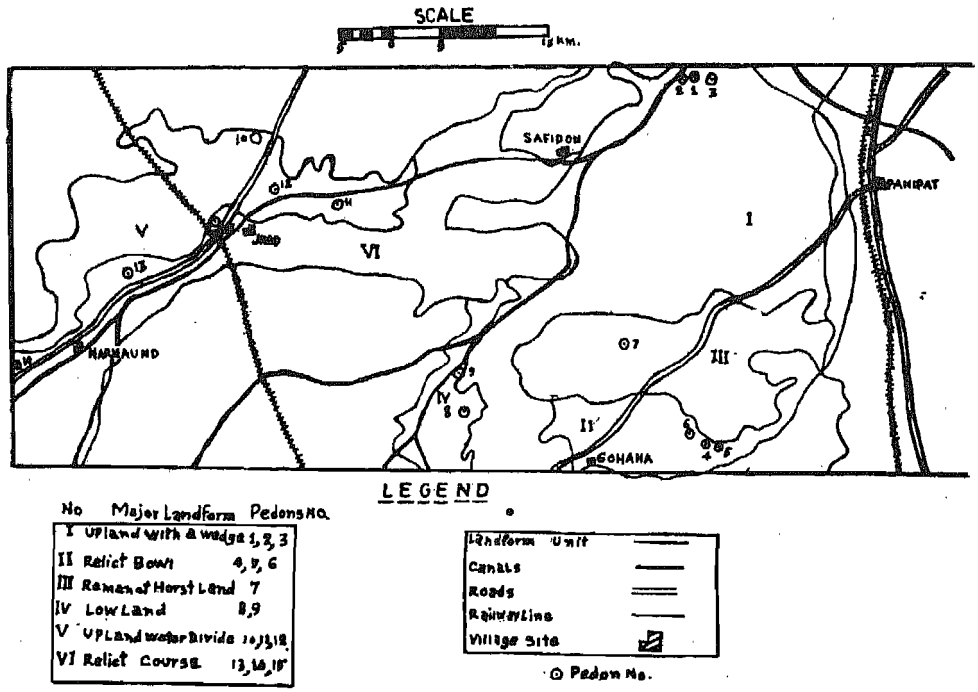


Fig. 1. Major landscapes of a part of Jind-Panipat area (Haryana).

TABLE 1

Details of pedons exposed in each land form

Landform	Pedon No.		Pedon classification
1. **Upland with a wedge**			
Convex crest	1		Coarse loamy, moderately saline, Typic Natrustalf
Concave side slopes	2		Fine loamy, strongly saline, Typic Natrustalf
Depression	3		Coarse loamy, Typic Ustochrept
2. **Relict bowl**			
Convex crest	4		Fine loamy, strongly saline, Aquic Natrustalf
Concave side slopes	5		Fine loamy, slightly saline, Aquic Natrustalf
Plain land	6		Coarse loamy, Aquic Ustochrept
3. **Remanant horst land**			
Convex sloping crest	7		Coarse loamy, strongly saline, Typic Camborthid
Plain land			Coarse loamy, Typic Ustochrept
4. **Low land**			
Concave sloping side	8	(i)	Fine loamy, strongly saline, Typic Calciorthid
	9	(ii)	Fine loamy, strongly saline, Natric Camborthid
Plain land	*		Coarse loamy, Aquic Ustochrept
5. **Upland water divide**			
Light grey tone	10		Coarse loamy, moderately saline, Natric Ustochrept
	11		Coarse loamy, slightly saline, Typic Camborthid
Dark grey tone	12		Coarse loamy, Typic Ustochrept
6. **Relict course**			
Convex crest	13		Coarse loamy, strongly saline, Typic Natrustalf
Concave sloping side	14		Fine loamy, strongly saline, Aquic Natrustalf
Plain land	15		Coarse loamy, Typic Ustochrept

*Similar to pedon 6 in field morphology and soil composition.

ducted for evaluating the weathering status of the soil, its mineral resources, which indirectly influence the inherent fertility status. The relative abundance of the minerals in fine sand of different pedons is given in Table 2.

1. Upland with a Wedge

This is a tract overlying the tectonic basement ridge of Pre-Cambrian Aravalli extension. The quartz, muscovite and albite (plagioclase feldspars and lesser orthoclase feldspar) were present in decreasing order with sericitean altered product of feldspars, most conspicuously present in pedons 1 and 2 with lesser amount in pedon 3. Calcite (amorphous and crystalline) was present only in pedon 2 with no trace in pedon 3. However, in pedon 1 it was in lower layers. The heavy mineral suite was represented by hornblende, chlorite and iron ores (haematite and magnetite) throughout the profile and biotite in upper horizon. Epidote was present in strongly saline Natrustalfs (pedon 2) only. Tourmaline and zircon increased with depth. Other heavy mineral suites were found in irregular patterns but confining mostly to lower depths (Table 2). The mineral distribution showed a moderately mature soil profile with weathering stage of 9th, as outlined by Jackson and Sherman (1953). Differentiation of horizons and weathering was more conspicuous in Natrustalfs (pedons 1 and 2), but in Ustochrepts (pedon 3), it did not show much development with respect to eluviation and illuviation (Table 3).

2. Relict Bowl

This is a tectonic depression encompassing within the wider part of the basement ridge in the geological past, most probably in the post-Pleistocene times. Because of its physiographic location and its tectonic framework/origin, it acted like a sink (Ahuja *et al.*, 1978) for the surface and underground water and also northward flowing southern rivers/streams to dump their water and its paleoslopes are slightly tilted towards east with little slope.

Quartz was dominant followed by muscovite and orthoclase microcline in the light fraction. Saussuritised sericite, calcite and albite-oligoclase were also observed in varying amounts. The heavy fraction consisted of hornblende followed by iron ores, chlorite, epidote, tourmaline, zircon and apatite. Garnet and rutile were also observed in some horizons. Easily weatherable primary minerals had weathered appreciably giving rise to solvent concentration and heavy minerals increased with depth. Saussuritization and epidotization through geogenic and pedogenic weathering (Table 3) was most common.

Feldspar/Muscovite→

Saussuritized sericite+Na concentration in exchange complex with other acids.

Strongly saline Natrustalfs (pedon 4) had calcite con entration, and in other pedons (5 and 6) it was in traces. Hornblende also seemed to be weathered and gave rise to chlorite through chloritization. The soil profiles showed advanced stage of weathering with ferro-magnesium and feldspars, muscovite minerals weathering appreciably.

TABLE 2

Mineralogical composition of fine sand fraction

Depth (cm)	Light minerals (sp. gr. < 2.86)						Heavy minerals (sp. gr. > 2.86)									
	Quartz	Ortho-clase/ micro-cline	Albite oligo-clase	Musco-vite	Saussu-ritised sericite	Calcite	Horn-blende	Biotite	Chlo-rite	Epi-dote	Tour-maline	Zir-con	Apa-tite	Gar-net	Sph-ene/ Rutile	Iron ores
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
UPLAND WITH A WEDGE																
1. Coarse loamy, Moderately saline, Typic Natrustalf																
0-2	A	R	C	P	T	—	C	T	R	T	T	T	T	T	—	P
2-32	A	R	P	C	R	T	C	R	P	T	T	T	T	T	—	P
32-46	A	T	R	C	R	T	C	R	P	T	R	R	—	—	—	P
46-75	A	T	R	C	P	T	P	R	P	R	R	R	R	R	R	P
75-98	MC	R	R	P	P	R	P	—	P	R	P	P	—	R	R	P
98-130	MC	R	T	C	P	R	P	—	R	P	P	P	R	—	T	P
130-180	MC	R	T	C	R	R	C	T	R	P	P	P	R	—	—	P
2. Fine loamy, Strongly saline, Typic Natrustalf																
0-7	A	R	C	R	R	T	P	T	T	—	T	T	—	T	—	R
7-29	A	T	MC	R	C	—	P	T	R	T	T	T	—	—	—	R
29-59	A	R	P	T	C	—	C	—	P	—	R	R	T	—	—	P
59-87	A	R	C	T	C	—	C	—	P	—	P	P	T	—	—	P
87-119	A	R	P	R	P	—	C	—	P	—	P	R	—	R	—	P
119-130	A	R	P	P	P	R	P	T	P	P	P	P	—	R	R	R
130-180	A	P	P	P	P	P	C	—	P	C	P	P	—	—	R	R
3. Coarse loamy, Typic Ustochrept																
0-15	A	R	T	P	T	—	C	P	R	—	T	T	T	—	—	P
15-33	A	P	T	P	T	—	C	R	R	—	T	T	—	—	—	R
33-86	A	R	—	R	R	—	C	T	P	—	R	R	R	R	—	P
86-116	A	R	—	R	R	—	C	—	P	R	P	P	R	R	T	P
116-180	A	P	T	R	P	—	C	—	R	T	P	P	—	—	R	R

Contd.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
RELICT BOWL																
4. Fine loamy, Strongly saline, Aquic Natrustalf																
0-1	A	P	C	R	R	—	P	R	R	P	R	R	R	T	—	R
1-12	A	R	VP	P	C	T	VP	T	P	VP	P	P	P	R	T	P
12-33	MC	R	C	C	VP	R	C	—	P	P	P	P	P	R	T	VP
33-68	MC	P	C	C	VP	VP	C	—	P	P	C	P	P	R	T	VP
68-92	MC	P	C	C	C	C	P	—	R	C	P	P	P	R	R	C
92-120	MC	T	P	P	T	MC	R	R	T	T	R	R	T	—	T	R
120-185	MC	T	P	P	T	R	R	T	T	T	R	R	T	—	T	R
5. Fine loamy, Slightly saline, Aquic Natrustalf																
0-15	A	R	R	P	R	—	C	—	R	R	T	T	R	T	—	P
15-35	A	P	T	C	C	—	P	T	P	T	T	R	P	—	T	P
35-63	A	P	R	C	C	—	P	—	P	T	R	P	P	R	T	VP
63-98	A	R	P	P	C	T	C	—	P	R	P	P	R	R	R	C
98-138	A	T	P	P	P	R	C	T	P	P	P	P	R	R	R	P
6. Coarse loamy, Aquic Ustochrept																
0-13	MC	R	R	P	T	—	C	P	R	P	T	T	T	—	—	P
13-31	A	P	P	P	R	—	C	R	R	T	R	R	R	—	—	P
31-55	A	R	T	P	P	—	C	R	P	T	P	P	R	T	T	R
55-100	A	T	T	P	R	—	C	T	P	—	P	P	T	R	R	P
100-150	A	T	T	P	R	—	C	T	P	—	P	P	T	R	R	P
REMANANT HORST LAND																
7. Coarse loamy, Strongly saline, Typic Camborthid																
0-2	MC	R	P	C	—	—	P	R	R	—	T	—	T	T	T	R
2-7	MC	R	R	C	—	—	P	R	R	—	T	T	—	—	—	P
7-45	A	R	R	C	R	T	C	T	P	T	R	R	P	—	—	P
45-66	A	T	P	P	R	T	C	—	P	R	P	P	—	—	T	C
66-110	A	R	—	P	R	—	C	—	P	T	P	P	—	R	T	P
110-185	MC	T	T	C	R	—	P	—	P	—	P	P	—	R	—	P

LOW LAND

8. Fine loamy, Strongly saline, Typic Calciorthid

0-13	A	—	R	C	P	—	P	T	T	T	R	R	T	—	—	P
13-26	A	T	R	C	P	T	P	T	T	R	R	—	T	—	—	P
26-39	A	R	T	C	P	R	P	T	R	R	P	R	—	T	T	VP
39-65	MC	T	T	P	P	P	P	—	R	P	R	P	T	R	—	VP
65-85	MC	T	—	P	C	R	C	—	R	P	P	P	—	—	R	P
85-112	MC	T	—	C	P	T	P	—	R	P	P	P	—	—	R	P

9. Fine loamy, Strongly saline, Natric Camborthid

0-11	A	T	T	C	—	—	MC	P	T	—	T	R	T	—	—	P
11-48	A	T	T	C	T	—	MC	P	T	—	T	R	—	—	—	P
48-85	A	T	—	C	T	—	MC	R	T	—	R	R	—	—	T	VP
85-112	A	T	—	C	R	—	C	T	R	T	R	R	T	T	T	VP
112-160	A	T	—	C	R	—	C	—	R	T	P	P	T	—	T	P
160-200	A	R	—	C	T	—	C	—	R	—	P	P	—	—	—	P

UPLAND WATER DIVIDE

10 Coarse loamy, Moderately saline, Natric Ustochrept

0-4	A	R	P	C	—	R	C	—	P	T	—	—	—	—	—	P
4-12	A	R	P	C	T	—	C	T	P	—	R	—	—	—	—	P
12-36	A	R	R	P	R	—	C	T	R	—	R	R	R	T	—	P
36-69	A	R	R	P	R	T	C	—	R	R	P	R	T	—	T	C
69-92	MC	R	R	C	P	T	C	—	R	T	P	P	R	R	—	C
92-153	A	T	R	C	P	R	C	—	P	R	P	P	—	—	T	P
153-180	MC	R	T	C	T	T	C	—	P	R	P	P	—	T	R	P
180-225	A	R	T	C	T	T	C	—	R	T	P	P	T	—	R	P

11. Coarse loamy, Slightly saline, Typic Camborthid

0-19	A	—	R	MC	T	—	MC	R	T	—	—	—	—	—	—	P
19-38	A	R	P	MC	T	—	C	T	T	—	—	—	—	—	—	P
38-71	A	R	R	C	R	—	C	—	R	—	T	R	T	—	—	P
71-92	A	T	T	C	P	—	MC	—	P	T	R	R	—	T	T	VP
92-123	A	T	T	C	P	—	MC	—	P	—	R	R	—	T	T	P
123-160	A	T	—	C	P	—	MC	—	R	—	P	R	T	—	T	P

Contd.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
12. Coarse loamy, Aquic Ustochrept																
0-11	A	T	T	C	—	—	MC	P	T	—	T	R	T	—	—	P
11-48	A	T	T	C	T	—	MC	P	T	—	T	R	—	—	—	P
48-85	A	T	—	C	T	—	MC	R	T	—	R	R	—	—	T	VP
85-112	A	T	—	C	R	—	C	T	R	T	R	R	T	T	T	VP
112-160	A	T	—	C	R	—	C	—	R	T	P	P	T	—	T	P
160-200	A	R	—	C	T	—	C	—	R	—	P	P	—	—	—	P
RELICT COURSE																
13. Fine loamy, Strongly saline, Aquic Natrustalf																
0-7	A	R	R	C	T	—	C	T	R	—	—	T	T	T	—	P
7-27	A	R	T	C	—	—	C	R	R	—	T	T	—	—	—	P
27-44	MC	T	—	C	R	T	C	T	R	—	R	R	T	T	T	VP
44-81	MC	T	—	C	P	R	C	—	P	T	P	P	—	T	T	C
81-123	MC	—	—	P	P	R	C	—	P	R	P	P	—	—	—	VP
123-160	MC	T	—	P	P	T	C	—	R	R	P	P	T	—	—	VP
14. Coarse loamy, Strongly saline, Typic Natrustalf																
0-10	A	T	P	MC	—	—	C	P	R	—	T	T	R	—	T	P
10-24	A	T	R	MC	—	—	C	R	R	R	T	T	T	T	T	P
24-74	A	T	R	C	R	T	C	T	P	P	R	T	—	—	—	VP
74-118	MC	—	T	C	R	R	C	—	P	T	P	R	—	—	T	P
118-175	MC	—	—	C	R	T	C	—	P	T	P	R	—	—	T	P
15. Coarse loamy, Typic Ustochrept																
0-17	A	T	T	C	T	—	MC	R	—	—	—	—	—	—	—	P
17-36	A	T	T	C	T	—	MC	R	—	—	T	T	—	—	—	P
36-76	A	R	—	C	R	—	MC	T	T	—	R	R	T	—	T	P
76-98	A	T	—	C	P	—	C	—	R	—	R	R	T	T	T	C
98-140	A	R	—	C	R	T	C	—	R	T	P	P	—	T	—	C
140-160	A	T	—	C	R	T	C	—	R	T	P	R	—	—	R	C

A=Abundant	60%	R=Rare	2 to 5%
MC=Most common	21 to 25%	T=Traces	⩽1%
C=Common	16 to 20%	— =Nil	Absent
P=Present	6 to 10%		

TABLE 3

Degree of weathering

Depth (cm)	Horizon	Clay (%)	Per cent degree of weathering*
	1. Aquic Natrustalf (strongly saline)		
0-12	AP	12.8	78.0
12-33	B1t	16.5	89.7
33-68	B21t	21.0	87.3
68-92	B22t	22.4	72.5
92-120	C1Ca	23.8	70.4
120-185	C2Ca	20.0	51.1
	2. Natric Camborthid (strongly saline)		
0-11	Ap11	9.5	53.1
11-38	Ap12	13.4	56.2
38-57	B1	19.7	69.3
57-96	B21	28.0	94.7
96-122	B22	28.2	85.4
122-170	B31	21.0	87.1
170-200	B22	15.0	91.8
	3. Typic Camborthid (slightly saline)		
0-19	AP	5.0	32.9
19-38	B1	12.6	60.5
38-71	B21	12.4	60.5
71-92	B22	12.4	55.5
92-123	B31	13.2	68.6
123-160	B32	13.0	62.7
	4. Typic Ustochrept (non-saline)		
0-17	AP1	8.3	45.5
17-36	Ap3	9.5	53.0
36-76	B21	13.2	61.4
76-98	B22	13.4	65.9
98-140	B23	16.4	75.6
140-160	C	12.4	49.4

*Per cent degree of weathering $= \frac{\text{Clay alumina}}{\text{Total alumina}} \times 100$

N. B. The degree of weathering is similar for Aquic and Typic subgroups; Camborthid and Calciorthid great groups.

3 & 4. Remanant Horst Land and Low Land

These are tectonically uplifted parts (horst land) with a complementary down thrown (low land) part in Holocene times (recent past) of the basement ridge tract. Light fraction consisted of quartz, saussuritised sericite and calcite, whereas hornblende, chlorite, iron ores and tourmaline were observed in the heavy sand fraction (Table 2). Because of rejuvenation (Bakliwal and Sharma, 1980; Manchanda, 1982) the immaturity was shown in the profile development, but mineralogical make up remained the same as its parent body. The pedons showed low lo moderate degree of development, having cambic/ calcic sub-surface diagnastic horizon.

5. Upland Water Divide

It is an old raised landform lying in between the diverging slopes of NE to SW on the west and NW to SE in the east which had a moderate slope from north to south of its own terrain. Quartz, muscovite, and saussuritised sericite and in few horizons calcite, orthoclase and albite were found in the light fraction. Heavy fraction consisted of hornblende iron ores, chlorite and tourmaline. Biotite was observed only in surface horizons. Apatite, zircon, garnet and rutile were also observed in some horizons (Table 2). Because of over-flow and sheet-flow with a good quality ground water, this tract, which formed the uppermost part of the area, showed relatively more mature stage as the resistant minerals increased with depth (Table 2).

6. Relict Course

This tract was once the site of a major river called, Drishdawati, or Chautang of old Saraswati river system (Hakra river system). The three profile sites (pedons 13, 14 and 15) represented its three segments where it once flowed from (i) N to S; (ii) N-NE to S-SW; and (iii) E to W in the lower reaches with moderate, gentle and sluggish slopes characterising the three segments. In the light sand fraction, the minerals identified were quartz, followed by muscovite and saussuritised sericite. Albite-oligoclase was present in upper horizons and calcite was recorded in lower horizons. Heavy fraction had hornblende followed by iron ores. The other minerals recorded were chlorite, zircon, tourmaline, biotite, etc. (Table 2).

In this landform, mineralogical make-up and intensity of weathering in relative degree contemplated with moderate impeded and sluggish drainage, rise in fluctuating water table; capillary rise of salts; manifesting and modifying the tract and its soil profiles (Manchanda and Khanna, 1981a, b). Conspicuously albite plagioclase-saussuritised sericite with epidotization and chloritization were highest in pedon 14, and pedons 15 and 13 fell in the order of lower intensity.

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EFFECT OF PROFILE SOIL MOISTURE AND NITROGEN LEVELS ON YIELD AND OIL CONTENT OF RAYA (*BRASSICA JUNCEA* L. CZERN)

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ABSTRACT

A field experiment was conducted in 1975-76 and 1976-77 to study the response of raya (*Brassica juncea* L. Czern) to different levels of initial profile soil moisture, viz. 125, 160 and 200 mm, with and without 50 mm additional irrigation at flowering on the production of grain, N, P, K uptake and oil content of grain. Higher initial profile soil moisture or additional irrigation influenced the yield contributing characters, yield, oil yield and nutrients uptake. The grain yields under 125, 160 and 200 mm profile soil moisture were 958.8, 1065.5 and 1161.4 kg/ha, respectively, and the increase with application of 50 mm additional irrigation was 222.2, 201.5 and 196.0 kg/ha, respectively, over treatments receiving no additional irrigation. The increasing levels of nitrogen increased the yield significantly during both the years of investigation and the increase was 24.1, 36.3 and 45.1 per cent with the application of 20, 40 and 60 kg N/ha, respectively over control. Higher moisture supply by building 200 mm initial profile soil moisture supplemented with 50 mm protective irrigation at flowering resulted in 15.7, 13.9 and 44.5 per cent increase in N and K uptake and oil yield/ha, respectively by raya crop over lowest level (125 mm) of soil moisture.

Rapeseed and mustard group of oil seeds are second to only groundnut among all the oil seed crops of this country. From an area of 3,429,000 ha, annual production is 1,693,000 tonnes in India, the corresponding figures of area and production in Haryana are 104,300 ha and 87,000 tonnes. Average yield is low because of the fact that 93.2 and 42.4 per cent of the oil seed crops are grown under unirrigated conditions in India and Haryana, respectively, that too mostly on light textured or shallow soils having low profile soil moisture. Like other oil seeds, this crop also usually not fertilized because of its low yield potential under dryland conditions.

Some work done in the past has indicated beneficial effect of irrigation on this important oil seed crop. Singh and Moolani (1969) working on raya found one irrigation at flowering (60 days) to be adequate. Bishnoi (1975) observed that oil seeds raya and taramira can be grown when the soil moisture

*Directorate of Research

storage is less than 150 mm and the winter rainfall is also less than 60 mm. Bishnoi (1977) observed 205 to 242 cm consumptive use when planted on different dates. Singh *et al.* (1977) working on limited irrigation aspect of raya/sarson crops involving 25, 50 and 100 per cent soil profile moisture saturation, observed no significant increase in seed yield due to different soil moisture levels at Jodhpur. However, supplemental irrigation of 25 mm given at flowering stage resulted in significant increase in seed yield. Singh *et al.* (1978) obtained a yield of 10.4, 12.2 and 16 5 q/ha of raya (var. Prakash) with no irrigation, one irrigation and two irrigations, respectively. Singh (1978) gave $Y = -3.9140 + 11\ 2090\ I - 1.2450\ I^2$ as grain yield and irrigation response equation where three irrigations were found to be optimum. The response of nitrogen has been well established with regard to rapeseed and mustard by different workers (Das and Sharma, 1956; Jana, 1963; Maini *et al.*, 1964). Bhan and Singh (1974) obtained 80 kg N as the economic dose for raya crop. Majumdar and Sandhu (1964) reported increase in oil yield with the application of 50 kg N/ha. Contradictory to this, very little variation in the percentage of oil was noted by Ali Mohammad (1930) and Mathur *et al.* (1958) in linseed, and Yadav (1975) and Bishnoi (1977) in raya. Singh and Parsad (1975) observed an uptake of 125 kg N/ha in case of sarson Response of raya to N application like other non-legume crops, is likely to be higher under better moisture supply. However, very little is known about the response of raya to nitrogen application under different levels of soil moisture availability conditions.

MATERIAL AND METHODS

A field experiment keeping all combinations of three profile soil moisture levels, viz. 125, 160 and 200 mm/100 cm with and without 50 mm protective irrigation applied at flowering stage in main plots and 4 doses of nitrogen, viz., control, 20, 40 and 60 kg N/ha in subplots was laid out in split plot design during 1975-76 and 1976-77 at the Dryland Research Farm of HAU, Hissar. The soils were sandy loam, low in organic carbon (0.22%) and available nitrogen (180 kg/ha), medium in available phosphorus (14 kg/ha) and high in potash (540 kg/ha). The crop was sown at a row spacing of 30 cm on 30th October in 1975 and 10th November in 1976. The meteorological data during the crop season have been presented in Fig. 1. At harvest, number of pods/plant, test weight (1000-grain weight) and number of grains per pod were recorded in addition to grain yield per hectare. The N, P and K contents were determined in different components of the plant and it was multiplied with dry matter and seed yield to work out the total uptake of these nutrients by the crop at harvest. Oil yield per hectare was also determined to evaluate the treatments effect.

RESULTS AND DISCUSSION

Effect of Profile Soil Moisture Levels

Increase in initial soil moisture levels during 1975-76 and in pooled analysis increased the grain yield of raya, but the differences were significant between 125 and 200 mm initial soil moisture levels only. Further, an additional application of 50 mm water at flowering stage showed

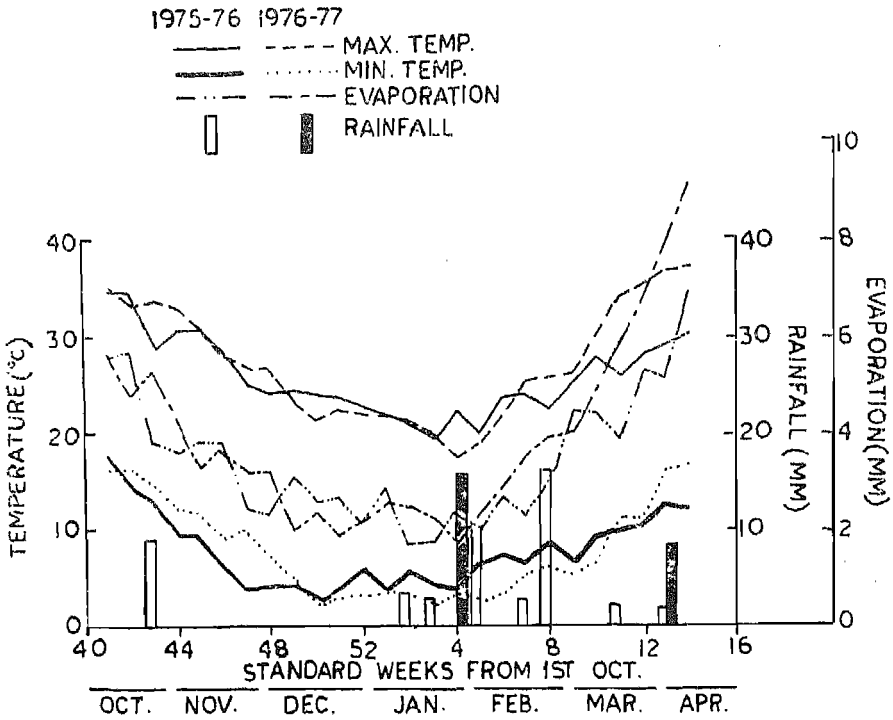


Fig. 1. Meteorological data during crop season.

an improvement in grain yield irrespective of different initial soil moisture levels during both the seasons. Significant differences in grain yield with additional irrigation were recorded in all initial soil moisture levels over their corresponding levels having no post sowing irrigation during 1975-76 and in pooled analysis and between 125 mm and 125+50 mm during 1976-77. Grain yield of raya also differed significantly between 125+50 and 200+50 mm treatments during 1975-76 and in pooled analysis. It was interesting to note that 125 mm initial moisture level supplemented with 50 mm additional water at flowering stage resulted in 23.2, 10.8 and 1.7 per cent increase in seed yield over 125, 160 and 200 mm initial soil moisture, respectively in pooled analysis and the increase in grain yield to the order of 41.5, 27.4, 16 7, 14.9 and 7.1 per cent was observed by 250 mm (200+50 mm) water application over 125, 160, 200, (125+50) and (160+50) mm of soil moisture status, respectively. The beneficial effect of higher initial moisture levels or additional irrigation on grain yield have been reported by Singh and Moolani (1969), Bishnoi (1975) and Bishnoi (1977). However, Singh *et al.* (1977) observed no beneficial effect of higher initial soil moisture level in raya under dryland conditions. However, the beneficial effect of 25 mm additional irrigation water applied at flowering stage was observed by them.

The regression equations E_2 and E_4 (Table 1) indicate that optimum moisture requirement was between 320 and 380 mm during 1975-76 and 1976-77, respectively. The higher yield of raya crop observed under higher levels of initial soil moisture level or due to additional post sowing irrigation was due to attainment of higher number of grains per pod and increase in 1000-grain weight over lower soil moisture regime. It is clear from the data in Table 2 that 1000-grain weight and grain number per pod increased with a very low margin but the number of pods per plant was the main factor in increasing per hectare yield. Similar results were observed by Singh (1978).

Effect of Nitrogen Levels

Application of nitrogen increased the number of grains per pod significantly during both the seasons and in pooled analysis. In pooled analysis 7.8, 13.1 and 18.2 per cent increase in grain number per pod was observed with the application of 20, 40 and 60 kg N/ha over control respectively. Nitrogen application increased the 1000-grain weight significantly over control. All the doses of nitrogen were found to increase the number of pods per plant significantly during both the years. An increase of 38.7, 57.5 and 76.3 per cent in number of pods per plant was observed with the application of 20, 40 and 60 kg

TABLE 1

Regression equations for the yield and profile soil moisture levels, nitrogen levels and combination of profile soil moisture and nitrogen levels during 1975-76 and 1976-77

Year	Form	Regression equation	R^2 values	
		For Soil Moisture Levels		
1975-76	Linear	$y=414.24+3.74x_1$	.4487	E_1
	Quadratic	$y=409.24+3.80x_1-.0001x^2_1$	.4487	E_2
1976-77	Linear	$y=734.16+2.56x_1$	.2757	E_3
	Quadratic	$y=448.76+5.77x_1-.009x^2_1$	.2811	E_4
		For Nitrogen Levels		
1975-76	Linear	$y=910.38+6.76x_2$	.4665	E_5
	Quadratic	$y=875.13+12.04x_2-.088x^2_2$	.4919	E_6
1976-77	Linear	$y=1011.33+6.85x_2$	.6192	E_7
	Quadratic	$y=975.96+12.16x_2-.088x^2_2$	.6522	E_8
		For Combination of Soil Moisture and Nitrogen Levels		
1975-76	Linear	$y=193.42+3.68x_1+11.31x_2-.0002x^2_1-.088x^2_2+.0039x_1x_2$	.9410	E_9
1976-77	Quadratic	$y=418.12+4.65x_1+5.15x_2-.0085x^2_1-.088x^2_2+.0376x_1x_2$	.9620	E_{10}
	Where	y=Expected yield (kg/ha), x_1=Levels of soil moisture (mm), and x_2=Levels of nitrogen (kg/ha)		

TABLE 2

Yield and yield contributing characters of raya as influenced by different profile soil moisture and nitrogen levels during 1975-76 and 1976-77

Treatments	Number of grains/pod			1000-Grain weight (g)			Number of pods/plant			Grain yield (kg/ha)		
	1975-76	1976-77	Av.	1975-76	1976-77	Av.	1975-76	1976-77	Av.	1975-76	1976-77	Av.
Profile soil moisture levels (mm)												
125+0	11.45	13.05	12.25	2.85	3.00	2.92	236.6	242.6	239.6	884.3	1033.3	958.8
160+0	11.52	13.31	12.41	2.98	3.02	3.00	248.5	285.7	267.1	989.6	1141.6	1065.5
200+0	11.76	14.02	12.89	3.04	3.07	3.05	280.9	308.1	294.5	1101.8	1221.0	1161.4
125+50	11.55	13.15	12.35	2.91	3.07	2.99	257.9	265.8	261.9	1112.0	1250.0	1181.0
160+50	12.07	13.57	12.82	2.97	3.09	3.03	285.7	335.8	310.8	1243.5	1290.4	1267.0
200+50	12.43	14.32	13.38	3.06	3.14	3.10	361.5	390.1	375.8	1347.2	1367.6	1357.4
SE±	NS	0.191	0.247	NS	0.022	0.046	11.18	15.59	9.99	59.18	48.53	40.39
C. D. at 5%		0.603	0.779		0.069	0.144	35.23	49.12	31.46	186.47	152 91	127.26
Levels of nitrogen (kg/ha)												
N_0	10.70	12.40	11.55	2.79	2.90	2.84	187.6	219.9	203.7	872 2	971.7	921.9
N_{20}	11.57	13.36	12.46	2.93	3.03	2.98	272.5	292.7	282.6	1090.7	1198.6	1144.6
N_{40}	12.14	13.97	12.06	3.04	3.14	3.09	305.6	336.2	320.9	1205.9	1306.7	1256.3
N_{80}	12.78	14.54	13.66	3.11	3.18	3.15	348.5	370.0	359.2	1283.4	1392.2	1337.8
SE±	0.095	0.098	0.070	0.025	0.010	0.013	7.08	6.60	5.27	25.42	23.48	17.31
C. D. at 5%	0.273	0.282	0.201	0.073	0.028	0.038	20.31	18.93	15.12	72 91	67.35	49.64

N/ha, respectively, over control treatments.

The significant increase in seed yield was obtained with the increasing levels of nitrogen during both the years. Even the highest dose of 60 kg N/ha tried in this experiment increased seed yield significantly over 40 kg N/ha. In pooled analysis the increase in grain yield was 24.1, 36.3 and 45 1 per cent with the application of 20, 40 and 60 kg N/ha, respectively, over control. Yadav (1975) also observed the beneficial effect of nitrogen to the raya crop.

The regression equations were fitted for the yield and soil moisture levels, nitrogen levels and combination of soil moisture and nitrogen levels in individual years (Table 1). The functional relationship between soil moisture levels or nitrogen levels and grain yield indicated that, in general, the quadratic relationship was sig. ificantly better than linear function E_1 to E_8 (Table 1). Further the equations E_9 and E_{10} revealed that the correlation between grain yield and soil moisture in association with nitrogen was better related than the relationship between yield and soil moisture status or nitrogen fertilizer alone. The coefficient of determination showed a value of more than 0.94 in equations E_9 and E_{10} as d- picted in Fig 2. The combined regression equations indicated that per kg

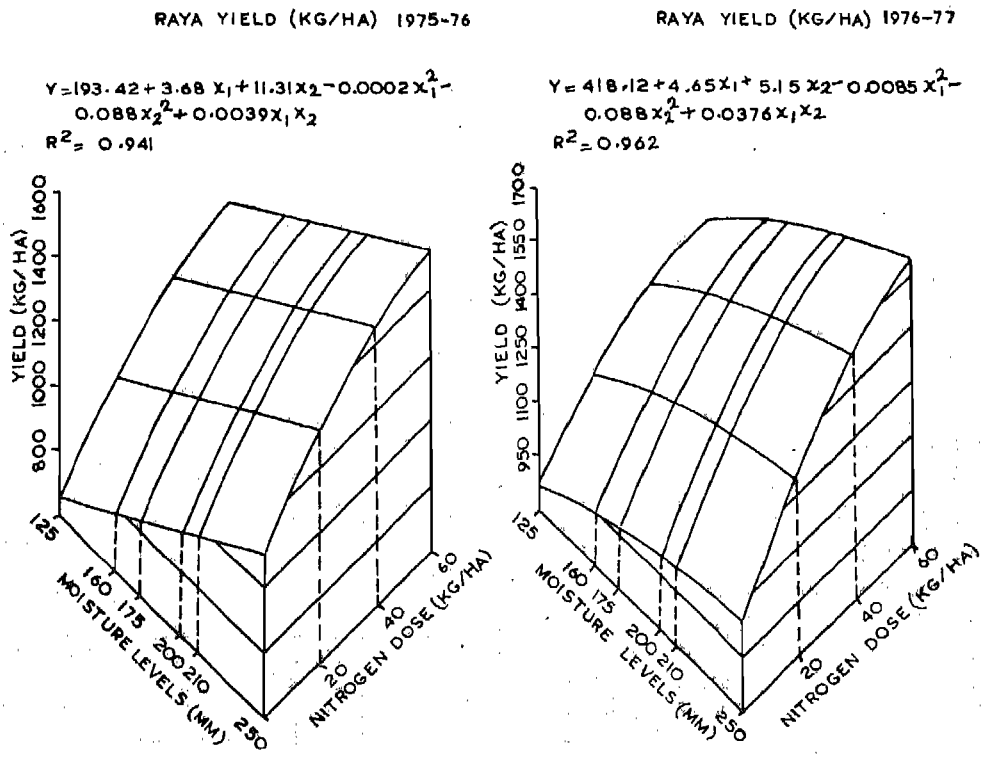


Fig. 2. Raya yield in relation to profile soil moisture and nitrogen levels.

nitrogen application increased the yield of raya seed by 10.4 and 9 8 kg/ha during 1975-76 and 1976-77, respectively.

Uptake of Nutrients

The uptake of N was increased significantly due to increase in initial soil moisture levels, which further increased with the additional irrigation applied at flowering stage (Table 3). It is interesting to note that on the basis of 2 years average, the uptake of N by raya crop at maturity stage was 15.7% higher under wet soil moisture level (200+50 mm) over the driest soil moisture level (125 mm). There was no significant increase in uptake of P due to different soil moisture treatments. There was no definite trend in uptake of K under different soil moisture treatments. The uptake of all these nutrients was increased significantly by the application of nitrogen. It is clear from the data that on the basis of 2 years average the uptake of N by raya crop at maturity stage was 37.5% higher under highest level of nitrogen (60 kg N/ha) application over control. The corresponding increase in P and K uptake were 80.9 and 22.2 per cent, respectively. Dhindsa *et al.* (1973) and Yadav (1975) also observed similar trend in case of N uptake.

Oil Content and Oil Yield

Though the oil content was not significantly influenced with the variation in soil moisture treatments but there was significant increase in total oil yield per hectare with the increase in soil moisture level (Table 4). The increase in oil yield under highest soil moisture level (200+

TABLE 3

N, P and K uptake (kg/ha) by raya crop as influenced by different profile soil moisture and nitrogen levels at maturity during 1975-76 and 1976-77.

	Nitrogen		Phosphorus		Potash	
Treatment	1975-76	1976-77	1975-76	1976-77	1975-76	1976-77
Profile soil moisture levels (mm)						
125+0	87.51	95.76	17.63	18.91	202.0	222.0
160+0	96.37	107.17	19.43	21.15	217.0	242.9
200+0	99.34	107.20	18.90	20.03	232.0	252.9
125+50	90.90	100.57	18.10	19.63	212.1	233.6
160+50	98 40	111.23	18.40	20.44	222.7	252.6
200+50	98.62	113.46	18.58	20.90	223.2	259.9
SE ±	0.68	0.43	NS	NS	2.72	2.79
C. D. at 5%	2.14	1.35			8.57	8.78
Levels of nitrogen (kg/ha)						
N_0	76.31	88.00	12.50	14.04	190.8	216.9
N_{20}	94.57	104.46	17.89	19.49	216.0	243.5
N_{40}	101.42	113.61	20.34	22.46	227.6	255.4
N_{60}	108.47	117.54	23.29	24.72	238.3	260.0
SE±	0.96	0.91	0.32	0.36	2.46	2.62
C. D. at 5%	2.75	2.60	0.90	1.03	7.05	7.52

TABLE 4

Oil content (per cent) and oil yield (kg/ha) of raya seed as influenced by different profile soil moisture and nitrogen levels during 1975-76 and 1976-77

Treatments	Oil content (per cent)		Oil yield (kg/ha)	
	1975-76	1976-77	1975-76	1976-77
Profile soil moisture levels (mm)				
125+0	37.74	36.34	332.7	373.6
160+0	38.23	37.99	377.9	433.4
200+0	38.63	37.45	425.5	455.2
125+50	37.86	36.85	420.5	459.8
160+50	38.33	37.85	475.5	486.4
200+50	38.01	38.09	511.8	519.2
SE±	NS	NS	2.46	2.21
C. D. at 5%			7.75	6.97
Levels of nitrogen (kg/ha)				
N_0	39.14	38.80	341.6	377.6
N_{20}	38.44	37.96	420.3	455.4
N_{40}	37.71	37.09	456.6	484.9
N_{60}	37.24	36.83	478.5	500.3
SE±	0.027	0.027	11.0	8.48
C. D. at 5%	0.076	0.076	31.7	24.33

50 mm) was 22.9% than that recorded under the lowest soil moisture level (125 mm). The oil yield per hectare was a function of seed yield/ha and the oil content. The oil content and seed yield were negatively correlated but the grain yield predominantly affected the oil yield/ha.

Application of nitrogen decreased the oil content significantly at all the levels during both the years. The oil yield/ha was significantly increased only upto 40 kg N/ha. On the basis of 2 years average the per cent increase with the application of 40 kg N/ha was 30.7 and 7.4 over control and 20 kg N/ha, respectively. The increase in oil yield infact was due to increase in seed yield per hectare. Similar effect of nitrogen in decreasing oil content of raya was reported by Bhan and Singh (1974). Such decrease in oil content with nitrogen application may be due to the utilization of more carbohydrates in protein formation in nitrogen rich plants.

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WEED EFFECT EXHIBITED BY DIFFERENT HERBICIDES IN CULTIVATED FIELDS OF INDIAN DESERT

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ABSTRACT

Seven herbicides, viz. amitrole, difenzoquat methyl sulphate, diuron, nitrofen, oxyfluorfen, pendimethylene and silvex, were applied as post-emergence on a number of weeds. Most of the weeds were controlled by amitrole and silvex; while some were controlled by diuron and oxyfluorfen. Amitrole killed the weeds by causing chlorosis in leaves; while silvex by wilting and drooping of plants. Diuron and oxyfluorfen scorched the plants. Difenzoquat methyl sulphate, pendimethylene and nitrofen were ineffective in controlling different weeds. *Indigofera cordifolia* and *Ipomoea pes-tigridis* were most susceptible towards different herbicides. Almost all the herbicides except amitrole proved ineffective on *Cyperus rotundus* and grasses.

There are several hundred species of weeds that are serious competitors with crops for water, mineral nutrients, space, and other growth requirements. Weeds interfere with agricultural operations, increase the labour input, add to costs and reduce crop yields. Chemical weed control has now become a part of modern agricultural technology, and its importance, though not yet fully realised, is slowly being recognised. Many chemicals of varied properties have found their way (Moreland, 1967). The chemical control of weeds, no doubt, has solved many problems, but a little information is available about the efficiency of several available herbicides to control various weeds in Indian desert. Thus, with this object of finding out the efficiency of herbicides to control various weeds, some trials were taken up, the results of which are presented here.

MATERIAL AND METHODS

Seven herbicides viz., amitrole (3-amino-1, 2, 4-triazole) @ 2.5 kg/ha; difenzoquat methyl sulphate (1, 2-dimethyl-3, 5-diphenyl-1H-pyrozolium methyl sulphate) @ 1 kg/ha; diuron (3-(3, 4-dichlorophenyl)-1, 1-dimethylurea-1) @ 2 kg/ha; nitrofen (2, 4-dichlorophenyl p-nitrophenyl ether) @ 5 l/ha; oxyfluorfen (2-chloro-1-(3-ethoxy-4-nitrophenoxy)-4-(trifluoromethyl) benzene) @ 1 kg/ha; pendimethylene (N-(1-ethylpropyl, 3, 4-dimethyl-2, 6-dinitrobenzeneamine) @ 1 kg/ha; and silvex (2, 4-dichlorophe-

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noxy acetic acid-ethyl ester) @ 2.5 l/ha, were applied as post-emergence to 5-6 weeks old weed plants over plots of 4×4 m in cultivated fields where the weeds were already growing. After the application of herbicides the weeds of these plots were observed regularly for different responses such as shoot morphology, wilting and chlorosis in leaves, and ultimate effect causing death of plants by these herbicides.

RESULTS AND DISCUSSION

1. Amitrole

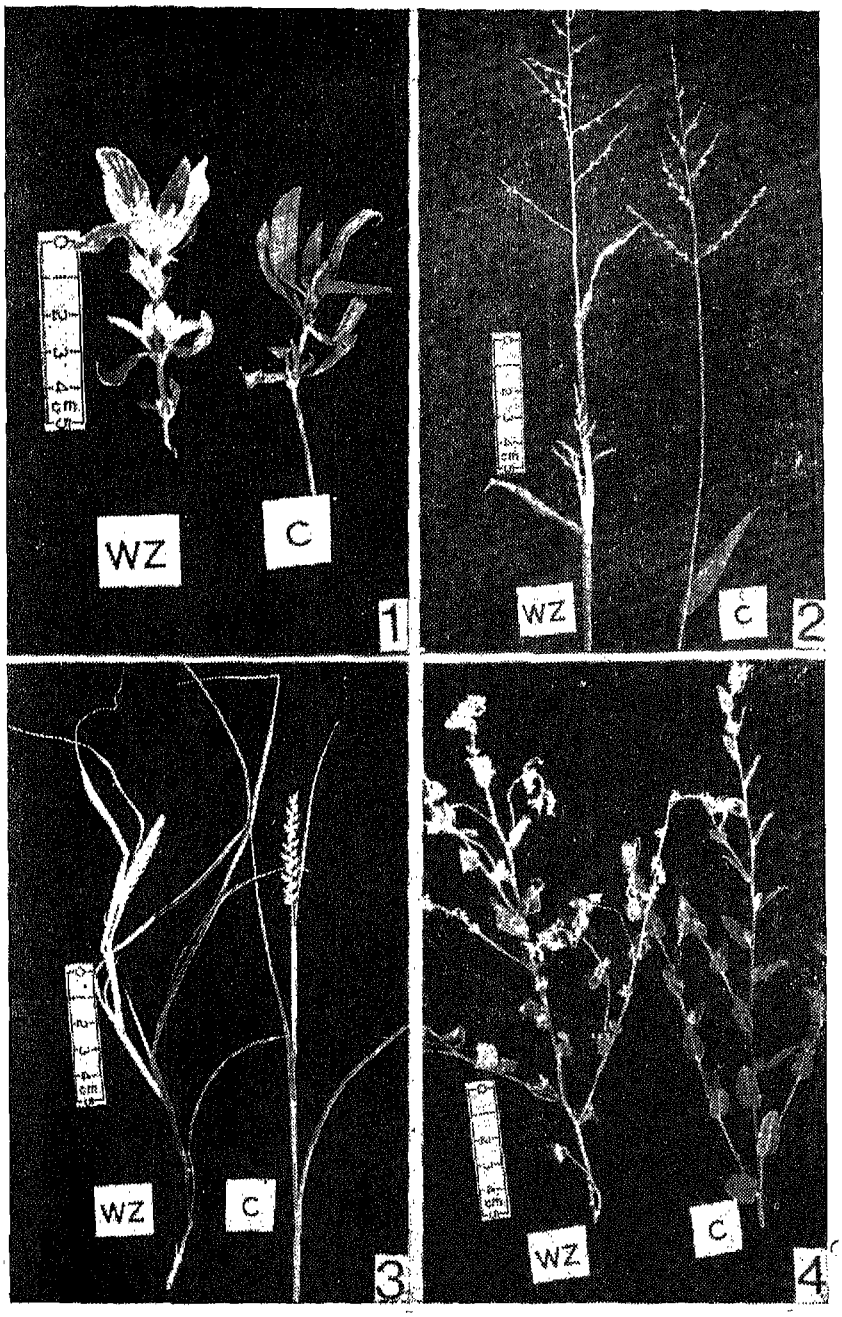
This herbicide caused severe chlorosis in leaves and stem. Chlorosis in the apical parts of *Borreria articularis* was noted (Fig. 1) and after few days plants dried up due to severe drooping and wilting in leaves and stem. Other weeds like *Brachiaria ramosa* (Fig. 2), *Convolvulus microphyllus* and *Dicoma tomentosa* showed severe chlorosis in all plant parts and they dried later on. Leaves of *Cenchrus biflorus, C. setigerus* (Fig. 3), *Chloris virgata, Dactyloctenium aegyptium, Digitaria adscendens, Indigofera cordifolia* (Fig. 4) and *Tribulus terrestris* (Fig. 5) showed severe chlorosis from base to top. Newly formed leaves were totally white and stem also showed chlorosis in some parts. Distinct anthocyanin was observed in *C. setigerus*. The plants completely dried due to severe wilting and drooping of leaves. *Celosia argentea* and *Ipomoea pes-tigridis* (Fig. 6) completely dried due to severe drooping and wilting of stem and leaves. Chlorosis from margin to centre was noted in the leaves of *Cleome viscosa* (Fig. 7) and *Corchorus tridens*. The primary effect was on apical parts of the branches but later on plants dried up from top to bottom. Chlorosis in leaves of *Cyperus rotundus* was noted from base to top and broad yellow rings were formed around the stem. The inflorescence axis remained stunted.

2. Difenzoquat methyl sulphate

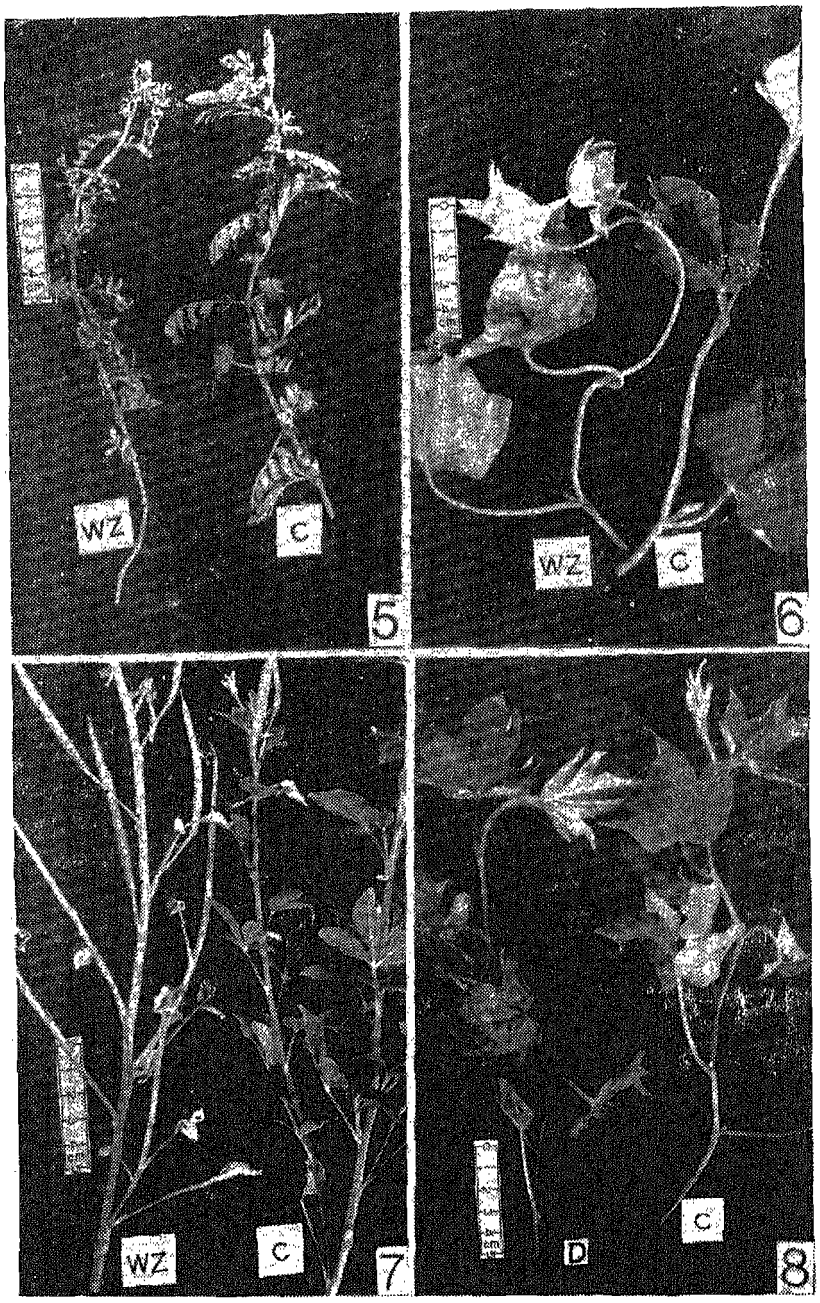
This herbicide was less effective in controlling different weeds. The leaves of *Celosia argentea* showed dark pink, white and brown patches and dried up afterwards. Wilting caused the drooping of apical portions of the branches. Partial killing was noted in *Cleome viscosa*. Leaves of *Corchorus tridens* exhibited chlorosis in patches which resulted in partial killing of the plants. Brown and light pink spots were observed in *Indigofera cordifolia* leaves within two days of spraying and ultimately parts of plant were found scorched. *Cenchrus biflorus, C. setigerus, Chloris virgata, Crotalaria medicaginea, Cyperus rotundus, Dicoma tomentosa, Digitaria adscendens, Ipomoea pes-tigridis* and *Tribulus terrestris* were found resistant against this herbicide.

3. Diuron

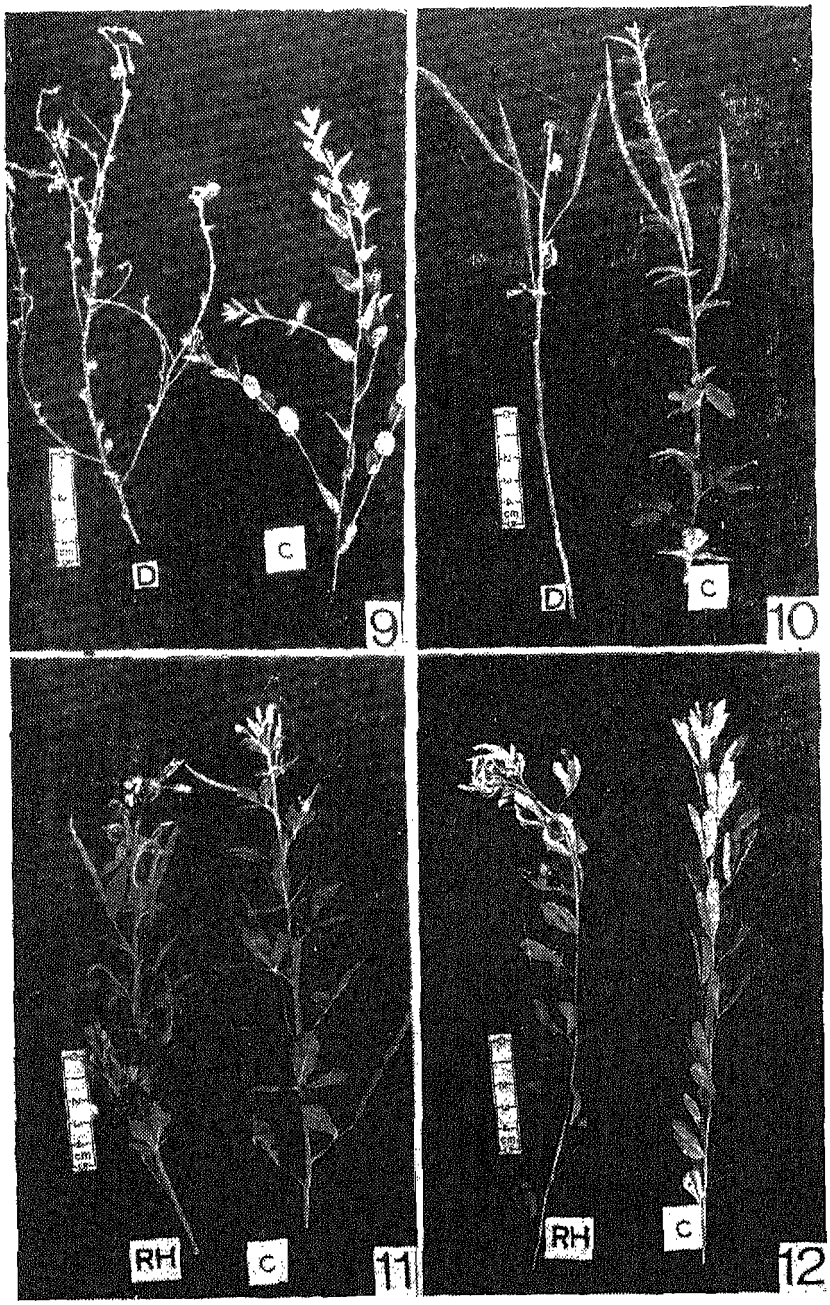
This herbicide caused scorching. All the plants of *Ipomoea pes-tigridis* were completely scorched and turned dark brown in colour (Fig. 8). After few days plants dried up completely. *Cenchrus biflorus, Indigofera cordifolia* (Fig. 9) and *Tribulus terrestris* showed chlorosis in their leaves and the plants ultimately dried up. The leaves of *Cleome viscosa* were scorched completely, while the stem turned brown in colour and after few days plants got completely killed (Fig. 10). *Brachiaria ramosa, Cenchrus setige-*



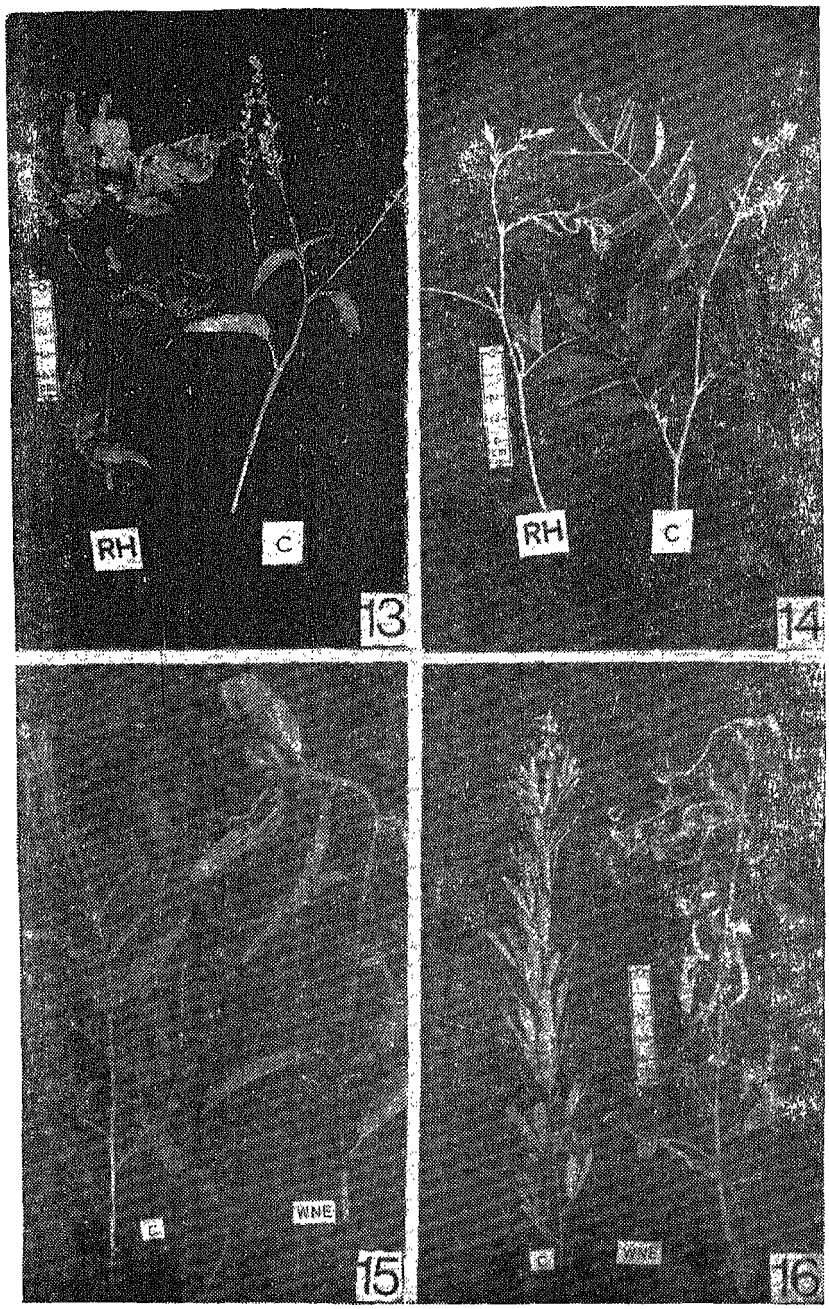
Figs. 1–4. Effect of amitrole (WZ) on *Borreria articularis* (1), *Brachiaria ramosa* (2), *Cenchrus setigerus* (3) and *Indigofera cordifolia* (4); C-control.



Figs. 5-8. Effect of amitrole (WZ) on *Tribulus terrestris* (5), *Ipomoea pes-tigridis* (6) and *Cleome viscosa* (7), and of diuron (D) on *Ipomoea pes-tigridis* (8); C-control.



Figs. 9–12. Effect of diuron (D) on *Indigofera cordifolia* (9) and *Cleome viscosa* (10), and of oxyfluorfen (RH) on *Cleome viscosa* (11) and *Crotalaria medicaginea* (12); C–control.



Figs. 13–16. Effect of oxyfluorfen (RH) on *Digera muricata* (13) and *Tephrosia purpurea* (14), and of silvex (WNE) on *Corchorus tridens* (15) and *Crotalaria medicaginea* (16); C-control.

rus, Chloris virgata and *Digitaria adscendens* had a little effect with this herbicide.

4. Nitrofen

Nitrofen remained largely ineffective against many weeds studied here. Leaves of *Aerva persica, Cleome viscosa, Corchorus tridens, Crotalaria medicaginea, Heliotropium subulatum, Indigofera cordifolia, Ipomoea pes-tigridis* and *Tribulus terrestris* showed wilting, but the growth of the plants remained unaffected. Grasses were resistant against this herbicide.

5. Oxyfluorfen

In *Cleome viscosa*, the effect was mainly on flowers (Fig. 11) which dried up without producing pods. *Corchorus tridens, Crotalaria medicaginea* (Fig. 12), *Digera muricata* (Fig. 13), *Heliotropium subulatum, Ipomoea pes-tigridis, Tephrosia purpurea* (Fig. 14), *Trianthema govindii* and *Trichodesma sedgwickianum* were completely scorched and dried up. Grasses were found resistant against this herbicide.

6. Pendimethylene

Most of the weeds were found resistant against this herbicide. The apical part of the branches in *Indigofera cordifolia* showed chlorosis and wilting but no killing took place. Chlorosis was observed at margins of *Tribulus terrestris* leaves. *Borreria articularis, Brachiaria ramosa, Cenchrus biflorus, C. setigerus, Chloris virgata, Cleome viscosa, Cyperus rotundus, Dicoma tomentosa, Digitaria adscendens* and *Ipomoea pes-tigridis* had no effect with this herbicide.

7. Silvex

This herbicide was very effective. *Cleome viscosa, Corchorus tridens* (Fig. 15), *Crotalaria medicaginea* (Fig. 16), *Dicoma tomentosa, Digera muricata, Indigofera cordifolia, Ipomoea pes-tigridis, Tephrosia purpurea, Tribulus terrestris* and *Trichodesma sedgwickianum* were controlled. A characteristic curling in the upper part of the branches took place after 24 h of treatment with this herbicide.

Weed control in drylands and semi-arid tropics has received scanty attention, particularly with reference to the use of herbicides. In the present investigation, most of the weeds were controlled by one or the other herbicide when applied as post-emergence. Ashraf *et al.* (1979) have reported the control of some weeds of this area by using some of these herbicides as pre-emergence. They found nitrofen and amitrole ineffective but in the present investigation control of various weeds was achieved by amitrole when applied as post-emergence. Pereira (1970) reported nitrofen as a contact herbicide which caused burning of mature foliage and malformation of developing leaves in cabbage. In the present investigation, nitrofen was found as a defoliant and difenzoquat methyl sulphate as a contact herbicide. Ashraf *et al.* (1979) used difenzoquat methyl sulphate and pendimethylene as pre-emergence and controlled some weeds while in present investigation these were ineffective as post-emergence. Diuron and silvex, newly introduced herbicide in this area, were found successful in controlling various weeds. Parker (1962), Scholtens (1966) and Gupta (1968) reported that diuron

was suitable for control of annual grasses when applied as pre-emergence @ 0.8 to 1.6 kg/ha. Sen (1979) applied oxyfluorfen as pre-emergence and observed that the weeds were completely controlled. In the present investigation also, oxyfluorfen controlled many weeds when applied as post-emergence. Recently in 1981, Singhal and Sen adopted a new method in the field of chemical weed control by using these herbicides as post-emergence.

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INFLUENCE OF DIFFERENT LEVELS OF SULPHATE CONCENTRATION ON NITROGEN METABOLISM OF JAPANESE MINT

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ABSTRACT

Sulphur deficiency (0 and 1 ppm) resulted in marked accumulation of all the soluble nitrogen fractions and a decrease in protein nitrogen in *Mentha arvensis* L. var. *Piperascens Holmes*. A higher content of amide and ammoniacal-N indicated that the N-metabolism was interfered with the transformation of ammonia and amide. With the increase in the levels of S-fertilization, the levels of soluble-N fractions decreased. Increase in protein content indicated that at higher levels of sulphate supply, the soluble fractions were rapidly utilized in protein synthesis. Among plant parts, leaves showed the maximum percentage of nitrogen in the insoluble form, while in stems and roots higher percentage of nitrogen was detected in the soluble form.

Sulphur plays an important role in nitrogen metabolism. It is constituent of amino acids—cystine, cysteine and methionine and other important metabolites (Gemlin, 1962; Warner, 1965). Sulphur deficiency has been reported to disturb the nitrogen metabolism and to cause marked accumulation of soluble nitrogen and reduction in protein nitrogen in plant tissues (Nightingale *et al.*, 1932; Eaton, 1935, 1941, 1951; Mertz and Matsumoto, 1956; Rending and Mc Comb, 1959, 1961; Adams and Sheared, 1966; Gupta and Veinot, 1974; Pal *et al.*, 1976; Sims *et al.*, 1979). The present investigation was, therefore, undertaken to find out the changes brought about by increasing levels of sulphur in the nitrogen metabolism of Japanese mint plant.

MATERIAL AND METHODS

The present experiment was conducted in the green house during the year 1970-71. Uniform stem cuttings with four pairs of expanded leaves were planted in 120 cemented pots, filled with well washed sand in the rainy season (long day and high temperature conditions).

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Treatments comprised of six levels of sulphate fertilization, viz., 0, 1, 3, 9, 27 and 81 ppm. Each treatment was replicated 20 times. Modified nutrient solution of Tisdale *et al.* (1950) was used to raise different levels of sulphate in the medium (Table 1).

All pots received 5 ppm of iron ammonium citrate, 2 ppm $MnCl_2.4H_2O$ and 3 ppm H_3BO_3 with each application of nutrient solution. Prior to application of the nutrient solution, its pH was adjusted to 6.3. The pots were flushed with water every third addition of nutrient solution. Plant samples were harvested at 80 days of growth and analysed for various nitrogen fractions, i.e. ammonia, amide, nitrate nitrite, 'rest' nitrogen, total soluble and insoluble (mainly protein) nitrogen as outlined by Loomis and Shull (1937). The total insoluble nitrogen was determined from the oven-dried residue of alcoholic extract by Micro-kjeldahl method. Total nitrogen was calculated indirectly from the percentage of total soluble nitrogen plus the percentage of total insoluble nitogen. All the nitrogen fractions were represented in g per 100 g dry weight.

RESULTS AND DISCUSSION

Sulphur deficiency (0 ppm) exhibited fairly consistent effects on nitrogen metabolism of mint plant. Insoluble nitrogen (mainly protein nitrogen) was decreased due to deficiency, whereas soluble nitrogen fractions increased in all the component parts at all the stages of growth (Table 2). It is evident from Table 3 that ammonia and amide formed the higher portion of soluble nitrogen of sulphur deficient plants as compared with other levels of sulphate fertilization. However, the proportion of nitrate and other form of soluble nitrogen to the pool of total soluble nitrogen decreased in 0 and 1 ppm of sulphate supply. Thus, it seems that when sulphur is lacking, nitrogen metabolism is interfered at amide and ammonia formation stages, resulting in the arrested protein synthesis. Similar findings have also been reported by Rendig and Mc Comb (1961).

As it is evident from the data in Table 2, 1 ppm sulphate treatment showed accumulation of soluble nitrogen fractions and decreased protein content. But under higher levels of S-fertilization the accumulated soluble nitrogen frac-

TABLE 1

Composition of nutrient solution

Sulphate (ppm)	Salt per litre of water (g)						
	$Ca(NO_3)_2.4H_2O$	KNO_3	KCl	K_2SO_4	$CaCl_2$	$MgCl_2$	KH_2PO_4
0	0.371	0.1669	0.220	0.0000	0.108	0.190	0.1073
1	0.371	0.1669	0.218	0.0018	0.108	0.190	0.1073
3	0.371	0.1669	0.215	0.0054	0.108	0.190	0.1073
9	0.371	0.1669	0.204	0.0163	0.108	0.190	0.1073
27	0.371	0.1669	0.171	0.0489	0 108	0 190	0.1073
81	0.371	0.1669	0.073	0.1468	0.108	0.190	0.1073

TABLE 2

Effects of increasing levels of sulphate fertilization on the nitrogen fractions (g/100 g dry wt.) of component parts of Japanese mint at flowering stage (180 days) grown under long day and high temperature conditions

Sulphate concentration (ppm)	Nitrogen fractions															
	Ammoniacal nitrogen				Amide N				Nitrate-N				'Rest' N			
	Leaf	Stem	Root	Mean	Leaf	Stem	Root	Mean	Leaf	Stem	Root	Mean	Leaf	Stem	Root	Mean
0	0.072	0.110	0.054	0.078	0.085	0.172	0.084	0.113	0.670	0.721	0.561	0.617	0.640	0.630	0.490	0.586
1	0.054	0.098	0.045	0.065	0.054	0.140	0.130	0.108	0.450	1.070	0.700	0.740	0.576	0.570	0.480	0.542
3	0.055	0.093	0.046	0.064	0.056	0.104	0.055	0.071	0.480	0.940	1.017	0.812	0.598	0.580	0.446	0.541
9	0.063	0.086	0.043	0.064	0.045	0.065	0.073	0.061	0.340	0.650	1.060	0.683	0.585	0.570	0.360	0.505
27	0.060	0.058	0.033	0.050	0.048	0.066	0.068	0.060	0.400	0.500	0.710	0.536	0.576	0.504	0.374	0.484
81	0.037	0.058	0.039	0.044	0.022	0.055	0.058	0.450	0.162	0.470	0.550	0.394	0.550	0.460	0.413	0.474
Mean	0.056	0.083	0.043		0.051	0.1103	0.078		0.417	0.725	0.766		0.587	0.552		
C. D. at 5%	Treatment 0.012		Plant parts 0.018		Treatment 0.018		Plant parts 0.025		Treatment 0.357		Plant parts 0.505		Treatment 0.021		Plant parts 0.029	

Sulphate concentration (ppm)	Total soluble N				Total insoluble N				Total N			
	Leaf	Stem	Root	Mean	Leaf	Stem	Root	Mean	Leaf	Stem	Root	Mean
0	1.467	1.633	1.189	1.430	1.916	1.149	0.780	1.291	3.383	2.700	1.997	2.693
1	1.534	1.878	1.355	1.455	1.847	1.067	0.808	1.231	2.981	2.945	2.135	2.687
3	1.189	1.717	1.464	1.456	2.125	1.262	0.935	1.440	3.314	2.979	2.499	2.930
9	1.033	1.371	1.536	1.313	2.224	1.587	0.841	1.550	3.257	2.958	2.377	2.864
27	1.084	1.128	1.185	1.132	2.540	1.540	0.990	1.690	3.624	2.668	2.175	2.822
81	0.771	1.043	1.060	0.958	2.310	1.457	1.106	1.624	3.081	2.500	2.166	2.582
Mean	1.113	1.461	1.298		2.160	1.343	0.910		3.273	2.791	2.224	
C. D. at 5%	Treatment 0.499		Plant parts 0.706		Treatment 0.148		Plant parts 0.209		Treatment 0.247		Plant parts 0.350	

TABLE 3

Relative composition of soluble nitrogen fractions of Japanese mint as affected by sulphate fertilization

Sulphate concentration (ppm)	Ammoniacal N			Amide N			Nitrate-N			'Rest' N		
	Leaf	Stem	Root	Leaf	Stem	Root	Leaf	Stem	Root	Leaf	Stem	Root
0	4.91	6.74	4.55	5.80	10.54	7.07	45.68	44.16	47.19	43.63	36.58	41.22
1	3.52	5.22	3.33	3.52	7.46	9.60	29.34	56.98	51.66	37.55	30.36	35.43
3	4.63	4.42	3.15	4.71	6 06	3.76	40.37	54.75	69.47	50.30	33.78	30.47
9	6.10	4.32	2.80	4.36	4.75	4.76	32.92	47.41	69.21	56.64	41.58	23.44
27	5.54	4.13	2.79	4.43	4.99	5.74	36 90	44.33	59.92	53.14	44.68	31.57
81	4.80	3.50	3.68	2.86	4.28	5.48	21.02	45.07	51.89	71.34	44.11	38 97

tions decreased, probably because of their utilization in protein synthesis. This was confirmed with the observations that increasing levels of sulphate supply caused a progressive build up of proteins. However, enhanced protein synthesis was noted only upto a certain limit of S-supply. For instance maximum protein content was noted at 27 ppm of sulphate supply, beyond which (81 ppm) a decrease in protein content was noted. Similar findings were also reported by other workers (Mertz and Matsumoto, 1956; Karim and Khan, 1957; Rendig and Mc Comb, 1961; Pumphrey and Moore, 1965; Gupta and Veinot, 1974; Martel and Zizka, 1977).

Rendig and Mc Comb (1961) reported that lower concentrations of sulphur caused an increase in the accumulation of amide nitrogen and as the sulphur concentration increased, the content of amide nitrogen fell down and the synthesis of sulphuretted amino acids was enhanced. Increasing levels of sulphate supply also increased the total N in mint plants. Pal *et al.* (1976) and Sims *et al.* (1979) also advocated that SO_4 markedly increased total N in tobacco leaves by accelerating the activity of nitrate reductase.

The accumulation of soluble nitrogen under lower supply of sulphate is mainly due to inhibition in protein synthesis for want of sulphuretted amino acids. The shortage of S-bearing amino acids causes disturbance in peptide chain formation. With increase in sulphate supply, synthesis of S-bearing amino acids and their incorporation into proteins is enhanced. Thus at higher levels of sulphate supply, the insoluble nitrogen is increased with a concomitant decrease in the soluble nitrogen.

Among plant parts, leaves showed the maximum percentage of nitrogen in the insoluble form, while stems and roots contained higher amount of soluble forms. It indicates that nitrate reduction and its assimilation into complex organic nitrogenous compounds takes place predominantly in the leaves. The stem served as medium of transport for various nitrogen fractions and, thus, stems acted as reservoir for accumulating the soluble nitrogen.

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FUNGAL ROT OF STORED ONION BULBS IN HARYANA

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ABSTRACT

The nature of decay of onion bulbs in different storage houses and vegetable markets of Haryana revealed that major proportion of onion bulbs decayed due to attack of *Aspergillus niger* and *Fusarium solani*. The second group of fungi, which occurred in less frequency were *Aspergillus nidulans*, *Fusarium oxysporum*, *Penicillium notatum* and *P. digitatum*. Storage rot due to *A. nidulans* and *P. notatum* on onion bulbs is reported for the first time in India or elsewhere and the characteristic symptoms of the rot along with the diagnostic features of the fungi are described.

Among pathogens responsible for decay and rotting of onion bulbs during storage, fungi play an important role (Venkatarayan and Delvi, 1951; Brien *et al.*, 1959; Geared, 1959; El-Helely *et al.*, 1962; Mathur and Sankhla, 1963). According to the estimation of Dang and Thakur (1972) nearly 15% of stored onion bulbs are lost every year due to various decays caused by several fungi in the various storage structures of Haryana. Now onion has become important foreign exchange earner for the country. It was, therefore, thought essential to determine the nature and extent of loss of stored onion bulbs due to various fungi in different districts of Haryana.

MATERIAL AND METHODS

To determine the nature of fungal rot, onion bulbs showing distinct symptoms of rotting were collected from various markets and storage houses of Haryana State at regular intervals. Based on the production and storage capacity, observations were limited to the markets and storages of Ambala, Gharaunda, Karnal, Hissar and Panipat. Infected bulbs were brought to the laboratory and the organisms were isolated by usual method. The fungi were purified by single spore isolation technique according to the method of Riker and Riker (1936). Due pathogenecity tests in respect of each fungus were conducted on uninjured bulbs of cv. Hissar-2 of uniform size taken from HAU Farm, Hissar. Five different methods of inoculation : without injury, with syringe injury (Tomkins and Trout, 1931), with sand paper injury, with scalpel injury (Yadav and Thakur, 1971), and with 'Well' method (Grainger and Horne, 1924) were tried. Young culture suspension of the fungus consisting spores and mycelial bits was used as inoculum. The injured surface of the bulbs was dipped in culture suspen-

sion for 5 min in all the methods of inoculation. In 'Well' method culture suspension was placed in the 'Well', the core was replaced and finally sealed with molten paraffin wax. In case of syringe inoculation 0.5 ml of culture suspension was injected inside the bulb with the help of hypodermic syringe. After inoculation, the bulbs were stored for 15 days in sterilized desiccators having saturated atmosphere at room temperature ranging between 26–32°C. Percentage of infection and disease intensity was determined according to the method of Srivastava and Tandon (1968).

RESULTS AND DISCUSSION

The results of pathogenicity tests, frequency of occurrence of organisms and characteristic symptoms produced by the two newly recorded fungi are described below:

From Table 1 it is observed that *Aspergillus niger* and *Fusarium solani* were found more frequently on onion bulbs in the storage structures and vegetable markets of Haryana. These two fungi jointly caused major decay of stored onion bulbs. The second group of fungi which were not common and could be isolated occasionally were *Aspergillus nidulans, Fusarium oxysporum, Penicillium notatum* and *P. digitatum.*

The results of the pathogenicity tests revealed that the fungi isolated from the infected onion bulbs not proved to be essentially wound parasite except *Fusarium oxysporum* and *Penicillium notatum* which could not induce the disease without injury (Table 2). Among different methods of inoculation, injury by 'Well' method, by scalpel method and by syringe inoculation, showed heavy rotting. The respective fungi could be isolated in each case from the infected bulbs.

Symptoms produced by different fungi were characteristic of their own kind according to earlier literature (Walker, 1924; Machacek, 1929; Du-Plessis, 1932). Since bulb rot caused by *Aspergillus nidulans* and *Penicillium notatum* happened to be the first report on this host, the detailed symptoms and diagnostic features of the organism are described here.

Aspergilius rot. The disease appeared with the discoloured patches on

TABLE 1

Fungi associated with rotting of onion bulbs in Haryana

Fungi	Frequency of occurrence of fungi on onion bulbs				
	Ambala	Gharaunda	Hissar	Karnal	Panipat
Aspergillus niger	+	+	+++	+++	++
**A. nidulans*	–	–	+	+	+
Fusarium oxysporum	+++	–	++	++	–
F. solani	+++	++	+++	+	+
**Penicillium notatum*	++	+	–	–	+
P. digitatum	++	+	–	–	+

+++=Most common; ++=Less common; +=Rare; –=Nil; *New record.

TABLE 2

Pathogenicity of fungi isolated from onion bulbs by different methods of inoculation

Method of inoculation	*Aspergillus niger*		*A. nidulans*		*Fusarium solani*		*F. oxysporum*		*Penicillium notatum*		*P digitatum*	
	PI	DI*	PI	DI	PI	DI	PI	DI	PI	DI	PI	DI
Syringe inoculation	80	70	36	25	100	70	91	57	25	26	65	72
Sand paper injury	25	26	16	3	16	12	16	10	8	7	16	18
Scalpel injury	88	76	46	30	100	83	100	91	75	85	88	94
'Well' method injury	75	77	55	50	100	91	100	90	75	94	100	92
Without injury	50	40	25	20	8	7	0	0	0	0	14	12
Control	0	0	0	0	0	0	0	0	0	0	0	0

PI=Percentage infection; DI=Disease intensity.

*=The loss due to dehydration in control has been deducted while calculating DI.

the scales of onion bulbs. Similar discoloration was also seen in the internal scales. In advanced stage, marked shrivelling of scales could be observed (Fig. 1) and on this basis the disease may be designated as dry rot.

On PDA, the fungus colony was cress green, later changed to greenish white. Conidiophore smooth, 92.05×7.3 μ; vesicle at the apex of the conidiophore, smaller with an average diameter of 42.92 μ. Sterigmata biserata, the primary sterigmata measuring 4.60-5.90×2.20-3.40 μ; secondary sterigmata 5.6×2.25 μ. Conidia globose 3-3.5 μ in diameter, green in mass. Cleistothecia full of light brown pear shaped, smooth walled ascospore. On the basis of the character of the perfect stage, the fungus was identified as *Aspergillus nidulans* (Fidam) Wint. according to Thom and Raper (1945).

Penicillium rot. This disease was characterised by the appearance of internal soft rot first in the core of the infected bulbs. The internal scales were completely rotted emitting a very offensive odour (Fig. 2).

On PDA, the fungus produced bright green colonies later becoming darker red. Fruitification in three stages. Conidia globose and oval, 2.6-3.2 μ in diameter. On the basis of three stages of fruitification and size of conidia, the fungus has been identified as *Penicillium notatum* Westling according to Gilman (1967).

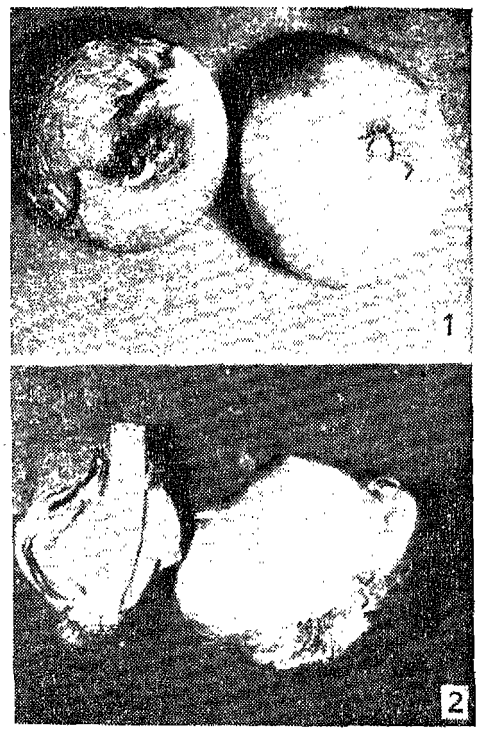


Fig. 1. Onion bulb infected (left) with *Aspergillus nidulans* showing shrivelling of scales. Right—healthy bulb.

Fig. 2. Onion bulb (cut across) infected (left) with *Penicillium notatum* showing the infected core and rotting of internal scales. Right—healthy bulb.

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VARIETAL DIFFERENCES IN ROOT DISTRIBUTION OF SUGARCANE

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A knowledge of rooting pattern of a crop plant is essential for recommending various agronomic practices. The agronomic practices vary from crop to crop and variety to variety in the same crop. The only method available for knowing the rooting pattern of any crop *in situ* is the ^{32}P plant injection technique which is rapid, accurate and reliable. This method has been used extensively for several crops, such as wheat, rice, sorghum, millets and fruit trees in India and abroad (Swaminathan, 1971). Based on such studies some of the cultural practices have been recommended for some crop varieties (Singh and Gupta, 1975). This work was undertaken to study the rooting pattern of three early maturing varieties of sugarcane using ^{32}P plant injection technique.

The experiment was conducted in a Coarse Loamy Typic Camborthids soil having pH 8.3, EC 0.30 mmhos/cm and bulk density of 1.4 and 1.5 g/cc of surface and sub-surface soils, respectively. Three varieties of sugarcane viz., CoJ-58, CoL-29 and Co-997A were sown in 10×3.5 m plot having row to row distance of 60 cm. All the cultural practices were kept constant in all the varieties and were optimum for normal growth of the crop. Four plants were selected in each variety which were located well inside the plots. One cavity was made in the stem of one tiller of the plant at maturity stage. One ml of carrier free ^{32}P was injected in the cavity and sealed. After an equilibration period of 5 days, the soil cores alongwith roots were taken out from 4 lateral distances, viz., 5, 10, 20 and 40 cm away from the plant and 4 depths, i. e., 0-15, 15-30, 30-60 and 60-90 cm. The samples were taken from all the four sides of the plant and the composite samples were dried and ground to pass through 1 mm sieve. Four g soil was weighed in a stainless steel planchet and the activity of ^{32}P was measured on a Geiger Muller Counter using end-window tube. The relative percentage of roots for each particular depth and lateral distance was calculated considering the total number of counts as 100 per cent roots.

A perusal of the data (Table 1) indicates that the distribution of roots varied at different depths and lateral distances. The differences were significant in case of variety CoJ-58. In case of variety CoL-29, the roots present at different depths at lateral distances of 5 and 10 cm varied significantly, whereas at 20 and

TABLE 1

Lateral and vertical distribution of roots of different sugarcane varieties (% roots)

Variety	Depth (cm)	Lateral distance (cm)				Total	CD at 5%
		5	10	20	40		
CoJ-58	0-15	9.79	2.80	9.41	5.41	27.41	2.29
	15-30	13.60	3.54	6.23	2.97	26.24	5.07
	30-60	8.63	6.02	2.70	7.18	24.53	0.93
	60-90	3.85	11.26	4.45	2.26	21.82	1.61
	Total	35.77	23.62	22.79	17.82	100.00	2.31
	C.D. at 5%	3 98	0.71	1.02	1.11	2.67	—
CoL-29	0-15	9.07	10.98	5.88	4.11	30.03	2.89
	15-30	4.06	4.41	6.44	4.36	19.27	NS
	30-60	9.99	7.73	8.01	4.39	30.12	3.55
	60-90	5.95	4.68	6.06	3.91	20.60	NS
	Total	29 07	27.80	26.39	16.77	100.02	2.63
	C.D. at 5%	3.04	2.23	NS	NS	3.21	—
Co-997A	0-15	3.47	14.33	5.91	6.40	30.11	0.79
	15-30	12.31	5.87	9 22	7.50	34.90	1.13
	30-60	5.73	5.07	4.53	9.45	24.78	1.34
	60-90	1.78	2.06	3.56	2.82	10.22	NS
	Total	23.29	27.33	23.22	26.17	100.01	1.96
	C.D. at 5%	1.27	1.41	1.36	1.35	2.01	—

40 cm lateral distances the differences were non-significant. In the same way, the distribution of roots at 0-15 and 30-60 cm depths were varying laterally and the differences were significant, whereas the lateral differences were non-significant at the other two depths, i. e., 15-30 and 60-90 cm. In case of Co-997A the root distribution varied significantly depthwise and laterally except at 60-90 cm depth where the lateral distribution was statistically uniform.

It is also evident from Table 1 that at 5 cm lateral distance, the maximum roots were recorded in case of variety CoJ-58 (35.77%) followed by CoL-29 (29.07%) and the least in the variety Co-997A (23.29%) At 10 cm lateral distance the variety CoJ-58 was having minimum roots (23.62%) but the difference between CoL-29 and Co-997A was only 0.47 per cent. At 20 cm lateral distance the variety CoJ-58 had maximum roots but again CoL-29 and Co-997A were at par. At 40 cm lateral distance the variety Co-997A had maximum roots, whereas minimum were present in CoL-29 and CoJ-58.

The data presented in Table 1 reveal that the depthwise distribution with respect to these three varieties also differed markedly. The roots of variety CoJ-58 had almost uniform distribution at different depths, whereas in case of

variety CoL-29 the roots were almost concentrated at 0-15 and 30-60 cm depths (about 60%) and the percentage of roots at these two depths were statistically non-significant. In case of variety Co-997A the maximum roots were noted in the first three layers (about 90%) having highest roots at 15-30 cm soil depth. This indicates that varieties CoJ-58 and CoL-29 had less lateral and more depthwise spread root system, whereas reverse of it in the variety Co-997A. Such varieties which are not deep rooted but have more of spreading type of root system would require shallow and frequent irrigation and need more of nutrients in the upper horizon. The varieties which are more deep rooted can explore the sub-soil and need heavy irrigation with longer interval.

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RESEARCH NOTE

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EFFECT OF FOLIAR APPLICATION OF ATONIK ON THE YIELD OF TOMATO (*LYCOPERSICON ESCULENTUM* MILL.) CV. HS-101

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The use of plant growth regulators has resulted in the improvement of growth and production of vegetable crops (Randhawa and Singh, 1970; Pandita *et al.*, 1979, 1981; Arora *et al.*, 1982). The influence of these substances on tomato has been reported and claims of better yield have led to much interest among the scientists and growers. Most of the beneficial effects of various plant regulators reported on tomato are either by whole plant or flower cluster spray. A new plant stimulant 'atonik' has been recently marketed commercially* for enhancing crop productivity in several crops including vegetables. Atonik is an aromatic nitro compound which stimulates plant activity without causing malformation or toxicity to the plant itself. Arora *et al.* (1981b) and Pandita *et al.* (1982) have reported beneficial effect of foliar application of atonik on the yield in radish and muskmelon, respectively. Pandita *et al.* (1981) also obtained highest yield of green leaves of palak by seed dip treatment and foliar spray of atonik. Since a little information about the effect of atonik on tomato crop is available, the studies were undertaken to assess the effect of foliar spray of atonik at various stages on early and total yield of 'HS-101' variety of tomato.

The experiment was conducted at the Research Farm of the Department of Vegetable Crops during 1979-80 and 1980-81. The soil of the experimental site was sandy loam with pH 8.2-8.5. Seeds of tomato variety 'HS-101' were sown in nursery in the end of July during both the years. Transplanting of seedlings was done on 11th September during 1979 and on 19th September during 1980. The experiment was laid out in randomized block design with four replications. The solution of atonik (0.05%) was sprayed on the plants at the start of flowering, seven days after start of flowering, 21 days after flowering and at mature green stages. Later, two additional sprays were done uniformly in all the treatments at fortnightly interval after the first spray. Control plants were sprayed with canal water. The experimental plots measured 4.0×2.4 m and there were 28 plants per treatment on 60 cm

*Asahi Chemical Mfg. Co. Ltd., 76, 2-Chome Osaka, Japan.

TABLE 1

Effect of atonik on number and weight of fruits of early and total yield of tomato during 1979-80 and 1980-81

Treatment	Number of fruits per plant from early yield			Early yield (kg/plant)			Weight of single fruit (g)			Number of fruits per plant			Total yield (kg/plant)		
	79-80	80-81	Av.	79-80	80-81	Av.	79-80	80-81	Av.	79-80	80-81	Av.	79-80	80-81	Av.
Control	1.7	5.1	3.4	0.09	0.12	0.11	47	19	33.0	19.1	33.7	26.4	0.89	0.61	0.75
Spray at start of flowering	3.4	6.7	5.1	0.18	0.16	0.17	48	19	33.5	29.1	36.0	32.6	1.41	0.63	1.02
Spray at 7 days after start of flowering	2.4	9.9	6.2	0.15	0.24	0.20	49	18	33.5	26.0	45.9	36.0	1.28	0.83	1.06
Spray at 21 days after start of flower ing	5.0	12.3	8.7	0.29	0.30	0.30	42	24	33.0	34.7	51.9	43.3	1.44	1.22	1.33
Spray at mature green stage	2.1	11.7	6.9	0.15	0.22	0.19	38	19	28.5	32.5	40.1	36.3	1.24	0.79	1.02
C. D. at 5% level	0.8	3.9		0.06	0.08		NS	NS		3.1	3.1		0.15	0.08	

wide raised bed transplanted at a distance of 50 cm between plants. Tween-20 was used as surfactant during the spray. The observations were recorded on number and weight of tomato fruits from early and total yield. Yield from the pickings made upto middle of December was considered as early yield, whereas total yield was regarded as the sum of all the pickings made upto beginning of February during both the years. Recommended cultural practices were followed during the course of investigations.

It is evident from Table 1 that differences in the number and weight of ripe fruits from early yield during both the years were significant. Maximum number of fruits per plant from early yield were recorded in atonik sprayed three weeks after start of flowering followed by spray at mature green stage. Least number of fruits per plant from early yield were recorded under control. It was interesting to note that all atonik sprayed plants, irrespective of the stage of spray, were at par with each other but superior to control. Spray of atonik three weeks after start of flowering also gave the highest early yield per plant (Table 1). Similar findings with atonik spray were also reported by Arora *et al.* (1981a) on tomato variety 'HS-102'. The increased early yield with this chemical may be due to increase in the endogenous auxin level by external application which promoted fruit set and enhanced early yield. Another reason for increased early yield may be auxin stimulated ethylene production in plant tissue which hastened the ripening process (Pratt and Goeschl, 1969) there by giving higher early yield.

Atonik treatments had a significant effect on the number and weight of fruits per plant from total yield. Maximum number of fruits were harvested from plants sprayed with atonik at three weeks after start of flowering followed by spraying atonik seven days after start of flowering. Minimum number of fruits were obtained from untreated control plants during both the years Maximum yield was recorded from spray of atonik at three weeks after start of flowering followed by spraying seven days after flowering, whereas untreated control plants gave the lowest total yield. However, Arora *et al.* (1981a) obtained higher total yield in 'HS-102' tomato variety when atonik was sprayed seven days after flowering. Higher total yield with atonik spray at three weeks after start of flowering may be due to auxin diverted mobilization of nutrients into flowers and fruits by its external application (Weaver, 1973). Higher total yield with atonik spray may also be due to the fact that atonik have some effect on improving the germination of pollen on the stigma of the flowers and the elongation of pollen tube and thus leading to surer fertilization and fruit setting as reported by the manufacturers of the atonik. They have also reported that atonik affects the multiplication of soil microorganisms through foliage of the plants by accelerating the decomposition of organic matter.

In general, yield was better in 1979 than 1980 which may be because of more favourable conditions at the time of fruit set in that year. During 1980 the fruits remained under sized and thus gave low yields though the number of fruits were higher than in 1979 in all the treatments.

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RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XII, No. 3, pp. 521–522 (September 1982)

EFFECT OF CONTROLLING INSECT PESTS ATTACKING FORAGE SORGHUM EARHEADS ON GRAIN YIELD OF CROP

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In Haryana, earheads of sorghum have been found infested by sorghum midge *(Contarinia sorghicola* (Coq.)), stem borer (*Chilo partellus* (Swinhoe)), earhead worm *(Heliothis armigera* Hubner) and earhead bug *(Creontiades pallidus* (Ramb)) (Bhanot and Verma, 1977). Spraying with endosulfan has been found to be effective against all these pests (Joia and Deshmukh, 1973; Singh *et al.*, 1973; Ramarao, 1976). During 1976, seed crop of forage sorghum was protected from these insect pests and, thus, the avoidable loss caused by them was determined. At their 90% emergence (on 15th September), the earheads were sprayed with 0.07% endosulfan and the second spray was done 15 days later. Grain yield per plot was recorded at harvest.

Application of two fortnightly sprays of 0.07% endosulfan resulted in 115.4% enhancement in grain yield over control (Table 1). The avoidable loss in grain yield due to adoption of this control measure worked out to be 53.60 per cent.

TABLE 1

Effect of spraying forage sorghum earheads with 0.07% endosulfan on grain yield of the crop

Parameter	Value
Mean grain yield per 20 sq. meter unsprayed plot	0.52 kg*
Mean grain yield (kg) per 20 sq. meter sprayed plot	1.12 kg*
Increase in grain yield due to adoption of control measures	115.4%
Avoidable loss in grain yield due to adoption of control measures	53.6%

*Mean of 32 plots.

These studies, therefore, emphasize the necessity of controlling insect pests attacking forage sorghum earheads under agro-climatic conditions of Hissar (Haryana).

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RESEARCH NOTE

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SUSCEPTIBILITY OF *SOLANUM KHASIANUM* TO BRINJAL SHOOT AND FRUIT BORER (*LEUCINODES ORBONALIS* GUEN.)

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The attack of shoot and fruit borer is a serious problem in the cultivation of brinjal (*Solanum melongena* L.). Many workers (Srinivasan and Gowder, 1959; Jotwani and Sarup, 1963; Lall and Ahmed, 1965; Roy and Panda, 1972; Lal, 1973) have made attempts on chemical control of this pest but measures have not been proved very effective in controlling this pest as the larvae bore into shoots and fruits and escape the toxic effect of insecticides. Moreover, insecticides are also hazardous for human beings. Singh and Sikka (1955), Srinivasan and Basheer (1961), Padda *et al.* (1971) and Dhankhar *et al.* (1977) screened brinjal cultivars without using any insecticide under field conditions but were unable to locate a resistant variety with commercial importance. However, Lal *et al.* (1976) evaluated 69 cultivars of brinjal alongwith 6 species of solanum for relative susceptibility to this borer under field conditions and reported S. *khasianum* as immune against *Leucinodes orbonalis* Guen.

Keeping in view the advantage of immunity of this species, recently Sharma *et al.* (1980) succeeded in achieving a cross between *S. melongena* and *S. khasianum* through embryo culture. Hybrid plants were raised in test tubes which were transplanted in the pots later on. The attack of shoot and fruit borer was observed on the fruits of hybrid plants also. Therefore, to see the reaction of this species towards the pest under report a close watch on the plants was kept from August to November in the field. During this period some fruits were found infested with borer showing holes on them. The larvae from the infested fruits were taken and reared in the laboratory and the adults were sent to the Division of Entomology, I.A.R.I., New Delhi, for identification. The insect was identified as *Leucinodes orbonalis* Guen. (Pyraustidae).

This information necessitates a detailed evaluation of *S. khasianum* for its genetic variability with respect to this character and the species as a whole, as contemplated by Lal *et al.* (1976), can not be taken as a source of resistance for brinjal breeding programme aimed at evolving shoot and fruit borer resistant cultivars.

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Haryana agric. Univ. J. Res., Vol. XII, No. 3, pp. 525–529 (September 1982)

KNOWLEDGE, ATTITUDE AND PRACTICE OF CONTRACEPTIVES—AS REPORTED BY UNIVERSITY EMPLOYEES

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ABSTRACT

Present study reported the lack of awareness, unfavourable attitude and non-practice of contraceptives by respondents. It also revealed reasons which forced this situation. A few suggestions have been made to popularize contraceptives among the people.

From ancient time man has reproduced himself at such a pace that earth long ago would have become entirely uninhabitable and homosapiens probably extinct if high mortality had not balanced the fertility. That is why, the global increase in population was extremely slow until modern time. However, the effects of modernization, improvements in nutritional and health standards are resulting into reduced mortality but fertility remains high and, thus, rapid growth ensues. Family planning as an official programme to reduce population growth was launched by the Government of India in the early fifties. During First and Second five year plans, the approach was predominantly clinical, whereas in the Third plan an extension approach was introduced. However, during annual plans (i. e., from 1966 to 1969) it was made time bound and target oriented. In April 1976 a comprehensive population policy was enunciated and efforts were directed to achieve targets. But in the year 1977, it was again made voluntary. So, it is worthwhile to know the attitudes and practice of contraceptives amongst the educated sections of our society who are the reference groups for illiterate and ignorant masses.

Phadmis (1960) found that education was one of the factors motivating the people to adopt family planning. Siddique (1965) correlated positively education and higher income with favourable attitude towards family planning. Menon (1967) inferred that educated people had more favourable attitude towards family planning. Panda (1967) found education and income closely linked with awareness of family planning. Pohlman and Rao (1969) found that urban teachers preferred small families than the rural teachers. Bhatia (1970) revealed that educated respondents had greater knowledge of family planning. Naidu (1971) found that education was associated with both knowledge and approval of family planning. Chowdhary (1972) strongly correlated knowledge of contraceptives with education. Tiwari *et al.* (1971) noticed

a significant correlation between the opinions on family size and level of education. Jha (1969) revealed that people young in age, with higher education, better income and high social status were in a better position with respect to knowledge of the family planning and vice-versa. Poffenberger and Furbuchan (1975) found that vasectomy was considered the best method for limiting family size and diaphragm was least popular method. Pasrija (1980) reported that sterilization, condom, jellies and I. U. D. (intrauterine devices) were liked while diaphragm, pills and sheath were considered neutral and only abortion was disliked.

An overview of studies cited above leads to the conclusion that education is favourably related to knowledge, attitude and practice of family planning techniques. However, hardly any study has been conducted on these aspects on University employees. So, an attempt was made to know about these aspects scientifically with the following objectives :

1. To find out the awareness, attitude and practice of contraceptives among respondents.

2. To know the relationship between respondents' background attributes and their awareness, attitude and practice of contraceptives.

3. To suggest measures to popularize the use of contraceptives.

METHODOLOGY

The study pertains to the employees of the Haryana Agricultural University, Hissar. Respondents were selected with the help of stratified random sampling technique representing 10% of the total population of teaching and non-teaching employees. Three hundred and fifty respondents thus selected were distributed questionnaries for gathering primary data in the year 1979. The data thus collected were analyzed.

RESULTS AND DISCUSSION

Knowledge

Awareness about contraceptives is imperative for their observance. Around 90% respondents were knowing one or more than one contraceptives. However, a further analysis of awareness as per their background attributes singled out employees lacking in knowledge (Table 1).

A perusal of Table 1 reveals that 89% respondents were aware about contraceptives. Respondents coming from urban backgrounds (91%) and working in teaching profession (94%) were aware about contraceptives, whereas 88 and 86 per cent of those belonging to non-teaching category and having rural backgrounds, respectively were also knowing about these. It is because of the fact that those in teaching were more qualified than those in non-teaching. I confirms the findings of Panda (1967), Jha (1969), Bhatia (1970), Naidu (1971), and Chowdhary (1972) that level of education is favourably associated with awareness of family planning techniques. It was worthwhile to know the sources of information about contraceptives. Friends constituted as one of the main sources of information for 51% respon-

TABLE 1

Awareness and background attributes

Category	Awareness (%)		Total (%)
	Yes	No	
A. Background			
Urban	201 (91)	19 (9)	220 (100)
Rural	112 (86)	18 (14)	130 (100)
B. Nature of work			
Teaching	72 (94)	5 (6)	77 (100)
Non-teaching	241 (88)	32 (12)	273 (100)
Total	313 (89)	37 (11)	350 (100)

dents followed by books (25%), mass media (10%), hospital staff (6%) and Heads of the Departments (4%). It indicates that the performance of official media in diffusing the information was not very encouraging.

Attitude

Awareness leads to the formation of an opinion. Knowledgeable respondents were asked to display their attitude towards contraceptives.

Data in Table 2 reveals that 313 respondents displayed attitudes towards contraceptives. Amongst them, a vast majority (93%) favoured the use of contraceptives. More respondents coming from urban background and working as teachers liked contraceptives compared to those coming from rural background and employed as non-teaching staff. The reasons may be belief in traditional values, inadequate knowledge, and low level of education. Siddique (1965), Menon (1967), Pohlman and Rao (1969), Naidu (1971) and Tiwari *et al.* (1971) also observed similar attitudes towards family planning.

Practice

Out of 307 respondents, 89% practised one or the other contraceptives, whereas the rest did not. It may be due to the fact that a few who lacked in awareness had unfavourable attitude, and a few of them were unmarried or recently married.

Data in Table 3 reveals that respondents having urban background and working as teachers practised contraceptives more compared to those having rural background and working as non-teaching staff. Jha (1969) and Pohlman and Rao (1969) also reported similarly. It was found that the respondents had practised more than one contraceptives; 55% used condom followed by sterilization (31%), I. U. D. (14%), pills (12%), jellies (7%), abortion (6%) and foam tablets (3%). Poffenberger and Furbuchan (1975) and Pasrija (1980) had also found similar results.

Suggestions

1. It was noticed that 11% respondents were not aware about contraceptives which is really very surprising.

TABLE 2

Attitude and background attributes

Category	Attitude (%)		Total (%)
	Favourable	Unfavourable	
A. Background			
Urban	190 (95)	11 (5)	201 (100)
Rural	100 (89)	12 (11)	112 (100)
B. Nature of work			
Teaching	70 (97)	2 (3)	72 (100)
Non-teaching	220 (91)	21 (9)	241 (100)
Total	290 (93)	23 (7)	313 (100)

TABLE 3

Practice and background attributes

Category	Practice (%)		Total (%)
	Yes	No	
A. Background			
Urban	166 (92)	14 (8)	180 (100)
Rural	106 (83)	21 (17)	127 (100)
B. Nature of work			
Teaching	68 (92)	6 (8)	74 (100)
Non-teaching	204 (88)	29 (12)	233 (100)
Total	272 (89)	35 (11)	307 (100)

More so, is about the poor performance of official media to disseminate the information. Therefore, it is advocated that the existing sources of mass media and the family planning staff must be properly utilized to disseminate the information in a systematized and well planned manner, at least to generate awareness among educated people who may further communicate to their illiterate countrymen.

2. It was observed that out of 313 respondents, who were aware about contraceptives, 93% had favoured these. It is concluded that the minority which disliked contraceptives may not be knowing the philosophy of family planning and a complete knowledge of contraceptives. So, it is suggested that thorough information should be communicated through written material, lectures, etc. for developing favourable attitude towards contraceptives.

3. Out of 350 respondents, 307 were eligible to practise contraceptives because they were having two or more

than two children, however, 89% of them practised these Condom and sterilization were the two prominent contraceptives practised. Other contraceptives like I. U. D., pills, jellies, abortion, foam tablets, etc. were not very popular. It may be due to cost, complexity, lack of knowledge and non-availability of these contraceptives. Therefore, in order to popularize contraceptives, it is emphasized that these must be cheaper, easily assessible, convenient to use and simple to understand.

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AGRICULTURAL CREDIT IN AN ADOPTED VILLAGE—A CASE STUDY

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ABSTRACT

In order to meet the increased demand of credit, village adoption scheme was initiated. The present study was conducted in an adopted village Raipur of Haryana State. Borrowers were from joint families with larger size of land holding, higher income and lower education. Low rate of interest was the main motivating factor, whereas undue delay and complicated procedure were the deterring factors. As a result of present loan, new needs for diversification of occupation were felt and dairying was the most preferred one. Although additional income was generated yet the additional demand increased manifold.

Agriculture has undergone a substantial change after the introduction of high yielding varieties during mid-sixties. The credit needs of the farmers have increased manifold as a result of the adoption of capital intensive new agricultural technology. Majority of the farmers in the State are unable to meet the increased need of capital from their own resources and have to depend on various credit institutions.

Sincere efforts are being made to meet this increased demand for capital through various credit agencies. Commercial bank is also one of the institutions which is to play a vital role in this direction.

Inspite of these efforts a majority of the farmers are not coming forward to avail the bank credit facilities and many borrowers do not repay loans. Keeping this fact in view, the study was conducted with the following specific objectives :

(i) To trace out the socio-economic background of the borrowers and non-borrowers,

(ii) to know the motivating and deterring factors in taking loans, and

(iii) to bringforth the new credit needs and repayment behaviour.

METHODOLOGY

Present study was conducted in village Raipur, located at a distance of 8 km from Hissar City. The village was adopted by the Punjab National Bank, Hissar branch, under the village adoption

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TABLE 1

Distribution of respondents as per their socio-economic conditions

S. No.	Type of respondents	Caste[1]		Education[2]		Family size[3]		Family type		Income category[4]			Size of land holding[5]			Total
		High	Low	Literate	Illiterate	Planned	Unplanned	Nuclear	Joint	High	Medium	Low	Large	Medium	Small	
1.	Borrowers	36 (60.0)	24 (40.0)	13 (21.66)	47 (78.34)	6 (10.0)	54 (90 0)	12 (20.0)	48 (80.0)	20 (33.34)	23 (38.33)	17 (28.33)	24 (41.0)	25 (41.67)	11 (18.33)	60 (100.0)
2.	Non-borrowers	27 (45.0)	33 (55.0)	18 (30.0)	42 (70.0)	9 (15.0)	51 (85.0)	23 (38.33)	37 (61.67)	6 (10.0)	18 (30.0)	36 (60.0)	17 (28.34)	29 (48.33)	14 (23.33)	60 (100.0)
	Total	63 (52.50)	57 (47.50)	31 (25.83)	89 (74.17)	15 (12.50)	105 (87.50)	35 (29.17)	85 (70.83)	26 (21.67)	41 (34.16)	53 (44.17)	41 (34.16)	54 (45.0)	25 (20.84)	120 (100.0)

Figures in parentheses are the percentages.

[1]Caste—High caste category consists of Brahmin, Jat, Gujar and Ahir while low caste category consists of Mali, Khati and Harijan.

[2]Education—Literate means primary pass and above while illiterate means below primary or less than this.

[3]Family size—Planned family denotes the family which consists of four or less than four family members while unplanned family means five or more than five family members.

[4]Income—Low income category consists of respondents whose annual income from all resources in an year is below Rs. 5000/-, medium category having annual income of Rs. 5000–15000/- while high income category having annual income of Rs. 15001 and above.

[5]Land holding—Small farmers means having 2.5-5.0 acres, medium means 5.1-10.0 acres and large farmers means 10 1 acres and above.

scheme. A list of all the farmers who had taken loan from the bank during 1974-75 was prepared. There were only 60 such farmers.

In order to discern the difference in socio-economic background of the borrowers and non-borrowers, a sample of 60 farm households was selected with simple random sampling method from the non-borrowers.

Comprehensive respondent schedule covering the objectives was prepared, pretested and finalized. The pretested structured respondent schedule was administered personally. The data were interpreted with the help of simple frequency distribution and percentages.

RESULTS AND DISCUSSION

Contextual Matrix of Respondents

Borrowers were more from higher castes as compared to the non-borrowers (Table 1). It was because of their large size of landholding and higher income level. Lower caste people were deprived because of their poor social as well as economic status. Educational level was lower among borrowers because of the domination of joint family system and land ownership by the older members of family. Number of borrowers in high and medium income categories was more than non-borrowers in the same income categories due to the increased farm expenditure and higher income thereof. Similar trends were also reported by Keleta (1974) and Punia (1974) in this region itself.

Motivating Factors in taking Loans

It is evident from Table 2 that all the respondents consider low rate of interest as a major motivating force. Other major sources of loan were the moneylender and cooperative societies. In the former agency rate of interest was as high as 22 per cent. Punia (1974) reported the rate of interest charged by money lenders ranging from 18 to 24 per cent. Similar findings were reported by Grewal (1972), Dhankar (1974) and Keleta (1974). Rate of interest charged by cooperatives was 11.5% for crop loan and 13% for medium term loan irrespective of size of holding, whereas the rate of interest charged by the bank was 10% for farmers below 2.50 acres, 11% for 2.51 to 7.50 acres, 12.5% for 7.51 to 10 acres and 13% for above 10 acres size of holding. Other

TABLE 2

Motivating factors

S. No.	Factors	Frequency	Percentage
A.	**Personal**		
1.	Prestige in village is saved	28	46.66
2.	Get technical advice also	12	20.00
B.	**Procedural**		
1.	Low rate of interest	60	100.00
2.	Instalment repaying is easy	52	86.66
3.	More loan can be obtained	52	86.66
4.	Allows sufficient time for repayment	51	85.00
5.	Ensures timely availability of loan	48	80.00
6.	Provides rebates and subsidiaries	12	20.00

factors of motivation were easy repayment, ample scope for more loan and timely availability of loan.

Deterring Factors in taking Loans

As many as 43.33 per cent of borrowers did not face any difficulty. Major problem faced by others was undue delay caused by procedural formalities (Table 3). These not only caused delay but also made the process of getting credit much complicated for farmers. Malhotra (1977) also reported delay of loan in 51.11% cases. Lack of courteous behaviour by bank employees was also reported. Kahlon and Tiwana (1976) reported untimely availability, difficulty in getting loan and advances with influence as the main difficulty faced by the farmers.

TABLE 3

Deterring factors

S. No.	Factors	Frequency	Percentage
1.	Undue delay	34	56.67
2.	Complicated procedures	24	40.00
3.	Behaviour of Bank staff is not good	6	3.33

New Needs and Demands

Only among 53.33% of the borrowers, present loan created new needs for taking more loan. Purchase of milch animals was the main felt need (40.62%) followed by bullock, tractor, tubewell, gobar gas plant, fertilizer and toka with diesel engine. Similar pattern of occupational diversification was found by Singh and Singh (1968). Narayana (1961) also reported the anxiousness of farmers to improve in these regards.

Additional credit was demanded by majority of the farmers for purchasing fertilizer (Table 4). Though dairy was the most felt need but credit demand was second because they had cattle of their own. Some had desired for tractor and tubewell. Need of draft animal was placed second but for additional loan it was last. It might be because of the custom hire services. Large farmers demanded loan for tractors. Singh (1971) also found the same which was confirmed by Punia (1974).

Improvement and Repayment Behaviour

Only five farmers reported no improvement even after taking loans. Drought condition (100%) has been pointed out as one of the most important factor in this regard followed by untimely disbursement of loan (80%). Desai and Tambad (1970) reported that timely loan solves the problems of repayment of loans also. Inadequacy of loan for the purpose (Anonymous, 1954) and lack of water for irrigation were also reported as important factors affecting the farm improvement adversely which were also found in this study. Malhotra (1977) found that in 48.90% of the cases, amount of loan was adequate to meet the demand and in 44.44% cases availability was very late and in 6.67% not in time.

Additional income generation from the loan was reported by 90% of the borrowers. These findings are also supported by Malhotra (1977). Only

TABLE 4

Additional demand of loan from banks

S. No.	Purpose	Frequency	Percentage	Amount in Rs.
1.	Fertilizers	23	48.94	15,350
2.	Buifaloes	8	17.02	18,500
3.	Gobar gas plant	6	12.76	13,900
4.	Tractor	5	10.64	1 28,000
5.	Tubewell	3	6.38	15,000
6.	Bullocks	2	4.26	3,000
	Total	47	100.00	1,93,750

10% of the respondents did not get additional income, the reasons for which were mainly :

Loss of crops, poor market rates, costly fertilizers, lack of irrigation water, attack of insect-pests and diseases, insufficient rain and water supply, death of animals, heavy loan instalment, lack of electricity, the credit fell short to raise income, prolonged illness of family members, poor soil, unavailability of fertilizers.

Patel (1976) confirmed the above findings.

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EFFECT OF HYGIENIC PRACTICES AT THE FARM ON THE BACTERIOLOGICAL QUALITY OF BUFFALO MILK

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ABSTRACT

Six hygienic practices, singly and in combination were employed to study their effects on the bacteriological quality of buffalo milk under organised farm conditions. Washing and disinfection of milker's hands and udder of animal with chlorine solution (200 ppm), milking pail with Iodophor solution (50 ppm) and combination of these practices showed a marked influence on SPC and MBR time of milk. None of the hygienic measures employed influenced coliform, staphylococci and thermoduric counts significantly. Milker's hands, udder, milking pail and milk can proved important sources of bacterial contamination in raw milk.

Milk is likely to contain high bacterial population if produced under unhygienic conditions and their number increases further on storing at high temperature for a prolonged period. Sen and Laxminarayan (1948), Lavania and Singh (1973), Volovenko (1974), and Ulyanov and Shilaov (1976) have reported a considerable improvement in total bacterial count and MBR time of raw milk obtained on washing and disinfection of milker's hands, udders of animals and milking pails. Smythe (1961) studied the sources of milk contamination on farms and reported highest contamination from the milk cans and milker's hands.

The bacterial quality of milk produced and handled in India is very poor as reported by various workers (Iya, 1962; Pal and Sinha, 1965; Vijay and Saraswat, 1968; Juneja and Pal, 1975; Dwivedi, 1976). Not much work has been reported in India to delineate a comparative effect of various individual hygienic measures required for clean milk production on the bacterial quality of milk. The present study was, therefore, taken up with this objective in view.

MATERIAL AND METHODS

Ten milch buffaloes in their early lactation (upto two months) were selected at random from the University Farm herd and were divided into two groups (A and B) of 5 buffaloes each housed in identical separate sheds. While one group was under treatment, the other one was used as control. Six hygienic practices were studied singly and in combinations. A trial of 8 days period was

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conducted with each hygienic practice as well as with the combined practices. Milk samples were drawn aseptically from cans and were analysed for SPC, coliform and thermoduric counts and methylene blue reduction test as per the methods recommended in IS : 1479 (1962) and staphylococci as per the method of APHA (1967). Swab samples were also collected from the surfaces (200 sq cm) of milker's hands, udder of the animal and containers used in milking and handling of milk. The experiments were conducted during June and July, 1980.

The hygienic practices under study were as follows :

(i) Thorough washing of milker's hands with water followed by disinfection with 200 ppm chlorine water just before milking (T_1);

(ii) Thorough washing of udders followed by disinfection with 200 ppm chlorine water and wiping with clean cloth prior to milking (T_2);

(iii) Thorough washing of dome shaped pails followed by disinfection with 50 ppm Iodophor solution just before milking (T_3);

(iv) Thorough cleaning of milk cans followed by disinfection with 200 ppm chlorine water just before pouring milk (T_4);

(v) Wrapping of milk can with wet gunny bags just before milking (T_5);

(vi) Cleaning of shed of treatment group thrice a day and that of control group once daily (T_6);

(vii) A combination of hygienic practices from T_1 to T_6 followed together and in succession (T_7).

RESULTS AND DISCUSSION

The standard plate counts of buffalo milk produced under various hygienic practices have been presented in Table 1. The standard plate counts of milk produced under treatments T_1, T_2, T_3 and T_7

TABLE 1

Standard plate count (SPC) of buffalo milk produced under various hygienic practices

Treatment	SPC (log)/ml		Average decrease in counts	
	Control	Treated	(log)/ml	Percentage
T_1	4.12±0.13	3.64±0.09**	3.790^{ab}	79.67
T_2	4.38±0.12	3.67±0.07**	4.236^{ab}	83.65
T_3	4.60±0.06	4.07±0.09**	4.255^{ab}	63.26
T_4	4.24±0.13	3.97±0.05	2.636^{b}	51.81
T_5	4.42±0.10	4.10±0.13	4.104^{ab}	46.61
T_6	4.09±0.09	3.96±0.09	3.365^{b}	24.76
T_7	5.10±0.11	4.35±0.14**	4.860^{a}	80.38

Analysis of Variance

Sources of variation	d. f.	s. s.	M. S.	'F'
Between treatments	6	24.79	4.13	2.66*
Within treatment	49	76.19	1.55	—

*, **Significant at 5 and 1 per cent level, respectively.

a, b Figures with different superscripts differ significantly from each other at 5 per cent level.

differed significantly with control, while treatments T_4, T_5 and T_6 reduced the count, but the difference obtained from the control was insignificant. The average decrease in standard plate count of milk was highest under treatment T_7 followed by treatments T_3, T_2, T_5 and T_1. The treatments T_4 and T_6 showed less decrease in counts and differed significantly from the other five treatments. More than 60% decrease in the count was obtained due to treatments T_1, T_2, T_3 and T_7. These results indicated that washing and disinfection of milking pail (T_3), udder of buffaloes (T_2) and milker's hand (T_1) as well as the combined hygienic practices (T_7) have a marked influence in improving the standard plate count of buffalo milk. Sen and Laxminarayan (1948), Iya (1962), Marai (1970) and Lavania and Singh (1973) reported wider variations in the standard plate count of milk under various hygienic practices than in the present study. The results of Volovenko (1974) in respect of this count are in agreement with the present study. The lesser variations in the standard plate count of milk obtained during the present study may be attributed to sufficient sanitary measures being exercised at this farm.

The results of coliform count of buffalo milk produced under various hygienic practices have been presented in Table 2. None of the hygienic measures studied showed significant effect on coliform counts. However, the decrease in coliform count was significantly of a higher order due to washing and disinfection of udder of buffaloes (T_2), milking pail (T_3), milk can (T_4) and cleaning of shed (T_6) than due to washing and disinfection of milker's hands (T_1) and wrapping can with wet gunny bags (T_5). These results are in agreement with those obtained by Iya (1962) and Volovenko (1974).

The results of staphylococci and thermoduric counts of buffalo milk produced

TABLE 2

Coliform count of buffalo milk produced under various hygienic practices

Treatments	Coliform count (log)/ml		Average decrease in count	
	Control	Treated	(log)/ml	Percentage
T_1	1.67±0.26	1.54±0.17	0.340[b]	44.32
T_2	1.95±0.16	1.55±0.11	1.625[a]	51.19
T_3	2.03±0.19	1.41±0.24	1.865[a]	73.60
T_4	1.89±0.27	1.38±0.31	1.520[a]	65.55
T_5	1.48±0.22	1.47±0.14	0.310[b]	40.00
T_6	1.81±0.25	1.22±0.34	1.575[a]	63.11
T_7	2.25±0.17	1.85±0.19	1.330[ab]	55.52

Analysis of Variance

Sources of variation	d. f.	s. s.	M. S.	'F'
Between treatments	6	24.79	4.13	2.66*
Within treatment	49	76.19	1.55	—

*Significant at 5 per cent level.

a, b Figures with different superscripts differ significantly from each other at 5 per cent level.

under various hygienic measures have been presented in Tables 3 and 4, respectively. None of the hygienic measures studied showed significant effect on staphylococci or thermoduric counts of milk. These treatments also did not differ with each other significantly in respect of average decrease of the above counts. However, more than 60% decrease in staphylococci was found due to washing and disinfection of milker's hands (T_1), milking pails (T_3) and combined hygienic measures (T_7) and only a smaller decrease in thermoduric count due to washing and disinfection of milker's hands (T_1) was obtained.

All hygienic measures under study, except cooling of milk can with wet gunny bag (T_5) and cleaning of shed thrice a day (T_6) influenced the MBR time significantly (Table 5). A maximum enhancement in MBR time was obtained due to combined hygienic practices (T_7) followed by cleaning and disinfection of milk can (T_4), milking pail (T_3) and udder of buffaloes (T_2). Wrapping of milk can (T_5), washing and disinfection of milker's hands (T_1) and cleaning of shed thrice (T_6), all had lesser influence on the enhancement of MBR time.

Overall the washing and disinfection of udder and milking pail and the combined

TABLE 3

Staphylococci count of buffalo milk produced under various hygienic practices

Treatments	Staphylococci count (log)/ml		Average decrease in counts	
	Control	Treated	(log)/ml	Percentage
T_1	2.89±0.15	2.53±0.11	2.170	66.39
T_2	2.73±0.06	2.41±0.15	2.346	46.96
T_3	2.96±0.20	2.69±0.15	1.473	65.88
T_4	3.02±0.18	2.89±0.10	1.080	46.77
T_5	2.62±0.12	2.37±0.11	1.060	43.00
T_6	2.60±0.11	2.50±0.11	0.704	26.11
T_7	2.33±0.17	1.95±0.13	1.916	65.03

Analysis of Variance

Sources of variation	d. f.	s. s.	M. S.	'F'
Between treatments	6	18.28	3.047	0.88
Within treatment	49	169.80	3.465	—

TABLE 4

Thermoduric counts of buffalo milk produced under various hygienic practices

Treatments	Thermoduric count (log)/ml		Average decrease in counts	
	Control	Treated	(log)/ml	Percentage
T_1	1.91±0.43	1.80±0.15	1.120	69.84
T_2	2.24±0.07	2.08±0.12	1.410	22.63
T_3	2.10±0.16	1.91±0.18	1.050	29.89
T_4	2.09±0.19	1.97±0.08	0.935	27.02

hygienic practices proved more effective measures to improve the bacterial quality of buffalo milk, while washing and disinfection of milker's hands and milk can proved only fairly effective. Wrapping of milk can with wet gunny bag and cleaning of shed thrice a day were least effective measures to improve the bacterial quality of milk produced at the farm.

The swab samples were taken from the surfaces of milker's hand, milking pail, udder of the animal and milk can just before and after the treatment. It is evident from Table 6, that the SPC/unit

TABLE 5

Methylene blue reduction (MBR) time of buffalo milk produced under various hygienic practices

Treatments	MBR time (1/2 h units)		Average enhancement in MBR time (1/2 h units)
	Control	Treated	
T_1	11.50±0.40	12.50±0.18*	1.00^{cd}
T_2	10.50±0.27	12.00±0.00**	1.50^{abc}
T_3	11.75±0.53	13.50±0.38*	1.75^{abc}
T_4	11.00±0.56	13.00±0.60*	2.00^{ab}
T_5	9.75±0.25	10.25±0.16	0.50^{d}
T_6	13.50±0.50	15.00±0.53	1.25^{bcd}
T_7	13.00±0.38	15.25±0.31**	2.25^{a}

Analysis of Variance

Sources of variation	d. f.	s. s.	M. S.	'F'
Between treatments	6	17.5	2.95	4.0*
Within treatment	49	36.5	0.74	—

*,**Significant at 5 and 1 per cent level, respectively.

a,b,c,d Figures with different superscripts differ significantly from each other at 5 per cent level.

TABLE 6

Average swab counts from the surfaces of various sources of contamination of milk

Type of counts	Sources of contamination							
	Milker's hands		Udder		Milking pail		Milk can	
	Control	Washed and disinfected	Control	Washed and disinfected	Control	Washed and disinfected	Control	Washed and disinfected
S. P. C. (log)/ 900 cm²	557.00	4.44	5.97	5.44	6.98	5.84	6.04	5.75
Coliform (log)/ 900 cm²	3.53	2.39	3.15	2.68	2.94	1.17	2.85	2.09
Staph. (log)/ 900 cm²	4.15	3.31	5.47	4.97	4.04	3.12	3.76	3.38

area was maximum in milking pail, but the counts for milk can, udder and milker's hand were also equally high. Milker's hands showed maximum coliform count, while staphylococci count was maximum from animal's udder. The results indicated that milker's hands, udder of the animal, milking pail and milk can, all were the potential sources of bacterial contamination of milk, and these require effective sanitation programme to clean and disinfect them properly. Juneja and Pal (1975) also observed that milking pail was the major source of staphylococci contamination of milk followed by unwashed hands of milkers, fore udder, teats' surfaces and hind udder.

The per day extra cost of chemicals, labour and other materials involved in following the hygienic practices under various treatments studied was worked out for five buffaloes under the treatment group. The extra cost involved in washing and disinfection of milker's hands, udder of the animal and milk can were almost negligible (less than one paise per buffalo), while in cleaning of shed thrice involved slightly higher cost (10.75 paise per buffalo). The cost involved in combined hygienic practices (15.92 paise per buffalo) was maximum, but the decrease in SPC and enhancement in MBR time of milk were the highest. The extra cost involved in following these hygienic measures seems to be negligible in terms of gains obtained through improved bacterial quality of buffalo milk.

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STUDIES ON PROFITABLE REPLACEMENT AGE FOR TURKEYS

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ABSTRACT

The costs of producing a fertile turkey egg, day old turkey poult and 16 and 30 weeks old turkeys were minimum when breeders were maintained upto 500 days age. The costs of all these items were maximum when turkeys were maintained upto 300 days age. The difference in costs was very low when birds were replaced at 400 or 600 days age. The results suggested that the birds should be replaced at 500 days age or under emergency at 400 or 600 days age but never at 300 days age.

The egg production, fertility and hatchability of turkeys are comparatively low and result in high cost of poult production which in turn reflects on the cost of replacement. Experimental evidences, giving the economical replacement age of turkeys in India, have not been reported in the literature. The present study was undertaken to fill this gap.

MATERIAL AND METHODS

Five hundred and thirty three unsexed turkey poults were hatched in 9 hatches from February to December, 1978. The records of hatchability on parents of these poults were maintained. The birds were reared under standard managemental conditions and data were recorded for their feed consumption, mortality and growth. Records were also maintained for the cost of feed, labour, medicines and electricity used for rearing these poults. From these data the cost of producing 16 and 30 weeks old birds (irrespective of sex) was calculated and has already been reported by Sharma *et al.* (1981).

About 192, 30 weeks old female turkeys were obtained from these birds. Data were recorded for their age at sexual maturity by trapnesting the individual birds of each hatch. The egg production, feed consumption and mortality upto 300, 400, 500 and 600 days age were recorded for the group of each hatch separately. The costs of different inputs were reckoned at the rates given in Table 1.

The method of calculation of cost of fertile eggs, day old poult and 16 and 30 weeks old turkeys, when breeders were maintained for different ages, was similar to the one reported by Chopra (1979) for ducks.

RESULTS AND DISCUSSION

The reproductive performance of birds maintained to different ages has been presented in Table 2. The birds on an average laid 11 eggs in the first 24 days of their laying period.

The average 100 days egg production per bird (19.41) was highest during the 300-400 days age of bird followed by 16.25 and 12.95 for 400, 500 and 500-600 days age, respectively.

The feed consumption per bird was also higher during 300-400 days age. The 100 days feed consumption between 400-500 and 500-600 days ages were similar, although the birds laid at a lower rate during these periods.

TABLE 1

Rates and method of calculation of cost of various inputs

Inputs	Rates	Method of calculation
Feed	Rs. 195/q.	Actual cost of ingredients plus handling and storage charges @ Rs. 10/q
Building	Rs. 50/sq. ft.	Actual estimated expenditure
Depreciation on building	5%	As per recommendation of engineering unit
Electricity charges	50 paise per unit	Actual expenditure
Depreciation on equipment	10%	Assumed
Interest on investment	16%	Current bank rate
Sale rate of culled birds	Rs. 20/kg	Assumed
Sale rate of culled eggs	30 paise each	Assumed
Per cent hatchability (total egg basis)	34.12%	Actual observation

TABLE 2

Performance of birds after 30 weeks of age to different ages (average age at sexual maturity 276 days)

Mean performance (trait)	Age in days			
	300	400	500	600
100 days egg production per bird (No. of eggs)	—	19.41	16.25	12.95
Cumulative egg production from sexual maturity per bird (No. of eggs)	11.12	30.53	46.78	59.73
100 days feed consumption per bird (kg)	—	18.30	15.81	15.81
Cumulative feed consumption per bird from 30 weeks age (kg)	16.52	34.82	50.63	66.44
Per cent mortality for 100 days	—	4.21	3.30	4.64
Cumulative per cent mortality from 30 weeks age	6.41	10.62	13.92	18.56

TABLE 3

Cost of producing a fertile egg, one day old turkey poult, 16 (marketing age) and 30 weeks old turkey when breeders were maintained upto different ages

Age to which breeders were maintained (days)	Cost (Rs.) per				Cost (Rs.) per kg live weight at	
	Fertile egg	Day old turkey poult	16 weeks old turkey	30 weeks old turkey	16 weeks age	30 weeks age
300	10.16	30.53	64.23	140.32	19.37	22.75
400	5.36	16.44	50.14	126.23	15.12	20.47
500	4.99	15.35	49.05	125.14	14.79	20.29
600	5.38	16.51	50.21	126.30	15.14	20.48

The per cent mortality for each of the three periods was 4.21, 3.30 and 4.64. The figures did not reveal a significant difference in mortality. The cumulative pre cent mortality for 290 days was 18.56 per cent.

The cost of production of a fertile egg, day old turkey poult, 16 and 30 weeks old turkey poults when birds were maintained to 300, 400, 500 or 600 days age is presented in Table 3. The cost of a fertile egg was almost double when birds were maintained only upto 300 days age compared to when these were maintained upto 400, 500 or 600 days age. Since the age at sexual maturity (276 days) in turkeys is much higher than that in chickens (180-200 days) such results are expected. The cost of a fertile egg was Rs. 5.36 and 5.38 when breeders were maintained to 400 and 600 days age, respectively. However, a saving of 37-39 paise was obtained when breeders were maintained to 500 days age. The cost of day old turkey poult (Rs. 15.35) was minimum when birds were maintained upto 500 days of age. The production costs were almost similar when birds were maintained upto 400 or 600 days age. These costs were higher than the one when breeders were replaced at 500 days age. Similar results were obtained for the cost of 16 and 30 weeks old turkeys. The minimum production cost was obtained when birds were replaced at 500 days age compared to other three ages. However, the differences in cost of production at 400 or 600 days age with 500 days age were quite low. The cost figures indicated that turkeys should never be replaced at 300 days age. Cost per kg live weight of birds at 16 and 30 weeks ages was also estimated and has been reported in Table 3. These costs also confirmed the above findings.

From above results it may be concluded that the best replacement age for turkeys was 500 days age. However, turkey breeders may also be replaced at 400 or 600 days age at a slight higher cost. The birds should never be replaced at 300 days age.

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PRODUCTION PERFORMANCE OF VARIOUS TYPES OF CROSSES OF WHITE LEGHORN STRAINS

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ABSTRACT

Performance of interse, single (2-way) and double (4-way) crosses of White Leghorns strains for 20 weeks body weight, rate of lay to 52 weeks of age and feed efficiency for egg mass and egg quality traits was compared. The type of crosses as a class did not differ significantly for all the traits except shell thickness and yolk colour. The results suggested that probably non-additive gene action is not important for the traits under study. But significant differences between genetic groups within a type of cross (class) were observed for all the traits except yolk colour. Higher mortality during 0–20 and 20-52 weeks of age was observed for single crosses. Apparent superiority of single crosses over the other crosses was present for body weight, rate of lay, feed efficiency and some of the egg quality traits. Considering the simplicity of producing single crosses by maintaining only two pure strains/stocks, this type of cross can be preferred for commercial use.

Heterotic effects are produced by the action and interaction of genes responsible for genetic variation. To have most favourable combinations of such genes is the way of achieving heterotic superiority. An economically viable hybrid chicken can be produced by crossing inbred lines as the undesirable characters of one line might be covered up/balanced with the superior characters of another line and, thus, the final cross would be expected to exhibit more average superiority in the desired traits. If the parental lines are not inbred, multiple crosses might be used to an advantage.

Yao (1958) observed that single incrossbreds were superior to the four-way crossbreds and the randombreds, for egg production. Singh and Singh (1971) concluded that strain crosses produced highest number of eggs compared to top crosses, crossbred and purebred stocks. Among the strain crosses, the popular are two-way and four-way crosses. The reports on the relative merits of one type of cross over the other are few. Therefore, this study was undertaken to compare the interse, single (2-way) and double (4-way) crosses for egg production and egg quality traits to suggest a suitable cross type for commercial use.

MATERIAL AND METHODS

Four commercial egg laying stocks (LH_1, LH_2, LH_3 and LH_4) purchased during

the year 1975 were utilized for the production of interse ($LH_1 \times LH_1$, $LH_2 \times LH_2$, $LH_3 \times LH_3$ and $LH_4 \times LH_4$), single ($LH_1 \times LH_3$, $LH_2 \times LH_4$ and reciprocals) and double ($LH_{34} \times LH_{12}$, $LH_{43} \times LH_{12}$ and reciprocals) crosses. In all, there were 12 genetic groups and each group was produced from 4 sires mated to 32 dams. Chicks were hatched in two hatches at weekly interval and brooded and reared together (irrespective of combination) under standard managemental conditions upto the age of 20 weeks. At this age, the pullets belonging to a particular group were housed in separate laying pens after recording their body weight. Daily rate of lay and feed efficiency for egg mass at 4 weeks interval from 24 to 52 weeks of age was recorded for each genetic group. At the age of 36 weeks, egg quality traits (egg weight, shape index, Haugh Unit, yolk index, shell thickness, shell weight and yolk colour) were studied by breaking 3 eggs daily from each group for 10 days. Mortality percentages during 0-20 weeks and 20-52 weeks of age were also calculated.

The data on each trait were subjected to analysis of variance (nested) for finding out the significant effect of type of crosses and among groups within type of crosses using the following mathematical model :

$$Y_{ijk} = u + a_i + b_{ij} + e_{ijk}$$

Where, Y_{ijk} is the kth observation in jth genetic group of ith type of cross,

u is the over all mean,

a_i is the effect due to ith type of cross (i=1, 2, 3),

b_{ij} is the effect due to jth group within ith type of cross (j=1,.....4), and

e_{ijk} is the random error associated to each observation assumed to be NID $(0, \sigma^2)$.

RESULTS AND DISCUSSION

Production Traits

Means alongwith their standard errors for 20 weeks body weight, rate of lay and feed efficiency for egg mass to 52 weeks of age have been presented in Table 1 and analysis of variance in Table 3. There were no significant differences among the types of cross. The results revealed that the production of multiple crosses (single or double) were not advantageous over the interse cross, though the double crosses showed apparent superiority over the other two types. The genetic groups within a type of cross differed significantly from each other. Among the interse crosses, $LH_3 \times LH_3$ group was the best in respect of 20 weeks body weight and feed efficiency for egg mass, while for rate of lay $LH_4 \times LH_2$ group was the best. Among the single cross types, $LH_1 \times LH_3$ group attained the highest 20 weeks body weight, while the reciprocal of this group ($LH_3 \times LH_1$) had highest rate of lay and feed efficiency for egg mass. The $LH_{12} \times LH_{43}$ group belonging to double cross type attained highest body weight at 20 weeks of age, while for rate of lay and feed efficiency for egg mass $LH_{34} \times LH_{12}$ group was observed as the best. From these results it may be concluded that in order to utilize the heterotic superiority of crossbred dam for the traits of fitness (rate of lay) and feed conversion efficiency, the production of $LH_3 \times LH_1$ group would be a desirable proposition over the interse crosses.

TABLE 1

Averages alongwith their standard errors for production traits and mortality in different types of crosses

Types of crosses	20 weeks body weight (g)	Rate of lay upto 52 weeks of age (%)	Feed efficiency for egg mass (kg)	Mortality (%)	
				0-20 weeks	20-52 weeks
Interse crosses					
$LH_1 \times LH_1$	$1308.75^{ab} \pm 24.63(24)$	$55.42^{a} \pm 1.04(196)$	$3.60^{a} \pm 0.38$ (7)	13.30	4.16
$LH_2 \times LH_2$	$1292.20^{a} \pm 21.11(50)$	$64.20^{b} \pm 1.06(196)$	$3.31^{ab} \pm 0.15(7)$	2.70	14.00
$LH_3 \times LH_3$	$1350.67^{b} \pm 21.54(59)$	$63.28^{b} \pm 0.79(196)$	$3.00^{b} \pm 0.12(7)$	12.70	1.69
$LH_4 \times LH_4$	$1321.61^{ab} \pm 35.27(31)$	$62.02^{b} \pm 0.77(196)$	$3.49^{a} \pm 0.09(7)$	16.80	3.33
Overall	$1318.30 \pm 12.63(164)$	$60.58 \pm 0.51(784)$	$3.41 \pm 0.11(28)$	8.38	5.24
Single crosses					
$LH_1 \times LH_3$	$1402.84^{a} \pm 26.03(123)$	$63.54^{a} \pm 0.66(196)$	$3.04^{a} \pm 0.04$ (7)	4.10	8.94
$LH_3 \times LH_1$	$1334.27^{b} \pm 13.63$ (96)	$65.86^{b} \pm 0.69(196)$	$3.00^{ab} \pm 0.33(7)$	8.00	9.37
$LH_2 \times LH_4$	$1328.75^{b} \pm 24.95$ (48)	$62.02^{a} \pm 0.77(196)$	$3.49^{b} \pm 0.09$ (7)	19.60	6.38
$LH_4 \times LH_2$	$1387.43^{a} \pm 15.67$ (82)	$63.87^{b} \pm 0.61(196)$	$3.39^{b} \pm 0.13$ (7)	6.20	23.52
Overall	1363.32 ± 8.58 (349)	63.82 ± 0.34 (784)	3.23 ± 0.06 (28)	9.47	11.24
Double crosses					
$LH_{34} \times LH_{12}$	$1326.00^{a} \pm 20.16$ (65)	$63.80^{a} \pm 0.79(196)$	$3.03^{a} \pm 0.04$ (7)	7.14	5.00
$LH_{12} \times LH_{34}$	$1327.14^{a} \pm 16.63$ (84)	$56.46^{c} \pm 0.60(196)$	$3.69^{b} \pm 0.10$ (7)	8.60	5.95
$LH_{12} \times LH_{43}$	$1365.15^{a} \pm 18.60$ (64)	$60.06^{b} \pm 0.79(196)$	$3.40^{b} \pm 0.25$ (7)	9.10	1.58
$LH_{43} \times LH_{12}$	$1337.70^{a} \pm 17.45$ (61)	$62.00^{ab} \pm 0.73(196)$	$3.53^{b} \pm 0.07$ (7)	8.70	8.33
Overall	1338.99 ± 9.10 (274)	60.58 ± 0.37 (784)	3.41 ± 0.06 (28)	8.38	5.24

Figures in parentheses are the number of observations.

Averages bearing different superscripts differ significantly at 5 per cent.

Maw (1942) observed that the egg production of 4 way incrossbreds did not excel that of the randombreds. Nair *et al* (1979) also reported that two way and three way cross as a class did not differ significantly from each other for hen day and hen housed egg production and body weight. These reports corroborate present findings. But incontrast to the present findings, Yao (1958) and Singh and Singh (1971) had reported the superiority of single incrossbred over 4 way crossbred and the randombreds and superiority of strain crosses over top crossbred and purebred, respectively, for egg production. Skaller (1954) from an experiment extending over 5 years also reported that 2 way crosses laid 6 eggs more than the 3 way crosses.

The over all mortality percentages (0-20 weeks) for different types of crosses were similar (Table 1). The laying period mortality percentages (20-52 weeks) were highest for single crosses (11.24%) but the single and interse cross types did not differ significantly. But this figure is lower compared to those reported by Choi (1970) and Nair *et al.* (1979).

The lack of superiority of multiple crosses over the randombreds (interse) for performance traits and survivability might have been due to recombination loss of useful genes determining these traits. These results lead to the conclusion that intra and inter-allelic interactions were not important or there is no difference in the frequency of these genes among the four strains as all these were developed for high egg production. Similar results were reported by Kumar *et al.* (1977) while comparing the production performance of F_1 and F_2 generations of the four strains used in this study. Considering the simplicity of producing single crosses by maintaining only two pure strains/stocks this type of cross should be preferred over others for commercial use.

Egg Quality Traits

Averages alongwith their standard errors for the egg quality traits (egg weight, shape index, Haugh Unit, yolk index, shell thickness, shell weight and yolk colour) are presented in Table 2, while the analysis of variance in Table 3. The differences among the cross types were not significant for all the egg quality traits except for shell thickness and yolk colour. But the differences among genetic groups within a type of cross were significant for all the egg quality traits except for yolk colour. In general, among the interse crosses, $LH_1 \times LH_1$ group performed better for all traits over other groups. While among the single cross type $LH_3 \times LH_1$ group was superior over other groups but among the double crosses, all the four groups were similar for most of the traits.

From the present findings, it may be concluded that multiple crosses were not superior to the interse crosses for the egg quality traits, except for shell thickness and yolk colour. This lack of superiority of single and double crosses over the interse crosses indicated that probably non-additive gene action is not important for egg quality traits. Redman and Shoffner (1961) and Singh *et al.* (1980) reported that general combining ability accounted for most of the total

TABLE 2

Averages alongwith their standard errors of various egg quality traits in different types of crosses

Types of crosses	Egg weight (g)	Shape index	Haugh Unit	Yolk index	Shell thickness (mm)	Shell weight (g)	Yolk colour score
Interse crosses							
$LH_1 \times LH_1$	$63.28^{b} \pm 0.75$	$74.34^{b} \pm 0.69$	$96.56^{b} \pm 0.94$	$49.07^{a} \pm 0.55$	$0.346^{a} \pm 0.007$	$6.74^{a} \pm 0.14$	$10\,53 \pm 0.25$
$LH_2 \times LH_2$	$58.11^{a} \pm 0.74$	$71.78^{a} \pm 0.54$	$87.85^{c} \pm 1.01$	$48.09^{a} \pm 0.51$	$0.367^{bc} \pm 0.005$	$6.30^{b} \pm 0.11$	10.53 ± 0.24
$LH_3 \times LH_3$	$62.68^{b} \pm 0.62$	$72.12^{a} \pm 0.65$	$91.71^{a} \pm 1.10$	$47.97^{a} \pm 0.61$	$0.379^{c} \pm 0.050$	$7.02^{a} \pm 0.10$	$10\,76 \pm 0.24$
$LH_4 \times LH_4$	$58.95^{a} \pm 0.67$	$71.30^{a} \pm 0.36$	$93.60^{a} \pm 0.67$	$48.21^{a} \pm 0.48$	$0.353^{ab} \pm 0.006$	$6.72^{a} \pm 0.11$	11.00 ± 0.11
Overall	$60.75 \pm 0\,34$	72.38 ± 0.36	92.43 ± 0.78	48.33 ± 0.24	0.361 ± 0.001	6.62 ± 0.04	10.70 ± 0.11
Single crosses							
$LH_1 \times LH_3$	$58.81^{a} \pm 0.85$	$73.16^{a} \pm 0.58$	$91.78^{a} \pm 0.90$	$47.75^{ac} \pm 0.64$	$0.372^{a} \pm 0.006$	$6.47^{a} \pm 0.11$	10.60 ± 0.24
$LH_3 \times LH_1$	$59.58^{a} \pm 0.81$	$72.53^{ab} \pm 0.47$	$94.32^{b} \pm 0.81$	$49.52^{a} \pm 1.04$	$0.373^{a} \pm 0.004$	$6.58^{a} \pm 0.13$	11.03 ± 0.28
$LH_3 \times LH_4$	$61.31^{b} \pm 0.67$	$71.37^{b} \pm 0.54$	$91.36^{a} \pm 0.87$	$47.41^{c} \pm 0.53$	$0.365^{a} \pm 0.046$	$6.52^{a} \pm 0.09$	11.06 ± 0.29
$LH_4 \times LH_2$	$59.91^{ab} \pm 0.84$	$72.09^{ab} \pm 0.40$	$90.41^{a} \pm 1.00$	$43.38^{b} \pm 0.39$	$0.372^{a} \pm 0.005$	$6.56^{a} \pm 0.13$	11.20 ± 0.20
Overall	59.90 ± 0.38	72.28 ± 0.23	91.96 ± 0.41	47.01 ± 0.52	0.370 ± 0.001	6.53 ± 0.08	10.98 ± 0.12
Double crosses							
$LH_{34} \times LH_{12}$	$61.65^{a} \pm 0.85$	$72.78^{a} \pm 0.48$	$94.65^{a} \pm 0.72$	$49.36^{a} \pm 0.39$	$0.357^{a} \pm 0.006$	$6.78^{ac} \pm 0.15$	11.66 ± 0.25
$LH_{13} \times LH_{34}$	$61.80^{a} \pm 0.98$	$71.69^{a} \pm 0.51$	$91.76^{b} \pm 1.00$	$48.85^{ab} \pm 0.63$	$0.348^{ab} \pm 0.009$	$6.50^{ab} \pm 0\,12$	12.13 ± 0.30
$LH_{12} \times LH_{43}$	$61.28^{a} \pm 0.78$	$72.91^{a} \pm 0.52$	$87.79^{c} \pm 1.34$	$47.11^{b} \pm 0.53$	$0.331^{b} \pm 0.008$	$6.28^{b} \pm 0.10$	11.73 ± 0.30
$LH_{43} \times LH_{12}$	$61.48^{a} \pm 0.80$	$72.14^{a} \pm 0.65$	$91.88^{b} \pm 0.78$	$49.01^{a} \pm 0.44$	$0.361^{a} \pm 0.006$	$6.81^{c} \pm 0.13$	11.90 ± 0.23
Overall	61.55 ± 0.40	$72.38 \pm 0\,24$	91.55 ± 0.67	48.58 ± 0.26	0.349 ± 0.002	6.59 ± 0.05	11.85 ± 0.13

Averages are based on 30 eggs from each cross.

Averages bearing different superscripts differ significantly at 5 per cent.

TABLE 3

Analysis of variance for various production and egg quality traits

S. V.	D. F.	Mean squares									
		20 week body wt.	Rate of lay	F. E. for egg mass	Egg wt.	Shape index	Haugh Unit	Yolk index	Shell thickness	Shell weight	Yolk colour
Among types of crosses	2	157759.10	2469.43	0.20	81.45	0.37	24.86	9.65	0.014**	0.25	43.08**
Among groups/ types of crosses	9	58372.70*	1820.74**	0.48**	79.20**	27.07**	242.68**	23.05*	0.004**	1.73**	1.72
Residual		24381.40 (775)	131.60 (2340)	0.16 (72)	18.95 (348)	8.91 (348)	27.69 (348)	10.44 (348)	0.001 (348)	0.47 (348)	2.07 (348)

*,**Significant at 5 and 1 per cent, respectively.

The numbers in parentheses are residual degrees of freedom.

genetic variability for egg weight, egg shape, Haugh Units and yolk colour.

Since, both egg production and egg quality traits were not affected much by non-additive gene action in the present study, production of multiple crosses will not be advantageous over the interse crosses. Single crosses may be preferred over interse and double crosses for commercial use to avoid depression in the performance due to unintentional increase in the inbreeding coefficient under the interse crossing.

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PREVALENCE OF *HAEMONCHUS CONTORTUS* INFECTION IN GOATS IN HISSAR

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ABSTRACT

Altogether 1295 abomasa of freshly slaughtered apparently healthy goats were examined during March, 1980 to February, 1981, out of which 967 (74.67%) harboured *H. contortus*. The per cent infected goats was studied in comparison to meteorological data and seasonal prevalence.

The reports on prevalence of *H. contortus* in goats as separate entity are meagre. Pande (1942), Contreras *et al.* (1976) and Bali and Singh (1977) have reported 66.6, 66.6 and 63.5 per cent prevalence of *H. contortus* in goats, respectively. A low incidence of 12.7% of *H. contortus* in goats has been reported by Shah and Pandit (1959). Haemonchosis could also occur wherever there was a good summer rainfall (Blood and Henderson, 1974). This study was designed to see the per cent infection of *H. contortus* in goats of Hissar including monthwise distribution of the infection vis-a-vis meteorological data.

MATERIAL AND METHODS

Abomasa of freshly slaughtered goats 1295 in number and all of about one year age group were obtained from the Haryana Veterinary Vaccine Institute, Hissar and local slaughter house. The source of these animals was the surrounding villages. Almost all goats were either crosses of Jamnapari and/or Betele with the local goats.

The contents of the abomasum were collected in separate trays alongwith the subsequent washings. The parasites adhering to the abomasal mucosa were collected by gentle scrapping with back of the scalpel. The entire collection was washed in tap water several times. The parasite was allowed to settle, the supernatant fluid poured off. This process was repeated until the supernatant fluid was clear. The worms were collected from the sediment, kept in saline for further study. Different parasites obtained from the abomasal contents were identified morphologically. In this study, only *H. contortus* infection was reported.

RESULTS AND DISCUSSION

Out of 1295 abomasa examined, 967 harboured *H. contortus*. Monthwise prevalence of *H. contortus* in goats in Hissar is shown in Fig. 1. The

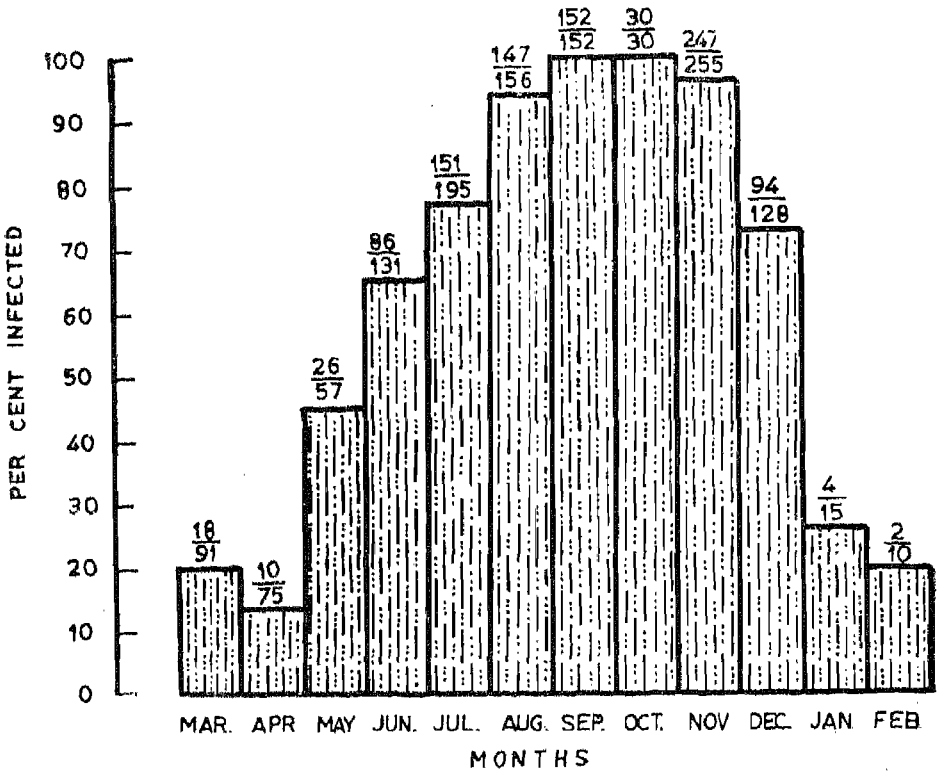


Fig. 1. Prevalence of *H. contortus* infection in goats in Hissar.

highest infection (100 per cent) was noted during September and October and it was lowest during April. Further it showed mild infection during January, February and March of the year under experiment. The overall per cent infection of *H. contortus* in natural infection was recorded 74.67 during the present investigation.

The prevalence of *H. contortus* in goats in relation to temperature, relative humidity (RH) and rainfall in Hissar is shown in Fig. 2. For the high plateau of per cent infection of *H. contortus*, the heavy rains in July and RH of 30-35 having environmental temperature of 18 to 36°C during the year appeared to be optimum.

The goats slaughtered at Hissar, from which abomasa were taken for screening belonged to a good number of Satellite villages. Thus, the representative prevalence of *H. contortus* in goats appeared highest (100 %) during September and October and lowest (13.33 %) during April. The peak prevalence from July

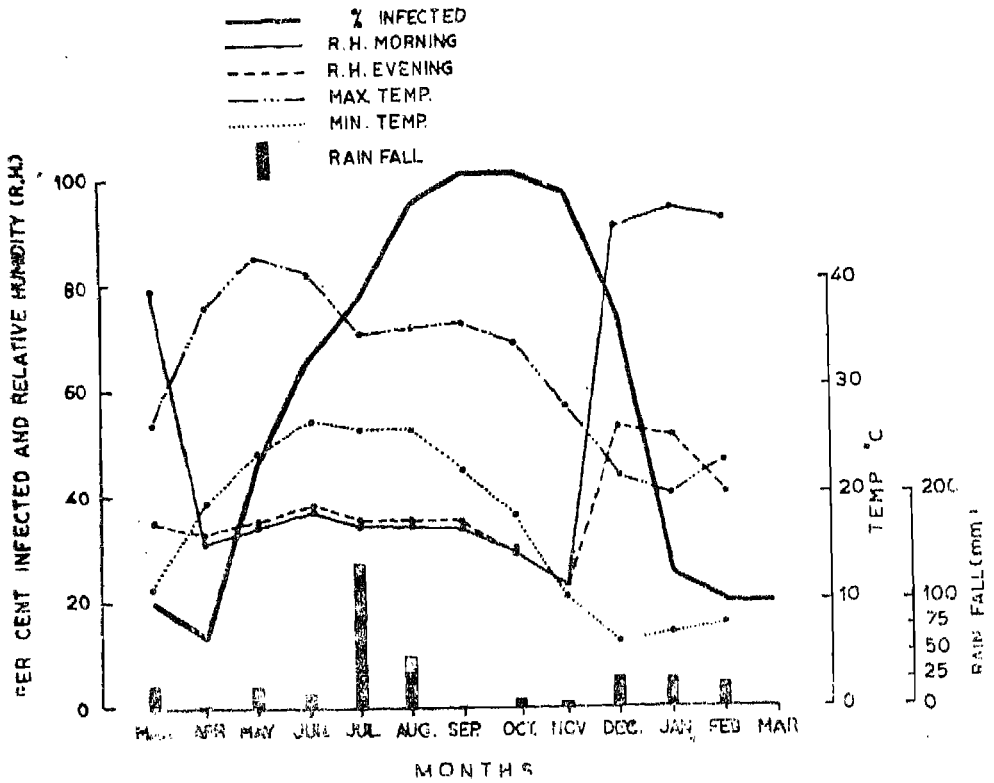


Fig. 2. Prevalence of *H. contortus* in goats in relation to temperature, relative humidity and rainfall in Hissar.

to December and fall in infection rate from February to April agree with the observations made by Bali and Singh (1977) who reported 100% prevalence in August and 15% in February. Overall prevalence of *H. contortus* in the present study was 74.67% which was slightly higher in comparison to Pande (1942), Contreras *et al.* (1976) and Bali and Singh (1977) who reported 66.6, 69.0 and 63.5 per cent, respectively. Pande (1942) examined only 120 goats in Uttar Pradesh and reported 66.6% *H. contortus* infection. In the present study, 1295 goats have been examined during the year and this may have more representative figure for prevalence of *H. contortus* in goats. Contreras *et al.* (1976) studied 2700 goats in several areas of Venezuela. Such variation in prevalence rates could be due to difference in agro-climatic conditions prevailing in different areas. The overall prevalence rate of 74.67% in present investigation as compared to 63.5% reported by Bali and Singh (1977) indicated the increasing trend of *H. contortus* infection in this district. This could be due to imple-

mentation of intensive irrigation facilities and the associated changes in agro-climatic conditions.

The bioclimatography indicated high plateau of per cent infection under optimum conditions of heavy rain in July with RH 30-35 and environmental temperature 18-36°C. The statement "worms work by the weather" made by Gordon (1948) appeared true. Blood and Henderson (1974) also mentioned that the disease occurred where there was good summer rainfall and it was uncommon in semi-arid regions. They further reported that a great deal of effort had been devoted to determine the conditions in which haemonchosis occurred in sheep so that outbreaks could be predicted and preventive measures taken. Thus, a climatograph for a particular geographical area may be taken as an index of the occurrence of haemonchosis in goats.

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DETERMINATION OF RANIKHET DISEASE VIRUS INFECTIVITY TITRE BY EGG BIT TECHNIQUE

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For the infectivity titration and serum neutralisation tests in the case of viruses belonging to orthomyxo and paramyxo groups, about 25-30 eggs are required for each virus sample. Using so many eggs is a costly affair and these may not be available at all times. Fulton and Armitage (1951) observed that influenza virus was capable of propagation on small fragments of chorio-allantoic membrane. Fazeskas and White (1958 a, b) conducted detailed studies on the egg bit technique and standardised the procedural details. Beard (1969) also used the technique for measuring Newcastle disease virus and its neutralising antibodies. In the experiment described here, this technique has been used for the determination of Ranikhet disease virus infectivity titre.

The 'F' strain virus procured from the Indian Veterinary Research Institute, Izatnagar, was given several passages in 10 days old embryonated White leg horn eggs. The infected allantoic fluid was tested for ID_{50} infectivity titre.

Embryonated eggs of 10 to 15 days age were used. These eggs were taken out from the incubator and the shell was sterilised by means of 70% alcohol. A hole was made at the narrow end with the help of a pointed scissor and then the end was cut in circular fashion to remove the contents of the egg alongwith the embryo taking care that the allantoic membrane did not detach from the shell. After emptying the egg, the chorio-allantoic membrane on the shell was washed with sterile normal saline solution. The egg shell was cut into strips of 1 sq. cm size. These strips were transferred to the Earle's maintenance medium in a petridish and later on transferred to test tubes according to the requirement of experiment.

Ten fold dilutions of the virus were made in Earle's medium. From each of the last three dilutions 1 ml of virus was placed in five test tubes. Now in each tube one egg bit of 1 sq. cm was added. After this incubation, from each of five tubes 0.25 ml of virus was taken for recording haemagglutinin titres according to the method of Allan and Gough (1974).

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The infectivity titre calculated by applying Reed and Munech (1938) formula was found to be ID_{50} $10^{6.7}$.

The findings of this study regarding the successful use of the technique were in conformity with the views of Beard (1969) who described the technique as sensitive, easy and time saving. The technique is also used as a research tool for studying problems such as virus adsorption, penetration and release (Beard, 1969). Economy of eggs used for the infectivity titration was stressed in this study as one, 11 days old egg yield upto 100 bits of tissues, each equal in sensitivity of a whole egg (Fazeskas and White, 1958 a, b).

ACKNOWLEDGEMENT

Thanks are due to Dr R. C. Pathak, Prof. of Bacteriology, College of Veterinary Science & Animal Husbandry, Mathura for his expert guidance.

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RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XII, No. 4, pp. 558 –560 (December 1982)

GENETIC AND NON-GENETIC FACTORS AFFECTING BIRTH AND WEANING WEIGHT IN NALI AND ITS CROSSES WITH MERINO AND CORRIEDALE

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Birth weight and weaning weight bear great importance because of their association with market and mature body weight (Dass and Acharya, 1970; Chopra and Acharya, 1971; Acharya, 1978; Singh, 1980) and also as an indicator of mothering ability of dam (Bawa, 1968). Birth and weaning weights might be affected by several non-genetic factors (sex of lamb, season of lambing, age and weight of the dam at lambing, etc.), thus, concealing the true genetic merit of the individual. This may bias the selection of superior individuals. Therefore in the present investigation effort was made to find out the magnitude of various factors affecting birth and weaning weights of lambs.

Data were recorded on 258 lambs of three genetic groups, viz. Nali, $\frac{1}{2}$ Merino $+\frac{1}{2}$ Nali and $\frac{1}{2}$ Corriedale $+\frac{1}{2}$ Nali maintained in this Department. The recordings were made for two lambing seasons March-April and August-September during the year 1978. Lambs were allowed to suckle their dams upto 90 days of age thereafter they were weaned. The data were classified for genetic groups, sex, seasons of lambing, age of lambing, age of dam at lambing (below 731 days, 731-1460 days, and above 1460 days), weight of dam at lambing (below 21 kg, 21-25 kg, 26-30 kg, 31-35 kg, and above 35 kg) and parity of dam. The data were analysed according to Harvey's (1966) technique of fitting constants. Heritability was estimated by Paternal Half sib correlation method on adjusted data.

Least squares means for the birth and weaning weights are presented in Table 1. The overall means for the two traits were obtained as 2.97 ± 0.05 and 10.66 ± 1.22 kg, respectively. Merino × Nali lambs were superior to Corriedale × Nali and pure Nali for birth weight (3.00 ± 0.06, 2.98 ± 0.06 and 2.94 ± 0.09 kg, respectively). While the sequence for weaning weight was Nali, Merino × Nali and Corriedale × Nali (10.83 ± 1.33, 10.63 ± 1.29 and 10.51 ± 1.21 kg, respectively). The sex of lamb and weight of dam at lambing significantly affected ($P < .01$) the birth weight.

The males dropped were heavier as compared to females. The lambs born out of dam having weight groups below 26 kg were lighter to those which were

TABLE 1

Least-square means and standard errors of birth and weaning weights

Factors	Birth weight (kg)	Weaning weight (kg)
Overall mean	2.97±0.05(258)	10.66±1.22(180)
Genetic groups		
Nali	2.94[a]±0.09(35)	10.83[a]±1.33(25)
Merino × Nali	3.00[a]±0.06(91)	10.63[a]±1.29(67)
Corriedale × Nali	2.98[a]±0.06(132)	10.51[a]±1.21(88)
Sex of lamb		
Male	3.05[a]±0.06(136)	10.60[a]±1.30(100)
Female	2.90[b]±0.04(122)	10.71[a]±1.15(80)
Season of lambing		
March-April	2.75[b]±0.06(180)	12.29[a]±1.11(126)
Aug.-Sep.	3.20[a]±0.35(78)	9.02[b]±1.35(54)
Age group of dam (days)		
Below-731	3.06[a]±0.07(60)	—
731-1460	2.88[a]±0.07(39)	—
Above 1460	2.98[a]±0.05(159)	—
Parity of dam		
1	—	9.97[a]±1.42(63)
2	—	10.81[a]±1.41(61)
3	—	10.62[a]±1.44(21)
4	—	11.00[a]±1.39(9)
5	—	10.80[a]±1.29(15)
6	—	10.72[a]±1.42(11)
Weight group of dam (kg)		
Below 21	2.67[b]±0.11(20)	10.28[a]±1.40(9)
21-25	2.85[b]±0.06(106)	10.32[a]±1.16(75)
26-30	3.08[b]±0.06(84)	10.93[a]±1.27(63)
31-35	3.11[b]±0.08(39)	10.73[a]±1.29(27)
Above 35	3.15[b]±0.16(9)	11.03[a]±1.85(6)
b_1	—	2.23**

b_1 is the partial regression of weaning weight on birth weight.

Averages bearing different superscripts differ significantly at 1 per cent from each other.

Figures in parentheses are the number of observations.

**Significant at 1 per cent.

born out of dams heavier than 26 kg. The genetic groups did not show any significant effect on birth and weaning weights. Similar results were obtained by Raina *et al.* (1973), Sharma *et al.* (1978) and Trivedi *et al.* (1978). Season of lambing had significant effect on both the traits, the lambs born in March-April (season I) were lighter as compared to those born in August-September (season II). However, the reverse trend was observed for weaning weight. This may be attributed to congenial climatic conditions and better pastures available from April to June to the dams which provided better mothering ability to the lambs born in season I. The age and parity of dam did not have significant effect on both the traits. These findings are in agreement with those of Raina *et al.* (1973). A significant regression of weaning weight on birth weight (b= 2.23) was obtained indicating that per kg gain in birth weight would enhance weaning weight by 2.23 kg. The heritability estimates calculated on adjusted data were obtained as 0.01 ± 0.14 and 0.04 ± 0.15, for birth and weaning weights, respectively. These estimates were very low as compared to values reported in the literature (Singh, 1980).

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EFFECT OF TYPE OF FLOOR AND CONCENTRATE SUPPLEMENTATION ON PHYSIOLOGICAL REACTIONS AND BEHAVIOUR OF GROWING BUFFALO HEIFERS

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Though specialists advocate to farmers a hygienic concrete or brick floor for rearing healthy cattle, there is no clear cut experimental proof in favour of or against one or the other type of floor under Indian conditions. The objective of the present study was to obtain evidence in this direction.

The experiment, a 2×2 factorial in randomised blocks, was conducted from 20th November, 1979 to 20th March, 1980 on the Animal Farm of Haryana Agricultural University, Hissar. Twenty, 6-16 months old Murrah buffalo heifers were dewormed and sprayed with insecticides against ectoparasites. They were divided into 4 groups of 5 animals each based on nearness in their age and body weight. Each group was allotted randomly to the four treatment groups. The treatment groups and their average initial body weights were : (i) housed on brick floor with no concentrate supplementation, 144 kg; (ii) housed on brick floor with concentrate supplementation at the rate of 0.2% body weight, 143.8 kg; (iii) housed on dirt floor with no concentrate supplementation, 143.8 kg; and (iv) housed on dirt floor with concentrate supplementation at the rate of 0.2% body weight, 144.0 kg.

The above level of concentrate (having 16.5% DCP and 65% TDN) supplementation was reported to be the most economical level for growing buffalo heifers during berseem feeding period (Sharma and Thomas, 1981). All the animals were fed green berseem *ad lib.* with sufficient quantities of dry fodder. Mineral salt bricks were provided for calves not getting concentrates. Other managemental practices were similar for all the groups.

The average values of respiration rate of experimental animals recorded at fortnightly intervals were well within normal range for this season (13-14.5/min). There were no significant differences with respect to this character either between floors or between two levels of concentrates (Table 1). Though, the average values of pulse rate of experimental animals were also more or less within the normal range, there were significant differences in pulse rate between the floor conditions; animals

TABLE 1

Average values of respiration rate, pulse rate and body temperature of buffalo heifers as influenced by type of floor and concentrate supplementation

	Brick floor+ 0.0% concentrates	Brick floor+ 0.2% concentrates	Dirt floor+ 0.0% concentrates	Dirt floor+ 0.2% concentrates	Concentrates 0.0%	Concentrates 0.2%	Brick floor	Dirt floor
Pulse	68.9 ±1.653	68.4 ±1.975	64.0 ±1.906	63.9 ±1.903	66.4	66.1	68.6	63.9
Respiration	13.1 ±0.914	14.4 ±0.737	13.4 ±0.845	13.6 ±0.896	13.3	14.0	13.8	13.5
Body temperature	99.55±0.356	99.47±0.306	99.27±0.230	99.05±0.270	99.47	99.26	99.51	99.16

Only differences between floors were statistically significant with respect to pulse rate ($P<0.01$) and body temperature ($P<0.05$).

TABLE 2

Average values of observational behaviour in Murrah buffalo heifers (per day) as influenced by type of floor and concentrate supplementation

	Brick floor+ 0.0% concentrates	Brick floor+ 0.2% concentrates	Dirt floor+ 0.0% concentrates	Dirt floor+ 0.2% concentrates	Concen- trates 0.0%	Concen- trates 0.2%	Brick floor	Dirt floor
Feeding time (min)	401.9±19.147	378.9±18.125	327.0±13.294	335.2±13.726	384.5	357.0	390.4	331.1
Rumination time (min)	456.3±20.539	459.1±21.129	405.0±20.311	405.8±21.149	430.5	432.4	457.5	405.3
Standing time (min)	416.0±15.894	490.0±27.799	432.2±21.430	472.5±17.085	424.9	481.3	453.0	452.2
Lying down time (min)	945.8±20.123	950.0±27.799	1004.3±19.954	967.4±17.081	975.0	958.7	947.9	985.8
Defecations (No. of times)	5.5±0.420	5.2±0.503	5.2±0.421	5.2±0.435	5.4	5.2	5.4	5.2
Micturations (No. of times)	9.1±0.817	8.7±1.191	6.3±0.716	7.8±0.615	7.8	7.7	8.9	6.6
Mean daily dry matter consumption (kg)	5.44	5.48	5.25	5.36	5.34	5.42	5.47	5.31

Only floor differences in standing and lying down time ($P<0.01$) and number of micturations ($P<0.05$) were statistically significant.

housed on brick floor had higher rate than their counterparts on dirt floor. When overall values for the four treatment combinations were studied, the differences between the pulse rate of these groups were only marginal.

The lowest body temperature (99.05°F) was recorded in case of calves on dirt floor with 0.2% concentrates and the highest (99.55°F) for calves on brick floor with no concentrates (Table 1). There was a difference of 0.5°F between calves housed on brick and dirt floor, the difference being significant (Table 1). The difference in body temperature due to two levels of concentrates was not statistically significant.

It is seen that differences between periods (fortnights) with regard to body temperature were highly significant. This may be due to variation from fortnight to fortnight in ambient temperature. The lowest recordings of body temperature (97-98°F) were at the middle period of the experiment which coincides with the peak of winter (January). The values were progressively higher towards the beginning and end of the experiment.

It is well known that among these three physiological reactions, respiration rate shows immediate and sharper changes with change in micro-climate (Mullick, 1960; Thomas and Razdan, 1973). No differences were recorded between calves housed on brick floor and dirt floor with respect to their respiration rate but differences between these two groups of animals were highly significant with respect to their pulse rate and body temperature, both the values being higher in brick floor housed calves. Such a situation perhaps indicates that the two types of floor may not be having any noticeable effect on the thermal balance of animals. The common belief that dirt floor remains warm and gives more comfort to animal, and brick floor remains wet and cool during winter is untenable. On the other hand, according to our observations higher level of pulse rate and body temperature in calves housed on brick floor might be due to higher level of metabolic rate as evidenced from their higher rate of growth (5.404 against 4.987 kg/week). Also the higher level of pulse rate and body temperature of calves housed on brick floor may be a delayed and persisting response to the more comfortable contact surface provided by the brick floor. Such a view has to be taken since even the enhanced levels of pulse rate and body temperature of calves housed on brick floor were well within the normal range (Pal *et al.*, 1973; Sastry *et al.*, 1973).

Animals on brick floor spent significantly more (390.4 min/24 h) time in feeding as compared to those on dirt floor (331.1 min/24 h). But there was no significant difference between the two concentrate levels in this respect (Table 2). Calves on brick floor consumed more green and dry fodders per day (Table 2). Perhaps this is the reason why they spent more time in eating. Though, calves on brick floor spent more (457 against 405 min/24 h) time on rumination the differences were not statistically significant. However, the calves significantly spent more time in rumination during the night in comparison to day time.

Calves housed on dirt floor spent more time lying down than those on brick floor while calves receiving no concentrate supplementation too spent significantly more time lying down. The calves housed on dirt floor supplemented with no concentrate spent highest time lying down and the calves on brick floor with no concentrate spent the lowest time lying down (Table 2).

On an average, calves on brick floor defecated slightly more frequently than those on dirt floor and passed urine significantly more frequently than those on dirt floor (Table 2).

Thus, calves on brick floor spent more time in feeding as well as rumination but rested less. They also voided dung and urine more frequently which may be commensurate with greater consumption of feeds and fodders by them. Differences in behaviour pattern between the concentrates groups were, in general, only marginal. Animals spent more time eating during day and resting at night.

These findings, broadly speaking, are according to the known patterns of animal behaviour (Hafez, 1962). Sastry *et al.* (1981) reported that during summer, calves housed on brick floor rested more than calves on dirt floor. This finding is quite in contrast with that of the present study. This may be the seasonal difference.

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RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XII, No. 4, pp. 566—568 (December 1982)

CHEMOTHERAPEUTIC TRIALS AGAINST NATURAL *HEPATOZOON CANIS* INFECTION IN DOGS

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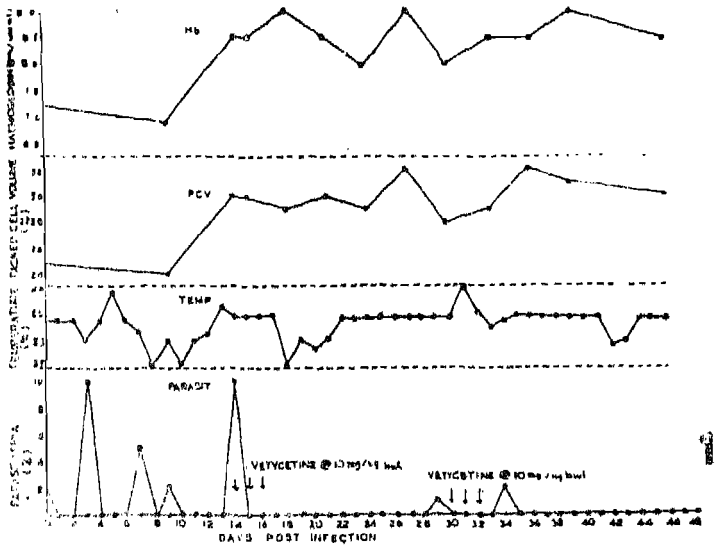
Hepatozoon canis infection in dogs produces a disease leading to weakness and emaciation with intermittent fever, rheumatic pains, lumber paralysis and death. Scanty information is available about the chemotherapy of *H. canis* infection in dogs. Klopfer *et al.* (1973) used Ganaseg (Squibb) @ 5 mg/kg in treating this infection in dogs. The present paper is a report on systematic chemotherapeutic trial against *H. canis* infection in dogs from India.

Chemotherapeutic study was made on 7 naturally *H. canis* infected dogs confirmed microscopically on blood smear examination (Bansal, 1979). The 7 dogs were divided into three groups of two dogs each while one was kept as untreated infected control. Four dogs of groups I and II were given Vetycetine (Chloramphenicol—Teddington Chemical Factory) @ 10 mg/kg body weight I/M for three consecutive days and observed for two weeks. There were relapses of temperature and parasitaemia in these four dogs. Two dogs of group I were given second course of Vetycetine while the two dogs of group II were treated with Berenil (Diminazene aceturate—Hoechst) @ 12 mg/kg and then all were again observed for two weeks.

Third group of two dogs was treated with Anthiomaline (Lithium antimony thiomalate—May & Baker) @ 3, 4½, 6 and 7½ mg/kg body weight I/M at an acute stage of the disease on alternate days and followed as above.

The dogs of group I treated with Vetycetine alone and dogs of group II treated with Vetycetine and then with Berenil showed clinical recovery as indicated by haematological values and temperature (Figs. 1 and 2), however, there was a mild parasitaemia after some days. The dogs of group III treated with Anthiomaline showed intermittent fever and relapses of parasitaemia (Fig. 3) while one dog died on the 14th day of treatment and the other remained carrier throughout the period of observation. In *H. canis* infected and untreated control dog there were more frequent relapses of parasitaemia and temperature throughout the study period.

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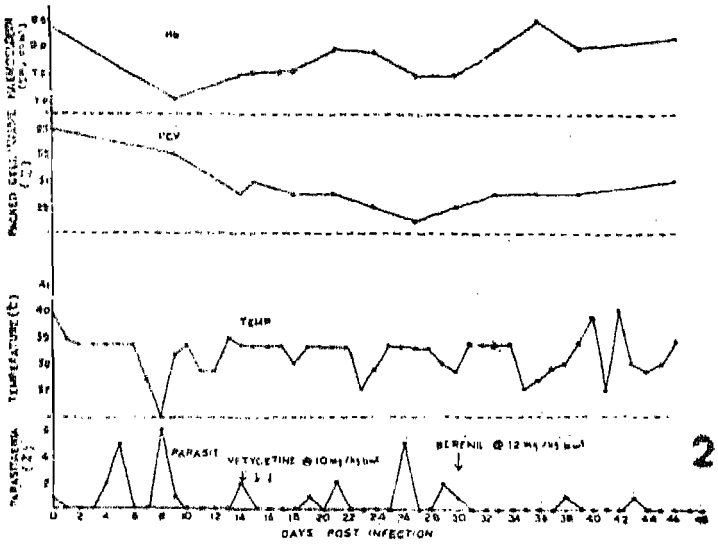


Fig. 1. Effect of Vetycetine on parasitaemia, temperature, packed cell volume and haemoglobin in natural *Hepatozoon canis* infection in dog.

Fig. 2. Effect of Vetycetine and Berenil on parasitaemia, temperature, packed cell volume and haemoglobin in natural *Hepatozoon canis* infection in dog.

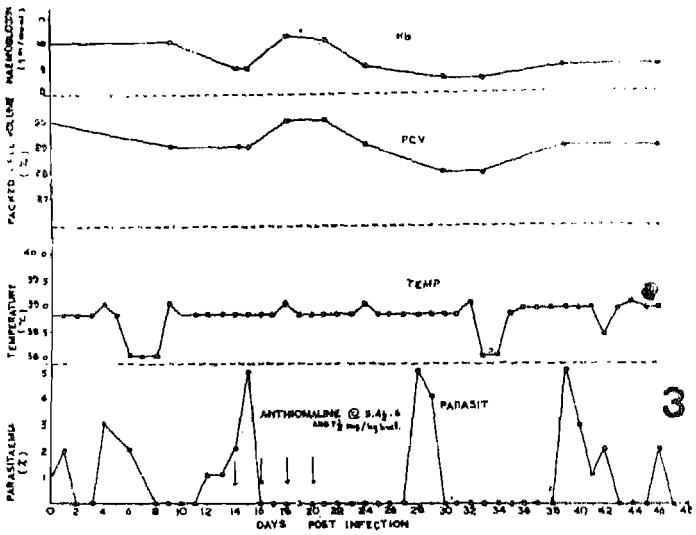


Fig. 3. Effect of Anthiomaline on parasitaemia, temperature, packed cell volume and haemoglobin in natural *Hepatozoon canis* infection in dog.

Klopfer *et al.* (1973) used Ganaseg (Diminazene aceturate) @ 5 mg/kg body weight I/M on two consecutive days and found ineffective in dogs, but in this study Berenil @ 12 mg/kg body weight could clinically cure the dogs. Anthiomaline was less effective as compared to Vetycetine and Berenil in bringing about the clinical recovery as one of the two dogs treated with Anthiomaline died. Thus, there is still a need for the development of more suitable chemotherapeutic agents against hepatozoonosis in dogs which could completely eliminate the *H. canis* infection though Vetycetine and Berenil could clinically cure the dogs of *H. canis* when given alone.

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KARYOLOGICAL OBSERVATIONS ON TWO SPECIES OF THE SUB-FAMILY OTIORRHYNCHINAE (COLEOPTERA : CURCULIONIDAE)

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ABSTRACT

Karyological observations on two species of the sub-family Otiorrhynchinae *Tanymecus cephalotes* and *T. sciurus* have been reported. Chromosomes of both the species are meta- to sub-metacentric. *Tanymecus sciurus* shows the phenomenon of sex-chromosomal polymorphism.

Our present cytological knowledge of the family Curculionidae of order Coleoptera is restricted to some genera which have largely been surveyed, such as *Otiorrhynchus* (Suomalainen, 1940; Mikulska, 1960; Takenouchi, 1965), *Hylobius* (Smith, 1958; Takenouchi, 1958a) and *Pissodes* (Takenouchi, 1958b, 1975). Since the karyological information about the species belonging to other genera is very scanty, it seemed useful to extend these studies to them also. Work on two species, viz. *Tanymecus cephalotes* and *T. sciurus* has been presented in this paper. *T. sciurus* shows the sex-chromosomal polymorphism.

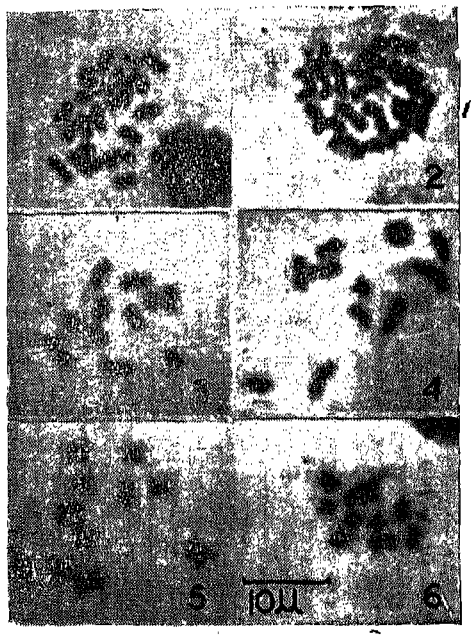
MATERIAL AND METHODS

Testes of males provided the required material. They were fixed in carnoy's fixative (1 : 3; Acetic acid : Absolute alcohol). After teasing them in 60% acetic acid, the slides were stained in Carbol fuchsin (Carr and Walker, 1961). The classification of chromosomes was carried out according to the system of nomenclature proposed by Levan *et al.* (1964).

RESULTS AND DISCUSSION

The spermatogonial metaphase plates (Figs. 1 and 2) clearly showed a diploid number of 22 chromosomes in case of *Tanymecus cephalotes* while *T. sciurus* represented two types of spermatogonial plates. One was normal having 22 while the other was polymorphic having 23 (Fig. 11) as the diploid chromosome number, respectively. As is clear from the karyotypes, the chromosomes in both the species (Figs. 7 and 15) were metacentric to sub-metacentric. The sex-chromosome X was metacentric in both of the above species.

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Tanymecus cephalotes

Figs. 1 & 2. Spermatogonial metaphase× 3000 X.

Figs. 3 & 4. Metaphase—I × 3000 X.

Fig. 5. Metaphase—II with X chromosome× 3000 X.

Fig. 6. Metaphase—II with y chromosome× 3000 X.

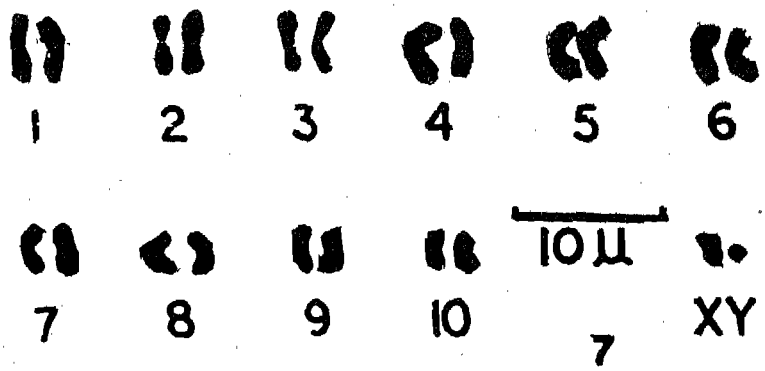
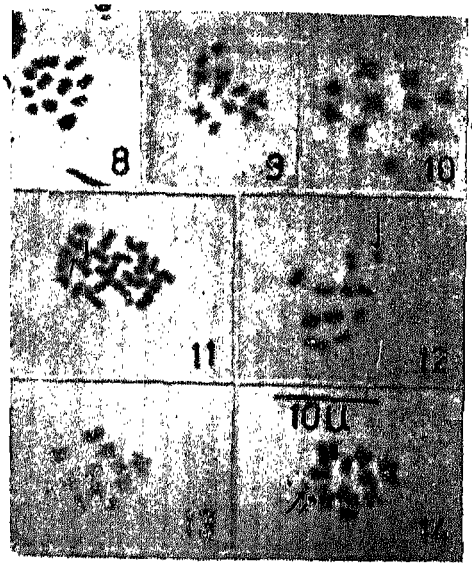


Fig. 7. Karyotype.



Tanymecus sclurus

Fig. 8. Metaphase—I (normal) × 3000 X.

Fig. 9. Metaphase—II with X chromosome (normal) × 3000 X.

Fig. 10. Metaphase—II with y chromosome (normal) × 3000 X.

Fig. 11. Spermatogonial metaphase (polymorphic) × 3000 X.

Fig. 12. Metaphase-I (polymorphic) × 3000 X.

Fig. 13. Metaphase—II with X chromosome (polymorphic) × 3000 X.

Fig. 14. Metaphase—II with two y chromosomes (polymorphic) × 3000 X.

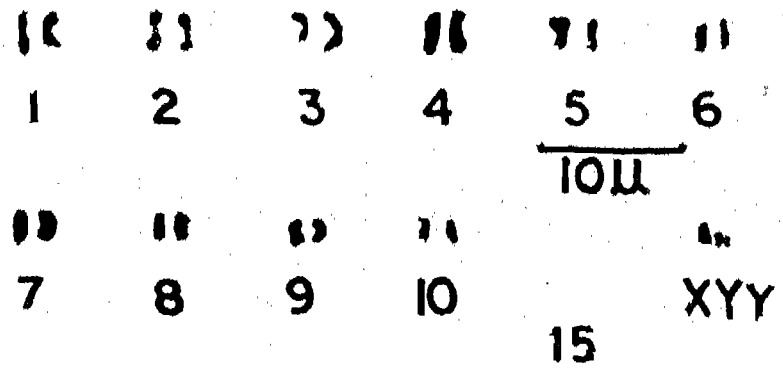


Fig. 15. Karyotype (polymorphic).

Metaphase I of the first meiotic division (Figs. 3 and 4) showed 11 bivalents in *T. cephalotes* while two types of plates—with 10 autosomes and Xyp bivalent (Fig. 8) and with 10 autosomes and Xyyp trivalent (Fig. 12) were shown by *T. sciurus*. The autosomal pairs were in the form of dumb bell, rods and spheres in the two species.

Two types of metaphase II plates encountered in first species were with the X chromosome (Fig. 5) and with the y chromosome (Fig. 6). The latter species showed a plate with X chromosome (Figs. 9 and 13) being similar in the normal as well as polymorphic form while there were two types of plates with the y chromosome. Normal form of *T. sciurus* showed one y chromosome (Fig. 10) while the polymorphic form showed the presence of two small y chromosomes (Fig. 14). The chromosomal formulae is Xyp for normal while Xyyp for the polymorphic form.

But for *Episomus turritus* (Takenouchi, 1976), *Myllocerus* sp. (Takenouchi, 1958b) and *Myllocerus nipponicus* (Takenouchi, 1972) which showed a variation in the haploid chromosome number from 12 to 16, almost all the remaining species including *T. cephalotes* and *T. sciurus* of the sub-family Otiorrhynchinae, showed a constant haploid chromosome number of 11.

The chromosomal polymorphism shown by *T. sciurus* is a wide-spread phenomenon. On one hand, it reveals what may be the process of speciation and on the other, it makes debatable the characterization univocally of one species through the morphology of its karyotypes.

Takenouchi (1972) is of the view that the above phenomenon may be due to : (i) dissociation and unification of certain chromosomal arms in the early embryos; (ii) several Robertsonian changes.

T. sciurus showed the presence of two small dot-shaped y chromosomes which may be due to the splitting up of the original y chromosome (Sharma *et al.*, 1978). It is suggested that the centric shifts were real and in all probability due to pericentric inversions. Such casual observations yield significant information regarding the mode of evolution in these species. In fact, it has been observed that the pericentric inversions have been highly successful for speciation.

As all the species studied under sub-family Otiorrhynchinae showed a constant diploid number of 22 chromosomes, it suggests the compact nature of the group. Previously it was suggested that the sub-families Otiorrhynchinae and Entiminae are closely related but from the present studies such relationship is not proved at all.

ACKNOWLEDGEMENTS

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EFFECTIVENESS AND INTERACTION OF URDBEAN (*VIGNA MUNGO* (L.) HEPPER) RHIZOBIA WITH URDBEAN VARIETIES

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The performance of any individual variety is influenced by the strain of *Rhizobium* that achieves symbiosis. In order to achieve effective legume *Rhizobium* symbiosis it becomes necessary to select simultaneously both symbionts. Different varieties of the same legume crop differ in their response to *Rhizobium* inoculation (Bapat *et al.*, 1977) and symbiotic variability of a range of *Rhizobium* strains with a given cultivar has also been established (Rai and Singh, 1979). This paper deals with the effectiveness and interaction of urdbean rhizobia with urdbean varieties under field conditions.

The experiment was conducted in a sandy loam soil having pH 7.5. The total amount of N, P and K in the top 15 cm soil was 385, 56 and 612 lbs/acre, respectively. Seeds treated with different *Rhizobium* strains were sown with 30 x 10 cm spacing in a randomized block design with four replications. A basal dose of single superphosphate @ 40 kg P_2O_5/ ha was applied. The viable counts of rhizobia on seeds were made on yeast extract mannitol agar plates (Vincent, 1970) by spread plate method. The number of *Rhizobium* like colonies per seed ranged from 10^3-10^4 cells. The observations on nodule number and nodule dry weight were recorded 42 days after sowing. Nodule samples were dried in oven at 80°C for 48 h. The crop was harvested 75 days after sowing when total dry matter and grain yield were recorded.

The results indicate increase in nodule number and nodule dry weight due to inoculation by different *Rhizobium* strains (Table 1). Strain KU_1 produced maximum nodules (81) and nodule dry weight (66 mg) per plant with var. T 9. On an average, strain UPH had maximum nodules (60) followed by KU_1 and BMBS P 47. However, the differences were non-significant. Total dry matter production measured at final harvesting time did not differ significantly due to inoculation (Table 2).

Surprisingly, significant increase in grain yields was observed at final harvest (Table 3). Strain KU_1 yielded best on an average followed by DU_2 and Badnapur.

TABLE 1

Nodule number (per plant) of urdbean varieties inoculated with different urdbean rhizobia

Varieties	Strains						
	Uninoculated	UPH	BMBS P47	DU_2	Badnapur	KU_1	Mean
T9	41 (44)	69 (56)	49 (56)	43 (50)	53 (48)	81 (66)	56 (54)
Pant U19	44 (36)	64 (44)	58 (49)	50 (51)	49 (38)	49 (45)	52 (44)
Mean	43 (40)	67 (50)	54 (54)	47 (51)	51 (43)	65 (56)	—

	Var.	Strains	Var. X strains
S. E. ±	5.2 (3.8)	9.0 (6.6)	12 8 (9.3)
C. D. at 5%	NS (NS)	NS (NS)	NS (NS)

1. Figures in the parentheses indicate nodule dry weight (mg/plant).
2. *Rhizobium* strains used were from HAU, Hissar (UPH); TNAU, Coimbatore (BMBS P47); ARS, Durgapur (DU_2); ARS Badnapur (Badnapur); and CSAU Kanpur (KU_1).
3. Nodulation data is mean of 15 plants, measured 42 days after planting.

TABLE 2

Total dry matter production (kg/plot of size 6.0 sq. m) of urdbean varieties inoculated with different urdbean rhizobia at final harvest

Varieties	Strains						
	Uninoculated	UPH	BMBS P47	DU_2	Badnapur	KU_1	Mean
T9	4.1	4.2	4.6	4.9	4.8	4.6	4.5
Pant U19	4.8	4 6	5.5	4.4	4.8	4.9	4.9
Mean	4 5	4.4	5.1	4.2	4.8	4.8	—

	Var.	Strains	Var. × strains
S. E. ±	0.16	0.27	0.39
C. D. at 5%	NS	NS	NS

TABLE 3

Grain yield (q/ha) of urdbean varieties inoculated with different urdbean rhizobia

Varieties	Strains						
	Uninocu-lated	UPH	BMBS P47	DU_2	Badnapur	KU_1	Mean
T9	9.0	9.58(6.4)	9.58(6.4)	11.66(28.8)	11.25(25.0)	10.33(14.8)	10.23
Pant U19	13.75	14.00(2.0)	16.41(19.0)	14.33(4.2)	14.26(3.7)	16.50(20.0)	14.87
Mean	11.38	11.79(3.6)	13.00(14.2)	13.00(14.2)	12.75(12.0)	13.42(17.9)	—

	Var.	Strains	Var. × strains
S. E. ±	0.02	0.04	0.05
C. D. at 5%	2.12	1.52	NS

The net harvest area of the plots was 6.0 sq. m. Figures in parentheses are per cent increase in grain yield over uninoculated control.

Host x *Rhizobium* strains interactions were not statistically significant though maximum per cent increase in grain yield (28.8%) was seen with combination of strain DU_2 and cultivar T9. Disparities between nodulation (nodule number and nodule weight) and grain yield might be due to differences in nitrogen fixation potential of different strains which was not measured. Past reports on responses to *Rhizobium* inoculation in case of urdbean are variable. Ramaswami and Nair (1965) and Mohammed *et al.* (1970) did not observe any significant increase while Chitriv and Wangikar (1978) observed a significant increase in one year and insignificant in other two years. A detailed study is warranted to explain the reasons for unrepeatable responses even at the same location.

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RESPONSE OF N, P AND K FERTILIZATION UNDER OPTIMUM AND CONSTRAINT DOSES CONDITIONS IN BAJRA-WHEAT CROP SEQUENCE

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ABSTRACT

Fertilizer trials were conducted on cultivators' fields to study the responses and economics of bajra-wheat crop sequence to applied N, P and K fertilization under irrigated conditions. The grain yield of bajra and wheat increased with increasing fertilizer doses and highest yield of bajra (24.13 q/ha) and wheat (51.94 q/ha) was obtained with $N_{120}P_{60}K_{60}$ treatment applied to each crop. Bajra crop responded economically to N only, whereas wheat crop gave economic response for N and P both. Response to K was not observed in any of the crop. Under fertilizer constraints 60 kg N/ha to bajra and 60 kg N alongwith 30 kg each of P_2O_5 and K_2O/ha for wheat was found most remunerative among the fertilizer treatments tested. The magnitude of response to applied P was many folds higher when applied in rabi than kharif The response to direct application of P was higher than the residual response.

Basic requirement in present day agriculture is to maximise the yield per unit area with minimum inputs. This can be obtained with efficient use of fertilizers under best management and cultural practices recommended for the crop. Until recently, the research on fertilizer use in our country was mainly confined to individual crops and fertilizer recommendations formulated on the basis of responses. A crop is only a component of a cropping system and consequently, the fertilizer needs of a crop will vary depending upon the characteristics of the preceding crop in the sequence. In this context, it is also important to mention that besides the influence of preceding crops, the fertilizer applied to one crop benefits to some extent the succeeding crops also because of their residual effects. Generally, the previous crop history and residual effects of fertilizers are not taken into account while formulating the fertilizer recommendations which are generally based on single crop. Sometimes this practice gives erroneous results.

Normally most of the farmers do not apply the prescribed doses of fertilizers for valid reasons of their high cost and unavailability at the time of sowing.

Naturally they confine to the fertilizer doses to such a level which may fetch them adequate economic returns. In order to find out the level of production under different levels of fertilizer constraints and to study the extent to which these levels could be reduced without appreciable decline in the total grain output in bajra-wheat crop sequence, the present study was taken in Jind district on cultivators' fields. The role of preceding crop and residual effect of applied fertilizer on succeeding crop were also accounted for. The main idea of conducting these experiments was that the degree of responses and magnitude of economics of fertilizer used at research farms is not true representative of the conditions prevailing at cultivators' fields.

The experiments were conducted continuously for 3 years in six blocks of Jind district, i.e. Narwana, Kalyat, Julana, Safidon and Rajond. All experiments were sown on 30 sites in a year with different levels and combinations of N, P and K.

MATERIAL AND METHODS

Jind district of Haryana State was divided into three agro-climatic homogenous zones each consisting of two blocks. Five villages in each block and one field from each village were selected randomly to layout the experiments adopting bajra-wheat rotation. Each selected field received the following 10 treatments in 10 equal plots of 50 sq. m each.

Treatments	Kharif	Rabi
T_1	$N_0P_0K_0$	$N_0P_0K_0$
T_2	$N_{120}P_{60}K_{60}$	$N_{120}P_{60}K_{60}$
T_3	$N_{90}P_{45}K_{45}$	$N_{120}P_{60}K_{60}$
T_4	$N_{90}P_{90}K_0$	$N_{90}P_0K_{90}$
T_5	$N_{90}P_0K_{90}$	$N_{90}P_{90}K_0$
T_6	$N_{60}P_{30}K_{30}$	$N_{90}P_{90}K_0$
T_7	$N_{60}P_{60}K_0$	$N_{90}P_{45}K_{45}$
T_8	$N_{60}P_0K_{60}$	$N_{60}P_{60}K_0$
T_9	$N_{60}P_{30}K_{30}$	$N_{60}P_{30}K_{30}$
T_{10}	$N_{60}P_0K_0$	$N_{60}P_{30}K_{30}$

All P and K and half of N were drilled at the time of sowing and rest of the N was top-dressed after 21 days of sowing in both the crops. Single superphosphate (16% P_2O_5), muriate of potash (60% K_2O) and calcium ammonium nitrate (25% N) were used as sources of P, K and N, respectively. Bajra cultivar HB-3 and wheat HD-2009 were used as test crops under irrigated conditions. Various cultural practices adopted in carrying out the experiments were kept uniform in all the 10 plots at each site. Crops were harvested at maturity and grain yield was recorded in each case. The data for whole district was pooled and analysed statistically for three years. Physico-chemical characteristics of the soils were determined by the method given in Jackson (1958) and are presented in Table 1.

RESULTS AND DISCUSSION

The highest grain yield in both the crops—bajra as well as wheat was obtained with highest and balanced dose ($N_{120}P_{60}K_{60}$) of N, P and K (Table 2). Results indicate that application of higher dose of fertilizers is remunerative only when applied judiciously. Such results have also been reported by Kanwar *et al.* (1972), Randhawa and Meelu (1974),

TABLE 1

Physico-chemical characteristics of the soils at experimental sites

Zone	Blocks	pH	E. C. (mmhos/cm)	O. C. (%)	Available nutrients (kg/ha)		
					N	P	K
1974-75							
I	Narwana, Kaiyat	7.5-8.2 (7.9)	0.18-1.73 (0.72)	0.24-0.58 (0.35)	145-208 (181)	14.4-49.8 (30.3)	352-928 (608)
II	Uchana, Julana	7.6-8.8 (8.1)	0.08-1.14 (0.46)	0.21-0.62 (0.41)	139-272 (207)	11.4-36.0 (21.3)	368-800 (579)
III	Safidon, Rajond	7.9-8.3 (8.1)	0.27-1.14 (0.51)	0.38-0.73 (0.54)	188-305 (236)	7.0-67.8 (34.0)	416-912 (617)
1975-76							
I	Narwana, Kaiyat	8.1-8.6 (8.2)	0.20-0.70 (0.42)	0.106-0.405 (0.213)	84-406 (242)	15.0-27.8 (19.4)	480-840 (682)
II	Uchana, Julana	8.0-8.4 (8.1)	0.30-4.00 (0.35)	0.180-0.430 (0.289)	126-490 (291)	9.9-27.5 (15.1)	225-780 (449)
III	Safidon, Rajond	7.5-8.6 (8.0)	0.25-1.00 (0.53)	0.080-0.465 (0.313)	98-430 (228)	7.8-26.0 (15.6)	345-1120 (701)
1976-77							
I	Narwana, Kaiyat	7.70-8.40 (8.1)	0.25-0.90 (0.30)	0.02-0.17 (0.10)	114-245 (184)	8-24 (15)	336-592 (456)
II	Uchana, Julana	7.70-8.45 (8.1)	0.25-1.00 (0.35)	0.08-0.78 (0.20)	154-340 (224)	11-20 (17)	312-640 (437)
III	Safidon, Rajond	8.09-9.05 (8.0)	0.20-1.75 (0.52)	0.03-0.35 (0.15)	100-392 (257)	6-23 (15)	336-664 (530)

Figures in parentheses are average values.

TABLE 2

Effect of various levels of N, P and K on the bajra and wheat responses in a fixed crop rotation of bajra-wheat

Treatments	Nutrients applied (kg/ha)		Kharif yield	*Additional* yield in kharif	*Rabi* yield	*Additional* yield in rabi	Total mean yield	Total additional yield	% increase over control	Grain/nutrient ratio
	Kharif	Rabi								
T_1	$N_0P_0K_0$	$N_0P_0K_0$	9.74	—	21.40	—	31.14	—	—	—
T_2	$N_{120}P_{60}K_{60}$	$N_{120}P_{45}K_{60}$	24.13	14.39	51.94	30.54	76.07	44.93	144	9.36
T_3	$N_{90}P_{45}K_{45}$	$N_{120}P_{60}K_{60}$	20.22	10.48	50.24	28.84	70.46	39.32	126	9.36
T_4	$N_{90}P_{90}K_0$	$N_{90}P_0K_{90}$	21.96	12.22	38.89	17.49	60.85	29.71	95	8.25
T_5	$N_{90}P_0K_{90}$	$N_{90}P_{90}K_0$	18.53	8.79	46.28	24.88	64.81	33.67	108	9.35
T_6	$N_{60}P_{30}K_{30}$	$N_{90}P_{90}K_0$	18.32	8.58	46.01	24.61	64.33	33.19	106	11.06
T_7	$N_{60}P_{60}K_0$	$N_{90}P_{45}K_{45}$	19.24	9.50	40.77	19.37	60.01	28.87	93	9.62
T_8	$N_{60}P_0K_{60}$	$N_{60}P_{60}K_0$	16.75	7.01	40.39	18.99	57.14	26.00	84	10.86
T_9	$N_{60}P_{30}K_{30}$	$N_{60}P_{30}K_{30}$	18.04	8.30	37.81	16.41	55.85	24.71	79	10.29
T_{10}	$N_{60}P_0K_0$	$N_{60}P_{30}K_{30}$	15.68	5.94	38.70	17.30	54.38	23.24	75	12.91
	C. D. at 5%		1.58		3.69					

All yield data are in q/ha.

*Additional grain yield.

Bhumbla (1976) and Roy and Kanwar (1979).

A critical evaluation of treatments T_4 and T_5 (Table 2) indicated that mode of P application was important in these soils. Ninety kg P_2O_5/ha was applied through both the treatments to bajra-wheat rotation. But in T_4, 90 kg P_2O_5 was applied during **kharif**, whereas in T_5, the same quantity was applied during **rabi**. Application of N was basal in both the treatments and crops. A significantly higher yield of wheat (46.3 q/ha) was obtained with T_5 over T_4 (38.9 q/ha). This indicated that a direct application of P was much superior to its residual effect. These findings are in confirmation with the results obtained by Sharma and Saxena (1966). Total amount of grain produced during **kharif and rabi** was 4.0 q/ha higher when 90 kg P_2O_5 was applied to **rabi** crop.

A comparison of treatments T_8 and T_9 also confirmed that application of P during **rabi** was more remunerative. When 60 kg P_2O_5/ha was applied to wheat alone instead of 30 kg to bajra and 30 kg to wheat, 2.6 q/ha more wheat grain was obtained. These results indicate that P application was more remunerative when applied to **rabi** only and residual effect could not increase the yield substantially. Goswami and Singh (1976) also favoured phosphate application during **rabi** in bajra-wheat rotation. The lack of P response to bajra may be attributed to more availability of Fe-P, and Al-P during **kharif**.

In treatment T_6, the total quantities of N and K were reduced by 30 kg N and 60 kg K_2O/ha, respectively, while the P dose was enhanced by 30 kg P_2O_5/ha, in comparison to T_5. It is evident from the data that the total grain yield remained almost same. Data showed that bajra did not respond to K application nor there was any residual effect of K on wheat crop because the soils were high in native K. Formali *et al.* (1977) also observed no response to K application in rice-wheat rotation.

Application of 1 kg of nutrient produced 15.83 kg of wheat grain, whereas only 9.90 kg of bajra, which indicated that application of fertilizers was more economical in wheat as compared to bajra crop.

It is evident from the data that under resource constraints bajra may be grown only with 60 kg N/ha without P and K, whereas wheat should be grown with 60 kg N alongwith 30 kg each of P_2O_5 and K_2O/ha.

The per cent yield increase over control was highest (144.0%) with the highest fertilizer level and lowest (75.0%) with the lowest level. The average highest grain/nutrient ratio (12.91) was obtained with lowest fertilizer level (T_{10}) clearly indicating more net remuneration with lower level of balanced fertilization in wheat and only N fertilization in bajra crop. The average lowest grain/nutrient ratio (8.25) was recorded with T_4, in which a very high dose of P (90 kg P_2O_5/ha) was applied to **kharif** crop and no P was applied to **rabi** crop, clearly pointing out no residual response of P in these soils due to their high P fixation capacity. It is also clearly revealed from the data

that with very limited availability of fertilizers, it would be more remunerative to use fertilizers in more area than to a limited one.

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GENETIC VARIABILITY AND HERITABILITY STUDIES IN TOMATO IN RELATION TO QUALITY CHARACTERS UNDER HIGH TEMPERATURE CONDITIONS

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ABSTRACT

Sixty genotypes of tomato were evaluated in relation to quality characters under high temperature conditions with two summer plantings. Variety Monarch had maximum locule number per fruit. Maximum seeds were found in the fruits of Pusa Ruby and TAMU-Saladette. Vitamin C content was highest in Monarch Pondorosa in March planting and in HS-101 M_3, Tomato No. 232 and Pusa Lal in June planting. Maximum T. S. S. was recorded in Resistant-2, Sioux, Red Plum and Improved Meeruti. Highly acidic fruits were of HS-101 M_3, Mikado and S-12×73-1-F_1; while TAMU-Saladette and Tomato No. 2972 were having least acidic fruits. Both genotypic and phenotypic components of variance were increased during June planting for all the characters except Vitamin C and acidity. Heritability estimates were high for all the characters in March planting with increased trend in June planting except for number of locules per fruit, seed content and acidity. High heritability coupled with low genetic advance almost for all the characters under study suggested the involvement of non-additive gene action in their inheritance which can be exploited through heterosis breeding.

Tomato is well known for its nutritive value among important vegetable crops. Fruit quality in relation to vitamin C content, particularly in tomatoes is very important because they are consumed raw also. The quality in tomato is judged by its ascorbic acid, sugar, total soluble solids, acidity and lycopene contents. The chemical composition in tomatoes varies greatly with the variety, soil and climatic conditions in which they are grown (Jayadeviah *et al.*, 1965). Significant varietal differences in total soluble solids, acid content and ascorbic acid have also been reported by Arora *et al.* (1975) and Singh *et al.* (1969). However, these informations are available in normal season tomato only. The present investigation was aimed to study the components of heritable and non-heritable variation of quality characters in a collection of tomato varieties raised under high temperature conditions (Table 1).

TABLE 1

Average maximum and minimum temperature of Hissar for the experimental period in 1976

Month	Highest day temp. (°C)	Mean max. temp. (°C)	Highest night temp. (°C)	Mean max. temp. (°C)
February	27.1	22.6	13.7	8.6
March	31.5	27.8	16.6	10.5
April	41.8	34.9	22.5	15.9
May	43.3	39 4	26.7	22.1
June	45.2	38.0	31.6	25.2
July	42.3	36.6	30.5	26.3
August	36.3	32.5	26.1	24.6
September	35.6	33.8	25.6	22.2
October	37.1	34.4	20.0	16.1

MATERIAL AND METHODS

A collection of sixty exotic and indigenous tomato varieties was grown at the Vegetable Research Farm of Haryana Agricultural University, Hissar in a randomised block design with three replications and two planting dates (March 25 and June 20) during summer season of the year 1976-77. The rows and plants were spaced 60 and 45 cm apart, respectively. Treatments consisted of two rows each 3.6 m long in a repeat. Red ripe fruits from randomly selected five competitive plants were taken for the study of quality characters. The observations were recorded on number of locules/fruit, seed content (g) per kg fruit weight, vitamin C content (mg/100 g edible fruit weight), T. S. S. (%) and acidity (g citric acid/100 ml fruit juice). Statistical analysis of data was carried out for coefficient of variation according to Burton (1952), heritability in broad sense (Lush, 1949), being a ratio of genotypic and phenotypic variance, was calculated as suggested by Burton and De Vane (1953) and the expected genetic advance was estimated according to Johnson *et al.* (1955) and Allard (1960).

RESULTS AND DISCUSSION

Mean performance of the varieties for different characters has been given in Table 2. Maximum number of locules per fruit were observed in variety Monarch and minimum number in case of Kalyanpur Angurlata in both plantings. However, Tomato No. 2972 recorded least number of locules for March planting and Tomato No. 1076 for June planting. In general, March planting reduced the number of locules while June planting increased it which confirm the results of Saito and Ito (1971). The effect of season and variety on locule number is difficult to explain. Varieties Pusa Ruby and TAMU-Saladette had maximum seed content in both plantings. Monarch also recorded high seed content in both plantings while Improved Meeruti only

TABLE 2

Mean performance of tomato varieties for various quality characters under high temperature conditions for two planting dates

S. No.	Variety	Number of locules per fruit		Seed content (g/kg fruit wt.)		Vit. C content (mg/100 g fruit)		Total soluble solids (%)		Acidity (g citric acid/ 100 ml juice)	
		M	J	M	J	M	J	M	J	M	J
1	2	3	4	5	6	7	8	9	10	11	12
1.	Pusa Ruby	5.1	5.2	8.1	8.6	21.5	22.9	5.3	5.3	1.72	1.09
2.	TAMU Saladatte	3.7	3.6	7.6	7.7	24.4	23.9	4.5	5.3	0.84	0.92
3.	Ox-heart	4.9	5.3	4.1	4.2	19.9	18.4	5.3	5.1	1.52	0.88
4.	HS-102	3.6	3.9	5.2	5.8	21.7	21.2	5.0	4.9	1.93	0.91
5.	Panaco	3.6	4.1	3.4	4.3	18.5	23.5	4.3	5.7	1.77	0.68
6.	Pusa Lal Meeruti	3.5	4.2	5.2	5.4	21.6	23.9	6.0	4.8	2.05	0.90
7.	HS-101	3.5	4.2	6.8	5.3	19.5	21.2	5.5	6.1	2.03	1.20
8.	Pusa Early Dwarf	4.1	4.7	4.8	5.8	22.0	22.5	5.7	5.8	1.45	1.00
9.	Pusa Lal	3.7	4.2	6.7	5.9	20.2	25.1	5.9	5.7	2.08	0.89
10.	Cherry	4.0	4.3	5.5	5.9	18.6	20.0	6.4	5.5	1.99	0.81
11.	Kalayanpur Kuber	5.5	5.4	4.0	5.9	22.8	20.9	5.5	4.9	2.07	1.15
12.	Kalyanpur Type-1	4.4	4.7	4.6	6.2	20.1	22.1	6.0	5.9	2.58	1.06
13.	HS-101 M_3	4.2	4.6	6.3	6.8	25.2	25.3	6.0	6.7	2.68	1.05
14.	Pusa Ruby × S-12 F1	3.9	4.2	4.7	6.4	20.6	22.4	5.5	6.1	1.50	1.19
15.	SI 120 × HS 101 F1	4.0	4.2	6.5	6.6	17.6	22.1	5.4	5.2	1.43	0.99
16.	Italian Red	3.5	4.1	5.2	5.5	22.7	20.1	5.5	5.5	1.60	0.73
17.	Kalyanpur Angurlata	2.2	3.0	4.0	4.4	16.9	19.6	4.6	6.5	1.33	0.88
18.	Pusa Rubi (Pocha)	3.7	4.0	4.8	5.7	17.1	24.5	5.2	5.7	1.58	1.06
19.	H S 103	3.9	4.6	6.1	5.7	22.0	24.4	5.2	6.9	1.48	1.07
20.	Marglobe Standard	5.1	5.1	5.5	6.6	14.6	21.1	5.8	5.6	1.47	0.96
21.	63 V. F.-21	4.3	4.6	5.4	5.6	21.7	21.9	5.3	5.6	1.26	1.05
22.	Pritchard	6.0	5.8	5.4	6.1	22.4	19.4	6.1	6.0	1.72	1.37
23.	Resistant-2	4.0	4.2	5.9	7.3	19.5	22.7	7.2	5.7	1.34	0.89
24.	Tomato No. 1076	2.5	2.9	4.1	4.4	19.0	22.8	5.0	5.8	1.56	0.73
25.	„ „ 283	3.5	3.8	4.2	4.3	22.2	16.7	4.9	6.5	1.66	0.83
26.	„ „ 2872	2.1	3.4	3.2	4.5	21.7	16.4	6.0	5.1	2.01	0.52
27.	„ „ 232	2.6	3.2	5.7	5.8	21.1	25.3	5.1	4.5	1.47	0.93
28.	„ „ 3716	4.0	4.1	3.1	4.2	15.7	20.2	6.3	6.7	1.50	1.19
29.	„ „ 3693	2.7	3.4	3.1	4.3	21.8	17.5	5.9	6.1	1.62	1.29
30.	„ „ 226	2.9	3.2	2.9	3.3	22.6	23.5	5.2	5.1	2.46	1.17
31.	„ „ 3690	2.7	3.1	2.1	2.4	22.0	23.1	4.8	5.8	1.37	0.98
32.	„ „ 3692	3.1	3.3	2.0	3.1	21.7	19.8	4.7	5.0	1.56	1.05

1	2	3	4	5	6	7	8	9	10	11	12
33.	V-391	5.0	5.2	5.3	5.9	21.1	19.4	5.5	5.7	1.81	1.28
34.	Sel-4-1	4.0	4.5	5.6	5.9	20.8	21.3	5.4	5.3	1.93	1.17
35.	Red Pear	3.6	3.7	6.2	6.4	21.0	22 7	4.7	5.1	1.45	0.79
36.	Pantnagar Hybrid No. 14	4.0	4.3	6.2	6.7	18.7	20.9	6.2	6.0	2.16	1.05
37.	Sioux	5.6	5.5	5.5	6.5	21.1	22.9	5.8	7.0	1.86	1.34
38.	Best of all (Sutton)	3.6	4.2	5.1	6.1	18.3	21.1	5.8	5.1	1.73	0.96
39.	Hybride 42128	3.7	3.9	5.1	6.0	21.6	19.7	5.5	5.0	1.39	1.01
40.	Monarch	6.3	6.0	7.3	8.2	20.3	21.7	4.8	5.4	1.37	0.85
41.	Red plum	3.9	4.3	6.3	6.3	17.5	19.2	6.4	7.0	2.11	1.00
42.	Monarch Pondorosa	3.9	4.0	6.3	7.0	27.8	21.4	5.9	6.0	2.03	1.19
43.	Mikado	6.2	5.8	4.6	4.9	20.3	21.1	5.4	5.9	2.75	1.00
44.	Sweet-72	4.2	4.7	4.4	6.6	22.6	22.8	5.5	5.0	2.31	0.79
45.	Improved Meeruti	4.2	4.3	5.9	7.7	19.2	23.8	5.0	7.1	1.17	1.13
46.	Marglobe Supreme	3.8	4.1	6.4	7.1	20.9	20.9	5.6	5.9	2.69	1.06
47.	Italian Red Pear	2.9	3.0	6.4	7.0	21.7	19.9	5.2	5.3	1.00	0.99
48.	S-12×73-1 F1	5.0	4.9	5.5	6.7	21.9	21.0	5.0	6.1	2.75	1.02
49.	SL 120	3.4	4.1	6.9	7.0	22.8	20.6	4.7	6.6	1.74	1.00
50.	Bonny Best	4.0	4.2	6.3	7.0	18.2	19.8	5.1	5.9	1.60	1.00
51.	S-12	4.0	4.0	5.0	6.3	20.7	21.3	5.6	6.6	1.76	0.85
52.	Pb. Tropic×Imp. Meeruti F1	4.1	4.1	4.9	5.3	19.1	21.4	5.5	5.3	2.10	1.10
53.	HS-110	3.0	3.1	5.0	6.2	20.0	19.8	4.9	4.9	1.90	0.64
54.	SI 152	2.9	3.7	5.6	5.7	18.6	22.6	5.2	4.7	1.75	0.98
55.	104 S	3.7	4.0	4.6	6.3	18.6	21.6	5.2	5.3	1.86	0.89
56.	Grothens Globe	3.1	3.5	4.9	5.4	21.3	19.6	5.3	4.9	1.78	0.97
57.	Chameli Red Plum	2.9	3.3	5.6	6.3	23.2	21.3	6.0	6.8	2.01	0.80
58.	HS-104	4.1	4.3	6.2	6.5	22.8	22.8	4.6	5.0	1.39	0.92
59.	V-114	4.2	4.2	4.6	6.2	22.3	22.4	5.1	5.3	1.16	1.27
60.	Punjab Chhuhara	3.7	4.1	5.1	5.4	21.6	22.6	5.2	5.4	1.77	0.83
	Mean	3.9	4.2	5.2	5.9	20.7	21.5	5.4	5.6	1.76	0.99
	C. D. at 5%	0.7	1.5	0.9	1.6	2.8	2.2	0.7	0.6	0.26	0.14

for June planting. Tomato No. 3690 and Tomato No. 3962 were found to have least seed content. March planting reduced the seed content of varieties while June planting favoured it which was also confirmed by Imanishi and Hiura (1975). The probable reason for reduced seed content of fruits in March planting may be the adverse effect on pollination and fertilization of female gametes. As regards ascorbic acid (vitamin C) content Monarch Pondorosa

during March planting and varieties HS-101 M_3, Tomato No. 232 and Pusa Lal in June planting gave best performance. Minimum vitamin C content was recorded for Marglobe standard and Tomato No. 3716 during March planting and Tomato No. 2972 and Tomato No. 283 during June planting. Comparison of two planting dates on ascorbic acid content showed that March planting reduced the vitamin C content, whereas it was slightly higher in June planting. These findings are parallel to the earlier work of Glushchenko and Strekalova (1975) who found decreased vitamin C content in the warmer climate. Orzolek and Angell (1975) also reported low ascorbic acid in May planting towards the end of harvesting season. The probable reason for decreased amount of ascorbic acid during March planting might be the greater breakdown of the chemical reactions involved in the glycolysis which disturb the metabolic processes and pathways interfering in the attainment of the production of ascorbic acid. Highest T. S. S. per cent during March planting was recorded in Resistant-2 and during June planting for Improved Meeruti, Sioux and Red Plum. Panaco and Tomato No. 232 had minimum T.S.S. in March and June plantings, respectively. Arora *et al.* (1975) reported marked differences in T. S. S. among varieties. However, Hashad *et al.* (1958) reported higher total soluble solids in summer crop than in autumn crop. Orzolek and Angell (1975) found increased T. S. S. in some varieties when planted on May 15th, which confirmed the earlier work of Hashad *et al.* (1958). Fruits of Mikado, S-12×73-1 F_1 and Marglobe supreme had highest acidity during March planting while Pritchard and Sioux had highest content during June planting. Fruits of TAMU-Saladette and Tomato No. 2972 in respective plantings were minimum in acidic content. Varietal differences in the acid content were also reported by Lower (1964). Carlson (1975) reported higher content of citric acid in summer crop. Mandy (1966) recorded 2-4 times more citric acid content in warmer season than cool weather prevailing during the growing season. The results of the present investigation reveal that acidity was highest during March planting as compared to June planting. Similar findings were also reported by Mandy (1966). However, these findings were in contrary to the work of Hashad *et al.* (1958) who found higher acid content of fruits from autumn crop than in summer. The increase in the acidity of fruits during March planting may be due to the adverse effect of high temperature which inhibited the metabolic pathway by inactivating enzyme Aconitase (responsible for conversion of citric acid into isocitric acid in TCA cycle) resulting in the accumulation of citric acid under stress conditions. It is obvious from the comparison of mean of genotypes that no one variety was perfect in all the characters. A variety should contain higher vitamin C and low acidic content for table use, whereas for processing a variety with higher acidity is desirable.

General mean, range, treatment variance, genotypic variance, phenotypic variance, heritability and genetic advance are presented in Table 3. Treatment variance was highly significant for all the characters in both plantings suggesting a

TABLE 3

Components of variance, estimates of heritability and genetic advance for different characters in tomato

Character	Planting date	Mean	Range	Treatment variance	Phenotypic variance	Genotypic variance	Coefficients of variation		Heritability (broad sense) (%)	Genetic advance	Genetic advance as a per cent of mean
							Phenotypic (PCV)	Genotypic (GCV)			
Number of locules per fruit	March	3.90	0.4—6.3	2.48**	0.96	0.77	24.95	22.45	80.99	1.62	41.63
	June	4.20	2.9—6.0	1.63**	1.15	0.24	25.54	11.66	20.87	0.46	10.98
Seed content (g/kg fruit wt.)	March	5.20	2.0—8.1	4.71**	1.52	1.47	23.72	23.29	96.20	2.44	46.99
	June	5.91	2.4—8.6	4.24**	2.11	1.66	24.62	19.48	50.24	1.50	25.48
Vitamin C content (mg/100g fruit)	March	20.72	14.6—27.8	14.98**	6.99	3.99	12.76	9.65	57.21	3.12	15.03
	June	21.51	16.4—25.3	11.37**	5.01	3.18	10.41	8.29	63.47	2.93	13.62
Total soluble solids (%)	March	5.40	4.3—7.2	0.89**	0.41	0.24	11.86	9 07	58.54	0.77	14.29
	June	5.68	4.5—7.1	1.28**	0.53	0.37	12 82	10.76	69 81	1.05	18.43
Acidity (g citric acid per 100 ml juice)	March	1.76	0.8—2.8	0.55**	0.20	0.17	25.54	23.65	85 64	0.79	45.01
	June	0.99	0.5—1.4	0.10**	0.05	0.03	18 79	16.63	78.32	0.30	30.31

**Significant at 1 per cent.

March=25th March and June=20th June, 1976.

wide range of variation among genotypes and a good scope of selection for improvement. The population mean was higher during June planting than March planting for all the characters except acidity content. For vitamin C and acidity contents both genotypic and phenotypic variances were low in June planting as compared to March planting. However, for number of locules per fruit in June planting the genotypic variance was also low. For rest of the characters under study an increasing trend was observed for both the components of variance. Similar trend was also observed for coefficient of variation. Genotypic and phenotypic variances were high for vitamin C content while the coefficients of variation were high for seed content, acidity and number of locules per fruit. Heritability estimates (in broad sense) were high for all the characters for March planting. These estimates were increased during June planting except for number of locules per fruit, seed content and acidity. The genetic advance was found to be low for all the characters. Genetic advance as a per cent of mean was high for seed content, acidity and number of locules per fruit in March planting. High heritability estimate associated with low genetic advance for all characters suggested the role of non-additive gene action in their inheritance (Panse, 1957). In order to improve the characters under investigation heterosis breeding followed by selection in desired direction is advocated.

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EFFECT OF YAMUNA FLOOD ON THE AVAILABILITY OF NUTRIENTS IN SOILS

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ABSTRACT

Soil samples from 0–15 and 15–30 cm depths were collected from the flood affected areas of Haryana State after an unusual heavy flood of Yamuna river in 1978. These soils were found low to medium in available N and low to high in availeble P and K. Availability of Mn, Fe and Cu were sufficiently high while availability of Zn varied from deficient to sufficient status.

On comparing with the unaffected soils, the availability of all the nutrients decreased considerably in the soils where sand deposition occurred. The eroded soils also showed a decrease in the availability of N, P, K_2O and Zn but to a lesser extent as compared with sand deposition, while the availability of Fe, Mn and Cu increased in eroded soils. Silt deposition and water flooding both, showed an increase in available N, Fe, Mn and Cu but a decrease in available P. The availability of K_2O and Zn was slightly increased under water flooding only.

Heavy floods, generally, damage the standing crops in the affected areas besides the loss of property and lives of animals and human beings. Floods affect the land, as at some places the soil is eroded, whereas at other places there may be silt or sand deposition, while some areas remain under flood water for a period of days. In all these situations, the fertility of the surface soil is likely to be affected. The present study was undertaken to evaluate the impact of Yamuna flood on the availability of nutrients in soils in the affected area.

MATERIAL AND METHODS

Yamuna flood-plain of Haryana occupies an area of about 16,000 hectares along the western side of Yamuna river in the districts of Ambala, Kurukshetra, Karnal and Sonepat. The width of the plain varies from 3 to 16 km from the river bank. An unusual heavy flood in Yamuna river was experienced in the rainy season of 1978. This flood caused a severe soil erosion and heavy depositions of sand and silt at many places and the larger areas remained submerged under 4 to 5 feet flowing water for 4–5 days leaving behind a very thin layer of finer soil particles on the ground.

Soil samples were collected from 0–15 and 15–30 cm depths after thorough traversing the affected area starting from Chhachhroli block of Ambala dist-

rict to Rai block of Sonepat district. The soil samples were taken from different sites such as eroded lands, sand and silt deposition, flooded lands and nearby unaffected land. Soil samples were prepared for analysis after passing through 2 mm sieve.

Soil texture was determined by feel method (USDA, 1951). Soil pH and electrical conductivity were measured in 1 : 2 soil-water suspension using Elico-pH meter and conductivity bridge, respectively. The organic carbon as an index of available nitrogen and phosphorus were estimated by the methods of Walkley and Black (1934) and Olsen *et al.* (1954), respectively. The available potash was estimated in neutral 1 N-ammonium acetate extract using flame-photometer. Available zinc, manganese, iron and copper were analysed on atomic absorption spectrophotometer in DTPA extract (Lindsay and Norvell, 1978).

Soil samples were distributed in low, medium and high categories for organic carbon, available phosphorus and potash, and deficient and sufficient categories for available zinc, manganese, iron and copper as per limits given in Table 1. For available nitrogen (O.C.%), phosphorus and potash, the nutrient indices of the area were calculated as the weighted average of the per cent samples falling in low, medium and high categories after multiplying them by 1, 2 and 3, respectively (Ramamoorthy and Bajaj, 1969). Similarly, for available zinc, manganese, iron and copper, the per cent samples falling in deficient and sufficient categories, were given the weightage of 1 and 2, respectively. Nutrient index value below 1.67 was considered low, between 1.67 to 2.33 as medium and above 2.33 as high in respect to available nitrogen, phosphorus and potash, while the value upto 1 50 was considered deficient and above 1.50 as sufficient in respect to available zinc, manganese, iron and copper.

RESULTS AND DISCUSSION

The soils of flood affected area (Table 2) have no problem of excess

TABLE 1

Limits for different categories of nutrients

Nutrients	Categories			Reference
	Low	Medium	High	
Organic carbon (%)	<0.40	0.40-0.75	>0.75	Anonymous (1980)
Available P (kg/ha)	<10	11-20	>20	Anonymous (1980)
Available K_2O (kg/ha)	<125	125-300	>300	Anonymous (1980)
	Deficient		**Sufficient**	
Available Zn (ppm)	<0.6		>0.6	Gupta *et al.* (1981)
Available Mn (ppm)	<1.0		>1.0	Lindsay and Norvell (1978)
Available Fe (ppm)	<2.0		>2.0	Lindsay and Norvell (1978)
Available Cu (ppm)	<0.2		>0.2	Lindsay and Norvell (1978)

TABLE 2

Physico-chemical properties and available nutrients status of soils of flood affected area

District	Block	Depth (cm)	Number of samples	Texture*	pH (1 : 2)	E. C. (1 : 2) (mmhos/cm)	O. C. (%)	P (kg/ha)	K_2O (kg/ha)	Zn (ppm)	Mn (ppm)	Fe (ppm)	Cu (ppm)
Ambala	Chhachhroli	0–15	7	S. L.	7.7	0.15	0.26	20.1	114	0.64	8.40	8.08	1.18
		15–30	7	S. L.	8.1	0.13	0.23	21.0	102	0.76	7.68	13.69	1.23
Ambala	Jagadhari	0–15	10	L. S.	8.5	0.14	0.30	29.0	118	0.94	8.20	19.37	1.48
		15–30	8	S. L.	8.5	0.12	0.22	20.4	111	0.67	6.70	11.55	1.28
Kurukshetra	Shahbad	0–15	7	L.	8.4	0.17	0.33	29.0	285	0.62	4.28	10.18	1.13
		15–30	7	L.	8.2	0.16	0.32	32.0	248	0.74	5.05	10.86	1.21
Kurukshetra	Radaur	0–15	20	S. L.	8.3	0.16	0.34	28.0	140	0.92	5.53	8.99	1.09
		15–30	19	L. S.	8.3	0.13	0.29	24.6	116	0.99	5.05	8.70	1.10
Kurukshetra	Thanesar	0–15	6	S. L.	8.5	0.30	0.25	22.5	182	0.48	4.28	7.17	0.81
		15–30	6	L.	8.7	0.41	0.19	22.8	158	0.64	4.01	4.75	0.72
Karnal	Karnal	0–15	108	C. L.	8.3	0.08	0.49	14.7	267	0.94	14.00	21.73	2.84
		15–30	108	C. L.	8.5	0.08	0.44	22.9	258	0.82	10.60	20.61	2.56
Karnal	Gharonda	0–15	30	C. L.	8.4	0.13	0.43	10.6	295	0.97	8.73	19.19	2.75
		15–30	30	C. L.	8.4	0.10	0.39	10.4	248	0.82	7.53	17.98	2.79
Karnal	Panipat	0–15	35	L.	8.5	0.05	0.35	12.9	209	0.59	13.56	17.04	2.29
		15–30	31	L.	8.4	0.04	0.31	13.3	207	0.49	10.25	14.39	1.98
Karnal	Samalkha	0–15	31	L.	8.5	0.10	0.41	11.6	256	0.59	12.89	18.15	2.30
		15–30	30	L.	8.5	0.09	0.37	9.1	269	0.49	11.89	17.73	2.18
Sonepat	Ganaur	0–15	13	L.	8.5	0.25	0.34	19.9	381	0.42	8.02	11.54	1.19
		15–30	12	C. L.	8.6	0.26	0.34	22.2	373	0.41	10.76	12.21	1.54
Sonepat	Sonepat	0–15	43	S. L.	8.6	0.32	0.40	19.5	317	0.41	6.70	9.05	1.24
		15–30	42	L.	8.7	0.32	0.36	20.5	304	0.44	6.51	8.39	1.20
Sonepat	Rai	0–15	16	S. L.	8.5	0.23	0.46	23.8	386	0.48	7.35	9.83	1.49
		15–30	18	S. L.	8.5	0.22	0.41	20.3	370	0.44	6.86	8.75	1.23

*L.S. = Loamy sand; S. L. = Sandy loam; L. = Loam; C. L. = Clay loam.

sodicity or salinity. The predominant texture of soils varied from loamy sand in Jagadhari block to clay loam in Karnal and Gharonda blocks, while rest of the blocks had loam or sandy loam soils. The average organic carbon content of surface soils varied from 0.25 to 0.49 per cent in various blocks. The sub-surface soils, generally, had lower organic carbon content as compared with surface soils, which varied from 0.19 to 0.44 per cent. Available phosphorus content varied from 10.6 to 29.0 kg P/ha in surface soils and 9.1 to 32.0 kg P/ha in sub-surface soils. Available potash, K_2O, content varied from 114 to 386 kg/ha in surface soils and 102 to 373 kg/ha in sub-surface soils. Available K_2O was lower in Ambala and Kurukshetra districts as compared with Karnal district and it was more in Sonepat district. Available Zn was found <0.50 ppm in Sonepat district while rest of the areas had >0.50 ppm. Available Mn, Fe and Cu contents were sufficiently high in all the soils and they were not likely to be depleted by crops in near future (Table 2).

Nutrient index for available N (Table 3) indicates that soils of all the blocks

TABLE 3

Nutrient indices of soils of flood affected area

Block	Depth (cm)	N	P	K	Zn	Mn	Fe	Cu
Chhachhroli	0–15	1.00	2.43	1.43	1.57	2.00	2.00	2.00
	15–30	1.00	2.00	1.29	1.57	2.00	2.00	2.00
Jagadhari	0–15	1.20	2.50	1.50	1.80	2.00	2.00	2.00
	15–30	1.00	2.25	1.38	1.50	2.00	2.00	2.00
Shahbad	0–15	1.43	2.71	2.29	1.43	2.00	2.00	2.00
	15–30	1.29	2.86	2.29	1.57	2.00	2.00	2.00
Radaur	0–15	1.40	2.90	1.60	1.60	2.00	2.00	2 00
	15–30	1.11	2.63	1.32	1.84	2.00	1.89	2.00
Thanesar	0–15	1.00	2.67	1.67	1.16	2.00	1.83	2.00
	15–30	1.00	2.83	1.67	1.50	2.00	2.00	2.00
Karnal	0–15	1.81	1.76	2.22	1.63	2.00	1.99	2.00
	15–30	1.61	1.73	2.13	1.48	2.00	1.98	2.00
Gharonda	0–15	1.50	1.40	2.30	1.60	2.00	2.00	2.00
	15–30	1.47	1.53	2.23	1.57	2.00	2.00	2.00
Panipat	0–15	1.34	1.69	1.91	1.31	2.00	2.00	2.00
	15–30	1.26	1.69	1.97	1.26	2.00	2.00	1.97
Samalkha	0–15	1.65	1.61	2.13	1.42	2.00	1.97	2.00
	15–30	1.33	1.47	2.10	1.23	2.00	2.00	2.00
Ganaur	0–15	1.31	2.08	2.77	1.15	2.00	2.00	2.00
	15–30	1.25	2.33	2.75	1.08	2.00	2.00	2.00
Sonepat	0–15	1.40	2.13	2.36	1.11	2.00	1.96	2.00
	15–30	1.29	2.11	2.30	1.20	2.00	2.00	2.00
Rai	0–15	1.68	2.50	2.69	1.13	2.00	2.00	2.00
	15–30	1.50	2.33	2.67	1.28	2.00	2.00	2.00

were low in available N except Karnal block which was rated as medium while Samalkha and Rai blocks had marginal values to be rated as low and medium, respectively. The areas in various districts might rank as Karnal >Sonepat >Kurukshetra >Ambala for available N status. Nutrient indices for available P for the districts of Ambala and Kurukshetra and Rai blocks fall in the high category, while the blocks of Sonepat, Ganaur, Panipat and Karnal were rated as medium and blocks of Gharonda and Samalkha were rated as low. Available potash index showed that it was low in Ambala and Kurukshetra districts, medium in Shahbad block and Karnal district and high in Sonepat district. Dixit *et al.* (1980) have shown these blocks as low in available N, low to high in available P and medium to high in available K_2O. The variations may be attributed to the fact that only the flood affected area of the block could be considered in the present study while whole area of the block was represented in that study.

Available micronutrient indices indicated that all the affected area was categorised as sufficient in respect to available Mn, Fe and Cu contents, while the blocks of Shahbad, Thanesar, Panipat and Samalkha and district Sonepat were deficient in available Zn only. Gupta and Dabas (1980) also showed these blocks in sufficient availability group for Mn, Fe and Cu and varying in availability of Zn only.

In comparison to the unaffected soils, the sand deposits contained extremely low amounts of all the available nutrients (Table 4) because fresh alluvial sand particles contained very little amount of organic matter, clay minerals and other nutrients bearing minerals. In case of eroded soils, the more fertile surface layers were washed away and sub-surface soils were exposed. The sub-surface soils generally contained lesser amounts of organic matter, available P, K_2O and Zn and higher amounts of available Mn, Fe and Cu. The increase in the availability of Mn and Fe in the sub-surface

TABLE 4

Physico-chemical properties and available nutrients status of different types of flood affected soils

Flood effect	Depth (cm)	Number of samples	O.C (%)	P	K_2O	Zn	Mn	Fe	Cu
				(kg/ha)		(ppm)			
Soil erosion	0-15	24	0.27	14.8	221	0.51	6.41	11.89	1.34
	15-30	23	0.25	14.9	194	0.58	6.83	10.04	1.37
Sand deposition	0-15	5	0.12	8.0	129	0.46	4.00	5.65	0.76
	15-30	5	0.08	8.0	77	0.32	3.57	4.14	0.60
Silt deposition	0-15	47	0.44	18.4	236	0.72	15.23	18.58	2.12
	15-30	48	0.37	17.7	222	0.59	10.12	13.14	1.81
Water flooding	0-15	220	0.43	14.5	259	0.76	7.14	17.51	2.33
	15-30	219	0.35	14.3	267	0.68	9.35	17.20	2.22
Unaffected	0-15	32	0.38	27.2	234	0.70	6.15	8.06	1.18
	15-30	29	0.33	28.4	235	0.69	5.35	8.23	1.05

soils might be ascribed to the more favourable conditions of their reduction (Ponnamperuma, 1972). Silt deposits contained more organic carbon and available Mn, Fe, and Cu and lower amount of available P, whereas almost the same amounts of available K_2O and Zn were found as in the unaffected soils. Water flooding also showed an increase in organic carbon and available Mn, Fe and Cu but to a lesser extent than silt deposits. There was a slight increase in available K_2O and Zn and more decrease in available P in case of water flooding than silt deposits (Table 4).

The increase in the amounts of available Mn, Fe and Cu may be expected as a result of deposition of finer soil particles carried by flood water from the catchment areas. The flood water usually washed away and carried the finer soil particles which were more fertile than the bulk of the soil body. The decrease in available P may be possibly due to conversion into lesser extractable forms or physical adsorption. The decrease in available P as a result of Yamuna flood has also been reported by Ghosh *et al.* (1979) in Dinpur and Chhawla villages of Union Territory of Delhi. Flooding of the soils was generally expected to increase the amount of available P as reported by several workers but the flooding by a river may not have the similar effect as the flooding of dry soils. However, this needs further investigation to explain the decrease in available P in Yamuna flood affected soils.

The unaffected soils were categorised as low, high and medium in available N, P and K_2O, respectively, and sufficient in available Zn, Fe, Mn and Cu based on their nutrient indices values. These values for available Mn, Fe and Cu of the flood affected soils did not vary and fell in sufficient category while available Zn index showed variation and fell in deficient category (Table 5). Sand deposits had the lowest values and were categorised as low in available N, P and K_2O,

TABLE 5

Nutrient indices of different types of flood affected soils

Flood effect	Depth (cm)	N	P	K	Zn	Mn	Fe	Cu
Soil erosion	0-15	1.12	1.91	1.96	1.29	2.00	1.96	2.00
	15-30	1.13	1.91	1.74	1.39	2.00	1.96	2.00
Sand deposition	0-15	1.00	1.20	1.20	1.20	2.00	2.00	2.00
	15-30	1.00	1.20	1.20	1.00	1.80	1.80	2.00
Silt deposition	0-15	1.70	2.14	1.98	1.49	2.00	1.96	2.00
	15-30	1.73	2.20	1.96	1.42	2.00	2.00	1.98
Water flooding	0-15	1.61	1.81	2.31	1.45	2.00	2.00	2.00
	15-30	1.47	1.75	2.21	1.38	2.00	2.00	2.00
Unaffected	0-15	1.37	2.57	2.12	1.50	2.00	1.97	2.00
	15-30	1.28	2.48	2.13	1.55	2.00	1.93	2.00

while water flooded and eroded soils had been categorised as low in available N and medium in available P and K_2O though the values of indices were lower in eroded soils than water flooded soils with the exception of available P only.

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EFFECT OF VARIOUS PLANT GROWTH REGULATORS ON VEGETATIVE GROWTH, SEX-EXPRESSION AND FRUIT YIELD IN SUMMER SQUASH (*CUCURBITA PEPO* L.)

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ABSTRACT

An investigation to study the influence of MH, NAA, GA and ethrel on the vegetative growth, flowering and yield of summer squash was conducted during 1979 and 1980. GA 25 ppm stimulated the elongation of main vine. Appearance of staminate flowers was delayed and pistillate flowers appeared early in the plants treated with ethrel as compared to control. Ethrel 100 and 250 ppm were effective in inducing female flower at lower node, increasing the number of female flowers and number of fruits and ultimately the yield. The same treatments suppressed the male flowers and male to female sex-ratio was lowered.

In cucurbits there is high correlation between the number of pistillate flowers and total yield. Several plant growth regulators have been tried to modify sex-expression in monoecious cucurbits. Iwahori *et al.* (1969) reported that sex-expression of cucumber can be altered by exogenous growth regulators, temperature and day length. Choudhary and Phatak (1960) observed that some chemicals like MH, NAA, IAA and 2, 4-D increase the production of female flowers in cucumber. These plant regulators have been successfully utilized not only to increase the number of female flowers but also the fruit set and ultimate yield (Bhandary *et al.*, 1974, Singh *et al.*, 1974). Little information is, however, available regarding the effect of these plant regulators on the sex-expression (Saimbhi, 1974) and yield of summer squash (*Cucurbita pepo* L.), a popular vegetable of Northern India. The present investigations were, therefore, carried out to study the effect of some plant regulators like maleic hydrazide (MH), napthalene acetic acid (NAA), gibberellic acid (GA), and ethrel (CEPA) on growth, sex-expression and yield of this vegetable.

MATERIAL AND METHODS

The investigations were conducted at the Vegetable Research Farm, Haryana Agricultural University, Hissar, during 1979 and 1980. The seeds of local monoecious variety "Hissar Selection-1" were grown on one side of 1 m wide and 4 m long raised beds with plant to plant spacing of 60 cm. The dates of sowing were 20th Feb. and 28th Feb. in 1979 and 1980, respectively. The treatments were 50 and 150 ppm MH, 50 and 100 ppm NAA, 10 and 25 ppm GA,

100 and 250 ppm ethrel and control (sprayed with canal water only). Two aqueous sprays of each treatment were made at 2 and 4 true leaf stages which had an interval of six days. Tween-20 @ 0.005% was used as surfactant. The experiment was laid out in a randomized block design with three replications. Recommended cultural practices were followed during the course of experimentation in both the years. The observations on the various growth characters were recorded at the time of final harvest.

RESULTS AND DISCUSSION

The length of main axis was significantly influenced by the treatments during both the years (Table 1). Based on the average of two years data the application of 25 ppm gibberellic acid followed by 10 ppm of the same chemical increased the height of the main vine, whereas 250 ppm ethrel showed the stunting of the vine length as compared to other treatments. Reduction in the height of plant with ethrel treatment may be attributed to its effect on the polar auxin transport (Randhawa and Singh, 1970; Saimbhi and Thakur, 1973).

None of the treatments influenced the internodal length during both the years. However, GA 25 ppm increased the length of the internode to a maximum which might have resulted in an increase in length of the vine. The number of branches were not influenced by any of the treatments. However, ethrel 100 ppm and 250 ppm improved the number of branches per plant. The lowest number of branches were recorded from water sprayed control plants.

Based on the average of two years data, maximum number of days and nodes to first male flowers were recorded in ethrel treatments (Table 1), whereas 50 ppm and 150 ppm MH resulted in the earlier appearance of male flowers at lower nodes. It was also very interesting to note that during both the years, minimum number of days and lowest node to first female flowers were recorded in ethrel treatments (Figs. 1 and 2) as compared to 100 ppm NAA which delayed the appearance of first female flower which appeared at higher node. Similar response of ethrel has been reported by several workers who observed that ethrel spray induced more number of female flowers at lower nodes in many cucurbits (Miller *et al.*, 1969; Sams and Kraeger, 1977). The results of present investigations are similar to that of Saimbhi (1974) in summer squash but contrary to the earlier work of Saimbhi and Thakur (1973) in squash melon who found delayed appearance of female flowers at the upper nodes with ethrel. Failure of ethrel to produce such results in squash melon is difficult to explain. It is, therefore, possible that this crop might be having different mechanism of sex control than the summer squash. The data further revealed that ethrel at all concentrations induced the female flower much earlier and at lower nodes (Figs. 1 and 2) which is in confirmity with the work of Miller *et al.* (1969) but contrary to the findings of Singh *et al.* (1974) who reported earlier node position of first female flowers in summer squash with 2500 ppm Alar.

The sex-ratio as indicated in Table 2 showed that, there was a suppression in

TABLE 1

Effect of plant growth regulators on vegetative growth and node to first staminate and pistillate flower in summer squash during 1979 and 1980

Treatment (ppm)	Length of main vine (cm)			Average internodal length (cm)	Average number of branches per plant	Number of node to first staminate flower			Number of node to first pistillate flower		
	1979	1980	Av.			1979	1980	Av.	1979	1980	Av.
Control	105.8	136.4	121.1	4.2	4.3	6.5	3.0	4.8	8.9	6.0	7.5
MH 50	113.3	135.3	124.3	4.4	4.7	2.4	2.7	2.6	6.3	6.3	6.3
150	112.9	128.5	120.7	4.4	5.2	3 0	2.1	2.6	6.5	5.1	5.8
NAA 50	106.9	140.3	123.6	4.9	4.6	6.5	7.1	6.8	6.9	6.4	6.7
100	108.8	113.2	111.0	4.3	4.5	5.7	4.9	5.3	8.9	10.2	9.6
GA 10	135.0	147.0	141.0	4.5	4.9	3.1	2.7	2.9	8.1	5.3	6.7
25	143.1	170.4	156.8	5.0	5.0	4.1	2.1	3.1	10.0	6.9	8.5
Ethrel 100	101.5	131.5	116.5	4.3	5 5	6.7	7.1	6.9	5.4	3.1	4.3
250	84.7	125.3	105.0	4.7	5.3	8.6	9.3	9.0	5.0	3.8	4.4
C. D. at 5%	25.9	26.3		NS	NS	2.0	2.9		3.1	2.3	



Figs. 1-4. Effect of 250 ppm ethrel (1), 100 ppm ethrel (2), 10 ppm GA (3), and water sprayed control (4) on flowering and fruit set in summer squash.

TABLE

Effect of plant growth regulators on flowering, sex-ratio

Treatment (ppm)	Number of days to first staminate flower			Number of days to first pistillate flower			Sex-ratio (Male : Female)		
	1979	1980	Av.	1979	1980	Av.	1979	1980	Av.
Control	48.6	58.0	53.3	49.2	59.3	54.3	4.3	4.3	4.3
MH 50	44.8	59.1	52.0	48.8	57.8	53.3	3.0	3.2	3.1
150	48.9	57.7	53.3	49.8	55.9	52.9	3.6	4.1	3.9
NAA 50	52.4	60.4	56.4	49.3	57.4	53.4	3.0	3.1	3.1
100	52.7	58.3	55.5	50.7	62.3	56.5	3.2	3.4	3.3
GA 10	47.0	55.8	51.4	48.8	55.9	52.4	4.6	4.9	4.8
25	47.4	50.9	49.2	50.1	56.4	53.3	4.4	4.8	4.6
Ethrel 100	61.6	57.5	59.6	46.9	46.9	46.9	2.8	2.3	2.6
250	66.3	68.7	67.5	45.5	50.1	47.8	1.0	0.9	1.0
C. D. at 5%	9.7	4.6		NS	6.3		2.1	0.8	

the number of male flowers with the ethrel treatments during both the years. There was no suppression of staminate flowers with GA treatments (Fig. 3), rather at the lower concentration (GA 10 ppm) there was some increase in the number. Similar results were reported by Choudhary and Singh (1970) in cucumber. Since GA has been reported to promote maleness (Shifriss and Galun, 1957 in cucumber) as well as femaleness (Randhawa and Singh, 1970 in muskmelon), it is felt that the mechanism of sex-expression might be independent of endogenous levels of gibberellins or auxins. The more number of pistillate flowers in ethrel (250 and 100 ppm) treated plants can be attributed to the physiological and biochemical changes caused by the ethylene released in the plant tissues by the exogenous application of ethrel. Such a modification by ethrel has also been reported by Freytag *et al.* (1970) in cucumber and Saimbhi (1974) and Shannon and Robinson (1978) in summer squash, respectively. It can also be suggested that ethephon treated plants produced fewer staminate and more pistillate flowers because of the sex reversal of undifferentiated flowers which could normally be staminate.

The number of fruits harvested per plant during both the years were significantly more than control in ethrel 250 ppm followed by ethrel 100 ppm (Table 2). Similar results have been reported with 120 ppm ethrel in summer squash variety 'Chaubhattia local' by Singh *et al.* (1974). Increased number of fruits per plant with ethrel treatments may be attributed to the maximum num-

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and yield in summer squash during 1979 and 1980

Number of fruits per plant			Yield per plant (g)			Yield per plot (kg)		
1979	1980	Av.	1979	1980	Av.	1979	1980	Av.
6.1	4.7	5.4	1119	1105	1112	6.64	6.63	6.64
10.4	8.7	9.6	1893	1086	1490	11.36	6.52	8.94
9.0	9.6	9.3	2074	1512	1793	12.44	9.07	10.76
7.7	7.8	7.8	1593	1071	1332	9.56	6.43	8.00
7.9	8.3	8.1	1481	1036	1259	8.88	6.21	7.55
7.1	9.8	8.5	1587	1358	1473	9.52	8.15	8.84
9.1	8.4	8.8	1836	1178	1507	12.08	7.07	9.58
10.6	15.6	13.1	2164	2027	2096	12.98	12.16	12.57
14.9	17.5	16.2	2667	2200	2434	16.00	13.13	14.57
2.7	3.1		515	368		3.75	2.32	

ber of pistillate flowers (Figs. 1 and 2) and more number of branches (Table 1). These results are in conformity with the earlier findings of Sams and Kraeger (1977).

The present findings, therefore, showed that among all the plant regulators used ethrel at 250 ppm followed by 100 ppm concentrations proved most effective in increasing the fruit yield in summer squash variety 'Hissar Selection-1' in both the years. The increase in the fruit yield with ethrel was mainly attributed to the reduction in the number of male flowers followed by the higher number of female flowers (Table 2) and higher number of fruits harvested (Fig 1). Fruit yield was also significantly enhanced by MH 150 ppm followed by GA 25 ppm. Least fruit yield was recorded in control plants (Fig. 4) followed by NAA 100 ppm. Another possible reason for increased fruit yield in ethrel treated plants may be the increased number of branches per plant. Such treated plants remained physiologically more active to build up sufficient food stock for the developing flowers and fruits, ultimately leading to higher yield.

From this investigation it is concluded that ethrel was most effective in inducing early and more number of female flowers and producing more number of fruits per plant. It is possible to increase the yield to an appreciable extent in summer squash with the spray of ethrel provided alternate or third row is left without spraying so that female flowers on ethrel treated plants can be pollinated from pollens appearing in untreated control plants at

that stage. Although, initially a few female flowers may abort but as the number of female flowers are much more in ethrel treated plants, it will hardly affect the yield. However, further investigations in this direction are necessary before it can be recommended to farmers.

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TRANSFORMATION OF NATIVE AND APPLIED PHOSPHORUS FROM DIFFERENT SOURCES IN THE SOIL AS AFFECTED BY TWO MOISTURE REGIMES UNDER PEARL MILLET

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ABSTRACT

The influence of two moisture regimes at cumulative pan evaporation (CPE) ratio of 0.5 and 1.0 under pearl millet on the transformation of native and applied P in soils and its availability to pearl millet was studied on a low P Ambala soil (inceptisols) using radioactive P^{32}. The results revealed that higher moisture (CPE ratio of 1.0) could maintain a greater amount of added P in the saloid bound and Olsen's available P forms for the crop as compared to the lower moisture (CPE ratio of 0.5). With the addition of DAP, saloid bound P and Al-P immediately increased but after 40 days the ultimate product was Al-P. When the source of phosphate was Al-P, the final fractions of added phosphate were Fe-P and Ca-P that were formed at the expense of saloid bound P and Al-P; however, when iron phosphate was added, the stabilised forms of P were Al-P and Ca-P in the presence of growing crop of bajra. Regression equation worked out between available P (Y) and different fractions of P, viz. saloid bound P(X_1), Al—P(X_2), Fe—P(X_3) and Ca—P(X_4) was as under :

$$Y = 19.67 + 1.29\ X_1 + 3.03\ X_2 - 0.14\ X_3 - 7.23\ X_4 \quad (r^2 = 0.757)$$

A major part of the applied phosphate gets transformed into Al- and Fe- phosphates in neutral soil and with the passage of time these compounds get stabilised. Fe-phosphate compounds which are not readily available in well aerated soil (Blanchet *et al.*, 1978) undergo transformation and become available at low soil moisture tension. Taylor *et al.* (1963) reported that even in calcareous soils, Al-P compounds hydrolyse more rapidly and were quite available to the corn crop. Since Al-P and Fe-P are the two important forms of P to which added P gets transformed under different moisture regimes, it was deemed fit to study the transformation of P when applied in these very forms, i. e. aluminium phosphate (S_2), ferric phosphate (S_3) alongwith the standard source of DAP (S_1) to bajra (pearl millet) at two moisture regimes of CPE ratio of 0.5 (M_1) and 1.0 (M_2) in a calcareous soil (inceptisol) of Ambala.

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MATERIAL AND METHODS

A pot culture study was carried out in a green house with low P soil, having $CaCO_3$ less than 1%, AEC of 1.5 me/100 g soil, total sesquoxides as 5.8% and total phosphorus 0.26%, keeping pearl millet as the test crop.

Earthen pots of 16 cm in diameter and 28 cm in height were selected for pot experiment. The drainage holes were closed and a thick polythene bag of 16 cm diameter and 30 cm length was placed in each pot so as to avoid leakage of water and nutrients. Polythene sheet covers were provided to safeguard the experiment against rains.

(i) **Preparation of tagged salts/ fertilizers.** Aluminium phosphate and ferric phosphate being insoluble were prepared as follows :

A known volume of phosphoric acid (AR) was tagged with P^{32} @ 0.6 mci/g of P. This tagged phosphoric acid was allowed to react with calculated amount of dissolved aluminium chloride (AR). The precipitates were washed. These precipitates were later on dried under ultra red lamp, finally kept in desiccator overnight and were crushed and passed through 0.5 mm sieve. Finally the product was tested for its phosphate content.

In the same way, ferric phosphate was prepared by reacting ferric chloride with phosphoric acid. The reaction equations, as given in the Condensed Chemical Dictionary (Rose and Rose, 1961), are as under :

$$AlCl_3.6H_2O + H_3PO_4 = AlPO_4.3H_2O + 3H_2O + 3HCl$$

$$FeCl_3.xH_2O + H_3PO_4 = FePO_4.6H_2O + (x-6)H_2O + 3HCl$$

Diammonium phosphate being water soluble was directly tagged with P^{32} @ 0.6 mci/g of P.

(ii) **Moisture levels.** Two levels of moisture were kept on the basis of ratio of depth of irrigation water (IW) to the cumulative pan evaporation (CPE) based on U. S. W. B. Class A pan. These ratios were :

(a) IW/CPE of 0.5 (M_1)

(b) IW/CPE of 1.0 (M_2)

For giving 5 cm of water, the pots were watered when 100 mm of water evaporated under M_1 and when 50 mm of water evaporated under M_2.

(iii) **Sources of fertilizers.** Three sources of fertilizers were used.

(a) Diammonium phosphate (DAP) (S_1);

(b) Aluminium phosphate (S_2);

(c) Ferric phosphate (S_3).

(iv) **Levels of fertilizers.** There were three levels of these fertilizers, i.e. 0, 40 and 80 ppm P.

The experiment was laid out in completely randomised design with 3 repeats. Hybrid bajra BJ-104 was sown in the pots @ 10 seeds/pot on 16th July 1977 after giving pre-sowing irrigation. Later on thinning was done leaving the number of plants to four per pot.

Soil samples were collected with pot-tube auger to a depth of 15 cm after 0, 10, 20 and 40 days of sowing for transformation of applied P and native P and for the study of available P status. Radioactive counts were recorded on G. M. counter. Soil available P was determined by the method given by Olsen *et al.* (1954).

RESULTS AND DISCUSSION

Data presented in Table 1 reveal that in control, the dominant form of inorganic P was Ca-P (93%) followed by Fe-P (4%), Al-P (1.6%) and least being saloid P, on the first day of experimentation. Addition of P through DAP markedly increased saloid bound P which may be ascribed to the pH effect of the saturated solution of this fertilizer in the soil system. At this pH of 7.9 the activity of both Fe and Al is considered to be low. Later on, the major forms of P recovered were Al-P>Fe-P>Ca-P. It has been observed that orthophosphate ions continue to react with other soil constituents such as ionized compounds of Al, Fe, Ca and on their surfaces with passage of time (Yuan *et al.*, 1960). Besides transformation to other forms, a decrease in saloid bound P may also be attributed to the crop removal of this form of P by growing crop of bajra (Smith, 1965).

The rate of reaction of different fractions was initially fast and then slowed down after 20 days; showing thereby, that major transformations took place immediately after reacting with soil system. Khanna and Datta (1968) also found increased Al-P and Fe-P activity with the addition of DAP during cropping.

TABLE 1

Transformation of native and applied phosphorus into various forms with time under pearl millet at moisture content equivalent to 1.0 C. P. E. ratio

Source	Level of P(ppm)	Time (days)	Forms of soil P(ppm)				
			Sal-P	Al-P	Fe-P	Ca-P	Available-P (Olsen's)
1	2	3	4	5	6	7	8
	Control	0	2.4	3.2	7.8	185.0	3.2
		10	2.4	2.8	8.0	184.0	2.8
		20	2.0	2.0	9.4	183.0	2.4
		40	1.0	1.6	10.2	181.8	2 0
DAP	40	0	25.7 (60.34)	11.0 (28.73)	9.8 (7.47)	185.0 (3.44)	37.4
		10	13.3 (30.70)	19.0 (45.45)	10.3 (18.93)	187.0 (5.37)	32.6
		20	5.8 (13.80)	20.8 (51.52)	12.8 (27.60)	188.5 (6.90)	28.4

contd.

1	2	3	4	5	6	7	8
		40	2.4 (4.46)	21.6 (53.57)	13.6 (34.82)	188.8 (7.14)	18.8
	80	0	43.0 (68.73)	16.0 (18.62)	12.7 (8.86)	190.7 (3.76)	64.0
		10	24.7 (29.55)	29.7 (46.30)	13.8 (19.70)	192.8 (4.43)	48.0
		20	12.8 (18.26)	33.0 (54.79)	20.8 (22.83)	193.0 (4.10)	35.0
		40	5.6 (9.43)	33.4 (60.14)	21.4 (25.94)	194.6 (4.98)	24.0
Al-phos	40	0	12.6 (21.79)	35.5 (62.67)	8.0 (10.35)	181.7 (5.17)	18.4
		10	8.7 (16.12)	27.7 (58.06)	11.6 (19.35)	182.3 (6.45)	12.8
		20	6.0 (9.45)	23.6 (59.45)	12.5 (23.64)	183.2 (7.43)	9.0
		40	2.0 (7.19)	20.1 (57.55)	15.0 (22.97)	184.8 (8.27)	8.0
	80	0	15.3 (17.42)	56.5 (66.15)	14.7 (12.69)	185.0 (3.72)	19.2
		10	12.6 (12.05)	49.3 (62.37)	17.3 (20.79)	186.2 (4.78)	15.0
		20	8.6 (7.4)	42.6 (62.55)	18.8 (24.88)	188.0 (5.50)	13.4
		40	5.3 (4.92)	36.6 (54.18)	19.6 (34.48)	188.0 (6.40)	12.9
Fe-phos	40	0	7.3 (11.23)	10.0 (15.16)	32.5 (67.71)	183.5 (6.17)	8.1
		10	4.6 (6.17)	20.8 (37.03)	22.7 (49.62)	184.2 (8.89)	5.8
		20	2.6 (4.27)	19.4 (37.01)	22.0 (49.82)	185.0 (8.89)	5.0
		40	1.6 (9.43)	16.7 (36.43)	21.0 (48.58)	186.0 (10.12)	4.0
	80	0	10.6 (9.43)	14.0 (11.74)	62.3 (74.73)	182.7 (4.09)	12.4
		10	9.6 (10.63)	29.7 (31.91)	43.0 (53.19)	183.0 (4.25)	11.7
		20	5.6 (4.27)	30.4 (36.81)	39.8 (52.73)	185.2 (6.17)	8.2
		40	3.0 (3.59)	34.6 (30.83)	30.0 (57.48)	186.5 (8.08)	5.7

Figures in parentheses indicate the percentage of applied P.

When Al-phos was the source of P, there was an increase in Al-P and saloid bound P in the soil at both the moisture regimes. Aluminium phosphate is sparingly water soluble and after dissociation in the soil system, a fraction of P might have been adsorbed on the soil colloids increasing the saloid bound P. Al-P was much higher because the P had a greater proximity with Al-ions originating from Aluminium phosphate source leading to a greater formation of Al-P. These two forms decreased with time, whereas Fe-P increased. This was perhaps due to the conversion of more soluble forms into less soluble forms. Similar trend was followed with the higher level of P when applied through this source, though the values were of higher magnitude.

As regards iron phosphate, when applied @ 40 ppm P, the immediate forms obtained at both moisture levels were in the order: Fe-P>Al-P>saloid bound P>Ca-P. This seems to be the effect of source in which phosphate was applied. There was a little increase in saloid bound P because ferric phosphate (the source) is a little water soluble. Fe-P rapidly decreased showing thereby that it was either utilised by the crop or being transformed to some other forms, due to chelation of Fe by decomposing organic matter, as in pot studies particularly, the reducing conditions exist in micropores of even aerated soil (Greenland, 1962).

The decrease in both Al-P and Fe-P under their respective sources of fertilizers (P^{32}) showed that major part of Al-P and some of Fe-P were taken up by the crop. These findings are in agreement with those of Payne and Hanne (1965) who, on the basis of their green house experiment on millet indicated that a substantial portion of P required by plants could be supplied by pure Al- and Fe phosphate and further concluded that P content of millet tops was chiefly correlated with Al-P fraction of the soils.

The differences in the behaviour of applied P, when moisture content was maintained at CPE ratio of 0.5 are presented in Table 2.

Under DAP treatment, transformation to Ca-P was little less at this moisture. This was because the activity of Ca was low at higher moisture tension. Values for different fractions obtained here were of lower magnitude than under higher moisture level, except for Fe-P. Higher values of Fe-P at lower moisture level may be attributed to aeration. At low CPE ratio, the chances of Fe-compounds for reduction are minimal and preponderance of Fe^{+++} ions can be visualised under such a situation, whereas reverse will be the case for ions like Ca, Al, etc.

The Olsen extractable P had a tendency to decrease with the period of incubation in all the treatments (Tables 1 and 2). Under DAP this decrease was from 37.4 to 18.8 ppm when 40 ppm was applied and the correspondence values under 80 ppm were 64.0 to 24.0, after 40 days of incubation at CPE ratio of 1.0. The availability of this form of P under aluminium phosphate and iron phosphate was much lower in magnitude and it decreased progressively with time.

TABLE 2

Transformation of native and applied phosphorus into various forms with time under pearl millet at moisture content equivalent to 0.5 C P. E. ratio

Source	Level of P (ppm)	Time (days)	Forms of soil P (ppm)				
			Sal-P	Al-P	Fe-P	Ca-P	Available-P (Olsen's)
1	2	3	4	5	6	7	8
	Control	0	3.9	3.8	7.8	186.0	3.0
		10	2.8	2.8	8.0	185.0	2.4
		20	1.8	2.8	9.0	183.5	2.0
		40	1.0	1.0	9.4	183.1	1.8
DAP	40	0	26.8 (57.69)	15.0 (28.84)	8.2 (9.61)	183.0 (3.8)	34.6
		10	12.6 (24.48)	20.2 (44.89)	14.3 (24.48)	183.8 (6.12)	26.2
		20	8.6 (11.15)	22.6 (48.32)	16 0 (34.20)	184.8 (6.31)	22.4
		40	2.4 (5.83)	24.6 (51.09)	17.5 (36.49)	184.8 (6.56)	14.4
	80	0	33.2 (59.25)	18.6 (24.69)	9.8 (12.34)	184.8 (3.70)	48.2
		10	21.6 (22.67)	31.0 (45.34)	22.6 (27.70)	185.8 (4.28)	40.0
		20	13.0 (11.26)	33.8 (52.11)	23.4 (32.39)	186.0 (4.22)	25.5
		40	3.8 (5.97)	37.0 (54.71)	25.9 (34.94)	186.5 (4.36)	20.4
Al-phos	40	0	7.2 (11.90)	28.0 (56.54)	12.8 (23.80)	183.4 (7.73)	11.2
		10	5.6 (9.61)	22.2 (47.31)	16.6 (34.54)	184.0 (8.51)	6.4
		20	4.6 (6.34)	19.8 (43.17)	19.0 (41.26)	185.0 (9.20)	6.0
		40	1.8 (3.47)	16.0 (38.19)	21.0 (47.91)	186.0 (10.41)	5.8
	80	0	13.0 (14.67)	56.0 (64.84)	17.9 (15.35)	187.0 (5.07)	13.8
		10	10.0 (8.54)	43.6 (55.55)	24.9 (30.76)	188.5 (5.47)	10.7
		20	5.8 (5.90)	39.4 (45.99)	28.0 (40.92)	189.0 (7.17)	9.0
		40	3.0 (4.25)	35.0 (40.18)	30.0 (47.28)	190.6 (8.27)	8.8

contd.

1	2	3	4	5	6	7	8
Fe-phos	40	0	5.2 (10.25)	8.2 (13.6)	38.8 (68.37)	183.2 (7.69)	6.8
		10	4.3 (7.73)	14.3 (30.76)	25.6 (51.28)	183.6 (10.62)	4.8
		20	2.8 (6.10)	15.0 (34.35)	20.6 (48.09)	185.0 (11.45)	4.2
		40	1.6 (3.87)	16.0 (42.24)	18.2 (41.86)	186.1 (12.01)	3.8
	80	0	7.0 (7.11)	10.0 (10.32)	67.0 (76.86)	184.0 (5.69)	8.4
		10	4.6 (4.98)	23.5 (20.28)	51.0 (68.68)	185.1 (6.04)	5.0
		20	3.8 (4.26)	28.6 (27.29)	40.4 (60.98)	187.0 (7.46)	4.2
		40	2.0 (2.29)	33.0 (32.18)	34.0 (57.01)	188.3 (8.00)	4.0

Figures in parentheses indicate the percentage of applied P.

At lower moisture regime (CPE ratio of 0.5) the values of available P were much smaller under all the levels and sources of fertilizers. The greater availability of P under DAP treatment may be due to the total water solubility and pH of this fertilizer. The increased P availability under aluminium phosphate than under iron phosphate source may be due to difference in the pksp values of these compounds, which are 29.5 and 35.1, respectively. Increased availability at CPE ratio of 1.0 over CPE ratio 0.5 may be attributed to the reduction of iron phosphate at higher moisture level and consequent release of P from ferrous phosphate (Greenland, 1962).

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METHODS OF NITROGEN FEEDING TO WHEAT AND TRITICALE

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ABSTRACT

Relative efficiency of nitrogen application in wheat and triticale was studied during winter seasons of 1973-74 and 1974-75. Nitrogen application through soil as half basal and rest top dressing proved significantly better than total amount of N as basal or foliar feeding for both the cereals. However, somewhat more amount of N is desired to be kept for top dressing in the case of triticale. The 1000-grain weight increased with foliar application.

Maximum LAI was observed during the period of 80 to 110 days of crop growth in both the genotypes. Positive association was observed between LAI and grain yield.

Since nitrogen is required throughout the growth period and nitrogenous fertilizers are lost through leaching, therefore, it is better not to apply very high quantity of nitrogenous fertilizer at one time and should be fed in split doses throughout the growth period. However, same recommendation may not hold good under all the situations because of the variations in nature of fertilizer, amount of nutrients to be applied, soil type, availability of water and differences in nutritional requirement of crops/varieties grown.

Agarwal and Moolani (1978) working on wheat variety Kalyan Sona, found that there were significantly higher grain and straw yields when the nitrogen was applied in split doses, i. e. $\frac{1}{2}$ basal + $\frac{1}{2}$ top dressing or $\frac{1}{3}$ basal + $\frac{1}{3}$ top dressing + $\frac{1}{3}$ foliar spray over full nitrogen as basal and other combinations studied. However, Gupta and Seth (1978) reported no significant variation in the grain yield when nitrogen was applied either partly through soil and foliar or the entire quantity was applied through soil. Not much variation in the grain yield of wheat, due to different modes of N application, was observed by Sharma *et al.* (1966).

Sufficient information is available to compare the effect of N applied at sowing and at first or second irrigation in wheat. However, information on fractional application versus full at sowing or after first irrigation throughout the crop growth is lacking, particularly on durum wheat and triticale. Therefore, the experiment was designed to evaluate the relevance of different methods of nitrogen feeding for these genotypes.

MATERIAL AND METHODS

Experiments were conducted on wheat (*Triticum aestivum* and *T. durum*) and triticale (*X-triticosecale* Wittmack) for two crop seasons of 1973-74 and 1974-75 at the Research Farm of the Haryana Agricultural University, Hissar. S-308, an aestivum wheat variety; Raj 911, a durum wheat variety; and TL 22, a triticale genotype, were used during both the years. Combinations of basal application, top dressing and foliar feeding were tested in a field experiment with three replications under randomised block design. The soil was sandy loam having organic carbon 0.24%, available phosphorus 23 kg/ha, available potash 696 kg/ha and pH 8.2. Crop was sown on Dec. 4, 1973 and Nov. 11, 1974, during first and second year, respectively.

During 1973-74 crop season, rainfall was less and evaporation demand was more (3.8 mm rain, 3.98 mm/day evaporation and 8.40 bright h/day) as compared to 1974-75 (25.50 mm rain, 3.78 mm/day evaporation and 8.18 bright h/day).

The details of the treatments are given below :

1. S_{120} : 120 kg N/ha at the time of sowing;
2. T_{120} : 120 kg N/ha as top dressing;
3. F_{120} : 120 kg N/ha as foliar spray;
4. $S_{80}T_{40}$: 80 kg N/ha at the time of sowing+40 kg N/ha as top dressing;
5. $S_{80}F_{40}$: 80 kg N/ha at the time of sowing+40 kg N/ha as foliar spray;
6. $S_{60}T_{60}$: 60 kg N/ha at the time of sowing+60 kg N/ha as top dressing;
7. $S_{60}F_{60}$: 60 kg N/ha at the time of sowing+60 kg N/ha as foliar spray;
8. $S_{40}T_{80}$: 40 kg N/ha at the time of sowing+80 kg N/ha as top dressing; and
9. $S_{40}F_{80}$: 40 kg N/ha at the time of sowing+80 kg N/ha as foliar spray.

The foliar application was started after first irrigation (35 days after sowing) with an interval of one week. Only 20 kg N/ha was applied in the form of urea to the crop in one spray. The amount of N to be used as top dressing was also applied at the time of first spray.

Plant samples taken during the crop growth period of 1974-75 were subjected to the measurement of leaf area. The leaf area was measured with simple device (L×W×K) as discussed by Dhiman and Kalra (1975), and Kalra and Dhiman (1977) for triticale and wheat, respectively. Leaf area index (LAI), a physiological parameter of crop growth, was computed with the help of these data for both the crops. The relationship of LAI at heading stage of crop to grain yield was also worked out.

RESULTS AND DISCUSSION

The data on yield and 1000-grain weight of different genotypes are presented in Tables 1 and 2.

TABLE 1

Grain yield (q/ha) as influenced by methods of N feeding

S No.	Treatments	S-308			Raj-911	Triticale
		1973-74	1974-75	Mean	1973-74	1974-75
1.	S_{120}	29.8	28.2	29.0	28.5	16.9
2.	T_{120}	33.2	30.9	31 8	28.2	18.6
3.	F_{120}	25.5	10.8	18.2	28.5	7.6
4.	$S_{80}T_{40}$	33.7	28.4	31.1	29.7	18.1
5.	$S_{80}F_{40}$	28.2	26.9	27.6	27.9	12.6
6.	$S_{40}T_{80}$	39.6	28.6	34.1	39.2	16.3
7.	$S_{40}F_{80}$	30.0	24.4	27.2	24.9	13.5
8.	$S_{40}T_{80}$	36.5	30.2	33.4	32.7	20.3
9.	$S_{40}F_{80}$	32.2	19.6	25.9	33.3	11.8
	Mean	32.0	24.8	28.7	30.3	15.1
	C. D. at 5%	3.36	2.9	—	5.76	3.45

TABLE 2

1000-grain weight (g) as influenced by methods of N feeding

S. No.	Treatments	S-308			Raj-911	Triticale
		1973-74	1974-75	Mean	1973-74	1974-75
1.	S_{120}	48.1	50.6	49.4	42.0	44.0
2.	T_{120}	50.2	50.1	50.2	48.0	49.0
3.	F_{120}	52.2	52.4	52.3	55.9	38.0
4.	$S_{80}T_{40}$	45.2	48.8	47.0	51.8	42.5
5.	$S_{80}F_{40}$	52.8	54.4	53.6	47.8	40.0
6.	$S_{40}T_{80}$	49.3	48.1	48.7	46.4	40.0
7.	$S_{40}F_{80}$	51.6	54.1	52.9	48.7	46.0
8.	$S_{40}T_{80}$	47.3	49.7	48.5	44.5	45.0
9.	$S_{40}F_{80}$	47.2	47.4	47.3	50.8	46.7
	Mean	49.3	50.6	49.9	48.4	43.4
	C. D. at 5%	7.37	6.12	—	6.94	6.81

Genotypes

During the first year, S-308 produced about 5% more grain yield than Raj 911 under the same environmental conditions (Table 1). This might be due to higher test weight (1000 grain) of the aestivum wheat as compared to durum (Table 2). Similarly, under the second year set of environment, the wheat variety S-308 proved significantly superior than triticale variety TL 22. This again may be due

to higher test weight of variety S-308. Therefore, it can be stated that wheat variety S-308 is better under late sown conditions than Raj 911 and TL 22. Sisodia *et al.* (1973) reported the reduction in grain yield with the delay in sowing of triticale. Moreover, Gill (1974) opined that triticale did not have the potentiality to the level of wheat grain production with the present genotypes.

Method of Nitrogen Feeding

During the first year, the application of N as $\frac{1}{2}$ basal (soil) + $\frac{1}{2}$ top dressing produced significantly higher grain yield than other combinations tested for both the wheat genotypes. However, the application of nitrogen through soil either basal or top dressing proved superior than foliar feeding for wheat and triticale during second year. The results of pooled analysis also show the similar trend. Application of 40 kg N/ha at sowing time and top dressing of 80 kg N/ha at tillering gave significantly higher yield than application of 60 kg N/ha at sowing and 60 kg N/ha at tillering in triticale. Therefore, it shows that more amount of nitrogen should be applied as top dressing in case of triticale. The beneficial effect of foliar feeding was observed in the 1000-grain weight in most of the cases. This might be due to readily available nutrient to the leaves and more opportunity for the translocation of photosynthates to the developing grain. Dhiman (1978) working on Branco-90 variety of triticale reported that the favourable impact of foliar application was reduced under high level of nitrogen, whereas it is beneficial only with low level of nitrogen.

Leaf Area Index

This physiological parameter was computed under different methods of nitrogen feeding and genotypes tested (Fig. 1). It is evident from the figure that the behaviour of LAI is quite similar in both the genotypes (wheat and triticale) under test. Moreover, triticale has shown more photosynthetic surface throughout the crop growth period. With the high LAI, the grain yield level of triticale was poor. This might be due to the variation in photosynthetic efficiency of different genotypes (Thorne and Watson, 1955) and more dry matter in the form of straw in triticale. The peak level of photosynthetic surface during the crop growth period was recorded from 80 to 110 days after sowing.

Almost similar LAI was observed during the vegetative growth of crop when full nitrogen dose was applied as basal or part of it was applied as basal plus top dressed at first irrigation. While, on the other hand, somewhat lower LAI was recorded when full dose of N was applied only as top dressing after first irrigation or as foliar spray. However, after heading, there was not much variation in the LAI with different methods of nitrogen application except in case of foliar application (Fig. 1), wherein LAI remained lowest even at this stage also.

These results clearly indicate that low yield under foliar application of nitrogen over soil application was mainly because of low LAI which resulted into low photosynthetic rate per unit of land area.

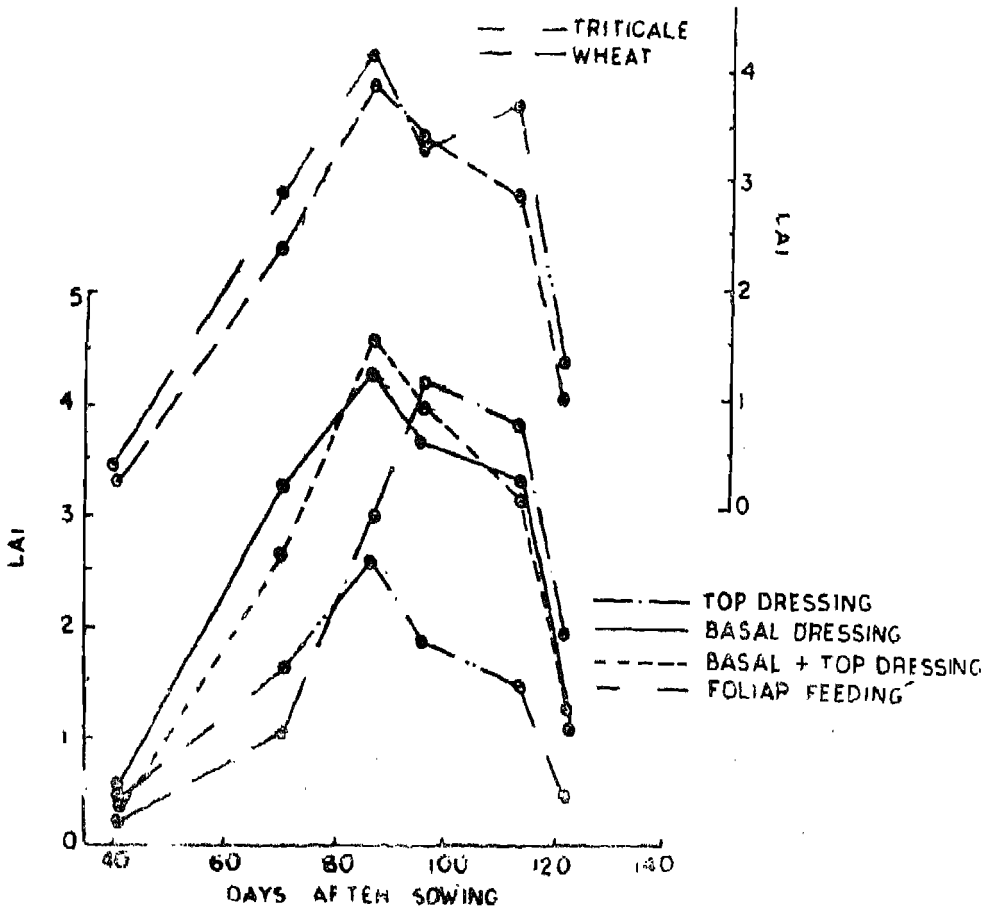


Fig. 1. Variation of leaf area index with days after sowing.

Relationship between Yield and LAI

The association between grain yield and LAI at heading was computed for both the genotypes and has been depicted in Fig. 2. The respective linear equations and correlation coefficient were also worked out (Fig. 2). It is clear from Fig. 2 that there was better correlation between grain yield and LAI in wheat than that in triticale. This might be due to poor translocation of photosynthates from the source to the sink in triticale than wheat.

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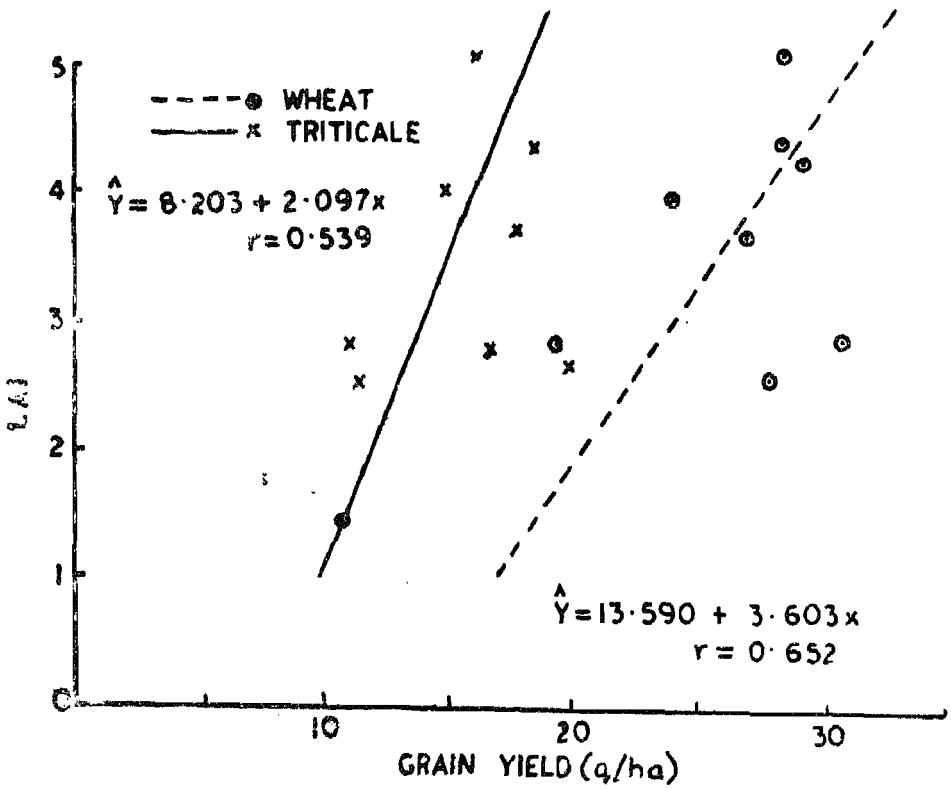


Fig. 2. Association between leaf area index and grain yield in wheat and triticale.

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STUDIES ON THE BACTERIAL LEAF BLIGHT OF RICE CAUSED BY *XANTHOMONAS ORYZAE* (UYEDA AND ISHIYAMA) DOWSON

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ABSTRACT

Survival and transmission of *Xanthomonas oryzae* (Uyeda and Ishiyama) Dowson, the incitant of bacterial leaf blight of rice, were studied in naturally infested twelve rice seed lots of different cultivars, collected from major rice growing areas of Haryana. Eight out of twelve seed lots indicated the presence of *X. oryzae* in varying degrees as detected by the standard methods of isolation at the time of crop harvest. Seed lots of Pusa-33 and Taichung Native 1 having 36 and 35 per cent seed infestation, respectively, were stored in plastic jars at room temperature and analysed to determine the presence or absence of *X. oryzae* in hull, dehulled and whole grain at an interval of one month during storage. *X. oryzae* could not be detected in/on the seeds after 3 months of crop harvest indicating short lived bacterium in seeds. The seedlings raised under congenial environmental conditions, in sterile potted soil, from infested seeds in next crop season, yielded negative results. Apparently infested seeds may not be responsible to reinitiate the disease in renewed crop, since the infested seeds carried the incitant for short period.

Bacterial leaf blight of rice, incited by *Xanthomonas oryzae* (Uyeda and Ishiyama) Dowson, is known to occur annually (in renewed rice crop) in the major rice growing areas of Haryana. The primary sources of the disease are not yet fully established. Many reports on the survival of *X. oryzae* in soil, irrigation water, diseased parts, alternative hosts and seeds have been documented in the literature (Goto *et al.*, 1953; Wakimoto, 1955, 1956; Wakimoto and Tamari, 1956; Inoue *et al.*, 1957; Nakazawa and Kato, 1958; Mizukami, 1961; Srivastava and Rao, 1963; Dalmacio and Exconde, 1967; Isaka and Miyakoshi, 1967; Chattopadhyay and Mukherjee, 1968; Goto, 1969; Rao and Kauffman, 1971; Singh, 1971; Hsieh *et al.*, 1974) in the past. At present, only a few conflicting reports on the survival of *X. oryzae* on/in rice seeds at different frequencies are available (Fang *et al.*, 1956; Srivastava and Rao, 1964; Chakravarti and Rangarajan, 1967; Kauffman and Reddy, 1968). Attempts have also been made to study the transmission of the disease from infested seeds but failed (Kauffman and Reddy, 1975). The above mentioned reports only indicated the presence of

X. oryzae on/in rice seeds but the role of these infested seeds has not been fully explained.

The present investigation was initiated to explore the possibility of naturally infested seeds in constituting the sources of primary inoculum to reinitiate the disease in renewed rice crop in Haryana by studying the length of survival of *X. oryzae* on/in naturally infested rice seeds, usually stored at room temperatures.

MATERIAL AND METHODS

Collection of seeds. Twelve naturally infested rice seed lots, used in the present investigation, were collected from different rice cultivars (exhibiting severe blight infection) grown in major rice growing areas of Haryana, at the time of crop harvest (Table 1). These seed lots were stored in plastic jars at room temperature in the laboratory.

Detection of *X. oryzae* in naturally infested rice seeds. *X. oryzae* was detected in the seeds of different seed lots by direct plating of hull, dehulled and whole rice grain on agar plates and by streaking the bacterial suspensions (obtained from different parts of infested seeds) on agar plates. Wakimoto's medium (potato decoction, 200 g; $Ca(NO_3)_2$. 2 H_2O, 0.5 g; Na_2HPO_4. 12 H_2O, 2 g; peptone 5 g; sucrose 15 g; agar 20 g and distilled water 1000 ml with pH 7) was used for plating and isolation of the bacterium. Glucose chalk agar medium (calcium carbonate, 20 g; yeast extract, 10 g; dextrose 10 g; agar 20 g; distilled water 1000 ml) was used for the storage of the bacterial cultures obtained from different parts of seed of different lots at the time of crop harvest. Each seed lot was analysed to determine the presence of *X. oryzae* in different parts of seed. The seed lots having high percentage of seed infestation were stored and used for further investigations. Subsequently, plating of different seed parts was carried out at an interval of one month upto the next crop growing season. Pure cultures were obtained by probable isolations of bacterial colonies appeared on agar plates. These cultures were subjected to certain biochemical and pathological tests to determine the presence of *X. oryzae* in/on the seeds.

Transmission tests. The seedlings were raised separately in sterile potted soil from the stored infested seed lots (SL-8 and SL-9) in the next crop season to determine the presence of *X. oryzae* in the seedlings under congenial environmental conditions. Ten seeds were sown in one pot and each pot was replicated 10 times. Such, resulted rice seedlings were carefully watched to record the typical symptoms of bacterial leaf blight upto 45 days of plating. Ooze test and direct plating method were also tried to locate *X. oryzae* in different parts of seedlings (root, stem and leaf) at an interval of one week.

RESULTS AND DISCUSSION

Detection of *X. oryzae* in Naturally Infested Seeds

Eight out of 12 infested seed lots had 4 to 36 per cent seed infestation at the time of crop harvest. Cultivars, Taichung Native-1 (SL-9) and Pusa-33 (SL-8) had the maximum seed infestation of 36 and 35 per cent, respectively (Table 1). It indicates that natural infestation of

TABLE 1

Sources and per cent seed infestation of *X. oryzae* in the naturally infested rice seed lots collected from different rice growing areas of Haryana

Seed lot	Name of cultivar	Place of collection	Per cent seed infestation
SL-1	IR.8	Ambala city	4
SL-2	Jaya	Agriculture Farm (Jind)	4
SL-3	IR.8	Agriculture Farm (Jind)	8
SL-4	IR.8	Uchani (Karnal)	5
SL-5	IR.8	Jundla (Karnal)	6
SL-6	Jaya	Nilo Kheri (Karnal)	5
SL-7	IR.8	Nilo Kheri (Karnal)	6
SL-8	Pusa-33	Rice Research Centre Kaul (Kurukshetra)	35
SL-9	*Taichung* Native-1	*Rice Research Centre* Kaul (Kurukshetra)	36
SL-10	IR.8	Dhand (Kurukshetra)	5
SL-11	Jaya	Radaur (Kurukshetra)	6
SL-12	Jaya	Pipli (Kurukshetra)	6

TABLE 2

Detection of *X. oryzae* in infested rice seeds at various time intervals after crop harvest

Seed cultivar lot	Detection of *X. oryzae* in infested seed after harvest at monthly intervals							
	1	2	3	4	5	6	7	8
SL-8 Pusa-33								
Whole grain	++++	+++	++	—	—	—	—	—
Dehulled grain	+++	++	+	—	—	—	—	—
Hull	++++	++	++	—	—	—	—	—
SL-9 Taichung Native-1								
Whole grain	++++	+++	++	—	—	—	—	—
Dehulled grain	+++	++	+	—	—	—	—	—
Hull	+++	++	++	—	—	—	—	—

— = None, + = traces, ++ = Low, +++ = medium, ++++ = high infestation.

seed is occurring at varying frequencies in different rice cultivars grown at different locations in Haryana. This variation in seed infestation may be attributed to the mild or delayed disease development in different rice growing areas of Haryana.

The results presented in Table 2 reveal that *X. oryzae* could be detected at decreasing frequencies upto 3 months after crop harvest in different parts of naturally infested seed (hull, dehulled and whole grain) of the test cultivars. The association of *X. oryzae* in/on the infested seeds was established on the basis of certain biochemical and pathological tests of the pure cultures of bacteria obtained at different time intervals. Similar results have been reported by Wakimoto (1954), Fang *et al.* (1956), Srivastava and Rao (1964), Eamchit and Ou (1970) and Kauffman and Reddy (1975).

Transmission Tests

The seedlings raised in next crop growing season from the naturally infested seeds (after 8 months of harvest) did not show, typical wilt symptoms (Kresek stage) of bacterial leaf blight of rice. At the same time *X. oryzae* could not be detected in root, stem and leaf of the raised seedlings as tried by ooze test and direct plating methods.

The results reported here reveal that after 3 months, no viable *X. oryzae* could be detected in/on the infested seeds or in root, stem and leaf of seedlings raised from these seeds stored at room temperatures. It may be due to temperature dependent survival of *X. oryzae* as reported by Hsieh and Buddenhagen (1975). Eamchit and Ou (1970) also reported lower survival rate of *X. oryzae* at high temperatures. Since, temperatures of 43°C or above usually occur in summer in some parts of Haryana, therefore, it is unlikely that infested seeds/hull serve as the primary source of inoculum to reinitiate the bacterial leaf blight in the renewed rice crop. The possibility of survival of *X. oryzae* in the infested seeds which have been stored at low temperature can not be precluded. Such seeds may serve as the primary source of inoculum for reinitiation of bacterial leaf blight of rice in certain rice growing areas of the country.

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COMPARATIVE EFFICACY OF SOME INSECTICIDAL GRANULES AND DUSTS FOR THE CONTROL OF TERMITES AND SHOOT BORERS IN SUGARCANE

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ABSTRACT

Two experiments, one during 1978-79 and the other during 1979-80 were carried out at Karnal with gamma BHC 6G, dimethoate 4G, phorate 10G, bendicarb 5G, ficam 5G, endosulfan 4G, mephosfolan 5G, isofenphos 5G and carbofuran 3G each @ 1 kg a.i./ha; BHC 10% dust @ 3 and 5 kg a.i./ha and heptachlor 20 EC @ 1.25 kg a.i./ha for the control of termites and shoot borers. Heptachlor proved to be the best treatment. BHC dust @ 5 kg a.i./ha and gamma BHC 6G @ 1 kg a.i./ha were next best treatments. Incidence of termites was minimum (0.9 and 0.4 per cent) in heptachlor and 1.6 and 2.7 per cent in BHC dust @ 5 kg a.i./ha during 1978-79 and 1979-80, respectively. Similarly the incidence of shoot borers in June was 5.6 and 7.1 per cent in heptachlor, 7.9 and 9.4 per cent in BHC dust @ 5 kg a.i./ha during 1978-79 and 1979-80, respectively. It was 10 4% in gamma BHC granules during 1979-80. Yield of sugarcane was maximum in heptachlor (69.2 and 84.3 M. tons/ha during 1978-79 and 1979-80, respectively), followed by BHC dust @ 5 kg a.i./ha (60.3 and 72.9 M. tons/ha), gamma BHC 6G (70.8 M. tons/ha). In untreated plots the yield was only 40.2 and 41.6 M. tons/ha during 1978-79 and 1979-80, respectively.

Termites and shoot borers are two major pests of sugarcane in various sugarcane growing tracts of Bihar, U. P., Punjab, Haryana and Rajasthan (Gupta and Avasthy, 1956). The damage of termites is more serious in light soils, whereas attack of shoot borers occurs almost every where irrespective of soil types. The attack of termite begins right from the planting of cane setts, which continues upto the harvesting of the crop. They eat away the buds and hollow the cane setts which badly affects germination, makes the crop gappy and adversely affect the yield of crop. As many as 40 to 60 per cent buds are destroyed by this pest (Singh and Ram Kishan, 1946). Some of the young shoots also dry up during pre-monsoon months and the infestation of the termite damage persists even during post-monsoon periods. It has been roughly calculated that about 25 to 50 per cent plants are eliminated in the early stage of the crop growth due to attack of these borers alone in different cane growing areas of the country (Gupta and Avasthy, 1957) Even in Haryana both these pests (termites and shoot borers) cause considerable damage to cane crop.

Termites and shoot borers being very serious pests of sugarcane, work on their control appears to have started since 1934 (Gupta, 1959) and now application of gamma BHC and heptachlor emulsions have been recommended for the control of these two pests in all those sugarcane growing tracts of India, where these pests occur in serious form (Singh and Soneja, 1966).

Although emulsions of gamma BHC and heptachlor have been found to be the most effective insecticides for controlling these two pests, the application of these two chemicals in liquid formulations is a laborious job. For even distribution of these insecticides, 1000-1500 litres of water is required in a hectare of cane field. To overcome this difficulty and also to avoid cost of application, several insecticides in their granular and dust formulation were tested during the crop seasons of 1978-79 and 1979-80 and the results are discussed in this paper.

MATERIAL AND METHODS

Two experiments, one during 1978-79 and the other during 1979-80 were carried out at the Regional Research Station, Uchani, Karnal. The planting of first experiment was done on 4th April, 1978, while second was planted on 20th March, 1979. Both the experiments were carried out in a randomised block design, replicated four times, in plots of 45 sq. m, with variety Co 1148. The seed was used @ 80,000 two budded setts/ha. The dusts and granules were applied as such but the liquid formulation of heptachlor was diluted in 1500 litres of water/ha. All the insecticides were applied in furrows at the time of planting alongwith the cane setts. They were immediately covered with soil. Before planting, all the cane setts were treated with 0.5% agallol solution.

The efficacy of insecticides was evaluated by recording data on germination, termite and shoot borer incidence, number of tillers and millable canes and yield of cane per hectare.

RESULTS AND DISCUSSION

The data presented in Table 1, show that the germination of cane in all the insecticidal treatments was significantly higher than control in both the trials, when observations were recorded after 8 weeks of planting. Even after 6 weeks of planting, all these insecticidal treated plots gave superior germination than control except in isofenphos 5G treated plots during 1979-80. In this case germination was almost similar to that of control. However, per cent germination was more consistent in plots treated with carbofuran granules @ 1.0 and 0.75 kg a.i./ha followed by heptachlor emulsion @ 1.25 kg a.i./ha and BHC 10% dust @ 3 and 5 kg a.i./ha. All the remaining insecticidal treatments proved inferior than the above mentioned treatments in respect of germination.

For reducing incidence of shoot borers, heptachlor emulsion @ 1.25 kg a.i./ha was found to be the best treatment followed by BHC 10% dust @ 5 and 3 kg a.i./ha in both the trials carried out during 1978-79 and 1979-80. Incidence of shoot borers was also low in plots treated with gamma BHC (Lindane) granules @ 1.0 kg a.i./ha. All the remain-

TABLE 1

Effect of different soil insecticides on germination, shoot borers incidence and termites damage

S. No.	Insecticides	Dose (kg a.i./ha)	Germination after 6 weeks		Germination after 8 weeks		Per cent shoot borers incidence May		Per cent shoot borers incidence June		Per cent termite damage	
			78-79	79-80	78-79	79-80	78-79	79-80	78-79	79-80	78-79	79-80
1.	Heptachlor 20 EC	1.25	37.8 (37.9)	28.6 (32.6)	53.1 (46.8)	36.8 (37.3)	2.4 (8.8)	2.3 (8.6)	5.6 (13.6)	7.1 (15.1)	0.9 (5.2)	0.4 (2.5)
2.	BHC dust (10%)	3.00	34.0 (35.6)	32.4 (34.6)	43.8 (41.4)	38.7 (38.5)	7.4 (17.6)	6.0 (12.6)	8.2 (16.2)	10.9 (19.1)	2.4 (8.4)	4.4 (13.7)
3.	BHC dust (10%)	5.00	33.4 (35.3)	32.0 (34.4)	43.7 (41.4)	38.1 (38.1)	2.9 (8.9)	3.8 (10.4)	7.9 (16.1)	9.4 (18.9)	1.6 (7.0)	2.7 (8.0)
4.	Gamma BHC 6G	1.00	N.T.	32.0 (34.4)	N.T.	37.8 (37.8)	N.T.	8.0 (15.7)	N.T.	10.4 (18.8)	N.T.	7.3 (13.8)
5.	*Mephosfolan* 5G	1.00	31.3 (34.0)	30.1 (33.2)	36.0 (36.8)	35.8 (36.7)	9.0 (17.5)	9.4 (17.5)	11.4 (19.7)	18.4 (25.0)	3.6 (10.8)	3.7 (9.2)
6.	Endosulfan 4G	1.00	30.1 (33.2)	31.9 (34.4)	36.4 (37.1)	35.7 (36.7)	10.4 (18.7)	15.3 (22.0)	16.8 (24.1)	30.8 (33.5)	6.5 (14.6)	8.7 (17.1)
7.	Dimethoate 5G	1.00	32.6 (34.8)	N.T.	38.6 (38.4)	N.T.	10.6 (19.0)	N.T.	18.3 (25.3)	N.T.	4.3 (11.9)	N.T.
8.	Phorate 10G	1.00	33.5 (35.2)	31.3 (33.2)	37.0 (37.4)	37.8 (38.0)	10.3 (18.2)	15.5 (22.6)	14.3 (22.1)	23.6 (28.6)	5.6 (13.3)	5.4 (12.7)
9.	Bendicarb 5G	1.00	34.1 (35.6)	32.4 (34.7)	38.1 (38.8)	38.0 (38.1)	15.1 (22.6)	19.4 (25.8)	18.3 (25.3)	31.6 (27.8)	6.1 (14.3)	9.4 (16.9)
10.	Bendicarb 5G	1.50	34.1 (36.1)	N.T.	42.1 (41.2)	N.T.	9.6 (17.8)	N.T.	15.8 (22.7)	N.T.	3.1 (10.0)	N.T.
11.	Ficam 5G	1.00	N.T.	31.6 (34.2)	N.T.	38.9 (38.5)	N.T.	14.9 (22.3)	N.T.	23.3 (25.8)	N.T.	9.7 (10.3)

12.	*Isofenphos* 5G	1.00	N.T.	26.9 (31.2)	N.T.	36.9 (37.4)	N.T.	12.0 (19.4)	N.T.	27.3 (30.8)	N.T.	6.4 (12.5)
13.	Carbofuran 3G	0.50	34.4 (35.8)	32.7 (34.8)	41.2 (39.9)	38.5 (38.2)	11.4 (19.2)	21.1 (26.6)	14.6 (22.4)	30.7 (33.4)	4.6 (11.9)	6.0 (13.8)
14.	Carbofuran 3G	0.75	36.7 (37.2)	33.0 (35.0)	42.3 (40.6)	39.4 (38.8)	5.5 (13.1)	20.7 (25.6)	11.9 (20.0)	31.4 (34.0)	3.5 (10.3)	3.7 (9.4)
15.	Carbofuran 3G	1.00	38.0 (38.2)	33.0 (35.0)	47.3 (43.5)	39.7 (39.1)	8.9 (17.1)	14.3 (21.9)	21.6 (26.6)	23.6 (28.8)	2.8 (9.0)	3.9 (9.7)
16.	Control (no treatment)		17.7 (24.7)	25.1 (30.1)	21.9 (27.6)	28.8 (32.4)	15.9 (24.0)	15.3 (22.7)	20.2 (26.6)	30.2 (33.1)	4.5 (12.0)	19.0 (25.8)
	C. D. at 5%		(4.2)	(2.8)	(4.8)	(2.8)	(5.7)	(10.1)	(5.8)	(8.3)	(3.6)	(9.6)

N.T.=Not tried.

Agallol treatment to setts was given in all the treatments.

Figures in parentheses are the angular transformed values.

TABLE 2

Effect of different soil insecticides on *tillers*, *millable canes* and yield of cane/ha

S. No.	Insecticides	Dose (kg a.i./ha)	Tillers/ha		Millable canes/ha		Yield/ha (M. Tons)	
			78-79	79-80	78-79	79-80	78-79	79-80
1.	Heptachlor 20 EC	1.25	139479	109480	93040	99880	69.2	84.3
2.	BHC 10% dust	3.00	108698	107530	83120	100700	55.8	67.3
3.	BHC 10% dust	5.00	115521	112420	94840	109870	60.3	72.9
4.	Gamma BHC 6G	1.00	N.T.	101650	N. T.	100930	N.T.	70.8
5.	Mephosfolan 5G	1.00	79062	92650	77080	89590	49.5	53.3
6.	Endosulfan 4G	1.00	84010	78150	71090	78100	42.6	43.9
7.	Dimethoate 5G	1.00	78547	N.T.	65890	N.T.	42.2	N.T.
8.	Phorate 10G	1.00	82239	85800	78230	80430	43.3	43.2
9.	Bendicarb 5G	1.00	77812	89600	67550	79320	39.5	55.3
10.	Bendicarb 5G	1.50	93281	N.T.	91930	N.T.	57.9	N.T.
11.	Ficam 5G	1.00	N.T.	80950	N.T.	77760	N.T.	42.9
12.	Isofenphos 5G	1.00	N.T.	87700	N.T.	71760	N.T.	46.8
13.	Carbofuran 3G	0.50	83802	90820	72500	76980	41.8	45.2
14.	Carbofuran 3G	0.75	95626	90310	71980	75150	40.1	45.8
15.	Carbofuran 3G	1.00	99635	96986	81770	82540	49.5	55.3
16.	Control (no treatment)	—	76927	64880	68740	62050	40.2	41.6
	C. D. at 5%		19647	19580	19630	15310	7.7	9.4

N.T.=Not tried.

Agallol treatment to setts was given in all the treatments.

ing treatments were found ineffective in reducing incidence of shoot borers.

The incidence of termites to cane tiller was low (0.9 to 6.5 per cent) in the experiment carried out during 1978-79 but even in this experiment lowest incidence (0.9%) was recorded under heptachlor emulsion followed by BHC dust @ 5 and 3 kg a.i./ha. Incidence of termites to tillers in the remaining treatments during 1978-79 was almost similar to that of control. Similar to 1978-79 the incidence of termite to shoots was lowest (0.4%) in the heptachlor treated plots during 1979-80 followed by BHC dust @ 5 and 3 kg a.i./ha, carbofuran 3G @ 0.75 and 1.0 kg a.i./ha and mephosfolan 5G @ 1 kg a.i./ha. In other insecticidal treatments the incidence of termites to cane shoots during May and June varied from 5.4 to 9.7 per cent and were considered ineffective. In control treatment, however, termite incidence to cane shoots during summer was 19.0 per cent.

Considering the number of tillers/ha, the application of heptachlor emulsion @ 1.25 kg a.i./ha, BHC dust @ 5 and 3 kg a.i./ha and gamma BHC and carbofuran granules each 1 kg a.i./ha were found to be the most effective treatments as the number of tillers/ha in these treatments varied from 99,635 to 139,479 during 1978-79 and 96,980 to 112,420 during 1979-80. Heptachlor was again found most effective (Table 2).

Similar to number of tillers, the number of millable canes were also higher in heptachlor emulsion, BHC dust (5 and 3 kg a. i./ha) and bendicarb granules during 1978-79 and BHC dust (5 and 3 kg a.i./ha), gamma BHC granules and heptachlor emulsion during 1979-80. However, cane yield was significantly higher in heptachlor emulsion treated plots than all the remaining treatments in the trials of both the years. The cane yield in BHC 10% dust @ 5 kg a.i./ha and bendicarb granules @ 1.5 kg a.i./ha during 1978-79 and BHC 10% dust @ 5 and 3 kg a.i./ha and gamma BHC granules @ 1 kg a.i./ha during 1979-80 were almost equal and significantly higher than all the remaining treatments. This shows that the results of BHC dust @ 3 kg a.i./ha and bendicarb granules @ 1 kg a.i./ha were inconsistent. However, heptachlor emulsion, BHC dust @ 5 kg a.i./ha and gamma BHC granules @ 1 kg a.i./ha gave consistently similar results in both the trials.

Considering overall efficacy of different insecticides, heptachlor emulsion @ 1.25 kg a.i./ha was found to be the best treatment for giving higher germination, reducing shoot borers and termite incidence and improving number of tillers, millable canes and yield/ha. This insecticide was also found very effective by Teotia *et al.* (1963), Kalra *et al.* (1964) and Singh and Soneja (1966) for controlling termites and shoot borers. The other chemicals which may be placed in the second category in respect of their effectiveness were BHC 10% dust @ 5 kg a.i./ha and gamma BHC granules @ 1 kg a.i./ha. The BHC 10% dust @ 3 kg a.i./ha although gave promising results, yet BHC dust @ 5 kg a.i./ha being more effective may be preferred over 3 kg a.i./ha. As discussed above none of the insecticides either in their dust or granular formulation was found superior than the already recommended heptachlor

emulsion, however, BHC 10% dust @ 5 kg a.i./ha and gamma BHC granules @ 1 kg a.i./ha can also be safely recommended for the control of termite and shoot borers in the absence of heptachlor or where sprinkling is not possible due to shortage of water at the time of planting of cane. Gupta (1953) also recommended 5 lb a.i. of BHC dust per acre for the control of termites and shoot borers. Application of BHC dust has also been found effective for the control of termites and shoot borers by Siddiqi and Agarwal (1954), Gupta and Avasthy (1956) and Kalyanaraman *et al.* (1963).

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SODIUM-POTASSIUM INTER-RELATIONSHIP IN GREEN GRAM (*PHASEOLUS AUREUS* L.)

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ABSTRACT

Effect of sodium application on the composition and growth of sodium-sensitive crop-green gram (*Phaseolus aureus* L.) at different levels of potassium was studied in a pot culture experiment with a sandy soil deficient in potassium. Sodium application caused an adverse effect on the growth and decreased the crude protein content of plants at all levels of potassium. There was apparently a stoppage of sodium translocation at the root-shoot transition zone, since very small quantities of sodium were accumulated beyond this point. K : Na ratios data indicated a highly selective nature of leaves and low selectivity by roots for potassium over sodium. Both sodium and potassium were found to be antagonistic to each other and had an additive effect in depressing the uptake of calcium and magnesium in the case of this plant.

The response of plants to potassium application is well documented in the literature. However, very scanty information about sodium and potassium inter-relationship is available. Nevertheless, sodium has been found to be useful to certain plants, though not essential. It was found to be actually essential for the growth of sugarbeet (El-Sheikh *et al.*, 1967; Khanna and Balaguru, 1981a) and as a substitute for potassium in cotton (Joham, 1955), and increased the yields of cereal crops (Lehr, 1953; Khanna and Balaguru, 1981b) when potassium was in short supply. In the literature, there are reports, such as, by Whitehead and Jones (1972) who observed no difference in the yield of clover and lucerne by sodium application. The inhibitory effect of potassium on sodium and vice-versa on their absorption was also recognised (Vriendt *et al.*, 1965). An attempt was, therefore, made to study the effect of various levels of potassium and sodium application on the growth and composition in green gram (*Phaseolus aureus* L.) regarded as a sodium-sensitive crop.

MATERIAL AND METHODS

A green house study was carried out with *Phaseolus aureus* L. var. Pusa Baisakhi, using a sandy soil, low in avail-

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able potassium (20 ppm). Simple randomised block design was followed with four replications and nine treatments with different combinations of potassium and sodium, as mentioned below, applied as their respective chlorides using 5 kg of soil for each treatment :

S. No.	Treatment (ppm)	
	K_2O	Na_2O
1	0	0.00
2	0	19.75
3	0	39.50
4	30	0.00
5	30	19.75
6	30	39.50
7	60	0.00
8	60	19.75
9	60	39.50

Each replication was kept separately and separate pots were kept for two stages (25 and 50 days after sowing). Basal dose of 25 ppm P_2O_5 was applied. After germination and setting, plants were thinned to 2 with uniform stand. Pots were irrigated with deionised water as and when required, and proper plant protection measures were also taken up. Plant height was taken at weekly intervals and crop was harvested at the age of 25 days (first stage) and 50 days (second stage). Dry weights of upper leaves, lower leaves, stems and roots were determined after drying these at 65°C for 48 h in an electric oven. Chemical analyses for sodium, potassium, calcium and magnesium, and crude protein content were done after digesting the samples in diacid mixture (Jackson, 1958).

RESULTS AND DISCUSSION

Growth and General Appearance of Plants

Height of plants, dry weight of different parts of plants, leaf protein content and percentage hydration of shoots at various levels and combinations of potassium and sodium are presented in Table 1.

(i) **Height of plants.** In both stages, the height of plants increased significantly with an application of 60 ppm potassium from 16.26 to 18.09 cm and 36.19 to 39.35 cm over control, respectively. However, application of sodium had a deleterious effect on the height of plants even in the presence of potassium.

(ii) **Dry weight of plants.** Application of potassium at all levels increased the weight of upper leaves, lower leaves, stems and roots, but application of sodium at all levels led to a decrease in the dry weight of all parts of the plants in both the stages.

(iii) **Protein content of plants.** The crude protein content of leaves increased by potassium application but the sodium application decreased the crude protein content at all levels even in the presence of potassium indicating the toxic effect of sodium on protein synthesis.

It is obvious from the above results that sodium exhibited toxic effects on the growth of *Phaseolus* plants and this adverse effect was reduced to a certain extent in the presence of potassium. Similar results have been reported by Al-

TABLE 1

Influence of various potassium and sodium treatments on the growth, succulence and leaf protein content of *Phaseolus* plants

Treatment (ppm)		Height of plants (cm)		Dry weight of plants (mg/pot)								Percentage hydration of shoots		Leaf protein (mg/g)	
				First stage				Second stage							
K_2O	Na_2O	First stage	Second stage	UL	LL	S	R	UL	LL	S	R	First stage	Second stage	First stage	Second stage
0.00	0.00	16.26	36.19	214.9	179.3	108.1	312.5	2800	1410	1310	2280	86.4	82.7	126.6	74.0
0.00	19.75	15.63	34.83	192.1	163.8	103.1	281.6	2690	1350	1280	2230	87.0	82.9	125.4	73.6
0.00	39.50	15.30	33.88	167.0	162.5	101.4	261.5	2530	1270	1140	2170	87.0	82.8	123.4	71.1
30.00	0.00	17.78	37.65	226.0	207.2	117.1	361.3	2070	1710	1630	2580	87.3	82.9	128.3	80.5
30.00	19.75	16.76	36.45	216.0	186.5	110.1	314.2	2770	1470	1380	2520	87.2	82.3	124.8	78.7
30.00	39.50	15.69	35.45	196.5	175.7	103.1	366.9	2730	1300	1320	2370	87.4	82.7	123.6	76.2
60.00	0.00	18.09	39.35	256.1	221.2	123.2	331.8	3100	1800	1760	3270	87.7	83.1	129.3	85.0
60.00	19.75	17.18	36.68	221.4	192.6	116.0	340.7	3040	1520	1450	2790	87.5	81.7	126.0	79.5
60.00	39.50	16.39	36.10	215.7	183.6	111.5	402.5	2820	1320	1320	3060	88.4	83.7	124.4	79.1
C. D. at 5%															
Na and K		0.48	0.72	6.7	7.1	3.8	9.7	70	60	50	80	0.31	NS	Duncan's multiple	
Na×K		0.84	1.24	11.6	12.3	6.5	16.8	120	100	80	150	0.57	NS	range test :	
														L. S. R. at 5%=	
														1.62	0.57

UL=Upper leaves
LL=Lower leaves
S=Stems
R=Roots

TABLE 2a

Effect of various levels of potassium and sodium on the mineral content of *Phaseolus* plants

Treatment (ppm)		Sodium (%)								Potassium (%)							
		First stage				Second stage				First stage				Second stage			
K_2O	Na_2O	UL	LL	S	R	UL	LL	S	R	UL	LL	S	R	UL	LL	S	R
0.00	0.00	0.19	0.15	0.40	1.58	0.09	0.22	0.47	1.57	2.51	1.61	3.01	1.76	1.18	1.11	1.36	1.06
0.00	19.75	0.20	0.16	0.43	1.60	0.14	0.22	0.49	1.61	2.45	1.56	2.68	1.72	1.10	0.99	1.28	1.01
0.00	39.50	0.26	0.19	0.55	1.67	0.16	0.26	0.55	1.74	2.37	1.49	2.31	1.72	1.04	0.88	1.28	0.96
30.00	0.00	0.17	0.11	0.30	1.49	0.07	0.15	0.41	1.50	2.82	1.80	4.01	2.29	1.37	1.14	2.00	1.46
30.00	19.75	0.17	0.15	0.36	1.53	0.09	0.16	0.44	1.54	2.56	1.61	3.50	2.17	1.28	1.10	1.62	1.38
30.00	39.50	0.19	0.17	0.40	1.54	0.10	0.19	0.45	1.58	2.44	1.54	3.12	2.06	1.24	1.07	1.58	1.23
60.00	0.00	0.07	0.08	0.20	1.34	0.06	0.10	0.33	0.37	3.06	2.21	4.33	2.58	1.67	1.58	2.09	1.81
60.00	19.75	0.11	0.10	0.32	1.46	0.08	0.11	0.38	1.43	2.63	1.97	3.58	2.48	1.57	1.42	1.99	1.62
60.00	39.50	0.12	0.13	0.35	1.50	0.08	0.14	0.39	1.45	2.44	1.78	3.41	2.40	1.43	1.35	1.90	1.46
C. D. at 5%																	
Na and K		0.01	0.01	0.02	0.06	0.01	0.02	0.02	0.03	0.10	0.03	0.12	0.03	0.06	0.08	0.05	0.03
Na×K		0.02	0.02	0.04	0.12	0.02	0.04	0.04	0.06	0.21	0.06	0.24	0.06	0.12	0.15	0.11	0.06

UL=Upper leaves

LL=Lower leaves

S=Stems

R=Roots

TABLE 2b

Effect of various levels of potassium and sodium on the mineral content of *Phaseolus* plants

Treatment (ppm)		K : Na ratios								Calcium (%)		Magnesium (%)	
		First stage				Second stage				First	Second	First	Second
K_2O	Na_2O	UL	LL	S	R	UL	LL	S	R	Stage	stage	stage	stage
0.00	0.00	13.1	10.9	7.3	1.1	13.2	5.1	3.0	0.7	1.22	1.52	0.93	0.80
0.00	19.75	12.3	10.3	6.3	1.1	7.7	4.6	2.6	0.6	1.05	1.47	0.88	0.74
0.00	39.50	9.2	8.1	4.3	1.0	6.7	3.4	2.3	0.6	0.92	1 38	0.85	0.64
30.00	0.00	17.0	18.2	13.3	1.6	20.0	7.6	4.9	1.0	0.92	1.59	0.81	0.59
30.00	19.75	15.3	10.2	9.7	1.4	14.7	6.8	3.7	0.9	0.82	1.45	0.74	0.57
30.00	39.50	12.7	9.3	7.8	1.4	12.5	5.7	3.5	0.8	0.75	1.35	0.70	0.57
60.00	0.00	44.2	28.5	22.0	2.0	30.9	15.8	6.4	1.3	0.82	1.47	0.73	0.55
60.00	19.75	24.3	29.3	11.2	1.7	21.3	12.8	5.3	1.1	0.69	1.33	0.68	0.54
60.00	39.50	20.0	14.0	9.9	1.6	18.3	9.9	4.9	1.0	0.69	1.25	0.65	0.53
C. D. at 5%													
Na and K		1.0	0.5	1.1	0.08	1.2	0.3	0.21	0.09	0.05	0.01	0.02	0.02
Na × K		2.1	1.1	2.0	0.15	2.3	0.6	0.40	0.19	0.10	0.02	0.04	0.04

UL=*Upper leaves*
LL=Lower leaves
S=*Stems*
R=*Roots*

Ani and Ouda (1972), while working on the sodium-potassium inter-relationship in bean plants.

(iv) **Percentage hydration of shoots.** The succulence of plants was significantly increased by the application of sodium and potassium after 25 days and the maximum value of 88.4% was obtained by applying 60 ppm potassium and 39.50 ppm sodium. These results are in conformity with those obtained by Fomin (1966). However, after 50 days, no significant differences could be seen.

Cation Content of Plants

The distribution of sodium, potassium, calcium and magnesium, and K : Na ratios in different parts of the plants as influenced by various levels and combinations of potassium and sodium are presented in Table 2.

(i) **Sodium content.** In all the plant parts, sodium content increased with increasing levels of sodium. Maximum amounts of 1.67 and 1.74 per cent were found in roots and minimum amounts of 0.07 and 0.06 per cent in the upper leaves after 25 and 50 days, respectively. However, potassium application decreased the sodium content of all parts of the plants. These results reveal the high selectivity of leaves for potassium over sodium and the inhibitory effect of potassium over the absorption of sodium by *Phaseolus* plants. Vriendt *et al.* (1965) reported similar results.

(ii) **Potassium content** Application of potassium increased the potassium concentration in all the plant parts at both the stages, but sodium application at all levels of potassium decreased the potassium content, indicating the mutual antagonistic between the two cations.

(iii) **K : Na ratios.** The ratios increased with an increase in potassium levels and decreased with increasing sodium levels in the media, in all parts of the plants. The highest ratios of 44.2 and 30.9 after 25 and 50 days, respectively, in the upper leaves, and the lowest ratios of 1.0 and 3.4 during the same period in the roots were obtained. When the ratios in the media increased, there was an increase in the ratios in plants also, which was maximum in leaves and minimum in the roots with stems occupying an intermediate position. These results reveal a high selectivity of leaves and low selectivity of roots for potassium over sodium. Whitehead and Jones (1972) obtained similar results while working on the effect of replacing potassium by sodium on cation uptake and transport to shoots in leguminous crops. The maximum dry matter yields were obtained whenever the K : Na ratios in the tissues were maximum.

(iv) **Calcium and magnesium content.** Application of both potassium and sodium decreased the calcium and magnesium contents in the shoots in both the stages. The maximum amounts of 1.22 and 1.52 per cent calcium and 0.93 and 0.80 per cent magnesium after 25 and 50 days, respectively, were obtained at zero levels of sodium and potassium (Fig. 1). All these results indicate the additive effect of sodium and potassium in depressing the uptake of both calcium and magnesium. Al-Ani and Ouda (1972) obtained similar effect of potassium in beans, but found only a limited effect with sodium application.

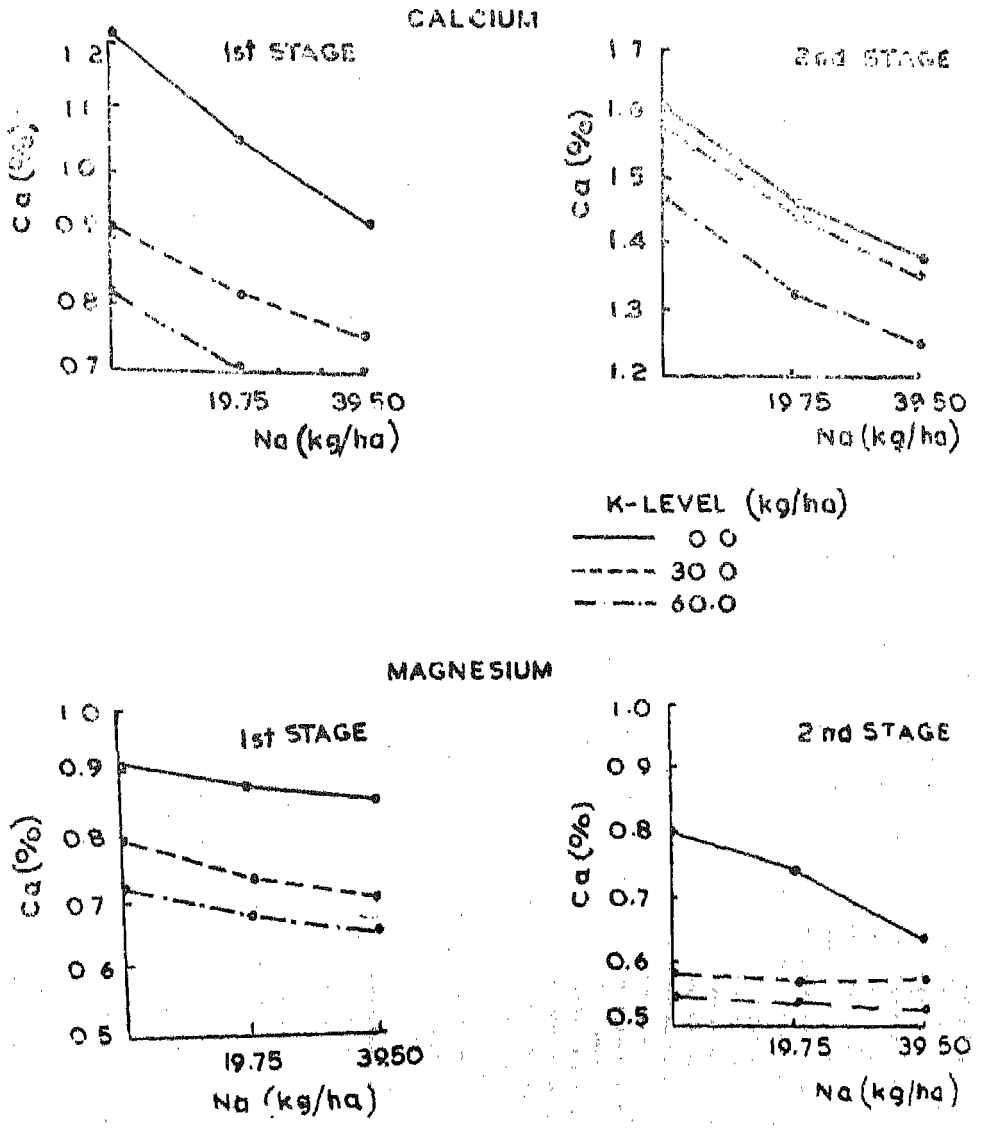


Fig. 1. Effect of sodium and potassium on calcium and magnesium contents of shoots in moong.

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PERFORMANCE OF MUNGBEAN VARIETIES UNDER DIFFERENT SOWING DATES IN RAINFED CONDITIONS

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ABSTRACT

Seven mungbean varieties (T-44, S-8, PS-7, K-851, MH-1, H 70-16 and PS-16) were sown on three dates (July 15, August 1 and 18). Variety K-851 gave significantly more seed yield/ha than all other varieties during both the years and in the pooled data. This variety outyielded significantly all other varieties under all the dates of sowing except T-44 in August 1 sown crop. Variety T-44 was second best in the first two sowing dates. Variety H 70-16 was lowest yielder under all sowing dates. Variety K-851 had maximum seed yield/plant and number of seeds/pod. The number of pods/plant were maximum in S-8 and K-851 while the test weight was maximum in H 70-16. There was significant reduction in seed yield with delayed sowing beyond July 15. The seed yield/plant, test weight, number of seeds/pod and number of pods/plant decreased with delay in sowing.

Mungbean *(Vigna radiata* (L.) Wilczek) is an important short duration **kharif** season pulse crop in India. The optimum time of sowing of mungbean has been found to be from middle of June to middle of July (Singh and Virk, 1965; Singh and Faroda, 1977). However, its sowing continues upto middle of August. Selection of a suitable variety for a particular date of sowing is more important. Batra *et al.* (1976) found strains S-8, S-9, R-288-8 better than Hyd. 45 both under normal and late sowings at Hissar. Similarly, Singh (1976) found variety S-8 better than RS-4, T-44 and Jawahar 45 under normal sowing at Jodhpur. However, under late sown conditions varieties RS-4 and S-8 performed better. At Kanpur, variety K-851 outyielded all other varieties (Panwar *et al.*, 1978). The information on the performance of new mungbean varieties under different dates of sowing is lacking, particularly under north Indian conditions. Keeping this in view the present study was undertaken.

MATERIAL AND METHODS

A field experiment was conducted in rainfed conditions at the Haryana Agricultural University Farm, Hissar during **kharif** seasons of 1978 and 1979.

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Seven mungbean varieties (T-44, S-8, PS-7, K-851, MH-1, PS-16, H 70-16) were tested under three sowing dates (July 15, August 1 and 18). The treatments were replicated thrice in the strip plot design.

The soil of the experimental plot was sandy loam in texture, poor in N (166 kg available/ha), medium in available P_2O_5 (22.8 kg/ha) and rich in available K_2O (412 kg/ha). A basal dose of 20 kg N and 40 kg P_2O_5/ha was applied at the time of sowing through urea and single super phosphate, respectively.

The crop was sown in rows 30 cm apart. An intra row spacing of 10 cm was maintained in all the plots by thinning after three weeks of sowing. Weather data recorded during the crop seasons of 1978 and 1979 are presented in Table 1. The crop season of 1978, in general, was more favourable than 1979. Total rainfall (July to November) in 1978 was 484.8 mm against only 347 6 mm in 1979. The distribution of rainfall was more uniform in 1978 than in 1979. Variations in temperature and humidity were more in 1979 than in 1978.

RESULTS AND DISCUSSION

Yield Attributes

During 1978, varieties T-44, S-8, PS-7, K-851 MH-1, and PS-16 being statistically at par recorded more number of pods per plant than H 70-16 (Table 2). During 1979, varieties K-851 and S-8 produced significantly more pods/plant than all other varieties. Varieties K-851 and PS-16 produced more number of seeds/pod than other varieties except PS-7 and MH-1 in 1978. However, in 1979, variety H 70-16 produced maximum number of seeds/pod being significantly higher than S-8, MH-1 and PS-16. Variety H 70-16 had significantly bolder seeds than all other varieties. Varieties PS-7 and K-851 also produced bolder seeds than other varieties. Variety K-851 gave maximum seed yield/plant during both the years. The crop sown on July 15 produced more number of pods/plant than August 1 and 18 which were at par in both the seasons. Crop sown on July 15 also produced maximum number of seeds/pod. However, the differences were significant in 1979 only (Table 2). There was significant reduction in test weight with delay in sowing time during both the years. The seed yield/plant was significantly more with July 15 sown crop as compared to August 1 and 18 sown crops in 1978. In 1979, the differences were not significant.

Seed Yield

Variety K-851 gave significantly more seed yield/ha than all other varieties during both the years and in the pooled data (Table 2). Varieties T-44, S-8 and PS-7 were at par and gave higher seed yield than MH-1, H 70-16 and PS-16 in both the years and in pooled data. Variety K-851 outyielded significantly all other varieties under all the dates of sowing except T-44 in August 1 sown crop (Table 3). Variety T-44 was second best in the first two sowing dates and the differences were significant as compared to MH-1, PS-16 and H 70-16. Varieties T-44, S-8 and PS-7 were statistically at par under all dates of

TABLE 1

Mean weekly weather conditions during crop seasons of 1978 and 1979

Met. week	Month/Dates	1978					1979				
		Temperature °C		Rainfall	R.H.%	U.S. open	Temperature °C		Rainfall	R.H.%	U.S. open
		Max.	Min.	(mm)	(Mean)	pan evaporation mm/day	Max.	Min.	(mm)	(Mean)	pan evaporation mm/day
27	July 2-8	34.9	27.1	14.8	75	6.9	40.4	28.6	—	49	10.8
28	9-15	35.5	27.1	13.4	75	8.1	36.3	25.6	107.0	79	7.9
29	16-22	31.3	26.4	180.0	72	4.1	34.8	25.6	33.0	72	6.7
30	23-29	33.4	26.8	108.8	72	4.2	37.3	25.5	6.0	63	7.4
31	July 30-Aug. 5	33.5	26.9	17.4	75	4.2	34.9	25.0	6.0	63	7.4
32	Aug. 6-12	33.3	23.4	53.5	79	3.3	35.0	26.5	121.0	70	3.8
33	13-19	32.0	24.0	2.9	78	4.2	36.2	25.1	22.8	64	7.5
34	20-26	33.9	24.2	14.7	78	3.8	35.8	25.5	—	59	7.3
35	Aug. 27-Sep. 2	34 3	24.8	19.8	80	5.1	38.5	25.1	—	48	8.9
36	Sep. 3-9	33.7	23.0	7.5	70	5.1	35.6	26.0	45.6	59	7.0
37	10-16	34.5	23.0	47.4	70	6.2	35.4	24.3	5.2	59	5.9
38	17-23	33.4	24.4	—	71	4.5	32.6	19.2	—	60	4.2
39	24-30	34.8	24.3	1.6	68	5.0	35.6	19.9	—	50	5.8
40	Oct. 1-7	35.3	23.5	3.0	62	5.9	36.4	17.2	—	46	7.0
41	8-14	34.9	15.3	—	54	6.2	35.6	18.6	—	56	6.9
42	15-21	33.9	15.0	—	49	4.7	34.8	15.9	1.0	64	5.2
43	22-28	34.7	16.3	—	48	5.0	31.4	15.1	—	60	4.5
44	Oct. 29-Nov. 4	32.0	14.9	—	54	3.7	33.1	15.8	—	64	3.5
45	Nov. 5-11	31.1	13.2	—	57	3.7	31.0	14.9	—	65	3.7
	Total			484.8					347.6		

TABLE 2

Effect of varieties and sowing dates on yield attributes and grain yield of mungbean

Treatment	Number of pods/plant		Number of seeds/pod		Test weight (g/1000 seeds)		Seed yield (g/plant)		Grain yield (q/ha)		
	1978	1979	1978	1979	1978	1979	1978	1979	1978	1979	Mean
Varieties											
T-44	16.0	13.8	5.5	9.5	33.5	30.7	4.5	5.3	8.3	6.8	7.6
S-8	16.9	15.4	6.2	8.9	35.7	25.4	4.5	5.2	8.4	6.5	7.5
PS-7	14.4	13.9	7.5	9.3	39.1	35.2	4.6	4.9	7.7	6.7	7.2
K-851	16.6	15.7	7 9	9.8	41.8	32.3	5.4	5.6	10.5	8.0	9.3
MH-1	17.0	13.5	7.4	8.7	33.8	30.3	5.0	4.5	5.5	4.8	5.1
H 70-16	12.6	10.7	7.1	10 4	55.4	46.4	3.8	4.7	3.1	4.2	3.6
PS-16	16 9	13.5	8.0	9.0	29.8	29.2	4.6	5.1	6.4	5.7	6.0
S. Em.±	1.4	0.4	0.2	0 4	1.4	0.7	0.2	0.3	0.5	0.3	0.3
C. D. at 5%	3.8	1.2	0.7	1.2	3.9	1.9	0.5	NS	1.3	1.1	0.7
Sowing dates											
July 15	17.4	16.1	8.0	11.7	41.8	37.7	5.9	5.6	9.0	8.8	8.9
August 1	15.3	13.7	6.4	9.8	39.6	32.0	4.7	5.2	7.9	7.9	7.9
August 18	14.6	11.6	5 9	6.8	33.8	28.6	3.2	4.3	4.5	1.7	3.1
S. Em.±	0.5	0.6	0.4	0.1	0.3	0.9	0.2	0.3	0.5	0.2	0.2
C. D. at 5%	2.0	2.4	NS	0.5	1.2	3.6	0.6	NS	2.0	0.8	0.7

TABLE 3

Effect of varieties × sowing dates on seed yield (q/ha) of mungbean (pooled data)

Varieties	Sowing dates		
	July 15	August 1	August 15
T-44	10.0	9.2	3.4
S-8	9.5	9.0	3.9
PS-7	9.2	9.0	3.5
K-851	12.0	10.4	5.4
MH-1	8.5	6.0	1.0
H 70-16	6.2	3.5	1.2
PS-16	7.0	8.1	3.1
	S. Em. ±	C. D. at 5%	
Sowing dates	0.2	0.7	
Varieties	0.3	0.7	
D × V	0.5	1.3	

sowing. Variety H 70-16 was lowest yielder under all sowing dates. The higher seed yield/ha in K-851 may be attributed to highest seed yield/plant resulting from more number of pods (16.1/plant) and number of seeds/pod (8.8) than most of other varieties. The higher number of pods/plant and seeds/

pod in K-851 might be genetic characters. In other varieties, the beneficial effect of one yield parameter was nullyfied due to reduction in other parameter. But variety K-851 had cumulative effect of most of the yield parameters in contributing towards higher seed yield/ha. Panwar *et al.* (1978) also obtained similar results under Kanpur conditions.

Crop sown on July 15 produced significantly more seeds/ha as compared to that sown on August 18 in 1978 and August 1 and 18 in 1979 and in the pooled data (Table 2). The crop sown on August 1 was also significantly better than August 18 sown crop. On an average, July 15 sown crop produced 12.9 and 191.1 per cent higher seed yield than August 1 and 18 sown crops, respectively.

The higher seed yield/ha in early (July 15) sown crop was the result of maximum test weight, number of pods/plant and number of seeds/pod contributing to higher seed yield/plant. Weather conditions during the crop growth and reproduction stages have great role. The July 15 sown crop received more favourable weather during crop season. There was fairly good and uniformly distributed rainfall up to middle of September during both the years. The crop sown on July 15 was harvested in the third week of September. Since there was practically no rainfall (Table 1) after middle of September, the crop sown on August 1 and 18 had moisture scarcity at the time of flowering and fruiting and thus poor yield. Singh and Virk (1965) and Singh and Faroda (1977) have also found middle of June to middle of July as the optimum time of sowing for mungbean. The seed yield/ha, in general, was more in 1978 than in 1979. It was due to more favourable weather in the first year than in the second year.

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COMBINING ABILITY ANALYSIS FOR YIELD AND ITS ATTRIBUTES IN PEARL MILLET

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ABSTRACT

Combining ability analysis was done involving hybrids of 3 male sterile lines with the 16 pollinators of pearl millet over three environments. Both gca and sca variances were significant for grain yield, days to ear emergence, effective tillers, plant height and ear length under individual as well as over the environments. Predominance of non-additive gene effects was observed for all the characters. Hybrids (female × male) showed more interaction with the environment than the parents (females and males) for all the characters. Among male sterile lines 5141 A was the best general combiner followed by 111 A and 5054 A for most of the traits. Some of the hybrids were better than BJ 104.

Combining ability of yield and yield contributing traits has been reported by Gill *et al.* (1969), *Singh et al.* (1974), Pokhriyal *et al.* (1976), Tyagi *et al.* (1978) and Kapoor *et al.* (1979) using different male sterile lines of pearl millet *(Pennisetum americanum* (L.) Leeke). These reports, however, were based on only one experiment under one environment. Presently, three male sterile lines 5141 A, 111 A and 5054 A, which are resistant to downy mildew, are being extensively used for the development of hybrids. Comparative performance of these lines has not been tested under varying environments in a set of experiment. Keeping this point in view, the present experiment was conducted over three environments with the objectives : to select good cross combinations for commercial purpose and to identify good general combining parents among male sterile lines and restorers in the material.

MATERIAL AND METHODS

The material comprised 48 crosses of pearl millet between three male sterile lines (5141 A, 111 A and 5054 A) with 16 inbreds (H 77/1, H 72/2, H 77/3, H 77/23, H 76/1-9, H 77/13, H 76/8-1, H 77/28, H 77/4, H 77/226, H 77/9, H 76/21-4, H 76/28-2, H 135, H 76/30-2 and H 76/32-7). These hybrids alongwith a check (BJ-104) were grown in randomized block design with two replications of single row, 3 m × 45 cm plot size over three environments (E_1=early sown with 40 kg N/ha, E_2=late sown

with 80 kg N/ha, E_3=late sown with 40 kg N/ha). After thinning and gap filling 20 plants/plot were maintained.

The data were recorded on five plants per plot for days to ear emergence, plant height (cm) and ear length (cm). The data of effective tillers and grain yield (kg) were taken on per plot basis. The combining ability analysis was done following Beil and Atkins (1967).

RESULTS AND DISCUSSION

Pooled analysis over the environments (Table 1) indicated significant environmental differences for all the characters, except for days to ear emergence. The variances due to females, males and females × males were also significant for grain yield, plant height, ear length and days to ear emergence. Females × males interactions, were non-significant for effective tillers. The females × environment interactions were significant for grain yield and plant height. Males × environment interactions were significant for plant height and days to ear emergence only. The females × males × environment interactions were significant for all the characters. This indicated that sca variances interacted more with the environment than the gca variances. The estimated σ^2 sca were higher than those due to σ^2 gca. Consequently, the ratio σ^2 sca/σ^2 gca was more than one for all the characters. This further substantiates the predominance of non-additive gene effects for these characters in pearl millet. The importance of non-additive gene effects, for the characters studied here, has also been emphasised by Gill *et al.* (1969), Singh *et al.* (1974), Pokhriyal *et al.* (1976), Tyagi *et al.* (1978) and Kapoor *et al.* (1979). However, apart from the present findings these reports were based on single environment data.

TABLE 1

Pooled combining ability variances over the environments for five characters in pearl millet

Sources	d.f.	Grain yield	Effective tillers	Plant height	Ear length	Days to ear emergence
Environment(e)	2	0.513*	709.759*	4959.354*	65.966*	2.505
Females (f)	2	0.222*	227.708*	1856.635*	579.541*	65.725*
Males (m)	15	0.531*	61.672*	1760.766*	47.274*	32.628*
f×m	30	0.045*	17.162	383.426*	16.597*	17.125*
f×e	4	0.272*	25.433	476.754*	1.114	9.052
m×e	30	0.016	21.147	203.402*	5.116	12.474*
f×m×e	60	0.011*	19.875*	99.014*	4.033*	7.203*
Pooled error	143	0.003	3.763	6.04	1.670	2.820
σ^2gca		0.0008	2.1773	20.5387	5.1703	0.2063
σ^2sca		0.0208	6.6999	383.4365	7.4639	2.7195
σ^2sca/ σ^2gca		27.170	3.077	18.668	1.443	13.182

*Significant at 5% level.

The estimates of general combining ability (gca) effects (Table 2) indicate, among male sterile lines, MS 5141 A was good general combiner for grain yield, plant height and ear length. MS 111 A was good general combiner for ear length and ear emergence and MS 5054 A was good combiner for effective tillers. Among males, H 77/3 was the best general combiner for grain yield followed by H 76/8-1, H 76/21-4, H 76/32-7 and H 77/9. Contrary to this, parents H 77/2, H 76/1-9 and H 77/28 were poor combiners for grain yield. Parents H 77/1, H 77/9, H 76/8-1, H 76/30-2 and H 76/21-4 were good combiners for effective tillers. Considering plant height, H 76/8-1, H 77/28 and H 77/4 were good for medium height while H 76/21-4, H 76/32-7 and H 77/9 were good for tallness. For ear length, parents H 76/32-7, H 77/9, H 76/21-4 and H 77/1 were good general combiners. The parents H 135, H 77/1, H 77/2 and H 77/226 were good general combiners for early emergence. Ranking was made

TABLE 2

Estimates of general combining ability effects (pooled) for five characters in pearl millet

Due to	Grain yield	Effective tillers	Plant height	Ear length	Days to ear emergence	Total	Rank
Female							
5141 A	0.18*	1.57	19.78*	21.19*	3.80	8	I
111 A	−0.05	−7.17*	−2.04	11.86*	−3.17*	10	II
5054 A	−0.14*	−5.16*	−17.27*	−7.62	0.80	12	III
C. D 5% Gi±	0.03	1.66	2.10	1.08	1.40		
C. D. Gi-Gj±	0.03	2.91	2.65	1.92	2.43		
Males							
H 77/1	0.07*	11.08*	−4.84	3.20*	−6.32*	22	I
H 77/2	−0.98*	−5.26*	−18.10*	−3.62*	−5.15*	58	XIV
H 77/3	0.29*	−0.75	−12.42*	−1.52	−3.31	36	V
H 77/23	0.07	−1.75	16.39*	2.12*	1.19	40	VII
H 76/1-9	−0.29	3.13	−22.02*	−2.24*	1.19	56	XIII
H 77/13	0.01	−4.25*	18.90*	2.68*	7.02*	47	XI
H 76/8-1	0.27*	6.75*	−77.73*	6.71	−1.33	43	IX
H 77/28	−0.25*	1.08	−42.62*	−2.29*	−1.32	58	XIV
H 77/4	−0.04*	−8.15*	−26.10	0.98	7.52*	65	XVI
H 77/226	−0.04*	2.25	−3.12	1.92	−4.48	37	VI
H 77/9	0.11*	8.76*	46.18*	10.38*	4.69*	23	II
H 76/21-4	0.21*	5.91*	96.70*	5.34*	4.69*	24	III
H 135	−0.23*	2.86	8.81*	−3.10	−6.98*	41	VIII
H 76/28-2	−0.08*	−4.25	−21.64	1.11*	−1.65	45	X
H 76/30-2	−0.17*	5.92*	−18.28*	−7.76*	1.35	54	XII
H 76/32-7	0.11*	3.00	61.88*	16.49*	4.36*	28	IV
C. D. 5% Gi±	0.03	4.61	5.77	2.02	3.85		
C. D. 5% Gi-Gj±	0.03	7.08	6.13	4.43	3.34		

*Significant at 5% level.

for each character on the basis of gca effects. Considering all the characters together (Table 2), among male sterile lines 5141 A was the best general combiner followed by 111 A and 5054 A. Among pollinators H 77/1 was the best general combiner followed by H 77/9, H 76/21-4, H 76/32-7 and H 77/3. These parents can be utilized for developing high yielding populations.

Data on seven cross combinations based on high sca effects for grain yield alongwith their *per se* performance for all the characters are presented in Table 3. It is apparent that out of seven crosses, 5141 A×H 76/8-1 involved both good general combining parents, 5054 A×H 76/21-4, 5141 A×H 77/28 and 111 A×H 77/3 had one good and one poor general combiner and the remaining three crosses 111 A×H 76/30-3, 111 A×H 135 and 5054 A×H 75/3 possessed both the parents as poor general combiners for grain yield. These crosses could be utilized for commercial purpose after multilocation testing.

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TABLE 3

Top seven crosses selected on sca effects for grain yield, their sca effects for other characters and *per se* performance (in parentheses)

Hybrids	Grain yield	Effective tillers	Plant height	Ear length	Days to ear emergence
5054 A×H 76/21-4	0.43* (0.740)	4.6* (38.83)	14.11* (268.20)	−3.44* (26.80)	9.47* (59.16)
111 A×H 76/30-3	0.43* (0.533)	3.67* (33.70)	−11.93* (224 53)	−7.84* (27.41)	−3.17* (53.30)
5141 A×H 77/28	0.29* (0.563)	4.26* (35.50)	−5.95* (227.80)	1.46 (25.93)	14.53* (60.33)
111 A×H 135	0.29* (0.563)	1.68 (32.33)	37.29* (251.96)	−11.61* (26.82)	11.67* (55.00)
5141 A×H 76/8-1	0.26* (0.813)	−6.90* (33.33)	47.07* (233.81)	6.73* (26.73)	−1.97 (53.33)
5054 A×H 77/13	0.23* (0.603)	−5.43* (31.88)	−1.55* (237.40)	0.15 (26.78)	4.14* (58.16)
111 A×H 77/3	0.21* (0.671)	−9.16* (26.83)	−25.98* (222.87)	−4.43* (30.68)	−4.50* (47.70)
BJ-104 (check)	(0.668)	(36.50)	(234.80)	(23.23)	(52.83)

*Significant at 5% level.

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EFFECT OF PRE-HARVEST APPLICATION OF CALCIUM, POTASSIUM AND ALAR ON FRUIT QUALITY AND STORAGE LIFE OF GUAVA FRUITS

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ABSTRACT

Alar at 1000 ppm and calcium nitrate 2% improved fruit quality in guava cv. Sardar (L-49) in terms of increased sugar and carotenoid contents and reduced the spoilage by reducing weight loss and rotting. Fruits after this treatment can be safely stored upto four days at ambient temperature.

The physiological changes in fruits after harvest are continuous till they perish and become unfit for consumption. If the rate of these changes could be reduced to a certain degree, the storage life of fresh fruit can be effectively increased. The metabolic activity can be reduced by keeping the fresh fruits at low temperature but the number of 'cold storage' is less in this country to accomodate the bulk of the fresh fruit. Certain pre-harvest treatments like calcium, potassium and growth regulators are known to reduce the rate of respiration and transpiration even after harvest and reduce spoilage both at low and room temperatures. Minerals like calcium and potassium, and growth regulators like alar have been found very effective in improving quality and increasing storage life of apple (Mantinger *et al.*, 1978) and peach (Singh *et al.*, 1979). The present study was, therefore, undertaken to find the effect of these chemicals on quality and storage life of guava fruits cv. Sardar (L-49).

MATERIAL AND METHODS

Seven year old guava plants of cv. Sardar (L-49) growing at the Experimental Orchard of the Department of Horticulture, each bearing a normal crop, were used for studies. Three weeks before harvest, calcium nitrate and potassium sulphate at 1 and 2 per cent and alar at 500 and 1000 ppm were sprayed on the trees to drip point using foot sprayer. Teepol was used as wetting agent in all the cases. For control, trees were sprayed with water containing wetting agent. Fruits were harvested at colour break stage and 3 kg fruits in each treatment were packed in wooden boxes. For recording the loss in weight, 2 kg fruits from each treatment were packed separately. Each treatment consisted of four replications. Boxes were kept at room temperature (27±1°C). Fruits were sampled on alternate days for recording observations. Total soluble solids were determined by hand refractometer and ascorbic acid by titrating

the pulp against standard 2,6-dichlorophenol indophenol dye solution. Sugars were determined by ferricyanide micro method (Hulme and Narain, 1931), total phenols by the method of AOAC (1966) and carotenoids by a method described by Roy (1973). Fruit weight loss was determined and expressed as per cent cumulative weight loss. Number of rotten fruits were counted at each observation and per cent fruit rot was calculated.

RESULTS AND DISCUSSION

Effect of Treatments on T. S. S.

In general, total soluble solids were significantly increased upto 2 days of storage and thereafter it decreased (Table 1). Retention of total soluble solids was higher in the calcium and alar treated fruits. Slight increase in the level of T. S. S. in the first two days of storage may be due to conversion of starch into sugars. Calcium and alar treated fruits perhaps helped to reduce the rate of respiration which might be responsible for their higher retention of total soluble solids in these treatments.

Effect of Treatments on Ascorbic acid

Ascorbic acid content of the fruits decreased during storage and various chemicals did not show any significant effect (Table 1). Loss in ascorbic acid content in fruits during storage has been reported by Singh *et al.* (1979).

Effect of Treatments on Sugars

Both reducing and total sugars increased upto two days in storage and decreased thereafter. Fruits harvested from the trees treated with calcium and alar showed significantly higher content of reducing and total sugars (Table 2).

Effect of Treatments on Total Phenols

Phenolic contents of the fruits decreased gradually during storage and various pre-harvest treatments did not alter the changes in phenol levels (Table 3). Decline in phenolic contents in fruits during storage has also been reported in peach (Salunkhe *et al.*, 1968) and in mango (Shukla, 1977).

Effect of Treatments on Carotenoids

Level of carotenoids in fruits increased upto two days in storage and thereafter it decreased (Table 3). Alar treated fruits retained higher content of carotenoids. Thomas (1975) also found an increased level of carotenoids during storage of mango fruits.

Effect of Treatments on Weight Loss and Rotting

Per cent fruit weight loss and rotting, presented in Table 4, revealed that both weight loss and rotting increased during storage. Out of all the treatments only alar at 1000 ppm was found most effective for retarding the weight loss and fruit rottening. Decreased respiration rate after alar treatment as reported by Blanpied *et al.* (1967) may be responsible for retarding the weight loss and decreased fruit rot.

Effect of Treatments on Storage Life

Alar and calcium treated fruits can be stored for 4 days. This is based on

TABLE 1

Effect of pre-harvest application of calcium, potassium and alar on T. S. S. and ascorbic acid contents of guava cv. L-49 during storage

Treatments	T. S. S. (%)						Ascorbic acid (mg/100 g)					
	0	2	4	6	8	Mean	0	2	4	6	8	Mean
Control	9.73	11.50	9.00	7.56	5.13	8.58	103	109	101	51	30	78
$Ca(NO_3)_2$ 1%	10.80	12.00	10.00	8.46	6.26	9.50	110	117	104	59	35	86
2%	10.90	11.60	10.53	8.13	6.40	9.50	112	118	98	64	42	86
K_2SO_4 1%	10.20	10.76	9.00	7.80	6.10	8.76	108	119	108	65	31	84
2%	10.00	10.66	9.33	7.30	6.00	8.74	105	117	110	62	33	84
SADH 500 ppm	11.10	12.10	10.00	9.00	7.60	9.86	107	113	103	68	45	87
1000 ppm	10.90	11.90	9.90	9.33	7.57	9.95	110	115	106	68	45	87
Mean	10.50	11.50	9.68	8.22	6.43		107	115	104	62	37	
C. D. at 5%												
Treatments	0.57											
Days	0.48						6.02					

TABLE 2

Effect of pre-harvest application of calcium, potassium and alar on sugars of guava cv. L-49 during storage

Treatments	Reducing sugars (%)						Total sugars (%)					
	0	2	4	6	8	Mean	0	2	4	6	8	Mean
Control	3.26	4.82	3.67	2.62	1.27	2.93	7.55	9.36	7.51	6.96	3.30	6.80
$Ca(NO_3)_2$ 1%	3.62	4.84	4.51	3.06	1.89	3.58	7.72	9.10	8.25	6.93	3.75	7.15
2%	3.80	4.28	4.20	3.30	2.00	3.52	7.17	9.06	8.20	6.94	4.10	7.19
K_2SO_4 1%	3.63	4.23	3.61	2.17	1.23	3.11	7.39	8.88	7.74	6.08	3.80	6.71
2%	3.73	4.04	3.98	2.23	1.18	3.10	7.65	8.94	7.70	5.76	3.60	6.92
SADH 500 ppm	3.87	4.47	3.93	3.30	2.51	3.68	7.95	8.81	7.98	6.96	4.75	7.29
1000 ppm	3.52	4.84	4.23	3.74	2.52	3.77	7.50	8.90	8.25	6.75	4.95	7.37
Mean	3.64	4.36	4.07	2.96	1.85		7.56	9.00	7.89	6.67	4.03	
C. D. at 5%												
Treatments	0.3082											
Days	0.2604						0.64					

TABLE 3

Effect of pre-harvest application of calcium, potassium and alar on total phenols and carotenoids (O. D. at 450) of guava cv. L-49 during storage

Treatments	Total phenols (mg/g)						Carotenoids					
	0	2	4	6	8	Mean	0	2	4	6	8	Mean
Control	2.80	2.20	2.00	1.70	1.35	2.01	0.112	0.215	0.068	0.019	0.007	0.084
$Ca(NO_3)_2$ 1%	3.00	2.50	2.75	1.80	1.40	2.17	0.112	0.194	0.074	0.038	0.012	0.086
2%	3.00	2.50	2.15	1.80	1.40	2.17	0.108	0.192	0.066	0.034	0.012	0.082
K_2SO_4 1%	2.90	2.45	2.15	1.70	1.42	2.12	0.110	0.199	0 071	0.018	0.006	0.080
2%	2.95	2.50	2.20	1.80	1.40	2.17	0.112	0.198	0.071	0.025	0.010	0.083
SADH 500 ppm	2.80	2.35	2.20	1.75	1.45	2.11	0.111	0.189	0 078	0.041	0.015	0.086
1000 ppm	2.85	2.55	2.10	1.85	1.45	2.16	0.108	0.179	0.090	0.041	0.018	0.087
Mean	2.90	2.43	2.13	2.17	1.41		0.110	0.194	0.072	0.031	0.010	

TABLE 4

Effect of pre-harvest application of calcium, potassium and alar on weight loss and fruit rot of guava cv. L-49 during storage

Treatments	Weight loss (%)						Fruit rot (%)					
	0	2	4	6	8	Mean	0	2	4	6	8	Mean
Control	0	8.87	13.57	18.36	25.2		0	0	35.29	51.37	99.80	
	(1)	(3.14)	(3.82)	(4.40)	(5.11)	3.49	(1)	(1)	(6.02)	(7.22)	(10.04)	6.06
$Ca(NO_3)_2$ 1%	0	6.52	8.87	15.76	19.43		0	0	27.82	34.69	81.50	
	(1)	(2.74)	(3.14)	(4.08)	(4.52)	3.04	(1)	(1)	(5.37)	(5.96)	(9.06)	4 48
2%	0	5.73	8.49	15.46	18.89		0	0	25.40	33.82	81.38	
	(1)	(2.59)	(3.08)	(4.05)	(4.46)	3.03	(1)	(1)	(5.13)	(5.89)	(8.91)	4.39
K_2SO_4 1%	0	7.98	11.8	16.33	22.81		0	0	28.42	44.71	99.80	
	(1)	(2.90)	(3.58)	(4.16)	(4.9)	3.31	(1)	(1)	(5.78)	(6.75)	(10.04)	4.91
2%	0	8.0	13.40	16.64	22.72		0	0	31.41	44.04	99.80	
	(1)	(3.0	(3.79)	(4.20)	(4.89)	3.37	(1)	(1)	(5.69)	(6.68)	(10.04)	4.88
SADH 500 ppm	0	4.12	6.88	11.52	14.31		0	0	17.58	25.72	66.91	
	(1)	(2.26)	(2.81)	(3.48)	(3.91)	2.69	(1)	(1)	(4.30)	(5.03)	(6.24)	3.91
1000 ppm	0	3.67	5.95	10.38	13.83		0	0	15.94	20.88	62.74	
	(1)	(2.16)	(2.64)	(3.37)	(3 85)	2.60	(1)	(1)	(4.11)	(4.67)	(7.97)	3.76
Mean	1	2.69	3.26	3.96	4.52		1	1	5.20	6.02	9.18	
C. D. at 5%												
Treatments			0.862						0.1815			
Days			0.729						0.1533			

Values in parentheses are $\sqrt{n+1}$ transformation.

the guideline of 10-15 per cent loss in fruit weight and rotting as given by Dalal *et al.* (1971). Various pre-harvest treatments like alar and calcium which reduced weight loss and fruit rotting, and helped to retain higher levels of sugars, T. S. S. and carotenoids, resulted in prolonging storage life of fruits.

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BIOCHEMICAL CHANGES IN SORGHUM LEAVES DUE TO INFECTION BY *HELMINTHOSPORIUM ROSTRATUM* DRECHSLER

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ABSTRACT

The quantitative and qualitative estimation of total phenols and O-dihydroxy phenols determined in diseased and healthy leaves of different sorghum lines/varieties, resistant, moderately resistant and highly susceptible to *Helminthosporium rostratum* indicated higher concentration of total phenols and O-dihydroxy phenols in healthy resistant line/variety than that of moderately resistant and highly susceptible line/variety. In diseased, the concentration of total phenols and O-dihydroxy phenols increased only in resistant line/variety while in moderately resistant line/variety, the concentration of total phenols and O-dihydroxy phenols decreased. However, in diseased leaves of highly susceptible line/variety, the concentration of total phenols decreased,while O-dihydroxy phenols increased. The same amount of hydrocyanic acid was estimated in diseased and healthy leaves of sorghum resistant and highly susceptible line/variety. Only the amount of hydrocyanic acid decreased with the advancement in the age of the plants.

Sorghum (*Sorghum bicolor* (L.) Moench.) is one of the important grain and forage crops in India. It is attacked by the leaf spot disease caused by *Helminthosporium rostratum* Drechsler in the months of August and September in North India which reduces forage quality. The disease becomes severe with the lapse of time causing complete blighting of leaf tissues. During the last few years, this disease has become a serious problem on forage sorghum in Haryana (Gandhi *et al.*, 1976). Considering its severity, importance and economic losses, it was considered proper to find out the biochemical basis for resistance in the available germplasm.

MATERIAL AND METHODS

The healthy and diseased leaves were collected from resistant (R), moderately resistant (MR) and highly susceptible (HS) lines/varieties for quantitative and qualitative analyses of total phenols and O-dihydroxy phenols. For hydrocyanic acid, collection was made from resistant and highly susceptible lines/varieties. Sampling for the estimation of hydrocyanic acid was done at 30 and 45 days old plants. The phenolic substances were estimated from leaves using 80% hot alcohol. Each sample weighing 0.5 g was crushed in mortar in 5 to 6 ml of 80% hot alcohol.

The extract, thus, prepared was centrifuged at 3000 rmp for 10 min, to remove the cellular material. Final volume was made upto 10 ml with 80% alcohol. The estimation of total phenols was made by Swain and Hill (1969) method and that of O-dihydroxy phenols by Johnson and Schaal (1957) method.

Extraction and Estimation of Hydrocyanic acid

Sample of 2 g, from leafy bud was taken after cutting into small pieces. These pieces were put into different test tubes. Four drops of chloroform were added. The test tubes were covered with wooden corks. Test papers of double strip saturated with alkaline picrate solution were put into these test tubes. After 24 h, 20 ml of distilled water was added in a 100 ml beaker and test papers were crushed which absorbed hydrocyanic acid, released by the small pieces of leafy buds of sorghum. Estimation of hydrocyanic acid content was made by Hogg and Ahlgren (1942) method.

RESULTS AND DISCUSSION

Total and O-dihydroxy Phenols

In healthy leaves of sorghum, the concentration of total and O-dihydroxy phenols was higher in resistant line/variety than that of moderately resistant and highly susceptible lines/varieties. In diseased leaves, the concentration of total and O-dihydroxy phenols increased only in resistant line/variety, while in moderately resistant line/variety, the concentration of total and O-dihydroxy phenols decreased. In diseased leaves of highly susceptible line/variety, the concentration of total phenols decreased while O-dihydroxy phenols increased (Table 1). Altered metabolism in diseased tissues was due to the host response towards infection. Similar results were observed in the accumulation of phenolics in the incompatible host-pathogen complex than in the compatible ones. Moreover there is not always a positive correlation between phenolic contents and resistance. However, based on these findings it could be concluded that

TABLE 1

Biochemical changes in sorghum leaves due to infection by *Helminthosporium rostratum* with respect to total and O-dihydroxy phenols

Variety/line	Healthy leaves		Diseased leaves	
	Total phenols* (mg/g)	O-dihydroxy phenols* (mg/g)	Total phenols* (mg/g)	O-dihydroxy phenols* (mg/g)
R (S 165)	3.443	1.969	4.433	3.173
MR (S 136)	2.567	0.259	1.565	0.143
HS (IS 6090)	1.777	0.333	0.989	0.595

*Average of four replications.

TABLE 2

Biochemical changes in sorghum leaves due to infection by *Helminthosporium rostratum* with respect to hydrocyanic acid content

Variety/line	Hydrocyanic acid content (mg/g)* in green primary leaves after days			
	Healthy		Diseased	
	30	45	30	45
R (S 165)	0.056	0.060	0.050	0.010
S (JS 263)	0.063	0.020	0.060	0.020

*Average of four replications.

rapid accumulation of phenolics level in incompatible (resistant) host-pathogen complex results into hypersensitive reaction during early stages and this hypersensitive reaction causes a localisation of spot by *H. rostratum* in resistant line/variety.

Hydrocyanic acid

There was decrease in the hydrocyanic acid content with the advancement in the age of the plant in resistant and highly susceptible lines/varieties. The same amount of hydrocyanic acid was estimated in diseased and healthy leaves of resistant and highly susceptible lines/varieties of sorghum (Table 2). In the present investigation it was observed that *Helminthosporium rostratum* was tolerant to hydrocyanic acid, but hydrocyanic acid did not stimulate this fungus to secrete formamide (a non-toxic compound), because almost the same amount of hydrocyanic acid was also found in diseased and healthy leaves of sorghum. It was observed by Fry and Munch (1975) that *Gloeocercospora sorghi* and *Helminthosporium sorghicola* was tolerant to hydrocyanic acid content, stimulated these fungi to secrete a formamide (a non-toxic compound). Thus, it can be concluded that hydrocyanic acid is non-toxic to *Helminthosporium rostratum* isolated from sorghum and no definite correlation can be drawn between hydrocyanic acid content and resistance to *H. rostratum*.

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CHEMICAL CONTROL OF RED MITE, *OLIGONYCHUS INDICUS* HIRST. (TETRANYCHIDAE : ACARINA) IN SUGARCANE

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ABSTRACT

Field experiments were carried out for the control of red mite, *Oligonychus indicus* Hirst. in sugarcane. In the first experiment, efficacy of methyl demeton, monocrotophos, dimethoate, phosphamidon, methyl parathion, chlorpyriphos and dinocap were compared with malathion, a pesticide already recommended for the control of this mite. All the pesticides were sprayed at 0.05% concentration @ 625 l spray material/ha (0.3125 kg a.i./ha). Only methyl demeton, monocrotophos and dimethoate gave effective control of this mite. In the second trial, effectiveness of only these three pesticides was further tested by increasing or decreasing the concentration and compared with an increased concentration of malathion 0.1 per cent. Spraying of monocrotophos and dimethoate @ 0.468 kg a.i./ha (0.075% concentration) and methyl demeton @ 0.3125 kg a.i./ha (0.05% concentration) gave 93-100 per cent egg and 98-100 per cent nymphal and adult mortality and were the most effective treatments.

Sugarcane red mite, *Oligonychus indicus* Hirst. is a sporadic pest of sugarcane in Haryana. The severe attack of this pest on sugarcane is generally observed during May-June as high temperature coupled with low humidity conditions are most conducive for its prolific multiplication. As a result of continuous feeding and probably because of inoculation of toxic secretions in cell sap, the leaf tissues are badly injured causing reddening of leaves. This adversely affects the photosynthetic activity which finally results in the drying of leaves. Though the red mite sometimes appears in very serious form, yet the work on its control aspect is very limited. Lime sulphur wash (1 : 6 dilution) has been found to be the most effective treatment against *O. indicus* (Singh *et al.*, 1961). Kelthane 0.1% (Anonymous, 1963) and parathion 0.05% (Prasad and Prasad, 1957) and 0.02% (Agarwal, 1957) have been reported to give effective control of webbing mite, *Schizotetranychus andropogoni* Hirst. Agarwal and Chaudhary (1965) recommended spraying of 0.1 to 0.2 per cent malathion or 0.1 per cent chloricide malathion for the control of all the species of mites attacking sugarcane in India.

During May-June 1980, the plant crop of sugarcane in almost all the sugarcane growing tracts of Haryana was heavily infested by the sugarcane red

mite, *O. indicus*. Considering the serious damage of red mite and failure of malathion to give effective control of this mite, experiments were carried out with several pesticides to find out an effective chemical for the control of this pest.

MATERIAL AND METHODS

Two experiments were carried out during May-June 1980 in the sugarcane field with variety Co 1148, heavily infested with mite, at the Farm of HAU Regional Research Station, Uchani, Karnal. Each treatment was replicated three times in plots measuring 11 × 2.25 m in size. In the first experiment, eight pesticides (Table 1), all at a concentration of 0.05 per cent (0.3125 kg a.i./ha) were tried and were compared with control (water spray) for the mortality of various stages of mites. In the second trial, only those pesticides (Table 2), found effective in the first trial, were tried at different concentrations and compared with control. The spray material in each treatment of both the trials was applied @ 625 l/ha and the spraying was done with knapsack sprayer.

Counts of all the stages of mite were made one day before and three and seven days after spraying. At each counting, 5 leaves selected at random from each plot were removed and examined under a binocular microscope. The eggs, nymphs and adults were counted through a square window (10 × 10 mm) made on graph paper and placed on the leaf. Each leaf was observed from basal, middle and top portions and average number of eggs, nymphs and adults per 100 sq. mm leaf area were calculated. The per cent increase or decrease in the population (eggs, nymphs and adults) to pre-spray population in the various treatments was statistically analysed for making comparison.

RESULTS AND DISCUSSION

In the first trial (Table 1), all the pesticides 3 days after spraying gave superior results than control in reducing the population of nymphs and adults as the per cent mortality in treated plots ranged from 52.8 (in dinocap) to 84.9 (in methyl demeton) as compared to only 30.8 in control. It was not possible to determine the ovicidal effect of pesticides. Generally, on hatching, the young nymphs came in contact with the pesticidal deposits on the leaf surface or sucked the plant sap and died subsequently. On this basis, some of the chemicals, particularly, methyl demeton and monocrotophos gave rather low initial kill. But within a week's time, these chemicals proved better than others in reducing the egg population due to heavy mortality of nymphs and adults, which ultimately helped in reducing further egg laying. The data presented in Table 1 reveal that methyl demeton, monocrotophos and dimethoate gave higher mortality of nymphs and adults, 3 as well as 7 days after spraying, giving 64.4 to 95.6 per cent mortality within 7 days of their spraying. Phosphamidon came next giving only 27.7% mortality of nymphs and adults. Other pesticides proved ineffective.

Methyl demeton, monocrotophos and dimethoate which proved effective within 7 days after their spraying in the first trial were further tried at a concentration higher, equal and lower than 0.05

TABLE 1

Comparative efficacy of different pesticides against sugarcane red mite, *O. indicus* (first trial)

Treatments	Average no. of eggs/100 sq. mm leaf area			Average no. of nymphs and adults/100 sq. mm leaf area			Per cent increase or decrease over initial population (days after spraying)			
							Eggs		Nymphs and adults	
	Before spraying	Days after spraying		Before spraying	Days after spraying					
		3	7		3	7	3	7	3	7
Methyl demeton 0.05%	23.3 (4.93)	15.7 (4.10)	3.1 (2.00)	10.0 (3.30)	1.6 (1.57)	0.4 (1.17)	—32.3	—87.2	—84.9	—96.6
Monocrotophos 0.05%	21.0 (4.67)	12.9 (3.73)	3.9 (2.20)	8.0 (3.00)	2.9 (1.87)	2.4 (1.83)	39.1	—81.6	—68.3	—70.4
Dimethoate 0.05%	31.6 (5.67)	5.6 (2.57)	19.9 (4.50)	10.6 (3.40)	3.1 (2.03)	3.6 (2.13)	—82.2	—36.9	—70.6	—66.4
Phosphamidon 0.05%	26.3 (5.13)	5.7 (2.53)	27.8 (5.27)	10.0 (3.33)	1.8 (1.67)	7.2 (2.87)	—79.1	+5.5	—81.3	—27.7
Malathion 0.05%	29.0 (5.47)	11.9 (3.57)	84.4 (9.23)	13.3 (3.80)	3.0 (2.00)	21.2 (4.7)	—58.7	+192.3	—77.2	+59.1
Methyl parathion 0.05%	26.0 (5.13)	5.5 (2.50)	18.5 (4.37)	11.3 (3.50)	3.5 (2.13)	22.9 (4.87)	—78.2	—28.6	—69.4	+101.9
Dinocap (Karathane) 0.05%	34.5 (5.90)	15.3 (3.97)	34.2 (5.87)	11.0 (3.47)	5.2 (2.50)	22.9 (4.87)	—55.7	—1.4	—52.8	+108.2
Chlorpyriphos 0.05%	23.0 (4.90)	7.6 (2.93)	12.1 (3.63)	22.3 (4.83)	6.5 (2.73)	51.8 (7.27)	—66.8	—47.3	—70.9	+131.8
Control (water alone)	20.0 (4.60)	20.4 (4.60)	49.0 (7.0)	12.3 (3.63)	8.6 (3.10)	38.2 (6.23)	+2.00	+144.8	—30.8	+212.2
C. D. at 5%	(NS)	(0.83)	(1.29)	(0.47)	(0.36)	(2.46)	—	—	—	—

Figures in parentheses are means of $\sqrt{N+1}$.

TABLE 2

Comparative efficacy of different doses of pesticides against sugarcane red mite, *O. indicus* (second trial)

Treatments	Dose (kg a.i./ha)	Average no. of eggs/100 sq. mm leaf area			Average no. of nymphs and adults/100 sq. mm leaf area			Per cent increase or decrease over initial population (days after spraying)				Cost of insecticides/ ha (Rs.)
		Before spraying	Days after spraying		Before spraying	Days after spraying		Eggs		Nymphs and adults		
			3	7		3	7	3	7	3	7	
Methyl demeton (0.075%)	0.468	22.7 (4.87)	12.1 (3.60)	0.0 (1.00)	14.4 (3.93)	0.0 (1.00)	0.0 (1.00)	—46.9	—100.0	—100.0	—100.0	130.00
Monocrotophos (0.075%)	0.468	26.1 (5.20)	13.5 (3.83)	0.0 (1.00)	15.8 (4.10)	0.6 (1.23)	0.0 (1.00)	—48.3	—100.0	- 96.4	—100.0	195.00
Dimethoate (0.075%)	0.468	27.2 (5.30)	5.8 (2.60)	2.6 (1.87)	18.0 (4.37)	2.3 (1.80)	0.3 (1.13)	—78.6	—90.5	—87.4	- 98.3	101.00
Methyl demeton (0.05%)	0.313	28.9 (5.47)	17.5 (4.30)	2.1 (1.77)	20.6 (4.63)	1.8 (1.67)	0.4 (1.20)	—39.6	—92.6	—91.3	—97.8	85.00
Monocrotophos (0.05%)	0.313	20.7 (4.67)	12.4 (3.67)	4.0 (2.23)	17.8 (4.37)	5.9 (2.60)	4.8 (2.43)	—40.2	—80.5	—66.7	—72.9	130.00
Methyl demeton (0.03%)	0.188	23.4 (4.93)	10.5 (3.37)	7.8 (2.97)	19.7 (4.53)	6.5 (2.77)	5.2 (2.57)	—55.2	—66.5	—67.1	—71.7	50 00
Dimethoate (0.05%)	0.313	25.3 (5.13)	7.3 (2.87)	15.8 (4.10)	17.5 (4.30)	4.1 (2.23)	6.0 (2.67)	-70.9	—37.3	—76.7	—65.4	65.00
Malathion (0.1%)	0.625	21.0 (4.70)	8.1 (3.00)	9.5 (3.23)	18.5 (4.43)	3.6 (2.17)	24.3 (5.03)	—61.4	—55.2	—80.3	+31.6	50.00
Control (water alone)	—	22.6 (4.87)	23.8 (4.93)	52.1 (7.30)	16.2 (4.17)	14.5 (3.93)	48.1 (7.00)	+5.3	+130.2	—10.4	+195.9	—
C. D. at 5%		(0.42)	(0.36)	(1.44)	(NS)	(0.30)	(0.36)	—	—	—	—	

Figures in parentheses are means of $\sqrt{N+1}$.

per cent. The efficacy of these pesticides was compared with malathion 0.1% (already recommended by Agarwal and Chaudhary, 1965) and also with the control in the second trial. The data presented in Table 2 show that methyl demeton and monocrotophos (0.075 and 0.05 per cent) did not show any ovicidal properties. But both the pesticides proved significantly better than control in reducing the population of nymphs and adults within 3 days of their spraying which resulted in reductions of further egg laying. Methyl demeton (0.075%) and monocrotophos (0.075%) gave 100 per cent kill of the mite within 7 days after their spraying but were almost similar to dimethoate 0.075% and methyl demeton 0.05% as the mortality in the last two treatments was 98.3 and 97.8 per cent, respectively. These four treatments were found significantly better than all the remaining treatments. Malathion 0.1% was found to be totally ineffective, as the population of mite (nymphs and adults) instead of decreasing, increased to 31.6% in this treatment.

The present studies contradict the earlier findings of effectiveness of malathion and parathion against sugarcane mites (Prasad and Prasad, 1957; Agarwal and Chaudhary, 1965).

The results of these studies indicated that monocrotophos 0.075%, dimethoate 0.075% and methyl demeton 0.05% are the most effective miticides against sugarcane red mite, giving 100.0, 98.3 and 97.8 per cent mortality, respectively (Table 2), within 7 days after their spraying. Since, monocrotophos 0.075% is very costly (Rs. 195/ha), dimethoate 0.075% (Rs. 101/ha) and methyl demeton 0.05% (Rs. 85/ha) may be recommended for the control of sugarcane red mite.

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EFFECT OF GIRDLING ALONE AND IN COMBINATION WITH BORIC ACID ON BERRY SET, BERRY DROP, YIELD AND QUALITY OF GRAPES (*VITIS VINIFERA* L.) CULTIVAR GOLD

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ABSTRACT

Trunk girdling alone or combined with boric acid spray at bloom increased the yield by more than 300 per cent. It was possible by reducing flower bud and flower drop which resulted in increased berry set. In girdling treatments, panicle drying was about 25% as compared to more than 50% in control and the berry retention was increased by more than 350 per cent. Single or double spray of boric acid also resulted in improved yield and berry set. However, there was no additive effect of boric acid with trunk girdling. Trunk girdling alone or in combination with boric acid spray also resulted in improved quality in respect of increased TSS/acid ratio. Bunch and berry weight and size were also improved. Double spray of boric acid also resulted in improved quality. However, boric acid spray could not show any marked additive effect when combined with trunk girdling. Trunk girdling alone was proved to be the best treatment with slight improvement when combined with boric acid.

The problem of bud, flower and berry drop was first reported in serious proportions from grape growing areas of Rajasthan around Jodhpur by an expert committee of I.C.A.R. Simultaneously, this problem was also observed in Punjab and Haryana. In a trial to find out the severity of the problem in different grape cultivars, Chundawat and Jindal (1978) found that in Gold cultivar, the abscission occurred just before the opening of floral buds. This resulted into extremely poor berry set and severe panicle drying.

Girdling, by altering the distribution of photosynthates can be expected to reduce this menace, as Chundawat *et al.* (1979) have suggested that bud, flower and berry drop has to be tackled through developing proper C/N ratio in the vines. Likewise, boron has also been known to improve berry set by sugar translocation, pollen germination and viability (Lupushor, 1973). Therefore, the present studies were undertaken to find out the effect of girdling alone and in combination with boric acid sprays on berry set, berry drop, panicle drying and yield of Gold cultivar of grapes.

MATERIAL AND METHODS

Investigations were carried out during 1980 at the Experimental Vineyard of the

Department of Horticulture. Thirteen years old vines of Gold cultivar of grapes, planted at 3 × 3 m apart and trained on double-wire Kniffin system were selected. The experimental vines were uniformly pruned in the third week of January keeping 16 canes per vine having 5 buds each. These vines received uniform cultural practices.

Girdling was done about 10 days before opening of the flowers with the help of a knife by removing ½ cm wide ring of bark from the trunk of the vines. Aqueous solutions of boric acid (0.2%) were sprayed either at bloom or repeated again after a week. Trunk girdling was combined with single spray (at bloom) of boric acid. These treatments were replicated four times with one vine as treatment unit. Five bunches on each vine were tagged to record the different observations.

For the purpose of calculating per cent berry set, initial number of flower buds per panicle and the total berries set were counted. Again at the time of harvest, total berries retained per bunch were counted. Per cent panicle drying was calculated by counting initial panicles per vine and the final bunches per vine at the time of harvest. Total soluble solids were measured with the help of hand refractometer (0–32) while the total acidity was measured by titrating the juice against N/10 NaOH (AOAC, 1970).

RESULTS AND DISCUSSION

The data recorded on per cent berry set, berry drop, panicle drying, berry retention and the yield per vine are presented in Table 1. The perusal of the data clearly indicates that all the treatments improved berry set, reduced berry drop and panicle drying. The treatments with girdling were far more superior to single and double spray of boric acid alone. Trunk girdling was found to be the best treatment. No additive effect of boric acid with girdling could be visualized. The total berry retention per bunch was 300% more

TABLE 1

Effect of girdling alone and in combination with boric acid on berry set, berry drop, panicle drying and yield of grapes cultivar Gold

Treatments	Berry set (%)	Berry drop (%)	Panicle drying (%)	Berry retention per bunch (no.)	Yield per vine (kg)
Control	45.12	87.88	53.75	105	2.95
Boric acid 0.2% once	52.00	85.25	43.05	109	5.35
Boric acid 0.2% twice	49.88	85.00	36.90	100	7.85
Trunk girdling	58.48	61.13	25.03	363	9.70
Trunk girdling + Boric acid 0.2% once	57.63	58.55	24.43	361	9.39
C. D. at 5%	2.41	1.88	4.52	20	1.20

in girdling treatments as compared to control and boric acid treatments. Likewise, maximum yield per vine was obtained in trunk girdling closely followed by trunk girdling with boric acid treatments. Boric acid alone also improved the yield/vine significantly over control while in girdling treatments, the yield was more than three times of that in control. It was made possible by reducing flower bud and flower drop which resulted in improved berry set. The beneficial effect of girdling on berry set could be due to its effect on increasing carbohydrate level (Chundawat *et al.*, 1979). They further found that berry set in different cultivars was directly related with their respective carbohydrate level. Similarly, boric acid sprays resulted in improved set, which might be due to the improved pollen fertility and germination (Randhawa and Sharma, 1960; Dvornic *et al.*, 1970).

With the improvement in berry set, the reduction in panicle drying was obvious as panicle drying has been attributed to the extremely poor set in this cultivar (Chundawat *et al.*, 1979). Likewise, reduced berry drop in girdling treatments may possibly be because girdling by altering the distribution of photosynthates, affected the pedicellar attachment and thickness (Sharma, 1980). The tremendous increase in yield per vine in girdling treatments over that in control was obvious as girdling increased berry set, reduced berry drop and panicle drying. That is why the berry retention per bunch was also maximum in girdling treatments.

The data recorded on the different attributes of quality are presented in Table 2. All the treatments increased bunch weight significantly over control. Bunch weight was the maximum on trunk girdled vines. However, there was no additive effect of boric acid with trunk girdling. Likewise, bunch length was also improved by different treatments while there was slight increase in bunch breadth. The improvement in bunch size and weight was obviously

TABLE 2

Effect of girdling alone and in combination with boric acid on quality of grapes cultivar Gold

Treatments	Bunch			Weight of 25 berries (g)	Total soluble solids (%)	Acidity (%)	T. S. S./ acid ratio
	Weight (g)	Length (cm)	Breadth (cm)				
Control	103.75	13.00	9.00	61.00	17.80	0.855	20.82
Boric acid 0.2% once	140.00	17.25	10.00	59.25	18.05	0.802	22.51
Boric acid 0.2% twice	145.00	21.00	10.50	60.25	18.23	0.835	21.83
Trunk girdling	250.00	19.88	13.50	67.00	18.75	0.668	28.07
Trunk girdling+Boric acid 0.2% once	246.00	16.00	10.00	70.00	18.90	0.590	32.03
C. D. at 5%	11.00	1.82	1.27	6.33	0.50	0.054	—

due to improved set and reduced berry drop (Table 1). Trunk girdling significantly increased the berry weight over control while the boric acid failed to do so. However, when combined with trunk girdling, boric acid had slight additive effect in increasing berry weight. Likewise earlier workers (Jindal and Bakhshi, 1970; Jawanda and Vij, 1973) also obtained increased berry weight by girdling different cultivars of grapes.

Quality in respect of T.S.S., acidity and T.S S./acid ratio was improved only by different girdling treatments while in case of boric acid alone, slight but not significant improvement or reduction was noticed. T.S.S./acid ratio was also significantly more in girdling or girdling with boric acid treatments when compared either with control or boric acid treatments. This was mainly due to reduced acidity and increased T.S.S. in these treatments. Girdling by making more photosynthates available to bunches made them sweeter which is in line with the earlier findings (Jawanda and Vij, 1973; Kondrya, 1974).

The results of these investigations, therefore, lead to the conclusion that girdling alone or combined with 0.2% boric acid spray at bloom apart from improving quality, increased the yield by more than 300 per cent mainly because of reduced flower buds and flower drop which resulted in increased berry set and reduced panicle drying also. Slight additive effects can be obtained if trunk girdling is combined with boric acid (0.2%) spray at bloom.

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GROUND WATER STUDIES IN RISING WATER TABLE AREA

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ABSTRACT

Ground water fluctuation and quality trend over an area of approximately 1,46,875 ha in rising water table area (part of Hissar district) have been analysed from June 1977 through June 1980 which includes a drought year. There was rising trend of water table and an average annual rise worked out to be 28.89 cm. The sub-surface inflow and outflow were almost in equilibrium with each other and the rise was mainly due to the losses from irrigation application and conveyance systems. Nearly 70% of underground water had electrical conductivity more than 3000 micromhos/cm and hence very low utilization for irrigation. There is need for increased pumpage of ground water and its subsequent utilization in conjunction with surface water to lower the rate of rise in water table.

Area under irrigation in Haryana State has increased considerably during the past few years. With the completion of Beas Link Project which will divert 0.47 million hectare meter water to Haryana through Bhakhra system, still more area is expected to come under irrigation (Duggal, 1977). The increasing supplies of irrigation and poor water management practices viz. both conveyance and application have led to the change in ground water regime and redistribution and accumulation of salts which are inherent in the soil profile of the region. The major change in ground water regime is the rise in water table and therefore an attempt was made to study the water table fluctuation trend and quality of underground water of such problem area.

METHODOLOGY

The study was conducted in a part of rising water table area comprising the two blocks (Hissar I and II) of Hissar district covering an area of approximately 1,46,875 ha where water table depths were observed by Haryana State Minor Irrigation and Tubewell Corporation (HSMITC) and Ground Water Cell of Haryana from 1974 onward during the months of June and October every year. There were fifty four observation points located over the entire area. Isobath maps (depth to water table) were drawn for 4 years from June 1977 to June 1980 to observe the fluctuation of per cent area under different water table depth ranges. An average water table contour map for the 4 years period

(June 1977-June 1980) taking into consideration the topography of the area was drawn which exhibited the direction of ground water movement. The contour map alongwith the transmissivity of the water bearing formation at the limit of the area was used to determine the inflow and outflow from the area. To estimate the average rise/decline of water table in the area, the water table fluctuation map from June 1977 to June 1980 was drawn and the area under different fluctuation ranges determined. An average iso-electrical conductivity map was also drawn to observe the spatial variability of ground water quality.

RESULTS AND DISCUSSION

Ground Water Movement

The average ground water contour map (Fig. 1) for the period of observation, June 1977 to June 1980 indicates that the sub-surface flow entered the Eastern and North-Western part of the area and flowed towards North-Eastern and South-Western direction. There was small area in the North-Western direction from where the sub-surface outflow occurred. Fig. 1 has been used to estimate the rate of sub-surface inflow and outflow through the boundaries of the area using flow net technique (Anonymous, 1974). Series of flow lines are drawn perpendicular to the system of equipotential lines such that the squares are formed. The flow rate to any channel or path of flow between two adajacent flow lines is obtained from Darcy's law. Considering a width 'Y' of unit thickness of the aquifer measured normal to the direction of flow, indicated by 'X' the Darcy's equation for this part of the aquifer is written as (Anonymous, 1974) :

$$q = k \frac{dh}{dX} Y \qquad \ldots\ldots \qquad (1)$$

where q = flow rate occurring between a pair of adajacent lines, m^3/day

$\frac{dh}{dX}$ = Hydraulic gradient

Y = Spacing of flow lines, m

k = hydraulic conductivity, m/day

If 'X' represents the spacing of equipotential lines, 'h' is the drop in hydraulic head between the equipotential lines, 'n' is the number of squares (when Y/X=1) and 'D' is the full saturated thickness of the aquifer, then equation (1) may be rewritten as follows :

$$Q = n.\ \Delta h.\ K.\ D \qquad \ldots\ldots\ldots \qquad (2)$$

or $Q = n.\ \Delta h.\ T$

where Q = total flow in the entire saturated thickness 'D', m^3/day

T = transmissivity of aquifer formation, m^2/day

The aquifer transmissivity 'T' values were taken from HSMITC and a few pumping tests conducted by University engineers. The 'T' value varied from 140 to 200 m^2/day (Singh and Kumar, 1979; Personal Communication from HSMITC, 1980). From Fig. 1 the number of squares in all the directions were counted and by considering the average value of 'T' in the respective direction, inflow and outflow were determined by using equation (2).

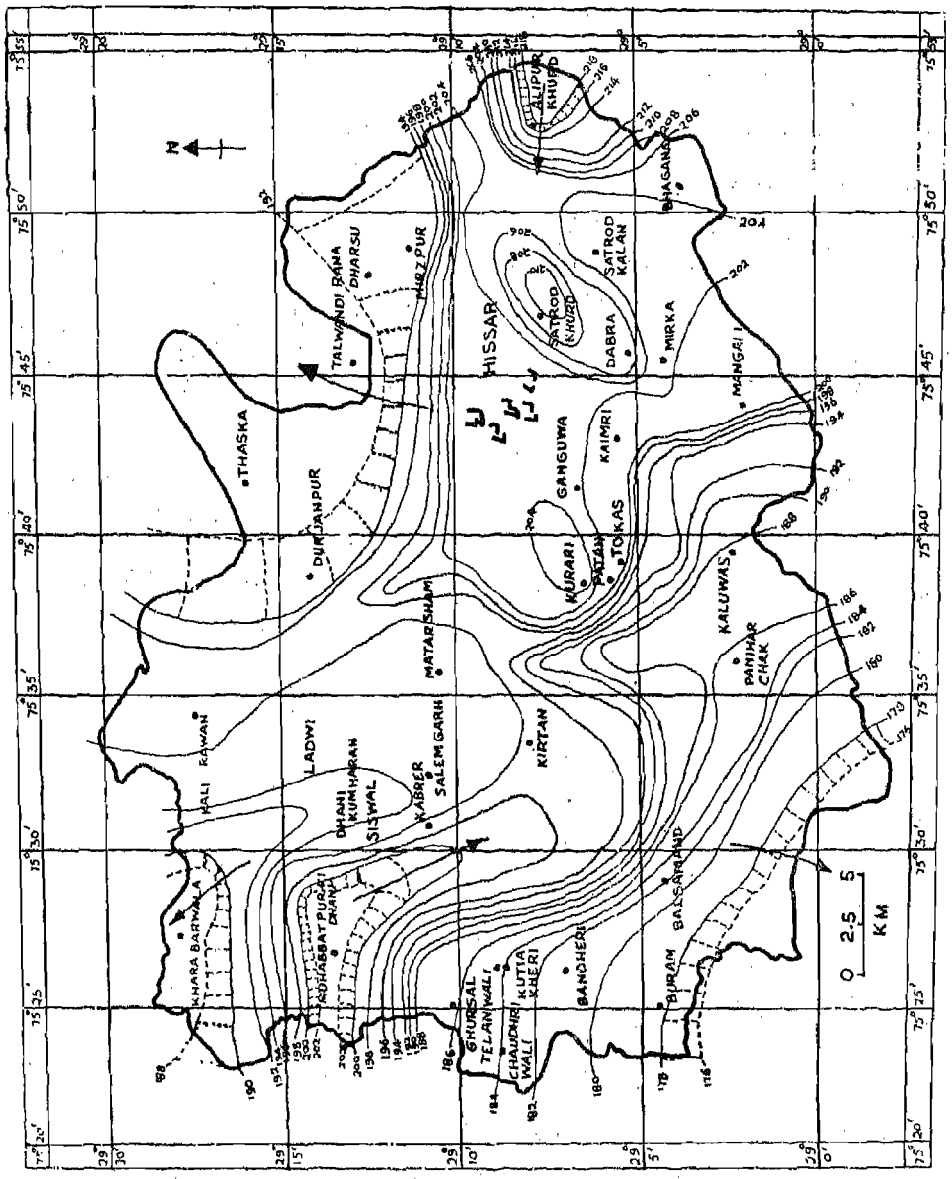


Fig. 1. Average water table contour and flow net map of Hisser Blocks I & II (June 1977-June 1980).

$$Q_{in}=(15\times2\times160+30\times2\times200)=16800\ m^3/day$$

$$Q_{out}=(16\times2\times180+12\times2\times140+11\times2\times190)=13300\ m^3/day$$

Therefore, the net sub-surface inflow into the ground water storage over an area of 1,46,875 ha was as follows :

$$Q_{gain}=Q_{in}-Q_{out}=3500\ m^3/day$$

$$\text{Average rise per year}=\frac{3500\times1000\times365}{1,46,875\times10000}$$

$$=0.869\ mm/year$$

Thus, it is clear that sub-surface inflow and outflow were almost in equilibrium with each other. The sub-surface flow component resulted in the rise of water table approximately less than 1 mm/year.

Change in Ground Water Storage

Water table fluctuation map (Fig. 2) for the period June 1977 to June 1980 was used to estimate the net average change in water table. 22.56% of the area experienced the decline in water table from 0 to 3 m and in rest of the area the water table rose during this period. The per cent area under different modes and ranges of fluctuation is given in Table 1. The lithology of the water fluctuation zones in the area is aeolian deposits of fine sand embedded with silty clay. The specific yield of these formation ranges from 5 to 10 per cent, therefore, an average value of 8% has been taken for the present study. The following relationship (Brown *et al.*, 1972) was used to calculate the net change in storage during three years period :

$$q=\mu.\ \Delta h.\ A \qquad (3)$$

Where

q = change in unconfined ground water storage (ha-m) for time interval 'ΔT'

μ = specific yield of aquifer formation —

Δh = average change in water table for time interval 'ΔT' m

A = area corresponding to change Δh heactare

Following was the total change in ground water storage, taking into consideration the decline and rise in water table and its spatial extent.

$$q_{+ve}=(23118.12.12\times0.25+24381.25\times0.75+16244.37\times1.25+4993.75\times1.75+22501.25\times2.25+14995.93\times2.75+7506.78\times3.25)\times0.08$$

$$=13549.89\ ha\text{-}m.$$

$$q_{-ve}=(5625.31\times0.25+6256.87\times0.75+10619.06\times1.25+4376.87\times1.75+4376.87\times2.25+1880\times2.75)\ 0.08$$

$$=3365.82\ ha\text{-}m.$$

Net gain in ground water storage (3 years) = 10184.07 ha-m

$$\text{Net average rise in water table per year}=\frac{10184.07}{146875\times3\times.08}=28.89\ cm$$

Thus, the water table had risen, on an average, 28.89 cm per year during the past three years, wherein, the year 1979 experienced an acute drought. The sub-surface component contributing to this phenomenal rise in water table was almost negligible (<1 mm). Therefore,

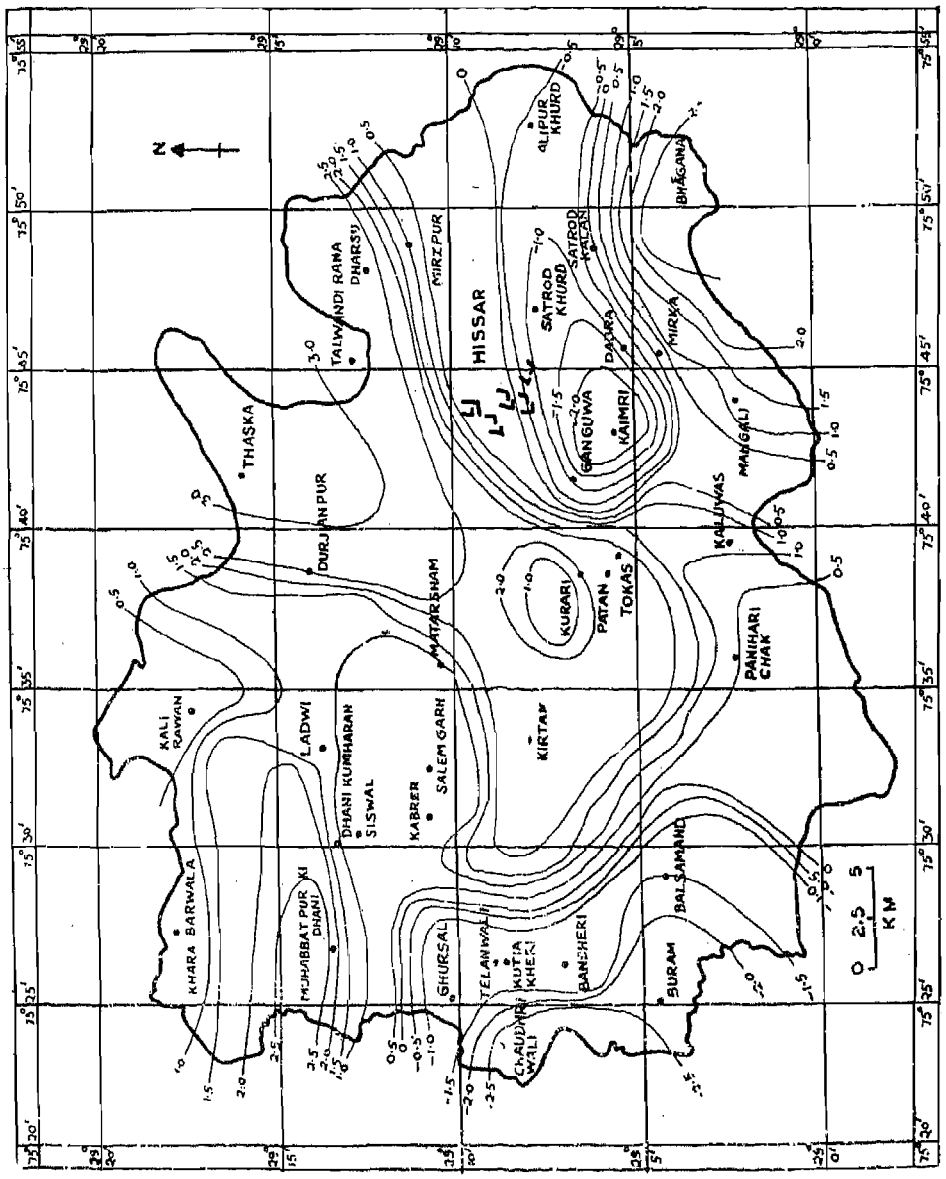


Fig. 2. Water table fluctuation map of Hissar Blocks I & II (June 1977-June 1980).

TABLE 1

Per cent area under different water table fluctuation amplitudes (June 1977 to June 1980)

Mode	Range of fluctuation (m)						
	0-0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	>3.0
Decline	3.83	4.26	7.23	2.98	2.98	1.28	—
Rise	15.74	16.60	11.06	3.40	15.32	10.20	5.11

TABLE 2

Per cent area under different water table depths in Hissar blocks I & II (1977-1980)

Period	Depth range (m)										
	<5	5-7	7-9	9-11	11-13	13-15	15-17	17-19	19-21	21-23	23-25	>25
June 77	1.50	3.00	4.11	5.62	6.37	5.99	7.12	19.85	20.60	10.86	6.37	8.66
June 78	3.43	4.72	6.87	2.15	4.72	12.87	15.45	17.60	8.58	13.73	7.73	2.15
June 79	2.95	3.32	5.54	4.43	3.69	5.90	25.83	11.07	11.44	9.59	9.59	6.64
June 80	2.10	3.78	10.50	6.30	3.36	9.24	10.50	11.34	19.33	7.98	10.50	5.04

during 1979, only rate of rise in water table had declined but the overall rising trend continued considering the water table depths observed during 1977.

Variation of per cent Area Under Different Water Table Depth Ranges

Isobath or depth to water table maps was prepared for 4 years from June 1977 through June 1980 by plotting the depth of water table below the ground surface and drawing the lines of equal water table depths. From these maps, the per cent of total area mapped under various water table depths was measured and given in Table 2. The area under less than 5 m depth was 1.50% during June 1977 and increased to 3.43% by June 1978. However, during June 1979 the per cent area under this range decreased to 2.95 and further to 2.10 by June 1980. The area under more than 25 m depth was 8.66% during June 1977 which decreased to 2.15 by June 1978 and increased to 6.64 during June 1979. There had been readjustment among different classes but overall more area came under lower water table depth. Of course, even at present 65% of the area is under more than 15 m depth, but in case no preventive action is taken at this stage it will lead more area under lower water table depth range.

Ground Water Quality

The average isoconductivity map (June 1977 to June 1980) shows the areas under different water quality ranges (Fig. 3). South-Western part of the area was usually underlain by poor quality ground water. The ground water movement was from North-Western to South-Western and the transmissivity of water

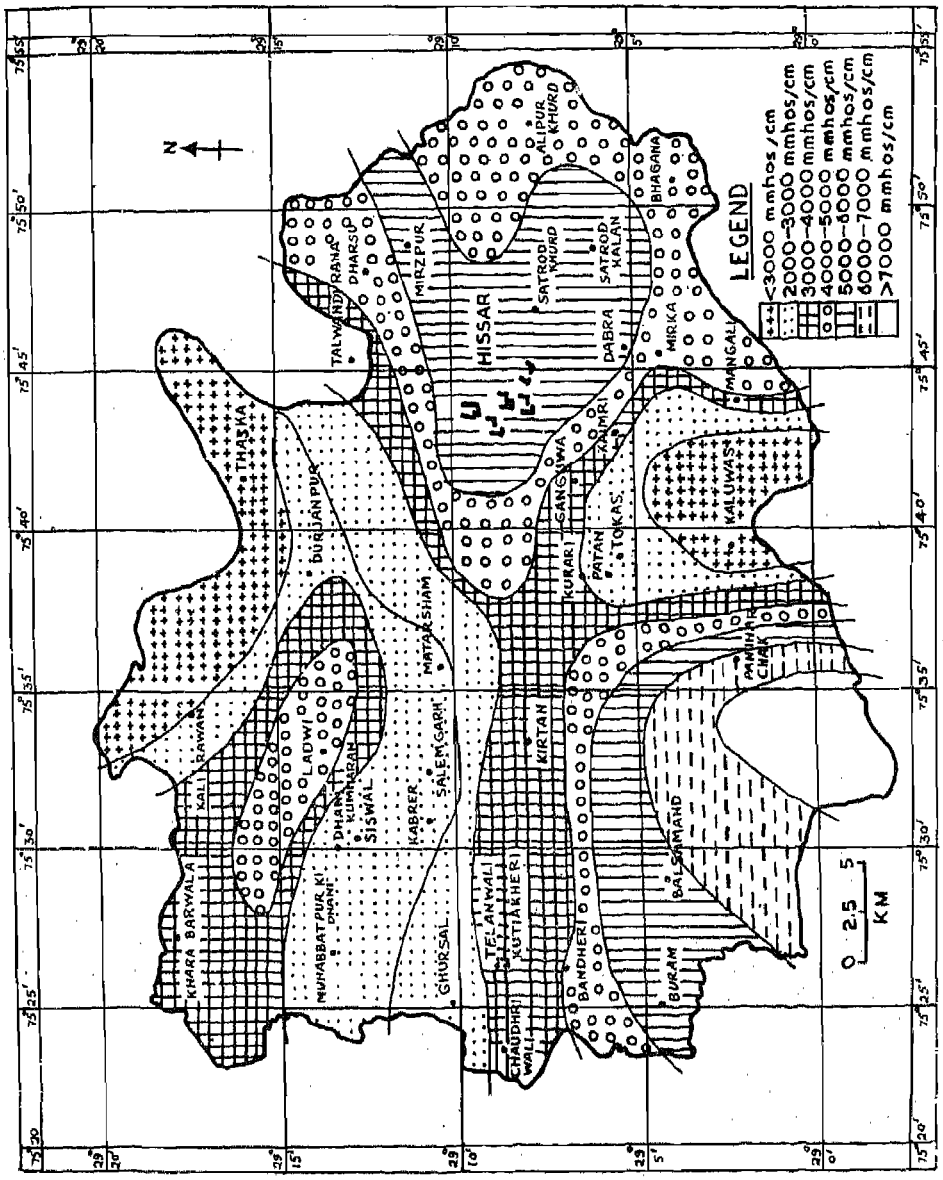


Fig. 3. Average isoconductivity map of Hissar Blocks I & II (June 1977-June 1980).

TABLE 3

Per cent and absolute area under different water quality ranges in Hissar blocks I & II (average for 1977-1980)

	Electrical conductivity range in micromhos/cm					
	<2000	2000-3000	3000-4000	4000-5000	5000-6000	>6000
% of area	6.93	23.81	19.48	22.94	18.18	8.66
Absolute area (ha)	10178.44	34970.93	28611.25	33693.12	26701.87	12719.38

bearing formation was comparatively higher than other part of the area (200 m^3/day). The salts in the North-West were slowly moving towards South-Western direction and, thus, deteriorating the quality in this side. However, in the Eastern direction this type of phenomena was not observed. It might be because the surrounding areas from where water was coming may be more saline and this was resulting in poor quality. Table 3 gives the per cent and absolute area under different quality ranges. It may be seen that approximately 70% of the area was underlain by water of more than 3000 mmhos/cm range. The poor quality of underground water restricts the pumpage for irrigation and the irrigation losses from conveyance and application systems are continuously adding to the ground water reservoir resulting in the rise of water table.

ACKNOWLEDGEMENTS

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RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XII, No. 4, pp. 675–678 (December 1982)

DIALLEL ANALYSIS FOR COMBINING ABILITY OVER ENVIRONMENTS IN WHEAT

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Estimates of genetic parameters provide guidelines for formulating efficient breeding policy. However, such estimates have values only when they are obtained from experiments repeated over environments.

A set of 9×9 diallel crosses and their parental lines was evaluated in two environments, irrigated timely sown and unirrigated late sown conditions, and the data were recorded on different traits including harvest index. Pooled analysis for combining ability was carried out following Method 2, model 1 of Griffing (1956) as further extended by Singh (1973).

Analysis of variance indicated significant differences due to environments and entries, except for number of grains and ear length, respectively (Table 1). Mean squares due to environment×entry interactions were significant for plant height, days to heading, number of grains, 1000-grain weight and harvest index. Interestingly, the two components of harvest index, biological yield and grain yield were also among those traits which did not show significant entry×environment interactions. Thus, the harvest index appeared to be more sensitive to changing environment than its components. Similar observations were also reported by DeLoughery and Crookston (1979) in corn.

Pooled analysis for combining ability revealed significant gca and sca effects for all the traits, except biological yield which showed no significance with respect to the former (Table 2). Thus, except for biological yield, both additive and non-additive gene effects appeared to be important for all the traits. This warrants some kind of population improvement approach as earlier suggested by Jensen (1970).

The gca×environment interactions were significant for plant height, days to heading, 1000-grain weight and harvest index. On the contrary, sca showed interaction with the environments only for the harvest index.

From the results described above, it is obvious that the additive gene effect was less stable than the non-additive one. But for harvest index both the gca and sca effects were sensitive to environmental changes. Obviously, information based on experiments in single environment, particularly with respect to harvest index,

TABLE 1

Pooled analysis of variance for different characters in F_1 generation

Source of variation	d. f.	Mean Squares								
		Plant height	Days to heading	Tiller number	Ear length	No. of grains	1000-grain weight	Biological yield	Grain yield	Harvest index
Environment	1	18972.90**	826.90**	1223.98**	73.63**	165.40	2073.54**	264328.40**	13311.04**	3452.70**
Replication	2	77.40*	102.00**	65.11**	8.53**	200.00*	11.90	440.10	255.90**	26.94**
Environment × Replication	2	598.00**	30.90*	54.65**	1.04	116.05	61.64**	5058.50**	415.32**	41.36**
Entries	44	1102.86**	74.04**	17.22**	2.93	314.14**	80.40**	1168.16**	141.94**	37.83**
Environment × Entries	44	54.42**	13.79**	5.96	0.39	79.67*	8.16*	445.29	46.52	10.83**
Error	176	22.44	9.72	6.95	0.38	61.59	7.53	492.48	50.17	5.87

*,**Significant at 5 and 1 per cent, respectively.

TABLE 2

Pooled ANOVA for combining ability

Source of variation	d. f.	Mean Squares								
		Plant height	Days to heading	Tiller number	Ear length	No. of grains	1000-grain weight	Biological yield	Grain yield	Harvest index
gca	8	1771.07**	114.37**	7.13**	3.35**	327.28**	73.08**	284.94	32.60*	44.99**
sca	36	55.75**	4.76**	5.43**	0.45**	55.26**	16.52**	412.60**	50.58**	5.42**
Environment	1	6324.42**	275.76**	407.99**	24.55**	55.22	697.90**	88109.60**	4437.07**	1150.94**
gca×Environment	8	70 69**	8.36**	4.13	0.16	37.30	5.28*	127.53	22.53	9.24**
sca×Environment	36	6.47	3.76	1.51	0.12	24.17	2.15	163 07	13.94	2.36*
Error	176	7.48	3.24	2.32	0.13	20.53	2.51	164.16	16.72	1.96
gca/sca ratio		3.22	6.64	0.14	0.06	0.80	0.46	0.04	0.04	0.07

*,**Significant at 5 and 1 per cent, respectively.

may not have any predictable relationship with grain yield. Thus, the belief that the harvest index may be a better selection criterion does not seem to be correct, unless the experiments are conducted over a number of environments.

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RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XII, No. 4, pp. 679—680 (December 1982)

EFFECT OF 4-CPA AND BENZYLADENINE ON COLOUR DEVELOPMENT IN BEAUTY SEEDLESS GRAPES

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Beauty Seedless is one of the important grape cultivar which is known for its earliness and prolificity in bearing. However, pre-harvest berry drop seems to be serious drawback which in recent years has attained its threatening severity resulting in considerable loss in overall production (Chundawat and Jindal, 1978). The berry drop occurs following colour break which has been attributed to the habit of uneven ripening in this cultivar. Further, due to climatic constraints and short growing season under north Indian conditions, the berries fail to attain full colour which is of considerable economic importance in influencing consumer appeal. The red, purple, blue or black skin colour of the grapes is mainly due to the presence of anthocyanin pigments. The synthesis or the degradation of the pigment is certainly influenced by the endogenous as well as external application of growth substances (Weaver *et al.*, 1962). Therefore, the present investigations were planned to study the response of exogenously applied auxin (4-chlorophenoxy acetic acid) and cytokinin (6-benzyl adenine) on colour development in Beauty Seedless grapes (*Vitis vinifera* L.). These investigations were carried out at the Experimental Orchard of Department of Horticulture, during the year 1979. Eleven years old vines of Beauty Seedless trained on double wire kniffin system were selected. All the experimental vines were uniformly pruned in the third week of January keeping 16 canes per vine having 3 buds per cane.

The stock solutions of 4-chlorophenoxy acetic acid (4-CPA) and 6-benzyl adenine (BA) were prepared by dissolving the weighed amount in a small quantity of alcohol and volume was made up with distilled water. The desired concentrations of 4-CPA (5, 10 and 20 ppm) and BA (50, 100 and 200 ppm) were obtained by diluting the stock solutions. All the bunches on a vine were dipped for one minute at veraison stage. The bunches on control vine received only distilled water alongwith sticker. Five bunches per vine were tagged for recording various observations on each vine as one unit. The treatments were replicated three times. The intensity of colour development in berry skins was determined by adopting the method described by Kliewer (1970). Out of the total berries per bunch, the uncoloured and dropped berries were counted to calculate the per cent berry drop and uniformity in colour development.

TABLE 1

Effect of PCPA and BA on anthocyanin content, uniform ripening and berry drop in Beauty Seedless grapes

Treatments		Anthocyanin content (O D values)	Uncoloured berries (%)	Pre-harvest berry drop (%)
PCPA	5 ppm	0.36	0.85	70.40
	10 ppm	0.39	0.75	65.30
	20 ppm	0.62	0.30	59.37
BA	50 ppm	0.34	0.81	53.70
	100 ppm	0.38	0.63	45.14
	200 ppm	0.66	0.20	31.61
Control		0.35	0.91	78.73
C. D. at 5%		0.21	0.17	12.61

Significant increase in anthocyanin content and decrease in per cent uncoloured berries were noticed only in case of the highest concentrations of PCPA (20 ppm) and BA (200 ppm). However, the other concentrations were also effective to some extent (Table 1).

This clearly indicated that still higher concentrations might be needed. BA has been reported to accentuate the development of purple anthocyanin pigment in Muscat cv. of grape (Weaver *et al.*, 1962). Likewise, kinetin has also been reported to induce formation of another pigment (Bamberger and Mayer, 1960). Apart from improved colour development and uniformity in ripening, all the growth regulator treatments have reduced pre-harvest drop. In both the cases of growth regulators, there was gradual reduction in berry drop with increase in concentrations, however, the reduction was significant only at 20 ppm level in case of PCPA and at all levels in case of BA, when compared with the per cent berry drop in control. This further suggested that higher concentrations may be more effective. Reduced berry drop alongwith improvement in uniform ripening further strengthened the idea put forth earlier (Chundawat and Jindal, 1978) that the berry drop in this cultivar was mainly due to uneven habit of ripening.

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Haryana agric. Univ. J. Res., Vol. XII, No. 4, pp. 681–686 (December 1982)

INFLUENCE OF FAMILY INCOME ON FOOD CONSUMPTION PATTERN OF THE NURSING MOTHERS OF HISSAR

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ABSTRACT

A study carried out with 121 lactating mothers of four villages and two suburbs of Hissar indicated a definite influence of family income on the consumption of pulses, milk and milk products, fats and oils and sugar and jaggery. Consumption of the items of these food groups was positively correlated with the family income. The nutrient intake, especially protein, energy, calcium and riboflavin, was also affected by the family income. Increased family income resulted in a reduction in carbohydrate contribution towards energy while reverse was true for fats.

For successful breast feeding, the first step is to maintain an optimum nutritional status of the nursing mothers. Human milk is not only a complete food for an infant, but is also highly protective against malnutrition. Improvement of the nutritional status of nursing mothers is only possible when their food habits and existing nutritional status are known. Though a number of research workers (Devadas *et al.*, 1978; Nath and Geervani, 1978; Dhaliwal, 1980) have reported the dietary pattern of lactating women, data pertaining to the effect of family income on the food and nutrient intake of nursing mothers is scanty in respect of Haryana State. Present study was undertaken to assess this effect in nursing mothers of Hissar.

MATERIAL AND METHODS

One hundred twenty one lactating mothers, who were inhabitants of either a cluster of villages (Dhani, Raipur, Mirazapur and Niana) or suburbs (Jawahar Nagar and Krishna Nagar) of Hissar, were the subjects of this study. A pretested structured respondent schedule was used for collection of data pertaining to their socio-economic status and dietary pattern during the period April to October, 1979. Measuring cups, glasses and spoons were used to help the mothers in estimating the quantities of foods consumed by them.

Recipes consumed by subjects were actually prepared in the laboratory by the mothers in vogue in the area to determine the quantities of raw food ingredients consumed from different food groups. Nutritive values of raw ingredients consumed were calculated with the help of food consumption tables (ICMR, 1977).

The subjects were classified on the basis of per capita income into three

groups. The subjects, with per capita income of Rs. 80 or below per month were placed in group I, those whose income ranged from Rs. 81-200 were placed in group II and those with income of more than Rs. 200 in group III. Statistical analysis of the data was done by standard procedures (Snedecor and Cochran, 1967).

RESULTS AND DISCUSSION

Food Intake

Data on the daily food intake of suburban and rural nursing mothers in different income groups have been given in Table 1. The perusal of the data revealed that the nursing mothers, in all the income groups, consumed cereals in quantities much less than their recommended allowances (ICMR, 1977). Income had no influence on cereal consumption by suburban and rural lactating mothers. The findings of present study support the results of Gupta and Sharma (1980) and Nath and Geervani (1978) who also did not observe appreciable differences in cereal consumption of urban lactating women in different income groups. The pulses consumed by suburban and rural nursing mothers in different income groups were below the recommended levels. Suburban mothers in different income groups consumed pulses in larger quantities than their rural counterparts. It was further revealed that as the income increased consumption of pulses also increased.

Consumption of roots and tubers did not follow a specific trend. It was noticed that subjects in all the groups consumed roots and tubers in quantities lesser than their recommended levels. None of the subjects studied was consuming green leafy vegetables. Intake of the vegetables other than roots, tubers and green leafy vegetables, and fruits by suburban nursing mothers had a specific increasing pattern in different income groups, while their rural counterparts exhibited no pattern. These results are in agreement with those of Geissler *et al.* (1978) and Gupta and Sharma (1980) who reported increase in consumption of fruits with rise in family income of urban subjects. Quantities of milk and milk products consumed by the lactating mothers in group I were below the recommended values, but it was upto recommended levels in other two groups. With increase in the family income, mothers included more of milk and milk products, fats and oils and sugar and jaggery in their diets. It may, thus, be inferred that income had a definite impact on consumption of foods.

Nutrient Intake

The data pertaining to nutrient intake of lactating mothers are presented in Table 2. It was observed that the mothers belonging to higher income group in the rural area were receiving the recommended quantities of protein, while all other subjects in different groups were consuming diets deficient in protein. Protein intake by mothers in group III was significantly ($P<0.05$) more than those in groups I and II. It was interesting to note that in none of the groups of nursing mothers intakes of energy met the national recommendations for this nutrient. Mothers in income group III consumed significantly ($P<0.01$) more energy than those in other two groups.

TABLE 1

Daily food intake (g) of nursing mothers belonging to different income groups in suburb and rural areas of Hissar

Food group	Suburban			Rural			Recommended dietary allowances*
	Group I	Group II	Group III	Group I	Group II	Group III	
Cereals	257.0±21.32	246.3±26.29	262.3±19.83	303.8±27.04	294.1±18.82	346.4±23.75	450
Pulses	17.2± 3.28	18.9± 4.32	76.4± 9.83	16.4± 2.31	16.8± 2.24	22.9± 5.01	80
Roots and tubers	39.2± 5.11	61.2±10.13	46.5± 5.62	16.3± 6.16	13.9± 5.81	12.2± 5.82	75
Green leafy vegetables	—	—	—	—	—	—	150
Other vegetables	31.0± 6.23	52.8± 5.13	47.0± 5.64	27.0± 8.93	11.1± 4.01	10.0± 9.13	75
Fruits	9.7± 3.12	42.0± 9.63	89.4±18.01	—	29.1±11.40	10.1± 5.95	30
Milk and milk products	236.6±23.71	293.2±18.82	527.2±39.13	235.1±39.69	382.3±36.98	477.9±42.46	325
Fats and oils	17.5± 5.01	22.8± 5.60	34.5± 4.39	17.3± 5.03	16.9± 2.16	21.6± 5.60	50
Sugar and Jaggery	28.0± 3.56	28.7± 5.66	36.3±11.35	34.6± 7.32	44.9± 7.60	52.6± 6.39	50

*ICMR (1977).

TABLE 2

Daily nutrient intake of nursing mothers belonging to different income groups in suburb and rural areas of Hissar

Nutrient	Suburban			Rural			Recommended dietary allowances*
	Group I	Group II	Group III	Group I	Group II	Group III	
Protein (g)	46.5±3.30^{a} (71.5)	47.8±2.28^{ab} (73.5)	62.6±3.88^{c} (96.3)	53.1±3.92^{a} (81.7)	56.1±2.50^{ab} (86.3)	69.0±3.31^{c} (106.2)	65
Energy (Kcal)	1517±92.36^{a} (52.3)	1662±81.02^{ab} (67.3)	2139±106.52^{c} (73.8)	1715±111.52^{a} (59.1)	1835±67.88^{ab} (63.3)	2240±96.38^{c} (77.2)	2900
Calcium (mg)	675±123.28^{a} (67.5)	798±79.69^{ab} (79.8)	1274±81.59^{c} (127.4)	766±80.51^{a} (76.6)	1021±73.46^{b} (102.1)	1243±79.99^{b} (124.3)	1000
Iron (mg)	32.4±1.63^{a} (107.6)	31.1±2.09^{a} (103.7)	32.8±2.97^{a} (109.2)	39.3±3.46^{a} (131.0)	38.7±2.25^{a} (129.0)	46.3±3.07^{a} (154.3)	30
Thiamine (mg)	1.44±0.10^{a} (96.0)	1.49±0.08^{a} (99.3)	1.72±0.17^{a} (114.7)	1.71±0.14^{a} (114.0)	1.68±0.09^{a} (112.0)	1.99±0.12^{a} (132.7)	1.5
Riboflavin (mg)	1.07±0.12^{a} (66.9)	1.24±0.06^{ab} (77.5)	1.38±0.08^{b} (86.2)	1.26±0.40^{a} (78.8)	1.41±0.37^{a} (88.1)	1.57±0.10^{a} (98.1)	1.6
Niacin (mg)	12.12±0.80^{a} (60.6)	11.93±0.81^{a} (59.6)	12.78±1.36^{a} (63.9)	13.88±1.24^{a} (69.4)	13.14±0.86^{a} (65.7)	15.84±1.04^{a} (59.2)	20
Vitamin C (mg)	35.2±22.26^{a} (44.0)	33.0±12.16^{a} (41.2)	58.7±36.79^{a} (73.4)	7.3±1.60^{a} (9.1)	16.1±6.07^{a} (20.1)	7.7±0.94^{a} (9.6)	80

*ICMR (1977)

Values in parentheses denote percentage of recommended allowances.

Values under a same sub-head in a row bearing similar superscripts do not differ statistically from each other.

TABLE 3

Per cent contribution of energy from different dietary constituents in the diet of nursing mothers

Area	Income group	Carbohydrate	Fat	Protein
Suburb	I	63.25	24.39	12.36
	II	59.12	29.50	11.38
	III	53.42	34.88	11.70
Rural	I	63.93	23.40	12.67
	II	62.56	25.05	12.38
	III	60.27	27.28	12.45
Recommended range (FAO, 1965)		65–70	20–25	9–10

Amounts of calcium consumed by the suburban mothers in groups I and II and rural nursing mothers in group I were below the national recommended levels. Calcium intake increased with rise in family income. Iron intake of the subjects in all the groups was satisfactory. Critical examination of data revealed that there were no significant differences in iron intake of suburban and rural nursing mothers in different income groups.

Intake of thiamine by the subjects in various income groups was almost adequate or in excess of the recommended values. Though intake of this vitamin increased with rise in family income, however, differences in thiamine intake between different income groups were not statistically significant. Riboflavin contents of the diets of nursing mothers in various income groups were short of its recommendations by 1.9 to 33.1 per cent. Intake of this vitamin increased with the rise in the family income. It was interesting to note that niacin and vitamin C fell short of their recommended allowances in all the categories and their consumption by mothers in different income groups did not manifest any specific trend.

From the results presented above it could be inferred that though the intake of most of the nutrients by nursing mothers increased with rise in their family income but the consumption of most of the nutrients in all the income groups was inadequate. Similar findings have been reported by Geissler *et al.* (1978), Nath and Geervani (1978) and Gupta and Sharma (1980).

Energy Contribution by Dietary Constituents

The contribution towards energy by carbohydrates, fats and proteins in the diets of nursing mothers have been summarized in Table 3. It may be observed that an increase in family income led to enhanced energy contribution by fats in both suburbs and rural areas, while carbohydrates followed a reverse pattern.

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BACKGROUND INFORMATION, PERSONALITY CHARACTERISTICS AND ACADEMIC ACHIEVEMENTS OF GIRL STUDENTS

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ABSTRACT

An attempt was made to know the relationship between background information and personality characteristics of Home Science Students with their academic performance. Studies were conducted upon 108 respondents from first and second year classes during 1979-80. The study revealed that urbanism, family income and parent's education were favourably associated with academic achievements, whereas personality characteristics like neuroticism, anxiety and extroversion were found to be negatively associated. The study suggested measures to improve the academic achievements of students in the existing socio-psychological circumstances.

It has long been recognised that individuals differ significantly in respect of their talents and temperaments. Background and personality characteristics play an important role in shaping these attributes, and influence the academic achievements of students. Kulkarni and Naidu (1970) found low positive correlation between socio-economic status and academic achievement. Moreover, no clear cut trend was noticed between education of parents and achievements of their children. Ambastha (1971-72) showed that the better study habits lead to better academic performance. Basu (1970) revealed that an optimum level of neuroticism helps in successful academic achievement and the most successful group was that with the lowest extroversion scores. Agya Jit Singh (1978) noticed that neuroticism was negatively correlated, whereas extroversion was positively related with academic achievement. Singh and Kumar (1977) reported that low anxious students achieved better in comparison to high anxious students.

A number of studies have been carried out on these aspects on school and college students. In view of the variations in the findings, an attempt was made to know the relationship between background information, and personality characteristics of Home Science students with their academic performance.

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METHODOLOGY

The study pertains to first and second year students of the faculty of Home Science, Baroda. These classes were purposively selected as these were under new scheme of Higher Secondary Education. Systematic random sampling procedure was restored to obtain 50% of the population of these two classes. The process yielded 108 respondents, 69 from the first and 39 from the second year classes. The data were collected with the help of a questionnaire, personally administered, in the year 1979-80. Contingency coefficient of correlation were calculated to know the relationship between background information, personality characteristics and academic achievements of the students.

RESULTS AND DISCUSSION

The residential area which was defined as urban or rural, family income and parents' qualification were included to find out the association between background information and academic performance of the respondents. For knowing academic achievements, their cumulative quality grade points that is high and low achievers representing students of O, A and B grades and C, D, E and F grades, respectively. Table 1 shows their relationship.

It is evident from Table 1 that urbanism was significantly related to academic achievement, may be because of availability of facilities necessary for studies and congenial environment which

TABLE 1

Relationship between background information and academic achievement

Background	Achievers (%)		Total
	High	Low	
Residence (X^2=4.605 ; C=0.20)*			
Rural	2(29)	5(71)	7(100)
Urban	69(68)	32(32)	101(100)
Income (X^2=4.352 ; C=0.203)			
High (above 15001)	40(71)	19(29)	59(100)
Medium (10001-15000)	20(65)	11(35)	31(100)
Low (5000-10000)	8(44)	10(56)	18(100)
Education			
Father (X^2=0.508 ; C=0.07)			
Post-graduate	20(63)	12(37)	32(100)
Graduate	32(70)	14(30)	46(100)
Matric	19(63)	11(37)	30(100)
Mother (X^2=0.022 ; C=0.01)			
Post-graduate	6(75)	2(25)	8(100)
Graduate	20(77)	6(23)	26(100)
Matric	44(60)	30(40)	74(100)

*Significant at 0.05 level of confidence with d. f. 1.

is usually absent in villages. Ambastha (1971–72) also reported similarly. However, with respect to parents education, family income and academic achievement, no statistically significant association was noticed but when percentages were calculated to measure their academic performance, the trend was signifying the importance of these variables in influencing academic achievement. Kulkarni and Naidu (1970) noticed similar trends in these aspects.

Personality is the sum total of the actual or potential behaviour pattern of the organism, as determined by heredity and environment. However, in the present study a few selected characteristics such as extroversion, introversion, anxiety and neuroticism were examined after following standardised methods as used by professional psychologists for identifying these characteristics. Table 2 elaborates their relations with academic achievement.

Analysis of Table 2 indicates that there was no association between extroversion/introversion and academic performance, however, further examination revealed that there was a tendency for introverts to be high achievers as compared to extroverts, but it was not statistically significant. Basu (1970) also reported likewise in a study on school children. Similarly, no relationship was observed between anxiety and academic achievements. Singal (1974) also observed similarly while studying school children and Singh and Kumar (1977) noticed a little relationship. A minute observation of the present results also reveals similar relationship. However, neuroticism was found to be negatively associated with academic achievement, meaning thereby that more the neurotic characteristics, the poor was the academic performance. Present study confirms the investigations of Agya Jit Singh (1978) in this respect.

TABLE 2

Relationship between personality characteristics and academic achievement

Personality characteristics	Achievers (%)		Total
	High	Low	
Extro-Introversion (X^2=0.610 ; C=0.09)			
Extrovert	21(58)	15(42)	36(100)
Introvert	21(68)	10(32)	31(100)
Anxiety (X^2=0.272 ; C=0.04)			
Anxious	29(63)	17(37)	46(100)
Normal	42(68)	20(32)	62(100)
Neuroticism (X^2=6.254* ; C=0.24)			
Neurotic	13(46)	15(54)	28(100)
Normal	58(72)	22(28)	80(100)

*Significant at 0.05 level of confidence with d.f. 1.

Based upon the above results, it may be concluded that urbanism, family income and parent's education were favourably associated with academic achievements. It may be due to the fact that rural schools are illequipped. Moreover, the poor family income and no or a little parental education resulted into inadequate and rudimentary socialization leading to poor academic achievement. Therefore, in order to improve the academic performance of students coming from rural areas, poor families and of illiterate parents, it is advocated that rural schools must be provided with facilities essential for a congenial academic environment. Personality characteristics like neuroticism, anxiety and extroversion were found to be negatively associated with academic achievement. However, for improving academic performances of respondents belonging to these categories the existing system of socialization has to be well looked into and made free from socio-psychological problems like neuroticism, anxiety, etc.

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JOB PREFERENCES OF AGRICULTURAL UNDER-GRADUATE STUDENTS

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ABSTRACT

Aspirations in terms of nature of job, agency of job and place of job of 70 students of B. Sc. (Agriculture) final year of Haryana Agricultural University, Hissar, were analysed with standard method of paired comparison. Majority of the students were from families with higher caste, income and education. Except married students, educational aspirations were fairly high. Administrative job was the most preferred and clerical the least. Field of specialization was given due importance but their choices had undergone substantial changes with expansion of employment opportunities and value attached to profession by society. Government agencies were given first preference and the private firm the last. Enterpreneurial ability was lacking among these students. Traditional choice to reside nearby home was still prevailing.

Modernisation of traditional agriculture and expansion of agricultural sciences have increased the demand of trained man power in various fields of agriculture. Rural Universities have been established to cater this increasing demand of trained man power. Besides, the conventional outlets like government departments, a large number of semi-government organizations and commercial concerns are also coming forward to employ these graduates. Now they have different careers to choose.

The students during the course of their studies have some plan to pursue a career after getting their degree. They aspire in terms of their choice of some specific type of job, agency of job and place of job. Preferences of students toward these aspects are of much practical significance for policy makers, planners and administrators of programmes of education, development programmes and commercial organizations. A study of this kind will also help in understanding whether this generation is being adequately motivated to accept the socially desired ideals or they are still holding fast to the traditional values.

Specific objective of the study was to know the career aspirations of agricultural under-graduate students in respect of the nature of job, avenue or agency in which job would be preferred and place of job.

METHODOLOGY

Universe and sample. The present study was conducted in academic year

1978-79 on B.Sc. (Agriculture) final year students studying in Haryana Agricultural University, Hissar. There were 95 Indian students in the class, out of which 70 students were available for response.

Stimulus material. Stimulus material was selected from field experiences and review of literature. Only closely related items were selected.

1. According to nature of job, seven jobs: Administrative, Research, Extension, Teaching, Social Service, Military and Clerical were selected.

2. According to agency in which job preferred, six types of agencies: Private Firm, Central Government, State Government, Semi Government Organization, Personal Business Organization and International Organization were selected.

3. Places of job were categorized on the basis of distance from home. These were Neighbour Country, Home Country, Neighbour State, Home State, Home District and Near Home Village.

The standard method of paired comparison was used. The stimulus, nature of job, avenue of job and place of job, were presented to the respondents in pairs, in all possible combinations. In order to avoid space and time errors, the pairs were so arranged that every stimulus appeared equally often on the right side and on the left, and maximum possible distance was kept between its appearances in pairs.

Students were explained about the different stimulus and were instructed to put a tick mark against one stimuli in each pair and also not to leave any pair unchecked.

Scale values were solved with equation involving 'Case V' of Thurstone (Edwards, 1969 : 31). This procedure was repeated for calculating the scale values of all groups of stimuli, i. e., as per nature of job, agency/avenue and distance of work place, separately.

RESULTS AND DISCUSSION

Background of the Respondents

Ones aspirations are substantially influenced by his socio-economic status and psychological make up. Information in this regard reveals that students of higher agricultural castes from rural areas with fairly higher education in family joined this career. Service and professionals also liked it. Students with bright academic career joined this course and had fairly high level of educational aspirations. Among those who aspired for post-graduation, 60% desired to do study continuously. Among married students only 20% aspired for higher education. All the married students were from rural background and lower level of education in family with farming as main occupation.

Nature of Job

Students preferred administrative jobs (1.978) most followed by research (1.429), extension (1.292), teaching (1.170), social service (1.063), military (0.992) and clerical (0) (Table 1). Research was the most overall preferred field followed by extension and teaching by agricultural under-graduate students of Punjab (Sandhu and Sinha, 1970).

TABLE 1

Z—Matrix, Nature of job

Job	Clerical	Military	Social service	Teaching	Extension	Research	Administrative
Clerical	0.000	1.036	1.036	1.206	1.468	1.206	1.977
Military	—1.036	0.000	0.108	0.181	0.253	0.524	0.954
Social service	—1.036	—0.108	0.000	0.126	0.253	0.412	0.842
Teaching	—1.206	—0.181	—0.126	0.000	0.146	0.253	0.745
Extension	—1.468	—0.253	—0.253	—0.146	0.000	0.253	0.842
Research	—1.206	—0.524	—0.412	—0.253	—0.253	0.000	0.568
Administrative	—1.977	—0.954	—0.842	—0.842	—0.745	—0.568	0.000
Sums	—7.929	—0.984	—0.489	0·272	1.122	2.08	5.928
Means	—1.132	—0.140	—0.069	0.038	0.160	0.297	0.846
Means+ 1.132	0.000	0.992	1.063	1.170	1.292	1.429	1.978
Rank	VII	VI	V	IV	III	II	I

Average discrepancy=0.014

In present study, research got second preference. The probable reason of difference might be the changes in choice and putting of only teaching, research and extension jobs to students for choice by Sandhu and Sinha (1970). Gupta and Sohal (1972) also reported lower preferences for jobs not in accordance with their field of specialization and higher preferences for research, teaching and extension. Singh *et al.* (1973) reported decending order of preference for extension, teaching and research jobs by agricultural undergraduate students of Bihar. Their findings (Sandhu and Sinha, 1970; Gupta and Sohal, 1972; Singh *et al.*, 1973) also confirm the least preference for jobs not in accordance with their field of specialization, as clerical jobs were least preferred (0).

It may be concluded that the job aspirations had undergone changes with changes in employment opportunities and point of view of the society. Administrative jobs were being given higher status. Research and teaching were preferred because majority (85.71%) of students aspired for higher education, for which research and teaching job might be most appropriate. Due consideration was given to the field of specialization in choosing a career.

Agency of Job

According to the agency in which job was preferred, centre government (1.212) ranked first followed by international organization (0.855), State Government (0.654), personal business organization (0.346), semi-government organization (0.065) and private firm (0) (Table 2). Sandhu and Sinha (1970), Gupta and Sohal (1972) and Singh *et al.* (1973) also found highest preferences for government departments and lowest for private firms by agricultural under-

TABLE 2

Z—Matrix, Agency of job

Agency	Private firm	Semi-Govt. organiza-tion	Personal business organiza-tion	State Govt.	Internatio-nal organi-zation	Centre Govt.
Private firm	0.000	0.063	0.292	0.653	0.842	1.282
Semi-Govt. organization	−0.063	0.000	0.319	0.613	0.700	1.175
Personal business organisation	−0.292	−0.319	0.000	0.305	0.524	0.842
State Govt.	−0.653	−0.613	−0.305	0.000	0.253	0.524
International organization	−0.842	−0.700	−0.524	−0.253	0.000	0.319
Centre Govt.	−1.282	−1.175	−0.842	−0.524	−0.319	0.000
Sums	−3.282	−2.744	−1.060	−0.794	2.000	4.142
Means	−0.522	−0.457	−0.176	0.132	0.333	0.690
Means+ 0.522	0.000	0.065	0.346	0.654	0.855	1.212
Rank	VI	V	IV	III	II	I

Average discrepancy=0.010

TABLE 3

Z—Matrix, Place of job

Place	Neighbour State	Neighbour country	Near home village	Home country	Home State	Home district
Neighbour State	0.000	−0.108	0.108	0.073	0.181	0.485
Neighbour country	0.108	0.000	0.146	0.181	0.217	0.000
Near home village	−0.108	0.146	0.000	−0.070	0.000	0.366
Home country	−0.073	−0.181	0.070	0.000	−0.070	0.292
Home State	−0.181	−0.217	0.000	0.070	0.000	0.217
Home district	−0.485	0.000	−0.366	−0.292	−0.217	0.000
Sums	−0.739	−0.652	−0.042	−0.040	0.111	1.360
Means	−0.123	−0.108	−0.007	−0.006	0.018	0.226
Means+ 0.123	0.000	0.015	0.116	0.117	0.141	0.349
Rank	VI	V	IV	III	II	I

Average discrepancy=0.027

graduates. This trend of choosing the government agencies might be because of security of job and more employment avenues in government departments.

It was asserted that agricultural under-graduate students were government service oriented and lacked enterpreneurial abilities.

Place of Job

Differences between successive scale values of different places of job like home State (0.141), home country (0.117) and near home village (0.116); and neighbour State (0) and neighbour country (.015) did not reveal much difference in degree of preferences. Students preferred most to serve in their home district (0.349). In none of the studies, Sandhu and Sinha (1970), Gupta and Sohal (1972) and Singh *et al.* (1973) preferences for place of job were asked directly. But preferences as per nature and agency of job reveals the liking of this section of students to serve in their home State which is also in accordance with the present findings.

Internal Consistency Check

Absolute average discrepancies for nature of job, agency of job and place of job were 0.014, 0.010 and 0.027 respectively for 7, 6 and 6 stimuli. Therefore, the observed proportions were in agreement with those of expected in terms of derived scale values (Hevner, 1930; Saffir, 1937; Edwards, 1969). Hence the ordering of preferences was rational.

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ECONOMIC FEASIBILITY OF SPRINKLER IRRIGATION IN DESERT AREAS OF HARYANA

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ABSTRACT

Studies on economic feasibility of sprinkler irrigation in comparison to traditional surface irrigation reveal that the average costs of tube-well and sprinkler set were Rs. 20,600 and 17,060, respectively. The total cost per irrigation per ha by sprinkler was Rs. 173 and the per hour cost of sprinkler irrigation was Rs. 5.55. After installing sprinkler sets the net irrigated areas in Haryana increased from 3.68 to 5.07 ha and cropping intensity from 66 to 121 per cent. This resulted in additional net annual income of Rs. 631 per ha. The study further indicated that the change over to sprinkler irrigation is economically feasible besides ensuring judicious use of scarce irrigation water.

In Haryana power and irrigation were given top priority in the development plan after its creation as a separate State in November, 1966 so as to develop agriculture at a faster rate. The south-western parts (Hissar, Bhiwani, Sirsa, Mahendergarh and part of Rohtak in general and Bhiwani district in particular) which fall in arid and semi-arid regions of the State, had been in the grip of chain of droughts and famines for decades due to scanty and erratic rainfall (300-550 mm annually). The soil of this region is sandy and undulating, otherwise the land is productive. Furthermore, the ground water is brackish and unfit for irrigation in most parts of this region and only a few pockets of good sub-soil water or usable quality of brackish water are found here and there. Thus, water is most precious input of agriculture, and its efficient utilization is of immense importance. Until 1975, the farmers of the region have by and large practised flood irrigation which under the prevailing conditions of sandy soils, undulating topography and very small discharge of tubewells resulted in very low irrigation efficiency besides high labour reguirement. Due to this, farmers could irrigate only small fraction of their holding. Sprinkler irrigation although costly, is ideally suited for such conditions and has been gradually adopted by farmers. However, the benefit : cost of sprinkler and flow irrigation needs to be estimated.

Irrigation requires relatively large investments regardless of type of system used. Consequently, the annual fixed cost is very high. In addition, the use of an irrigation system leads to variable costs, such as wages of labour, fuel and

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repairs. Since, most of the farmers have only limited capital, a choice must be made between two or more of the alternative uses of limited capital. Here, opportunity costs become the guide. Before the decision is made to invest in sprinkler system, the income that might be obtained by putting the money into some alternative use needs to be considered. The decision to buy the sprinkler set should be based on the rejection of the second best available alternative use of the funds. After the decision has been taken and the capital investment has been made, the capital is fixed or sunk for a given period of time. For example, when a tube-well is used as a source of water, its cost can be recovered only through use or sale of the farm at higher price because the tube-well is there ready for use. Movable equipment, e. g , sprinkler-set can be sold. If the assumption is made that fixed capital (tube-well+sprinkler set) cannot be recovered for a given period of time, then only the variable costs should be considered. The opportunity cost after acquisition of sprinkler set is the amount of farm income that will be foregone if the value or amount of variable costs needed is put to usess other than operation of irrigation equipments. As investment is made in irrigation, the need for basic data concerning its use is also increased. Present investigation was conducted with the following objectives :

(i) To determine the cost of installation of a sprinkler set;

(ii) To study the operating costs of sprinkler set;

(iii) To determine the effect of sprinkler set on farm income; and

(iv) To find out financial feasibility of sprinkler irrigation.

MATERIAL AND METHODS

Sprinkler sets have been installed in Hissar, Sirsa, Rohtak, Bhiwani and Mahendergarh districts. Bhiwani district was selected as maximum number of sets are installed in this district. From the district, two blocks Charkhi Dadri-I and Jui were selected. Data were obtained from 22 farmers, who owned sprinkler sets since the last three years. This was done to avoid the fluctuations in the cost of sprinkler set and the farmers had acquired some experience in its use. This is the period in which rapid development took place in the sprinkler irrigation. Data were collected from sample farmers regarding cost of construction of well, sprinkler set and its annual operational cost, area irrigated and labour used in irrigation before and aiter installation of sprinkler set, crops grown, terms and conditions of the loans, etc. Survey method of data collection was followed and information was collected in December, 1980.

Analytical techniques. Simple tabular method was used to analyse the data. The costs involved in the purchase and use of sprinkler set were categorised as fixed and variable costs. Annual fixed cost reflects the amount of capital invested in well, pumping unit and sprinkler set and length of time in investment period. Variable or operating and maintenance costs reflect prices of variable inputs such as labour, electricity

and expenses required to pump and distribute the water.

Annual fixed costs. The annual fixed costs included depreciation and interest on average investment. The following procedures were used for computing the annual fixed costs on the individual items :

$$\text{Depreciation} = \frac{\text{Original value}}{\text{Years of useful life}}$$

The useful life of wells and shelter was taken as 50 years, engine and pipes 15 years and of the sprinkler heads 8 years. The annual interest charge was equal to half of the original value of the equipment multiplied by the interest rate.

$$\text{Annual interest} = \frac{\text{Original value}}{2} \times 0.10$$

Annual operating and maintenance (variable) costs. After a farmer has invested in sprinkler set, he can apply supplementary water to crops by incurring variable costs. Annual operating and maintenance costs included electric charges, labour and maintenance cost of sprinkler system. Labour cost includes use of labour in moving laterals and main lines and supervision of electric motors. Maintenance costs were charged at the rate of 1% per annum. The details of the fixed costs are given in Appendix I.

Net returns from the crops were estimated on the basis of input-output data of the Bhiwani district given in the Haryana Agricultural University Packages of Practices for **rabi** and **kharif** crops. Net returns were estimated on the basis of opportunity costs. Only deviation from the data given in the Package of Practices is that the rental value has not been considered as cost item. These data were used as they represent larger sample size than used in this study. Further, returns from the additional area brought under irrigation since installation of the sprinkler set and custom service have been considered. This has been done on the logic that ever before installation of the sprinkler sets farmers were irrigating their fields from tube-wells already installed by them.

RESULTS AND DISCUSSION

Cost of Installation

To establish a sprinkler set for irrigation a farmer requires tube-well/ pumping unit and sprinkler set. Table 1 shows details of installation cost.

TABLE 1

Installation cost of sprinkler set

Items	Amount (Rs.)	Percentage
1. Cost of well	12,000	31.86
2. Cost of motor and pumps and boring in well	8,600	22.84
3. Cost of main and lateral pipe line	13,560	36.01
4. Cost of sprinkler heads and other accessories	3,500	9.29
Total cost	37,660	100.00

It is evident from Table 1 that even without sprinkler set farmer has to incur expenditure of Rs. 20,600 to install a tube-well/pumping set. The installation cost of a sprinkler set was found to be Rs. 17,060 which is about 45.30% of the total investment for irrigation on farm. Apparently sprinkler set cost looks very high.

Cost of Sprinkler Irrigation

The details of the costs are given in Table 2.

It is evident from Table 2 that the depreciation charges made up 54% of the annual fixed costs or 31% of the total cost. The annual fixed cost must be borne as long as the sprinkler set is owned or until the cost has been charged regardless of its annual use. If the production functions are known and accurate costs data are available, the farmer can apply sprinkler water upto the point at which marginal cost is equal to marginal revenue from the last unit applied in order to maximise the profit. However, in its absence farmer should consider the variable or operating costs of applying irrigation water in relation to expected returns from its use. If he expects the returns from the sprinkler irrigation to be equal or greater than the variable cost, the sprinkler water should be applied. Irrigation from the sprinkler can be justified so long as the average variable costs are covered. Any additional return above the average variable cost will reduce the average fixed costs. The farmer must receive a return greater than the average irrigation cost (fixed and variable costs). It has been assumed in this study that farmers who had invested money in sprinkler sets expected returns over the time period of the investment which would be equal to or greater than the returns from investment in other endeavours.

Variable costs as percentage to total cost were 31 per cent. Highest variable cost was of the electricity charges followed by labour. Total cost on sprinkler irrigation was Rs. 7,198 per year.

TABLE 2

Estimated annual cost of sprinkler irrigation

Items	Amount (Rs.)	Percentage
A. **Annual Fixed Costs**		
(i) Depreciation on investment	2,230	30.98
(ii) Interest on average investment	1,883	26.16
Total fixed costs	4,113	57.14
B. **Annual Operating and Maintenance Costs**		
(i) Electricity charges	1,310	18.20
(ii) Labour (1298 hours)	1,298	18.03
(iii) Maintenance of irrigation system	377	5.24
(iv) Miscellaneous	100	1.39
Total operating costs	3,085	42.86
Total cost (A+B)	7,198	100.00

The average per hectare cost of sprinkler irrigation was Rs. 1,074 and per irrigation cost was Rs. 173 (7198÷41.71) (calculated on the basis of data in Table 3). To run sprinkler set, the farmer has to incur expenses at the rate of Rs. 5.55 per hour. Average variable costs per hectare, per irrigation and per hour to run the sprinkler-set were Rs. 460, 73.96 and 2.38, respectively.

Effect of Sprinkler Irrigation on Farm Income

In the sprinkler irrigation watering could be controlled in the upper root-zone of the crops, especially in sandy soils where watering with low discharge tube-well by gravity flow irrigation is very inefficient due to high rate of seepage and deep-percolation besides being labour intensive. Under such conditions of soil and low discharge rate, the farmer is required to prepare small plots for irrigation (8 to 10 sq m) and has to employ 3 labourers for about 53 h per hectare per irrigation. Further, the water application by sprinkler is controlled and uniformly spread over the field like natural rainfall. The sprinkler irrigation also resulted in additional coverage of land due to saving in water and time. Further, the undulating lands with sand dunes on which crops could not be raised even during the rainy season could also be put under crops with the acquisition of sprinkler sets by the cultivators.

The average size of holding of the selected cultivators was 5.54 hectares. The farmers were irrigating on an average 3.68 hectares, i. e., about 66% of the holding before acquisition of the sprinkler sets. The average net irrigated area increased to 5.07 hectares which is about 92% of the average size of holding after acquisition of sprinkler sets. The use of human labour per hectare per irrigation declined from 159 h to 31 h. This itself is a big saving. In this case however no saving in cost has been apportioned as opportunities to employ family labour outside the farm are negligible.

Income from crops grown on the farm has been worked out and has been given in Table 4. It is evident from the table that the average net income of the farmer from the crops was Rs. 7,763. Sprinkler

TABLE 3

Particulars of irrigated area (average of 22 farmers)

S. No.	Crop	Area (ha)	No. of irrigations	Labour required to irrigate crop (h)
A.	**Rabi crops**			
1.	Wheat	3.14	10	977
2.	Gram	1.60	3	149
3.	Mustard	0.26	3	24
4.	Barley	0.07	5	11
B.	**Kharif crops**			
5.	Bajra	1.12	3	105
6.	Guar	0.51	2	32
	Total	6.70	41.71	1298

irrigation was mainly used for irrigating **rabi** crops. On account of sprinkler irrigation the cropping intensity on the sample farms increased from 66 to 121 per cent. Thus, with the acquisition of the sprinkler set the farmers were able to bring additional 3.02 hectares area under cultivation. Return from one hectare of land was Rs. 1159. Hence, additional net returns from 3.02 ha additional area were worth Rs. 3500. Thus, installation of the sprinkler set has improved the well being of the cultivators' of the area, besides providing them more leisure and satisfaction. However, in the areas, where sub-soil water is brackish, sprinkler irrigation had saved **rabi** crops from complete failure as it became feasible to provide protective irrigation to **rabi** crops and increase in farm income.

Besides income from the additional land put under crops, farmers are also doing custom hiring service. The details of the custom service and income are given in Table 5. It is evident from the table that the farmers on an average were earning additional per farm income of Rs. 3496 (Rs. 863.21/ha) from the custom service. However, income from custom service may decline with installation of more sprinkler sets.

Financial Feasibility Analysis of Sprinkler Set

All the sprinkler sets were purchased with the money borrowed from the Land Development Bank. Therefore, financial feasibility of sprinkler sets was examined. On the basis of the three tests of judging the financial feasibility of in-

TABLE 4

Average income from crops grown on farm

S. No.	Crop	Area (ha)	Cost/ha (Rs.)	Net return/ ha (Rs.)	Average yield (q/ha)	Net income from crop (Rs.)
1.	Wheat	3.14	1752	1404	23.50	4,409
2.	Gram	1.60	642	974	6.53	1,558
3.	Mustard	0.26	885	1419	9.92	369
4.	Barley	0.07	1322	1583	30.00	111
5.	Bajra	1.12	1542	647	7.00	725
6.	Guar	0.51	614	1159	6.18	591
	Total	6.70	—	—	—	7,763

TABLE 5

Details of custom service

S. No.	Crop	Area (ha)	Average yield (q/ha)	Sharing rate of produce	Income (Rs.)
1.	Wheat	2.47	24.75	1/2	2,453
2.	Barley	0.07	35.00	1/2	146
3.	Gram	1.20	6.46	1/3	642
4.	Mustard	0.31	5.47	1/3	256
	Total	4.05	—	—	3,496

TABLE 6

Economic feasibility of sprinkler irrigation

Particulars	Amount (Rs.)
(i) Additional returns from farm due to sprinkler irrigation	3,500
(ii) Income from custom service	3,496
(iii) Total (i+ii)	6,996
(iii) Additional expenses	
(a) Due to depreciation on sprinkler set	1,388
(b) Repair and maintenance	171
Total (a+b)	1,559
(iv) Net returns	5,437
(v) Instalment of loan when 25% subsidy is given	2,954
(vi) (a) Instalment of loan when no subsidy is given and interest is @ 10%	3,917
(b) Instalment of loan when no subsidy is given and interest is @ 6% and recovery period 6 years	3,469
(c) Instalment of loan without subsidy interest @ 10% and recovery period 8 years	3,504
(vii) Deflated net returns	
(a) 99% confidence limit	4,132
(b) 95% confidence limit	4,567

Note :—Average cost of sprinkler set came to Rs. 17,060. On this investment 25% subsidy was provided hence capital cost is equal to Rs. 12,864 (Rs. 17,060 – 4,196). The interest is charged @ 10% per annum. According to prevailing terms of loan a farmer is required to pay interest in the first year and later on he has to repay the loan in six annual instalments.

vestment, it was found that investment in sprinkler sets is highly profitable (Table 6).

Here additional returns from the sprinkler set has been considered because farmers were already having tube-well/ pumping sets, before purchasing of sprinkler set. It is evident from Table 6 that on an average sprinkler set will generate adequate income from farm. Therefore, it is advisable for the farmers to go for the installation of sprinkler sets.

The investment on sprinkler sets varied from Rs. 12,000 to Rs. 25,000 depending upon the number of pipes, nozzles and other accessories purchased by the farmer. Consequently, there were considerable variation in additional costs of sprinkler set which varied from Rs. 931 to Rs. 2,200 per annum (Appendix II). The average additional cost was Rs. 1,559. Additional returns from sprinkler set depend on location of pump house, availability of good quality water and its quantum in acquiffer, cropping pattern, use of sprinkler water in **kharif**

season and custom service. Hence, considerable variation in the additional income from sprinkler irrigation was observed on these farms. The additional net income from sprinkler set varied from Rs. 1900 to Rs. 4,145, when an income from custom service is ignored on the logic that in long run this income may decline.

It is evident from Table 6 that instalment of loan (Principal+Interest) in both the situations could be easily paid from the additional returns as this amount is more than the amount of loan instalment. If only net return from the farm is considered and custom service is ignored farmers will not be able to meet the loan instalment requirement. When no subsidy is given and income from custom service is assumed nil, then to make the sprinkler irrigation system economically viable for the farmers, the rate of interest should be reduced to 6% from existing 10 per cent. Another alternative is to increase the period of recovery from present 6 to 8 years. However, the former suggestion is more sound in the interest of popularizing sprinkler system in the region. This supports the case for subsidy on the advances given for the purchase of sprinkler set.

Gangwar and George (1971) estimated 24% variation in the farm income of the region. Hence, farm income has been deflated by 24 per cent. It is further evident from Table 6 that when subsidy is given to the farmers of the region, they have adequate income to bear the risk and uncertainties even at 99% level of confidence, although this extreme level of confidence is rarely desired by the financial institutions. At 95% level of confidence limit which is most commonly used in agriculture, advances for the purchase of sprinkler sets could be repaid, even without subsidy. But very little farm income (about Rs. 650) will be left for the use by the farmer. Since, the cost of well and pumping set which is essential component for sprinkler irrigation is more than the cost of sprinkler set, loan on soft terms of interest should be made available to the farmers to make the sprinkler irrigation more attractive. Further by making adjustments in the cropping pattern, i.e., having more irrigated area under gram and raya and greater use of sprinkler in **kharif** season will result in higher return on sprinkler irrigation as compared to surface irrigation.

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Gangwar, A. C. and George, M. V. 1971. Income price and yield variability for principal crops and cropping patterns in Haryana. *Agricultural Situation in India* **24 (2) : 23.**

APPENDIX I

Details of cost, depreciation and repairs

S. No.	Item	Cost (Rs.)	Depreciation	
			Rate	Amount (Rs.)
1.	Aluminium pipes	13,560	7%	950
2.	Sprinkler heads	3,500	12.5%	438
3.	Electric motor and pipe board	8,600	7%	602
4.	Well	12,000	2%	240
	Total (1 to 4)	37,660		2,230
5.	Repair and maintenance costs @ 1% on total investment (Rs. 37,660)			376
6.	Repair and maintenance of the sprinkler set @ 1% (Rs. 17,060)			171

APPENDIX II

Variation in costs and returns of sprinkler irrigation system

	Particulars	Minimum value (Rs.)	Average value (Rs.)	Maximum value (Rs.)
1.	Additional expenses			
	(a) Depreciation on sprinkler set	796	1,388	2,000
	(b) Repair and maintenance	135	171	220
	Total (a+b)	931	1,559	2,220
2.	Additional net returns			
	(a) From farm due to sprinkler irrigation	1,900	3,500	4,145
	(b) Income from custom service	3,937	3,496	—
	Total (a+b)	5,837	6,996	4,145

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