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COMBINING ABILITY ANALYSIS OF BROWN RUST RESISTANCE AND YIELD ATTRIBUTES IN WHEAT

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(Accepted : July 18, 1988)

ABSTRACT

Combining ability analysis was carried out for days to maturity, plant height, number of tillers per plant, number of grains per spike, 100-grain weight, yield per plant and susceptibility to brown rust in nine parent diallel set excluding reciprocals. Combining ability analysis revealed that days to heading, plant height, 100-grain weight and susceptibility to brown rust were mainly under the control of additive genetic variances while the remaining characters showed predominance of non-additive gene effects. Estimates of general combining ability for most of the characters showed significant rank correlations with *per se* performance. Considering *gca* and *sca* effects, Kenya Plume, CPAN 1409 and CPAN 1285 were the best parents and CPAN 1285 $\times$ K 227 M_4 , CPAN 1409 $\times$ CPAN 1285 and K 227 M_4 $\times$ Fortylaya were the most appropriate crosses for the improvement of wheat crop.

Combining ability analysis gives an indication of relative magnitude of additive and non-additive variances. It also provides a guideline to the breeder in selecting the elite parents and desirable cross combinations to be used for effective breeding programme. The information on these aspects was obtained by using 9 $\times$ 9 diallel set for brown rust resistance and yield attributes in wheat.

MATERIAL AND METHODS

Nine genetic stocks of wheat including highly resistant (CPAN 1409, CPAN 1285 and Fortylaya), resistant (WC 611, WC 313 and Kenya Plume), susceptible (E 6840), and highly susceptible (K 227 M_4) and thirty-six F_1 formed the material for the present study. These were grown

in the field in a randomized block design with two replications. Each genotype was accommodated in 3-meter long single row plot spaced 30 cm apart, distance among plants within rows being 25 cm. Field was surrounded by parallel and side infector rows (Agra local) so as to ensure uniform inoculum load of brown rust. The mixture of rust spores was sprayed three times at an interval of 15 days. The field was irrigated frequently to maintain proper humidity. Ten plants from each experimental row were randomly taken for recording data on days to heading, days to maturity, plant height (cm), tillers per plant, 100-grain weight (g), yield per plant (g) and rust severity. Modified Cobb's scale (Peterson *et al.*, 1948) was followed for recording rust severity. Severity of disease was recorded from one

to hundred per cent. Average rust severity was transformed by using angular ($\sin^2\theta$) transformations. Combining ability analysis was carried out using Method 2, model 1 (Griffing, 1956).

RESULTS AND DISCUSSION

Analysis of variance revealed significant differences for all the characters. Variances due to general combining ability (*gca*) were significant for all the characters except tillers per plant and yield per plant (Table 1). Mean sum of squares for specific combining ability (*sca*) were also found to be significant for all the characters except height, tillers per plant and 100-grain weight. Combining ability analysis indicated preponderance of additive gene action for plant height and 100-grain weight. Therefore, selection would be quite effective for the improvement of these characters. Both additive and non-additive types of gene action with the preponderance of the former have been shown to play role in the inheritance of days to heading, days to maturity, number of grains per spike and susceptibility to brown rust. This would suggest that sufficient genetic variability for these attributes has been preserved in these cultivars of wheat. Therefore, both additive and non-additive types of genes should be exploited effectively for further improvement rather than exclusive reliance on additive component.

The *per se* performance and *gca* effects of the parents revealed that these two parameters in general were directly related to each other (Table 2). Thus, when the character is unidirectionally controlled by a set of alleles and additive effects are

more important, choice of parents on the basis of *per se* performance may be effective.

An appraisal of the estimates of *gca* effects of the parents (Table 2) indicated that Fortylaya was the best general combiner for resistance but was poor combiner for all other economic traits. So it may be useful only for transferring resistance. Kenya Plume was a good combiner for resistance along with days to maturity and plant height. CPAN 1409 and CPAN 1285 were good combiners for days to heading, plant height and grains per spike. Such parents which are good combiners for many characters may be preferred in breeding programme as these are expected to give high yielding and resistant segregants.

Few promising crosses selected on the basis of *sca* effects and mean performance have been shown in Table 3. It was observed that *sca* estimates for various characters involve all three possible combinations between parents of high and low *gca* effects, *i.e.* high $\times$ high, high $\times$ low, and low $\times$ low. The cross WC 611 $\times$ Agra local having highly significant *sca* effects for number of grains per spike belonged to third category where none of the parents has high *gca* effects. However, most of the superior combinations involved at least one parent with high *gca* effect. Two parents with high *gca* effects did not necessarily result in a combination with high *sca* effects. Some of the crosses showed good *sca* effects for more than one character, *e.g.* CPAN 1285 $\times$ K 227 M₄ was good for days to maturity and resistance to brown rust. Similarly CPAN 1409 $\times$ CPAN 1285 was desirable

TABLE 1

Analysis of variance for combining ability in wheat

Source of variation	d. f.	Days to heading	Days to maturity	Plant height	Number of tillers per plant	Number of grains per spike	100-grain weight	Yield per plant	Susceptibility to brown rust
<i>gca</i>	8	95.62**	34.46**	1086.39**	9.62	107.32**	0.334**	33.10	1967.67**
<i>sca</i>	36	7.38**	21.33**	67.46	7.71	41.98**	0.078	31.32**	91.93**
Error	44	3.49	1.06	43.94	4.99	15.52	0.067	12.60	30.84

**Significant at $P=0.01$

TABLE 2

Estimates of general combining ability effects and their rank correlations with *per se* performance of parents for different traits in wheat

Parents	Days to heading	Days to maturity	Plant height	Number of tillers per plant	Number of grains per spike	100-grain weight	Yield per plant	Susceptibility to brown rust
WC 611	0.64	1.79**	8.32**	0.41	-5.77**	0.20*	-0.05	-4.78*
CPAN 1409	-0.64**	-2.30**	-5.38*	1.48*	1.07	0.05	1.85	-7.82**
Kenya Plume	-3.63	-0.94*	-9.38**	-0.43	1.85	0.08	-0.18	-8.02**
WC 313	1.09	1.24**	8.56**	1.02	-2.06	-0.14	0.45	-2.65
CPAN 1285	-3.09**	0.70*	-7.10**	-0.50	3.96**	0.05	-0.95	-6.85**
K 227 M ₄	0.64	-2.39**	-15.02**	0.13	3.99**	-0.27**	1.96	17.28**
Fortlaya	6.50**	2.70**	13.54**	-1.75*	-1.87	-0.15	-3.35	-12.86**
E 6840	-1.50*	-0.80*	-1.77	-0.22	-0.83	-0.09	-1.05	-1.87
Agra local	-0.14	0.01	8.24**	-0.15	-0.34	0.26**	1.77	27.62**
SE (gi)	0.53	0.29	1.88	0.63	1.12	0.07	1.01	1.58
SE (gi-gj)	0.80	0.44	2.83	0.95	1.68	0.11	1.51	2.36
rs (<i>gca</i> and <i>per se</i> performance)	0.80	0.83**	0.88**	0.73*	0.66	0.5	0.72*	0.89**

**Significant at $P=0.01$

TABLE 3
Some of the promising crosses selected on the basis of *sca* effects and *per se* performance for different characters

Ranks	Days to heading	Days to maturity	Plant height	Number of tillers per plant	Number of grains per spike	Grain yield per plant	Susceptibility to brown rust
I Cross	WC 611 x CPAN 1409	CPAN 1285 x Fortylaya	CPAN 1409 x Kenya Plume —11.043	CPAN 1409 x CPAN 1285 8.438	K 227 M ₄ x Fortylaya 12.785	CPAN 1409 x CPAN 1285 13.436	Kenya Plume x Agra local —18.650
<i>sca</i> effect	—5.001	—12.127	—11.043	8.438	12.785	13.436	—18.650
<i>Per se</i> performance	93.50	134.00	81.25	23.00	55.02	33.12	23.57
II Cross	Fortylaya x E 6840	CPAN 1285 x K 227 M ₄	CPAN 1409 x K 227 M ₄ —9.394	CPAN 1409 —	WC 611 x Agra local 12.096	WC 611 x Agra local 104.140	K 227 M ₄ x Fortylaya —18.159
<i>sca</i> effect	—4.500	—7.036	—9.394	—	12.096	104.140	—18.159
<i>Per se</i> performance	94.00	134.00	76.95	—	40.00	30.48	8.84
III Cross	CPAN 1409 x Agra local	CPAN 1285 x E 6840	CPAN 1285 x E 6840 —8.527	CPAN 1409 x CPAN 1285 11.963	CPAN 1409 x CPAN 1285 11.963	CPAN 1409 x CPAN 1285 11.963	—
<i>sca</i> effect	—	—6.945	—8.527	—	11.963	—	—
<i>Per se</i> performance	133.50	133.50	89.65	57.11	57.11	—	—

COMBINING ABILITY ANALYSIS IN WHEAT

for number of tillers per plant, number of grains per spike and yield per plant. WC 611 × Agra local did well for tillers per plant and yield per plant, K 227 M₄ × Fortylaya was having good specific com-

binning ability for grains per spike and resistance to brown rust. Such crosses should be preferred in the breeding programmes as they may do well for a number of characters.

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EFFECT OF REPELLENTS ON THE FORAGING BEHAVIOUR OF *APIS FLOREA* F. UNDER FIELD CONDITIONS

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(Accepted : July 18, 1988)

ABSTRACT

Three ketones, viz. ethyl benzyl ketone, o-amino acetophenone and 2, 4, 6-trimethyl acetophenone were tested on raya (*Brassica juncea*) and taramira (*Eruca sativa*) under field conditions for their repellent action against *Apis florea* F. The number of bees visiting untreated and treated crop plants was recorded. The effect of repellents decreased with the passage of time. Clearly, temperature is the main influential factor in the determination of repellent effect; and relative humidity acts as a balancing factor. Field experiments demonstrated that the duration of stability of ketones is greater on *B. juncea* than on *E. sativa*.

Importance of bee poisoning has increased with greater use of insecticides and other chemical material on a wider range of crops (Shaw, 1941; Stute, 1957; Anderson and Atkins, 1958; Palmer-Jones, 1958; Beya *et al.*, 1959; Chamberlain, 1959; King, 1959; Morse, 1964; Johansen, 1977; Mayer *et al.*, 1980; Sanford, 1983; Gupta and Mohla, 1986). Most bee poisoning occurs when insecticides are applied to crops during the blooming period.

Many chemicals have been used as repellents against honey bees. These chemicals exhibited a repellent effect in low concentration in the laboratory but none was found to be of practical use under field conditions (Gupta, 1982, 1983, 1986a; Gupta and Kapil, 1984).

Protection of bee pollinators can possibly be obtained by (i) sufficiently under-

standing the foraging behaviour of bees and using the knowledge as the basis of pesticidal operations and (ii) by providing a functional protection through the use of repellents individually or in combination with pesticides (Bhardwaj, 1974; Kumari, 1976; Goyal, 1977; Gupta, 1986 a, b, 1987 a, b, 1988). Moreover, various physical and biological factors affect the repellents. Some of these factors can change in a short span of time. Therefore, the studies of repellents need careful standardization before good results can be achieved. Thus, the aims of present investigation were (i) to study the efficient effectiveness (intrinsic repellency) of the compounds and (ii) the duration of repellency.

MATERIAL AND METHODS

Out of a total of 198 compounds screened earlier in the Apicultural Labor-

atory, HAU, Hisar, only three promising ketones, viz. o-amino acetophenone, ethyl benzyl ketone and 2, 4, 6-trimethyl acetophenone were screened under field conditions against the little honey bee, *Apis florea* F. The ketones were tested at 0.5% concentration on raya (*Brassica juncea* Hook and Thomas) and taramira (*Eruca sativa* Miller).

Ten quadrates of one M² size each separated by five metres were marked on crop area. Five of these quadrates (test) were sprayed with chemical water solution (CW) using one litre capacity hand spray pump. The other five quadrates (control) were sprayed with the same quantity of distilled water (DW). The number of bees visiting the two categories of quadrates was counted for 5 min alternately. The treatment sprays of repellents were applied at different times of their blooming period. The experiments started at 1000 h and continued till 1600 h. The recordings were started immediately after spray and then further recordings were made at hourly interval. Thus, 6-7 countings of each quadrate per day were recorded. The per cent repellency was calculated by using the formula:

$$100 - \left[\frac{\text{Number of bees on CW}}{\text{Number of bees on DW}} \times 100 \right]$$

RESULTS AND DISCUSSION

The ketones according to their maximum per cent repellency to *A. florea* can be arranged in the following order: ethyl benzyl ketone (98.5%) > o-amino acetophenone (65.0%) > 2, 4, 6-trimethyl acetophenone (58.0%) on *B. juncea*; ethyl benzyl ketone (78.0%) > 2, 4, 6-trime-

thyl acetophenone (71.5%) > o-amino acetophenone (62.0%) on *E. sativa*. But the comparison of their duration of effectivity (if 60% is taken as the acceptable level) placed the ketones in the following order: o-amino acetophenone 300 min > ethyl benzyl ketone 80 min > 2, 4, 6-trimethyl acetophenone less than 60 min on *B. juncea*; ethyl benzyl ketone 100 min > o-amino acetophenone 80 min > 2, 4, 6-trimethyl acetophenone 60 min.

Thus, the effect of repellents decreased sequentially with the passage of time (Figs. 1-6) and the relationships were linear and negatively significant. The stability of o-amino acetophenone is more on *B. juncea* than on *E. sativa*. The slopes obtained from the functional linearity are indicative of this conclusion. This means that the effect of repellents varies with the crop. Moreover, the duration of effectiveness of each repellent is also variable. This conforms with similar results obtained by Palmer-Jones *et al.* (1959), Anderson *et al.* (1960), Gupta and Kapil (1984), and Gupta (1982, 1986 a, b, 1987 a, b, 1988). Khan *et al.* (1975) obtained similar results in mosquitoes with different repellents.

Temperature, relative humidity and solar radiations were recorded before and after each set of observations to make comparison of various observations taken sequentially (Figs. 1-6). A significant relationship between temperature and solar radiations, temperature and repellency, temperature and relative humidity was obtained. However, the relationships between relative humidity and repellency, and solar radiations and humidity were not consistently significant (Table 1).

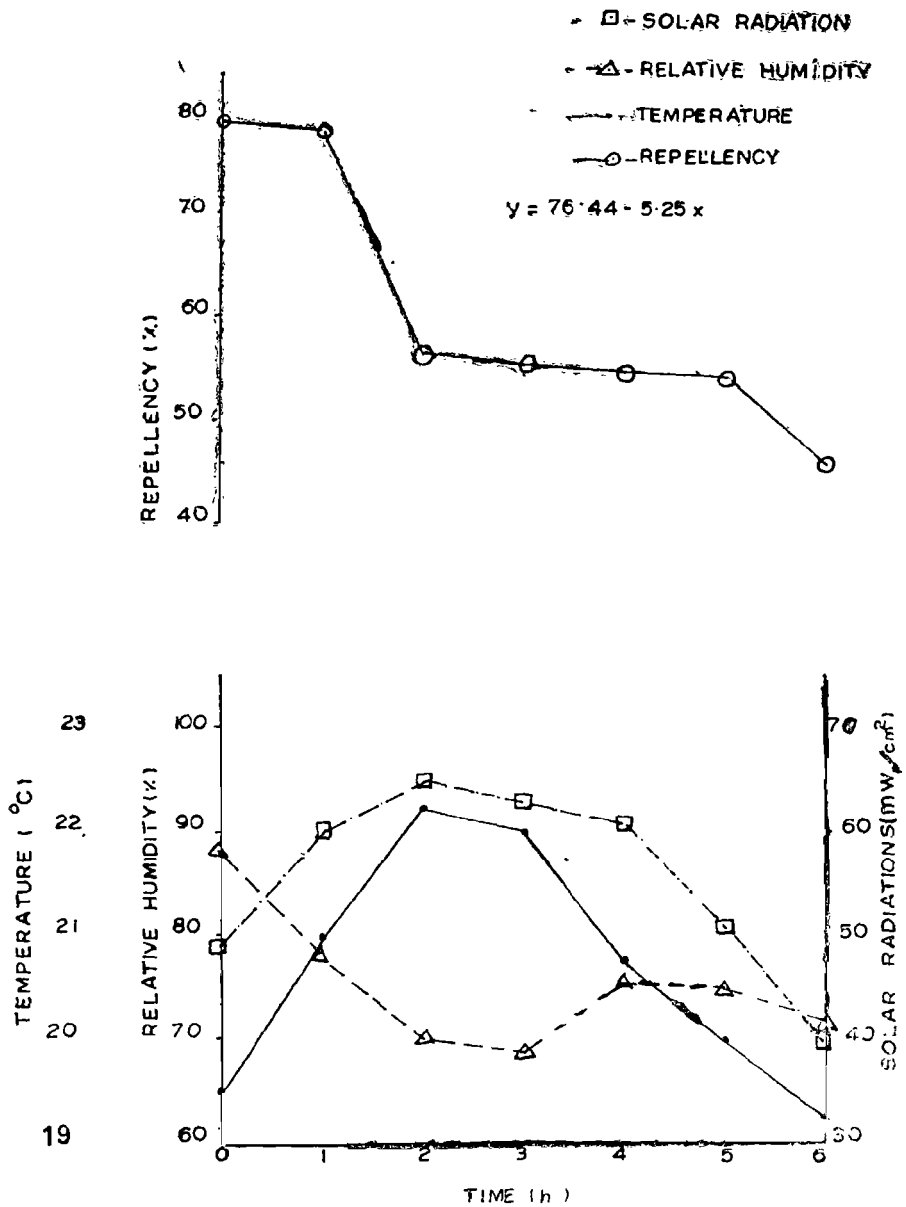


Fig. 1. Olfactory response of *A. florea* worker bee as a function of duration on the effectiveness of ethyl benzyl ketone (0.5%) *B. juncea*.

EFFECT OF REPELLENTS ON BEES

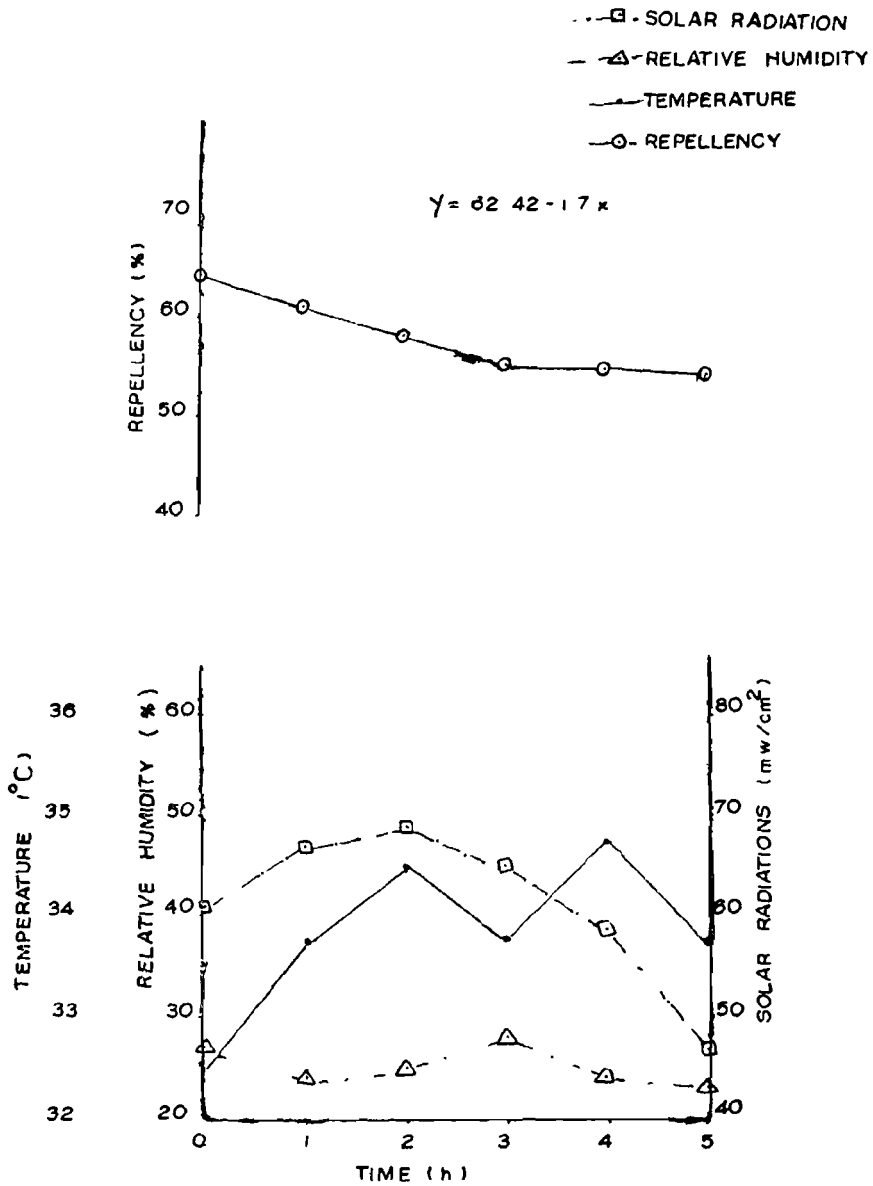


Fig. 2. Olfactory response of *A. florea* worker bee as a function of duration on the effectiveness of 0-amino acetophenone (0.5%) *B. juncea*.

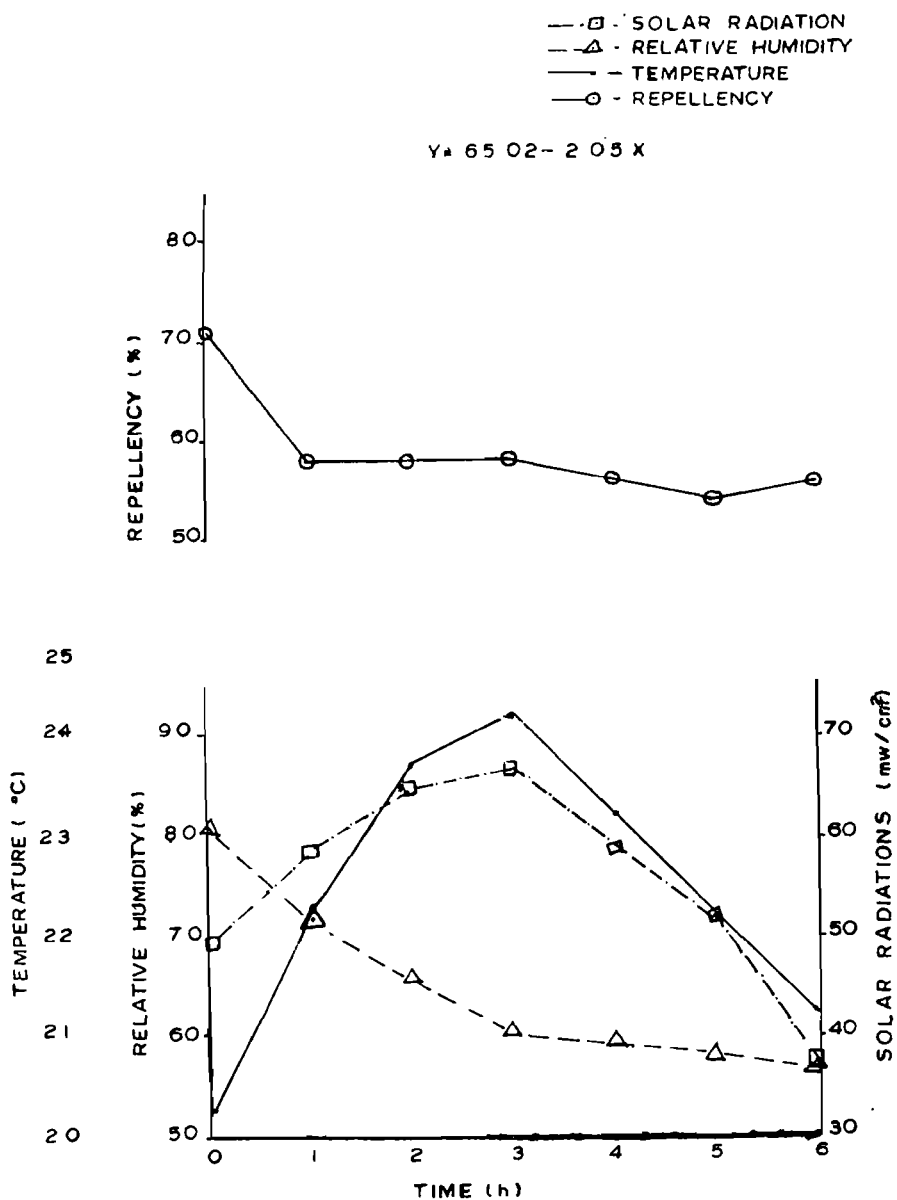


Fig. 3. Olfactory response of *A. florea* worker bee as a function of duration on the effectiveness of 2, 4, 6-trimethyl acetophenone (0.5%) *B. juncea*.

EFFECT OF REPELLENTS ON BEES

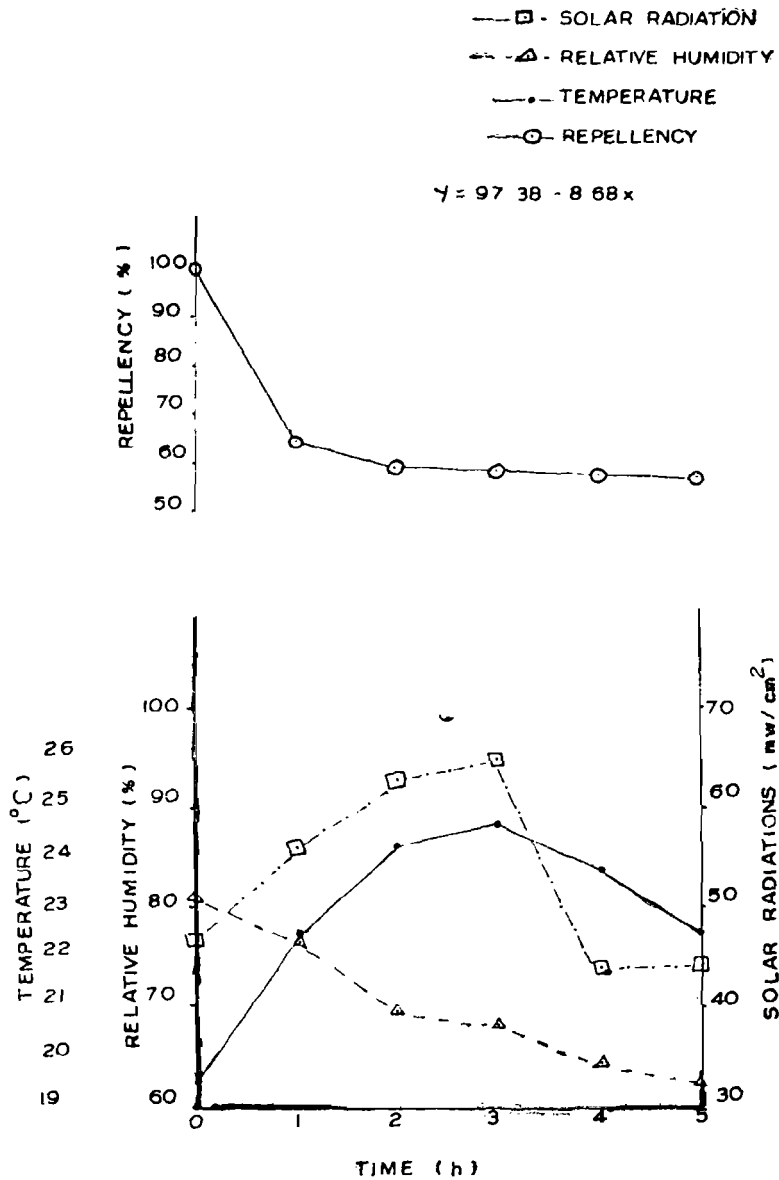


Fig. 4. Olfactory response of *A. florea* worker bee as a function of duration on the effectiveness of ethyl benzyl ketone (0.5%) *E. sativa*.

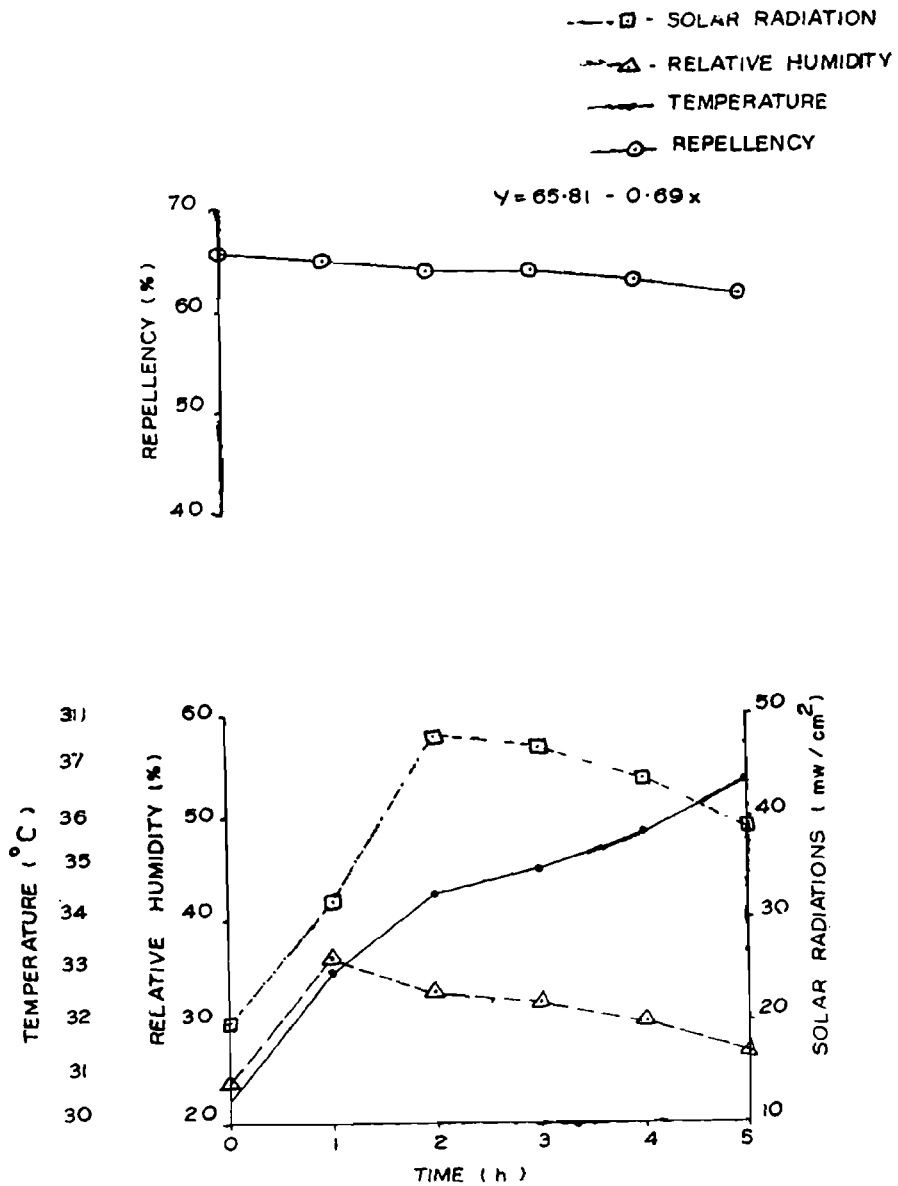


Fig. 5. Olfactory response of *A. florea* worker bee as a function of duration on the effectiveness of 0-amino acetophenone (0.5%) *E. sativa*.

EFFECT OF REPELLENTS ON BEES

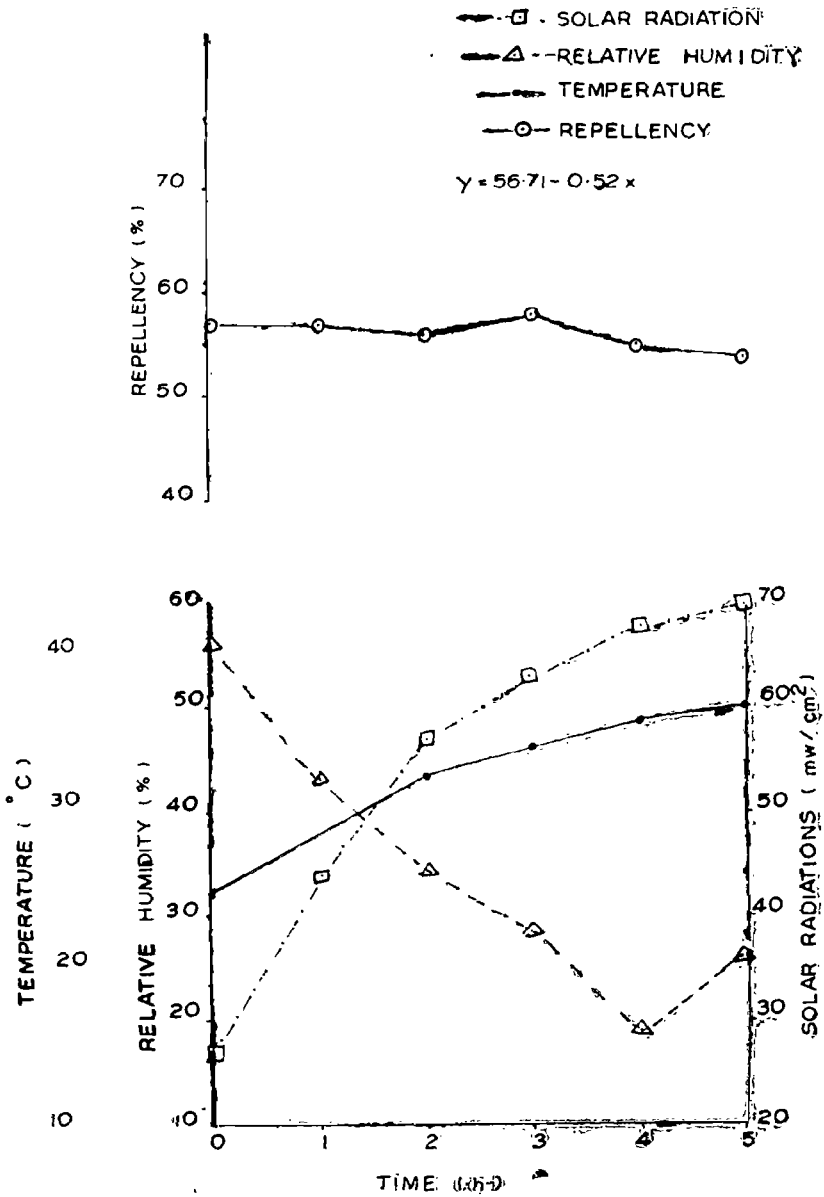


Fig. 6. Olfactory response of *A. florea* worker bee as a function of duration on the effectiveness of 2, 4, 6-trimethyl acetophenone (0.5%) *E. sativa*.

TABLE 1

Correlation coefficient (r)* of different combinations of repellents, temperature, relative humidity and solar radiations under field conditions to *Apis florea*

Repellent	Crop	Temperature × Repellency	Relative humidity × Repellency	Solar radiations × Repellency	Temper- ature × Relative humidity	Temper- ature × Solar radiations	Relative humidity × Solar radiations
Ethyl benzyl ketone	<i>B. juncea</i>	-0.71	-0.81	-0.43	-0.91	0.81	-0.84
O-amino acetophenone	<i>B. juncea</i>	-0.88	-0.75	-0.54	-0.88	0.87	-0.61
2, 4, 6-trimethyl acetophenone	<i>B. juncea</i>	-0.81	-0.85	-0.68	-0.91	0.90	-0.64
Ethyl benzyl ketone	<i>E. sativa</i>	-0.88	-0.81	-0.54	-0.94	0.87	-0.64
O-amino acetophenone	<i>E. sativa</i>	-0.82	-0.83	-0.40	-0.90	0.81	-0.61
2, 4, 6-trimethyl acetophenone	<i>E. sativa</i>	-0.80	-0.77	-0.59	-0.93	0.80	-0.63

*P=0.05

Clearly, temperature is the main influential factor in determination of repellent effect. The coefficient of correlation of repellency with temperature is negative. This supports the idea that solar radiation is a supportive factor and relative humidity with positive non-significant correlation appears to work as a balancing factor.

It was concluded that the effectivity of ethyl benzyl ketone was more on *B. juncea* than on *E. sativa* but the duration of effectiveness of o-amino acetophenone was greater on *B. juncea* than on *E. sativa*.

One means of protecting bees from pesticidal hazards is to repel them from

fields where insecticides are being applied so that exposure to toxicity is reduced below the lethal level. This work will be of more practical utility if application of pesticides is combined with the repellents. Such studies need to be extended further.

ACKNOWLEDGEMENTS

The author expresses his gratitude to late Dr. R. P. Kapil for providing the field facilities. Thanks are also due to Dr. B. N. Putatunda for helpful discussion and many insightful suggestions. The assistance of Sh. Jokhu Lal and Delbir Singh in field studies is also acknowledged.

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TWO NEW SPECIES OF GENERA *PELLENS* SIMON AND *SASSACUS* PECKHAM (ARANEAE : SALTICIDAE) FROM INDIA

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(Accepted : July 18, 1988)

ABSTRACT

Two new species one of genus *Pellens* Simon and other of genus *Sassacus* Peckham of family Salticidae are described. These two genera are being recorded for the first time from India.

While going through the collection of Salticid spiders from Northern India, the authors came across two new species belonging to genera *Pellens* Simon and *Sassacus* Peckham which are being recorded for the first time from India.

Genus *Pellens* Simon, 1876

Arachn. de. Fr. 3 : 1-360

Cephalothorax high, convex and longer than broad. Ocular quad wider than long and usually wider behind than in front. Small eyes of second row a little closer to posterior than to anterior row. Tarsi I and II not armed with scopulae or at the tips only. Legs III and IV with several stout spines.

Pellens samitae sp. nov.

(Figs. 1-3)

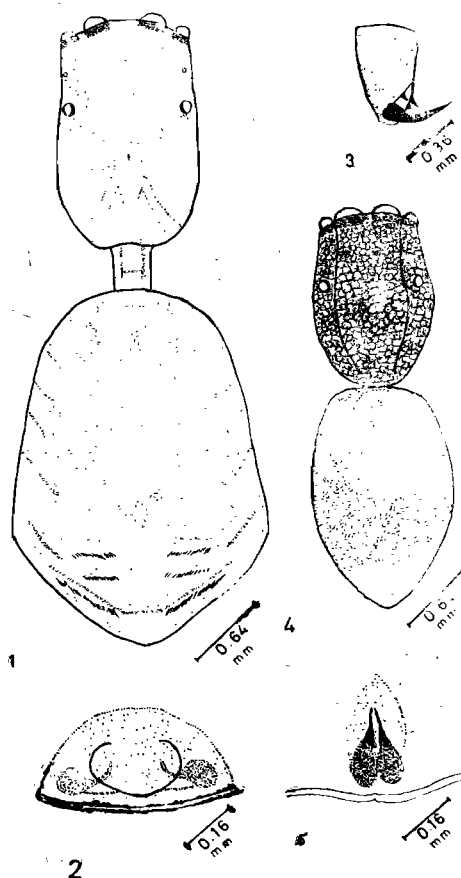
♀ **Carapace.** Length 2.08 mm; maximum breadth 1.28 mm; brown with black ocular area; thoracic region not narrower than cephalic region; thoracic fovea distinct. Eyes : eight, transparent, encir-

cled by black rims; arranged in three rows. Diameter of eyes (mm) : A. M. = 0.31, A. L. = 0.17, P. M. = 0.03, and P. L. = 0.16. Mutual distances between the eyes (mm) : A. M. — A. M. = 0.44, A. M. — A. L. = 0.16, P. M. — P. M. = 1.04, and P. M. — P. L. = 0.33. Second row located almost in middle of first and third rows and ocular quad occupies less than half the length of carapace. Width of clypeus : 0.02 mm. Chelicerae : small, pale brown with two teeth on promargin and one on retromargin. Labium : brown with yellow anterior end, beset with stiff hairs. Endite : brown with yellow anterior margin; broader at anterior end than at posterior end. Sternum : yellowish brown; anterior end as broad as labium; sternal cones indistinct. Legs : yellow, annulated, covered with hairs and spines. Tips of tarsi with scopulae. Length of legs (mm) : I—3.36, II—2.89, III—2.86, and IV—3.74.

♀ **Abdomen.** Length 3.32 mm; maximum breadth 2.03 mm; broadest at

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Figs 1-3. *Pellens samitae* sp. nov. 1—Dorsal view of female, 2—Epigynum, and 3—Chelicera.

Figs. 4-5. *Sassacus ambalaensis* sp. nov. 4—Dorsal view of female, and 5—Epigynum.

posterior one-third length and transversely constricted at this point. Dorsum brown with a broad yellow patch present anteriorly with two broad yellow bands emerging from it and extending up to one-third the length of abdomen. Lateral sides also brown with yellow patches arranged in oblique lines. Venter light coloured. Spinnerets compact; posterior spinnerets longer than anterior ones. Epigynum as in Fig 2.

Total length : ♀ 5.40 mm.

Holotype : ♀ in spirit, India : Jammu & Kashmir, Srinagar 22. xi.1977, K. Monga.

This species resembles *Pellens tripunctatus* (Walckenaer) as described by Locket and Millidge (1951) in size, colouration of cephalothorax and abdomen but differs in the pattern of yellow bands present on the abdomen and structure of epigynum.

Genus *Sassacus* Peckham, 1895

Oec. Pap. nat. hist. Soc. Wisc. 2 : 159-178.

Cephalothorax short and thick, flat in both the sexes in the first two-third; the posterior third slopes a little more abruptly in male. Ocular quad is wider behind than in front, occupying more than half of the length of cephalothorax. Tibia of first legs is armed with two or more pairs of spines

Sassacus ambalaensis sp. nov.

(Figs. 4-5)

♀ **Carapace.** Length 1.50 mm; maximum breadth 1.10 mm; brown with dark thoracic sides; cephalic region flat and not marked distinctly from thoracic region, covered with fine pubescence and with two dark patches in line with posterior median eyes. Eyes : eight, transparent, arranged in three rows, small eyes more remote from the posterior eyes than from the anterior eyes. Diameter of eyes (mm) : A. M.=0.27, A. L.=0.10, P. M.=0.05, and P. L.=0.13. Mutual distances between the eyes (mm) : A. M.—A. M.=0.30, A. M.—A. L.=0.23, P. M.—P. M.=0.80 and, P. M.—P. L.=

0.33. Width of clypeus : 0.03 mm. Chelicerae : small, yellowish brown with three small teeth on retromargin. Labium : yellowish brown with lighter anterior margin; almost as long as broad; circular at the base and broader towards anterior end. Endite : yellowish brown; almost as long as broad. Sternum : yellowish brown; covered with pubescence; narrowed both anteriorly and posteriorly, broader in the middle; sternal cones indistinct. Leg I quite heavy and brownish, legs II-IV yellow and slender. Tibia of first leg with three pairs of spines; tibia and patella of third leg shorter than fourth leg. Length of legs (mm) : I—2.27, II—1.70, III—1.84, and IV—2.52.

Abdomen. Length 2.00 mm; maximum breadth 1.20 mm; oval, and pointed behind. Dorsum dark brown with an

inverted V-shaped yellow band in the anterior one-fourth portion of abdomen, posterior end of abdomen lighter in colour. Venter dirty yellow with two brown longitudinal streaks extending from epigastric furrow to spinnerets. Epigynum as in Fig. 5.

Total length : ♀ 3.50 mm.

Holotype : ♀ in spirit, India : Haryana, Forest Sales Depot Yamuna Nagar (Distt. Ambala) 15. viii. 1979, K. Monga.

The present form resembles slightly *Sassacus papenhoei* Peckham as described by Comstock (1948) but can be separated from it in absence of white marginal stripe on cephalothorax and abdomen, in presence of V-shaped mark on abdomen and structure of epigynum.

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SOILS OF THE SAHIBI RIVER BASIN IN HARYANA AND THEIR SUITABILITY EVALUATION FOR MAJOR AGRICULTURAL CROPS

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ABSTRACT

In Sahibi river basin of Haryana, seven landforms, *viz.* bars (sand bars, point bars and channel bars), levee complexes, flood plain, sand dunes, basins, river beds and relict channel were identified and delineated on the imagery/aerial photographs. The soils developed on different landforms, were studied and a map showing association of families prepared. The major soils in associations are Typic Ustipsamments/Typic Ustifluvents/Typic Ustorthents/and Typic Ustochrepts.

For landuse evaluation a perusal of morphological and physico-chemical characteristics and other land features was made and it was observed that all the soils are low in organic carbon (0.03 to 0.57 per cent), alkaline (pH 8.0 to 9.1) and non-saline (EC 0.11 to 0.87 dsm^{-1}) except some patches of saline alkali soils where pH and EC range from 8.9 to 9.3 and 0.80 to 1.25 dsm^{-1} , respectively. The textural family, slope, drainage, ESP, electrical conductivity, organic carbon, cation exchange capacity, calcium carbonate, risk of flooding, relief and soil fertility were interpreted for suitability evaluation of different crops. The soils of bars, levee complexes and sand dunes are not suitable for paddy cultivation but are marginally suitable for wheat and sugarcane crops, whereas the soils of relict channels and basins are moderately suitable for paddy crops. Saline-alkali soils of the flood plain are only marginally suitable for wheat and paddy, whereas normal soils of this landform are highly suitable for wheat, moderately suitable for sugarcane and marginally suitable for paddy cultivation.

For land evaluation, it is essential to prepare a comprehensive inventory of soil resources and the factors affecting these. Aerial photographs and landsat imagery give perspective view of the terrain and help in quick and accurate mapping of soils. Duggal (1975) divided Haryana into six physiographic zones, *i.e.* Siwalik hills, dissected rolling plain, upland plain, flood plain, plain with sand dunes and

plains with Aravali hills and sand dunes. Subsequently, Ahuja *et al.* (1978) and Dhankar *et al.* (1983) reported good relationship between physiography and soils in Haryana. The Haryana state is confronted with the problems of thick sand cover, wind erosion, salinity and/or sodicity and water logging (Singh and Goyal, 1986). Manchanda *et al.* (1982) established the soil suitability classes for

wheat, paddy, berseem and sugarcane crops in Haryana. Goyal *et al.* (1984) suggested rational land use and crop planning in relation to soil characteristics of Gurgaon canal command area. However, soil suitability evaluation for different crops in Sahibi river basin in Haryana has not been attempted. In the present study, the soils developed on various landforms in Sahibi river basin

have been evaluated for their suitability for major agricultural crops.

MATERIAL AND METHODS

The study area covering 468 sq. km lies between $28^{\circ}8'36''$ to $28^{\circ}22'55''$ N latitude and $76^{\circ}38'22''$ to $76^{\circ}48'29''$ E longitude (Fig. 1). The area is sloping from south to north through which Sahibi

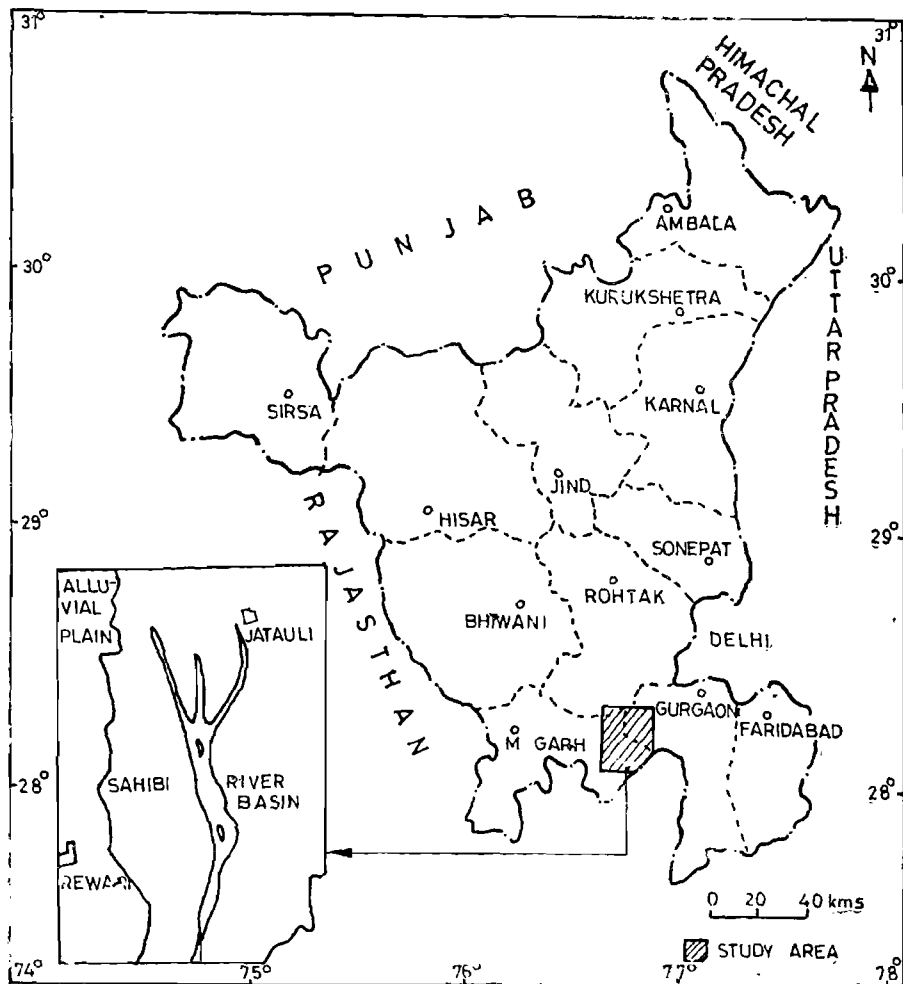


Fig. 1. Location of study area in Haryana.

river flows. There are a number of isolated basins and burried/filled up channels. The climate of the area is subtropical, semi-arid, continental and monsoonal type. The average annual rainfall at Rewari, Rohtak, Gurgaon and Narnaul is 593, 721, 645 and 426 mm, respectively; 75-80 per cent of which is received during the months of July, August and September. The maximum temperature reaches upto 47°C during the afternoons of May and June, whereas in January and February sometimes the freezing temperature is also recorded. Hot winds and high velocity dust storms are quite common during summer months. The principal rabi crops grown in the area are wheat, gram and barley while during kharif season bajra, sorghum, guar, maize and cotton are the main crops.

Visual and monoscopic interpretation of multitemporal (November 1975 and April 1976) and multispectral false colour composites (FCC) generated from bands 4, 5 and 7 of landsat imagery of 1:250,000 scale and transparencies of 1:1 m scale were made to identify and delineate the physiographic units. The physiographic units delineated on the imagery were confirmed and slightly modified through the interpretation of black and white aerial photographs of the year 1965 on 1:25000 scale. The soils developed on different landforms were studied by carrying out reconnaissance soil survey of the area and relationships between physiography and soil established. Eight pedons representing soils covering major acreage of the recognised physiographic units were studied for their morphology following the FAO Guidelines for Soil Profile

Description (FAO, 1966). Horizonwise soil samples were analysed for physico-chemical characteristics using standard methods (Jackson, 1958; Piper, 1966). The soils were classified using the criteria outlined in Soil Taxonomy (Soil Survey Staff, 1975). The irrigated soils of the basin were evaluated for their suitability for different crops under high management level following the FAO Framework for Land Evaluation (FAO, 1976).

RESULTS AND DISCUSSION

Field observations and results have been discussed under the following two heads :

- (A) Physiography-soil relationship and
- (B) Land evaluation for different crops (irrigated and high inputs).

(A) Physiography and Soils

The following physiographic units were identified in the study area.

(i) Bars

The bars were made up of relatively coarser material such as coarse sand, sand and silt (Table 1). These were also subjected to periodic inundation. The following three types of bars were observed in the area.

(a) **Sand bars.** The sand bars in the form of low ridges were observed along the Sahibi river course and the relict channels. These were formed of sandy material carried by turbulent water, when river flow was excess of the bankful stage.

(b) **Channel bars.** The channel bars were located in the river course.

(c) **Point bars.** These were developed on the convex side of the river course.

The soils of bars are sand to loamy sand in texture, low in organic carbon (0.02 to 0.38 per cent), calcareous (0.53 to 1.70 per cent CaCO_3), alkaline (pH 8.31 to 9.10) but non-saline (EC 0.17 to 0.40 dsm^{-1}). Irregular distribution of clay (4.85 to 18.92 per cent) and stratified nature of soil horizons indicated lack of profile development (Table 1).

(ii) Levee Complexes

These occupy north and north eastern part of the study area (Fig. 2). These are stratified depositional features of the Sahibi river. Because of the lateral shifting of the river the earlier levees were broken and newer levees with intervening medium textured patches with a number of ridges and sloughs were formed and were termed as levee complexes.

The soils are yellowish brown to grayish brown, sand to loamy sand, low in organic carbon (0.05 to 0.26 per cent), calcareous (0.86 to 1.85 per cent CaCO_3) and alkaline (pH 8.45 to 9.15) but non-saline (EC 0.27 to 0.48 dsm^{-1}) in nature (Table 1). The abrupt changes in the properties of various soil horizons indicated deposition of different times.

(iii) Flood Plain

Flood plain comprises of the stratified soils with distinct layers deposited by fluvio-aeolian agencies at different times. The surface is covered with a sheet of thin aeolian sand. Unlike levee complexes the area is more or less level. In this physiographic unit some patches of saline alkali soils are also observed. pH

and EC varied from 8.90 to 9.31 and 1.00 to 1.25 dsm^{-1} , respectively. The soils are sand to loamy sand, calcareous (0.63 to 1.25 per cent CaCO_3) and low in organic carbon (0.10 to 0.40 per cent). Manchanda and Khanna (1981) have also established landform and salinity relationships.

(iv) Sand Dunes

These were formed mostly by the shifting and deposition of the earlier loose sandy material brought from the Rajasthan along the south west or the north west directions and storms during the summer months. The abrupt changes in soil colour, irregular distribution of salts (EC 0.46 to 0.68 dsm^{-1}), calcium carbonate (0.0 to 0.38 per cent) and organic carbon (0.06 to 0.34 per cent) with depth indicated deposition of different times (Table 1).

(v) Basins

These are natural low land areas with intensive cultivation recognised by the dark gray tones and concave microrelief on aerial photographs. In the study area these occupied mostly the western part where finer material was deposited during the heavy floods.

The soils are calcareous (0.80 to 3.33 per cent CaCO_3), non-saline (EC 0.11 to 0.29 dsm^{-1}) but alkaline (pH 8.37 to 8.50) in nature with low organic carbon (0.20 to 0.29 per cent) and sandy loam to sandy clay loam. The presence of reduction mottlings indicated the impeded drainage. A regular increase in clay (13.95 to 22.75 per cent) content with depth, presence of flood coatings and

SOILS OF SAHIBI RIVER BASIN

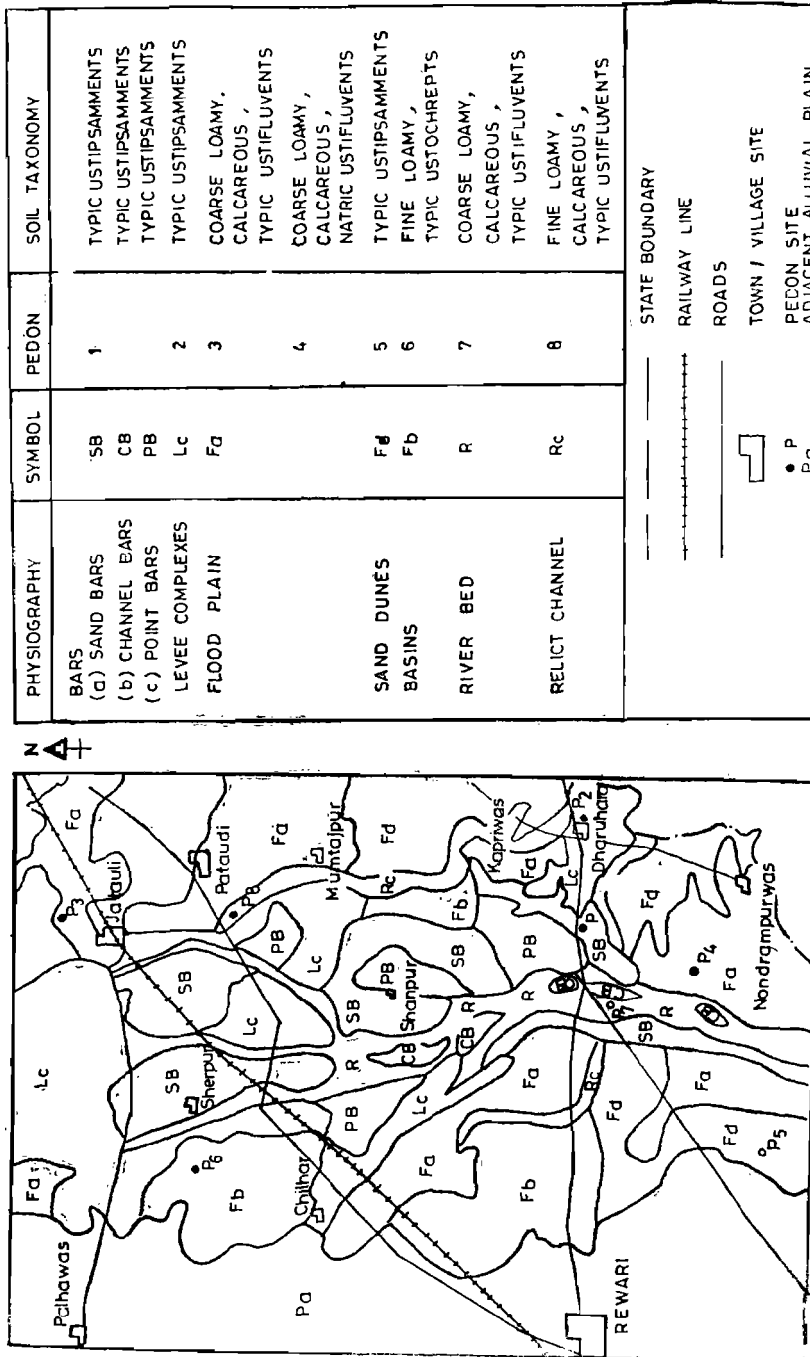


Fig 2. Soil map of a part of Sahibi river basin in Haryana.

lower chromas in lower layer indicated the development of cambic horizon (Table 1).

(vi) River Bed

The Sahibi is a seasonal river whose inflow of water depends on the rainfall in catchment area. The soils in the river bed are light in colour, non-saline (EC 0.08 to 0.21 dsm^{-1}), alkaline (pH 8.37 to 8.50), calcareous (0.63 to 2.30 per cent CaCO_3) with low values of organic carbon (0.02 to 0.36 per cent). The soil profile consisted of distinct stratified layers (Table 1).

(vii) Relict Channel

These are the relict, elongated, abandoned river channels of earlier times which are filled up by the fluvial and aeolian sediments. These channels are present in the forms of 'nalas' or drains in which excess of rain water flows.

In this physiographic unit the soil colour varied from dark yellowish brown to dark brown with reduced and oxidised mottlings indicating poor drainage conditions. The soils are loamy sand to clay, calcareous (0.30 to 2.02 per cent CaCO_3), low in organic carbon (0.08 to 0.45 per cent), non-saline (EC 0.18 to 0.39 dsm^{-1}) but alkaline (pH 8.40 to 9.10) with impeded drainage (Table 1). The irregular distribution of clay, organic carbon, calcium carbonate, salts and the abrupt changes in soil colour confirmed the heterogenous nature of the soil profile.

Based on the reconnaissance soil survey of the area, the physiography-soil

relationship was worked out and is presented in Fig. 2.

(B) Land Evaluation

The soils of the Sahibi river basin were evaluated for their suitability for main agricultural crops grown in the area (FAO, 1976). The different land utilization types considered are for the main agricultural crops with available irrigation, technical knowhow and high inputs.

The land qualities considered important for different landuse types were soil texture, drainage, slope, relief, risk of flooding, salinity, alkalinity (ESP), organic carbon and inherent soil fertility. The morphological and physico-chemical characteristics of the soil profiles are given in Table 1. The soil and site characteristics of various physiographic units have been given in Table 2. Based on this data, suitability rating tables for different crops, *viz.* wheat (Table 3), paddy (Table 4) and sugarcane (Table 5) were prepared. The suitability rating of various soil families for wheat, paddy and sugarcane have been summarised in Table 6 and are discussed hereunder :

(i) Typic Ustipsamments

These are slightly undulating, coarse textured (sand to loamy sand) soils with excessive drainage and low soil fertility. These are not suitable for paddy cultivation but are only marginally suitable for wheat and sugarcane crops.

(ii) Coarse Loamy, Calcareous, Typic Ustifluvents

These soils are level, loamy sand to loam with moderate drainage, low fertility

SOILS OF SAHIBI RIVER BASIN

TABLE 1
Morphological and physico-chemical characteristics of soil profiles

Depth (cm)	Horizon	Matrix colour	Mottlings	pH	EC (dsm^{-1})	O.C. (%)	CaCO ₃ (%)	Clay (%)	Soil texture	CEC ($\text{me}/100\text{ g}$)
1	2	3	4	5	6	7	8	9	10	11
Pedon 1. Typic Ustipsamments (developed on bars)										
0-25	Ap	10 YR 5/4	—	8.31	0.34	0.38	1.43	4.85	Sand	3.6
25-50	IIc	10 YR 5.5/4	—	8.44	0.40	0.23	0.85	9.97	Loamy sand	5.9
50-100	IIIC	10 YR 6/3.5	—	8.65	0.26	0.11	0.53	8.22	Loamy sand	5.2
100-135	IVC	10 YR 4.5/4	—	9.10	0.17	0.06	0.05	7.70	Loamy sand	4.1
135-165	VC	10 YR 4.5/4	—	9.10	0.31	0.02	1.70	15.92	Loam	9.7
165-175	VIC	10 YR 4/3	—	9.10	0.24	0.07	—	8.17	Loamy sand	5.1
Pedon 2. Typic Ustipsamments (developed on levee complexes)										
0-12	Ap	10 YR 6/4	—	8.45	0.27	0.28	—	5.60	Sand	5.4
12-41	IIc	10 YR 5.5/4	—	8.55	0.36	0.06	—	11.12	Sandy loam	5.9
41-115	IIIC	10 YR 5/5	—	8.65	0.38	0.05	0.86	6.45	Sand	4.3
115-210	IVC	10 YR 4.5/3	—	9.00	0.48	0.05	1.85	10.32	Sandy loam	6.1
Pedon 3. Coarse loamy, Calcareous, Typic Ustifluvents (developed on flood plains)										
0-16	Ap	10 YR 4.5/4	—	8.10	0.27	0.48	1.10	12.65	Loamy sand	5.1
16-39	IIc	10 YR 3.5/4	10 YR 4/2.5 (f)	8.00	0.33	0.42	2.00	21.77	Loam	9.2
39-60	IIIC	10 YR 4.5/4	10 YR 4/2.5 (f)	8.11	0.21	0.16	1.55	16.57	Loam	7.5
60-66	IVC	10 YR 5/4	—	8.77	0.36	0.23	2.40	14.97	Loam	7.1
66-99	VC	10 YR 4/3.5	10 YR 4/2.5 (f)	8.80	0.69	0.25	2.00	17.15	Loam	7.6
99-120	V C	10 YR 5/3.5	10 YR 4/2 (f)	8.85	0.70	0.21	4.15	18.22	Loam	8.9
120-126	VIC	10 YR 5.5/4	—	8.95	0.64	0.04	2.85	12.72	Sandy loam	6.9
126-150	VIIIC	10 YR 4/3	10 YR 4/1.5 (f)	8.85	0.63	0.03	0.32	9.70	Loamy sand	4.3
Pedon 4. Coarse loamy, Calcareous, Natric Ustifluvents (developed on flood plains)										
0-14	Ap	10 YR 5.5/3	—	8.90	0.80	0.40	1.25	4.20	Sand	2.8
14-37	IIc	10 YR 4.5/3	10 YR 4/2 (f)	9.15	1.20	0.13	1.05	4.80	Sand	3.1
37-64	IIIC	10 YR 4/3.5	10 YR 4/2.5 (f)	9.28	1.25	0.19	1.38	17.75	Sandy loam	10.6
64-92	IVC	10 YR 5/3	—	9.31	1.06	0.10	—	10.82	Loamy sand	6.0
92-150	VC	10 YR 4.5/4	—	9.09	0.92	0.23	0.63	13.87	Sandy loam	6.8

Contd.

1	2	3	4	5	6	7	8	9	10	11
Pedon 5. Typic Ustipsamments (developed on sand dunes)										
0-15	Ap	10 YR 5.5/3	—	8.81	0.46	0.34	—	6.92	Sand	3.8
15-37	IIc	10 YR 4.5/3	—	8.57	0.56	0.06	0.38	7.17	Sand	4.0
37-117	IIIC	10 YR 6/3.5	10 YR 5/6 (f)	8.40	0.61	1.16	1.13	7.75	Sand	4.2
117-160	IVC	10 YR 4.5/4	—	7.90	0.67	0.28	—	12.40	Sandy loam	6.6
160-175	VC	10 YR 5/3.5	—	7.59	0.55	0.20	—	8.45	Sand	4.8
Pedon 6. Fine loamy, Typic Ustochrepts (developed on basins)										
0-16	Ap	10 YR 4.5/4	—	8.51	0.15	0.29	0.80	13.95	Sandy loam	7.5
16-35	B ₁	10 YR 4.5/4	—	8.40	0.16	0.28	1.00	17.60	Sandy loam	10.8
35-71	B ₂₁	10 YR 4/3.5	10 YR 4/2 (f)	8.32	0.11	0.25	1.00	19.22	Sandy loam	12.8
71-117	B ₃₃	10 YR 4.5/4	10 YR 4/2 (f)	8.50	0.27	0.22	3.33	22.75	Sandy clay loam	13.7
117-160	IIb ₂₃	10 YR 6.5/3	—	8.52	0.29	0.20	3.33	22.30	Sandy clay loam	13.9
Pedon 7. Coarse loamy, Calcareous, Typic Ustifluvents (developed on river bed)										
0-25	A ₁	10 YR 6/4	—	8.50	0.20	0.21	2.30	7.00	Sand	4.4
25-32	IIc	10 YR 4/3	10 YR 6/5.5 (f)	8.46	0.21	0.36	2.10	22.27	Silt loam	12.1
32-75	IIIC	10 YR 6/4	—	8.37	0.08	0.02	1.27	5.14	Sand	3.7
75-130	IVC	10 YR 5.5/4	—	8.45	0.08	0.01	0.63	4.85	Sand	3.4
130-170	VC	10 YR 5.5/4	—	8.45	0.08	0.01	1.20	9.75	Loamy sand	5.4
Pedon 8. Fine loamy, Calcareous, Typic Ustifluvents (developed on relict channels)										
0-12	Ap	10 YR 4.5/4	—	8.93	0.30	0.45	0.37	17.35	Sandy loam	11.6
12-30	IIc	10 YR 4/4	—	8.90	0.31	0.35	0.87	23.67	Clay loam	15.9
30-51	IIIC	10 YR 5/4	—	9.00	0.18	0.12	0.30	11.35	Sandy loam	7.2
51-100	IVC	10 YR 5/4	10 YR 6/6 (f)	8.60	0.21	0.25	1.22	19.85	Loam	12.8
100-110	VC	10 YR 5/4	10 YR 6/6 (f)	8.60	0.23	0.08	0.45	19.35	Sandy loam	12.4
110-150	VIC	10 YR 5/4	10 YR 5/5 (f)	8.90	0.26	0.13	0.30	12.40	Sandy loam	8.3
150-170	VIIc	10 YR 4/3	10 YR 6/6 (f)	8.40	0.39	0.34	2.02	41.97	Clay	16.7

TABLE 2
Soil and site characteristics of the representative pedons

Physiographic unit	Pedon No.	Textural family	Slope	Drainage	ESP	Organic carbon	Risk of flooding	Relief	Soil fertility*
Bars	1	Sandy	Slightly undulating	Excessive	15-22	0.02-0.38	Almost nil	Subnormal	Low
Levee complexes	2	Coarse loamy	Slightly undulating	Well	13-21	0.03-0.26	Slight	Subnormal	Low
Flood plain	3	Coarse loamy	Level	Moderately	12-19	0.03-0.48	Low	Normal	Low
	4	Coarse loamy	Level	Poor	28-38	0.10-0.40	Low	Normal	Low
Sand dunes	5	Sandy	Moderately undulating	Excessive	8-18	0.06-0.34	Nil	Moderate	Very low
Basins	6	Fine loamy	Nearly level	Poor	13-16	0.20-0.29	High	Concave	Medium
River bed	7	Coarse loamy	Level	Poor	9-18	0.21-0.36	High	Concave	Medium
Relict channels	8	Fine loamy	Level	Poor	11-18	0.08-0.45	High	Concave	Medium

*Can be improved after adding recommended doses of FYM and fertilizer.

TABLE 3

Suitability rating of land qualities for wheat

S. Land quality No.	S ₁	S ₂	S ₃	N
1. Texture	Fine loamy	Coarse loamy	Sandy and fine	Very stony and very gravelly soils
2. Drainage	Moderately well and well drained	Imperfectly drained	Poorly and somewhat excessively drained	Very poorly and excessively drained
3. Inherent fertility (CEC)	High (>20)	Medium (10-20)	Low (5-10)	Very low (<5)
4. Salinity EC dsm ⁻¹ (1:2)	Very low (<2)	Low (2-3)	Medium (3-4)	High (>4)
5. Risk of flooding	Very low to low	Medium	High	Very high
6. Relief	Normal	Subnormal	Concave	Excessive

TABLE 4

Suitability rating of land qualities for paddy

S. Land quality No.	S ₁	S ₂	S ₃	N
1. Texture	Fine loamy and fine	Coarse loamy	Sandy	Sandy skeletal and fragmental
2. Drainage	Imperfectly to poorly drained	Well to moderately well drained	Somewhat excessively drained	Excessively drained and very poorly drained
3. Inherent fertility (CEC)	High to very high (>20)	Medium (10-20)	Low (5-10)	Very low (<5)
4. Salinity EC dsm ⁻¹ (1:2)	Low (<2)	Medium (2-3)	High (3-4)	Very high (>4)
5. Risk of flooding	Low to medium	High	Very high of short duration	Very high of long duration
6. Relief	Flat and subnormal	Normal	Concave	Excessive

SOILS OF SAHIBI RIVER BASIN

TABLE 5
Suitability rating of land qualities for sugarcane

S. No.	Land quality	S ₁	S ₂	S ₃	N
1.	Texture	Fine loamy	Coarse loamy	Sandy and fine	Fragmental and very stony
2.	Drainage	Imperfectly drained	Moderately well and well drained	Poorly and somewhat excessively drained	Very poorly and excessively drained
3.	Inherent fertility (CEC)	Very high (>20)	High (10-20)	Medium (5-10)	Low (<5)
4.	Salinity EC dsm ⁻¹ (1:2)	Low (<2)	Medium (2-3)	High (3-4)	Very high (>4)
5.	Risk of flooding	Low to medium	High	Very high to short duration	Very high of long duration
6.	Relief	Flat and subnormal	Normal	Concave	Excessive

TABLE 6
Suitability ratings of mapping units for main agricultural crops

S. No.	Soils	Crops		
		Wheat	Paddy	Sugarcane
1.	Typic Ustipsamments	S ₃	N	S ₃
2.	Coarse loamy, Calcareous, Typic Ustifluvents	S ₁	S ₃	S ₃
3.	Fine loamy, Calcareous, Typic Ustifluvents	S ₂	S ₃	S ₃
4.	Coarse loamy, Calcareous, Natric Ustifluvents	S ₃	S ₃	N
5.	Fine loamy, Calcareous, Typic Ustochrepts	S ₂	S ₃	S ₃
6.	Coarse loamy, Udic Ustochrepts	S ₂	S ₃	S ₃

S₁=Highly suitable

S₂=Moderately suitable

S₃=Marginally suitable

N=Not suitable

status and without any other specific soil problem. These soils are highly suitable for wheat, moderately suitable for sugarcane and only marginally suitable for paddy.

(iii) Fine Loamy, Calcareous, Typic Ustifluvents

These are sand to silt loam soils with moderate to poor drainage and medium

soil fertility. These are moderately suitable for wheat, paddy and sugarcane crops.

(iv) Coarse Loamy, Calcareous, Natric Ustifluvents

These are level, sand to loamy sand soils with poor drainage and low soil fertility. The high values of pH (8.90 to 9.31), EC (0.80 to 1.25 dsm⁻¹), and ESP

(28 to 38) of these soils limit their productivity for sugarcane cultivation but are only marginally suitable for wheat and paddy crops.

(v) Fine Loamy, Calcareous, Typic Ustochrepts

These are sandy loam to sandy clay

loam soils with moderate to poor drainage and medium soil fertility and without any other specific soil problem. These soils are moderately suitable for wheat, paddy and sugarcane cultivation.

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RESPONSE OF SAFFLOWER (*CARTHAMUS TINCTORIUS* L.) TO LEVELS AND DEPTH OF PHOSPHORUS PLACEMENT UNDER TWO MOISTURE REGIMES

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ABSTRACT

Field experiments revealed that safflower responded to applied P, though not markedly. P derived from fertilizer was higher in favour of 60 kg P_2O_5 /ha compared to 30 kg P_2O_5 /ha, but the utilization of applied P was higher in favour of 30 kg P_2O_5 /ha than 60 kg P_2O_5 /ha. Placement of phosphorus 20 cm deep pushed up yield marginally over 10 cm deep placement, but the two treatments did not show much variation for P uptake or Pdf or utilization of applied P. By and large, one irrigation proved beneficial over no irrigation for the yield, P uptake, Pdf and utilization of applied P.

Phosphorus enhances the root growth, thereby facilitating absorption of water and nutrients from the deeper soil layers. Fertilizer use efficiency of phosphorus depends not only on the optimum phosphorus level, but also on proper method of its application. In dry farming areas, though phosphorus is traditionally applied broadcast as basal but placement appears to be advantageous particularly for deep rooted crop like safflower. Normally, in all safflower growing areas, little or no rain is received after sowing. As a result phosphorus is rendered unavailable to the crop leading to its low recovery. Therefore, providing irrigation may enhance its availability to the crop and increase the production.

To study the exact contribution of phosphorus from soil and fertilizer towards P uptake by the crop, a side work was initiated using ^{32}P to study the effect of

phosphorus levels, its depth of placement and moisture regimes on utilization of P by safflower.

MATERIAL AND METHODS

Field experiments were carried out at the farm of Agronomy Division, Indian Agricultural Research Institute, New Delhi during rabi seasons of 1982-83 and 1983-84 with safflower var. A-300 which included three levels of phosphorus (0, 30 and 60 kg P_2O_5 /ha), two depths of its placement (10 and 20 cm) and two moisture levels (no irrigation and one irrigation at rosette) and were conducted in a factorial randomised block design with four replications. The soil was sandy loam having pH 7.5, organic carbon 0.31% and EC 0.29 mmhos/cm. It contained 0.03% total nitrogen and 6.6 and 161 kg per ha available P and K, respectively. The plot size was 6.0 m $\times$ 2.4 m

and inter-row and intra-row spacings were 40 and 20 cm, respectively. Three rows, each measuring one metre were applied with ^{32}P labelled superphosphate ($0.3 \text{ mCi/g/P}_2\text{O}_5$) as per treatment while the rest of the areas received ordinary superphosphate. A basal application of 60 kg N and 40 kg K_2O per ha was made to all the plots through urea and muriate of potash, respectively.

The crop received 248.8 mm rainfall in 1982-83 and only 71.4 mm during 1983-84.

The plant samples were collected 90 and 120 days after sowing and analysed for P content by Vanado-molybdo phosphoric yellow colour method (Jackson, 1973) and radio-assay by the method adopted by MacKenzie and Dean (1950).

RESULTS AND DISCUSSION

Effect of Levels of Phosphorus

Except in 1982-83 for seed yield, 60 kg $\text{P}_2\text{O}_5/\text{ha}$ pushed up the yield of safflower seed and stalk over 30 kg $\text{P}_2\text{O}_5/\text{ha}$ during both the years, but the differences were not significant (Table 1). When the yield of control was compared with the phosphorus treated plots, the latter proved significantly superior to the former, except for seed yield in 1983-84 where the difference was marginal. Likewise, the differences between 30 and 60 kg $\text{P}_2\text{O}_5/\text{ha}$ in respect of P uptake were not significant during both the years, though the latter showed superiority over the former, except for seed yield in 1982-83. Except at 120 days in 1982-83, 60 kg $\text{P}_2\text{O}_5/\text{ha}$ gave higher values of Pdf over 30 kg $\text{P}_2\text{O}_5/\text{ha}$

and the increase in favour of 60 kg $\text{P}_2\text{O}_5/\text{ha}$ at 120 days reached the significance level. This was owing to higher P concentration. At each stage of growth, the utilization of applied P was significantly higher in favour of 30 kg $\text{P}_2\text{O}_5/\text{ha}$ compared to 60 kg $\text{P}_2\text{O}_5/\text{ha}$ during both the years. This was mainly due to more competition for the nutrient at lower level of its application and these results are in conformity with those of other workers (Sinha and Rai, 1976; Rao and Sinha, 1980; Dahama *et al.*, 1984). By and large 60 kg $\text{P}_2\text{O}_5/\text{ha}$ proved significantly superior to 30 kg $\text{P}_2\text{O}_5/\text{ha}$ for 'A' values at each stage of growth during both the years because of relatively more P left in soil after harvest which is evident from the data on soil available P.

It may be seen that most of the differences between the levels of phosphorus were not significant for various characters/attributes studied, yet the information was of academic interest. Non-significant differences between the levels of phosphorus were owing to less P derived from fertilizer source (16.5 to 24.7 per cent) which means over 75% P was derived from soil source. This was possible because a deep rooted crop like safflower having less fibrous root system naturally depended much on soil P pool. As a result of poor nutrition of crop through fertilizer, the utilization of applied P also went down considerably irrespective of level of P applied to the crop.

Effect of Depth of Placement

Placement of phosphorus 20 cm deep proved superior to 10 cm deep at each stage during both the years for yield of seed and stalk but the difference was

RESPONSE OF SAFFLOWER TO PHOSPHORUS

TABLE 1
Effect of P₂O₅ level on various attributes

Level of P ₂ O ₅ (kg/ha)	Yield (q/ha)							
	Seed			Stalk				
	1982-83	1983-84	Pooled	1982-83	1983-84	Pooled		
30	18.3	15.4	16.8	94.4	74.6	84.5		
60	17.2	17.0	17.1	94.8	77.9	86.3		
S. Em±	0.68	0.88	0.56	2.47	2.42	—		
C. D. at 5%	NS	NS	NS	NS	NS	—		
Control	15.0	15.2	15.1	78.9	64.9	71.9		
Rest	17.7	16.2	16.9	94.6	76.2	85.4		
S. Em±	1.18	1.53	0.89	0.90	3.84	—		
C.D. at 5%	2.41	NS	NS	3.20	8.06	—		
P uptake (kg/ha)								
90 days120 days								
1982-831983-841982-831983-84								
30	5.45		5.29		8.359.66			
60	5.01		5.40		10.2910.49			
S. Em±	0.30		0.38		0.650.99			
C. D. at 5%	NS		NS		NSNS			
Control	5.87		3.52		8.7910.74			
Rest	5.23		5.34		9.3210.07			
S. Em±	0.52		0.67		2.131.71			
C. D. at 5%	NS		1.36		NSNS			
Pdf (%)Utilization of applied P (%)								
90 days120 days90 days120 days								
1982-831983-841982-831983-841982-831983-841982-831983-84								
30	21.4		16.5		24.714.9		9.016.5915.611.2	
60	22.0		19.4		21.820.9		4.253.888.38.4	
S. Em±	1.0		1.4		7.11.3		0.620.560.851.12	
C. D. at 5%	NS		NS		NS3.9		1.811.652.49NS	
'A' values (kg P/ha)Soil available P (kg/ha)								
90 days120 daysAfter harvest*								
1982-831983-841982-831983-841982-831983-84								
30	51.2		73.1		42.984.1		8.939.71	
60	97.1		119.2		99.0108.0		11.3712.66	
-S. Em±	5.3		6.9		6.36.7		— —	
C. D. at 5%	15.7		20.4		20.119.8		— —	

*At 0 kg P/ha : 1982-83=4.89 kg P/ha
1983-84=4.83 kg P/ha.

TABLE 2

Effect of depth of phosphorus placement on various attributes

Depth (cm)	Yield (q/ha)					
	Seed			Stalk		
	1982-83	1983-84	Pooled	1982-83	1983-84	Pooled
10	17.7	16.0	16.6	93.4	72.0	82.7
20	18.2	16.4	17.3	95.8	80.5	88.1
S. Em $\pm$	0.68	0.88	0.56	2.47	2.42	—
C. D. at 5%	NS	NS	NS	NS	7.21	—

	P uptake (kg/ha)			
	Seed		Stalk	
	1982-83	1983-84	1982-83	1983-84
10	5.43	5.63	8.87	10.20
20	5.03	4.85	9.77	9.94
S. Em $\pm$	0.30	0.38	0.65	0.99
C. D. at 5%	NS	NS	NS	NS

	Pdff (%)				Utilization of applied P (%)			
	90 days		120 days		90 days		120 days	
	1982-83	1983-84	1982-83	1983-84	1982-83	1983-84	1982-83	1983-84
10	21.3	17.6	23.5	16.4	6.93	5.41	11.4	9.0
20	22.1	18.3	23.0	19.4	6.33	5.06	12.4	10.6
S. Em $\pm$	1.0	1.4	1.3	1.3	0.62	0.56	0.85	1.12
C. D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS

	'A' values (kg P/ha)				Soil available P (kg/ha)	
	90 days		120 days		After harvest*	
	1982-83	1983-84	1982-83	1983-84	1982-83	1983-84
10	73.4	95.6	68.7	104.9	10.19	11.28
20	74.9	96.7	73.2	87.2	10.11	11.09
S. Em $\pm$	5.3	6.9	6.8	6.7	—	—
C. D. at 5%	NS	NS	NS	NS	—	—

*At 0 kg P/ha : 1982-83=4.89 kg P/ha
1983-84=4.83 kg P/ha.

significant for stalk yield in 1983-84 only (Table 2). The results for P uptake, however, were not consistent. Likewise, the differences between the two depths of placement for Pdff, utilization of applied P and 'A' values were not significant suggesting that each depth was equally

good for the crop. Soil available P after harvest of the crop was slightly higher in favour of 10 cm deep placement during each year compared to 20 cm deep placement because of relatively more left-over P in soil after the crop.

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TABLE 3
Effect of moisture level on various attributes

Level of moisture	Yield (q/ha)					
	Seed			Stalk		
	1982-83	1983-84	Pooled	1982-83	1983-84	Pooled
No irrigation	16.3	14.0	15.2	89.4	69.5	79.4
One irrigation	18.1	18.0	18.1	93.4	78.4	85.9
S. Em ±	0.58	0.79	0.50	2.20	2.17	—
C. D. at 5%	NS	2.29	1.44	NS	6.45	—

	P uptake (k/ha)			
	90 days		120 days	
	1982-83	1983-84	1982-83	1983-84
No irrigation	5.07	5.06	8.36	9.75
One irrigation	5.65	4.89	10.07	10.66
S. Em ±	0.27	0.34	0.58	0.88
C. D. at 5%	NS	NS	1.69	NS

	Pdff (%)				Utilization of applied P (%)			
	90 days		120 days		90 days		120 days	
	1982-83	1983-84	1982-83	1983-84	1982-83	1983-84	1982-83	1983-84
No irrigation	22.0	16.7	23.2	15.9	6.23	4.84	10.5	8.2
One irrigation	21.4	19.2	23.3	19.9	7.03	5.63	13.3	11.3
S. Em ±	1.0	1.4	7.1	1.3	0.62	0.56	0.85	1.12
C. D. at 5%	NS	NS	NS	3.9	NS	NS	2.49	NS

	'A' values (kg P/ha)				Soil available P (kg/ha)	
	90 days		120 days		After harvest*	
	1982-83	1983-84	1982-83	1983-84	1982-83	1983-84
No irrigation	74.2	101.3	72.3	107.1	8.91	9.81
One irrigation	74.1	91.0	69.6	85.0	9.28	10.01
S. Em ±	5.3	6.9	6.8	6.7	—	—
C. D. at 5%	NS	NS	NS	19.8	—	—

*At 0 kg P/ha : 1982-83=4.89 kg P/ha
1983-84=4.83 kg P/ha.

Non-significant differences between the two depths of placement can be explained similarly as discussed above. The deep rooting system of crop enabled the plant to tap native soil P as much as it required for its growth and development

no matter whether the fertilizer was placed shallow or deep. Tracer technique revealed that major portion of P was derived by plant from native soil source and much less from fertilizer source.

Effect of Moisture Level

It may be seen that the response of safflower was relatively more in 1983-84 than in 1982-83, though the total rainfall in that year during the crop season was only 71.4 mm as against 248.8 mm in 1982-83 (Table 3). Safflower being a deep rooted crop does not require enough moisture for its growth and development. In absence of enough rain in 1983-84, a supplemental irrigation proved beneficial and gave significantly higher yield of both seed and stalk. Except at 90 days in 1983-84, P uptake in favour of one irrigation was higher and reached the significance level

at 120 days in 1982-83. One irrigation increased the values of Pdf and utilization of applied P in both the years at each stage of growth over no irrigation except at 90 days in 1982-83 when the difference was just marginal. 'A' values in favour of no irrigation were higher and at 120 days in 1983-84 the increase was significant. This was owing to relatively more left-over P in soil because of less utilization of P by the crop in absence of sufficient moisture. The differences between no irrigation and one irrigation for soil available P as determined by chemical analysis were marginal and hence need no elaboration.

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CONCENTRATION OF Mn, Fe, Cu, Ca, Mg, N AND P IN WHEAT IN Cd AND Zn POLLUTED SOIL

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ABSTRACT

Studies on the effect of applied Cd (0, 12.5, 25, 50 and 100 ppm) and Zn (0, 5, 10 and 20 ppm) on nutrient composition of wheat revealed that Cd and Zn application alleviated Cu, Mn and Fe concentration both in grain and straw. Zinc depressed Ca in shoot, but enhanced it in grain. Application of Zn and Cd had an antagonistic effect on Mg concentration. Nitrogen concentration decreased with Zn due to dilution effect of increased plant growth. Cd enhanced N content of grain and straw of wheat due to yield reduction. Cadmium depressed the P concentration and the adverse effect of Cd on P absorption was averted with Zn application due to antagonistic effect of Zn on Cd.

The rapid industrial development has resulted in the accumulation of heavy metals in sewage sludge and city waste, the commonly used sources of nutrients for raising crops around big towns. The use of such waters may cause nutritional imbalance in plants. Mahler *et al.* (1978) reported a decrease in the concentration of Zn and Mn in leaf with Cd application while concentration of P, Fe, Ca and Mg were not affected. The information on the influence of Cd on nutrient concentration of plants is quite scanty. Therefore, the present study was initiated to investigate the influence of Cd and Zn on Cu, Mn, Fe, Ca, Mg, N and P concentration in grain and straw of wheat.

MATERIAL AND METHODS

A green house experiment was conducted in a sandy soil (Typic Torripsam-

ment) having pH 8.5, O. C. 0.07%, E. C. 0.08 dsm^{-1} and DTPA extractable Zn and Cd 0.27 ppm and traces, respectively. The crop (*Triticum aestivum* L.) was grown upto maturity in polythene lined pots having 4 kg soil. The treatments consisted of four levels of Zn (0, 5, 10 and 20 ppm) and five levels of Cd (0, 12.5, 25, 50 and 100 ppm). All treatments were replicated thrice. A basal application of 100, 50, 63, 5, 10 and 10 ppm N, P, K, Cu, Fe and Mn, respectively, was given through AR grade reagents in solution form. Zinc and Cd were applied as AR grade $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$ and CdCl_2 , respectively. Grain and straw yields were recorded. For N, samples were digested in ($\text{H}_2\text{SO}_4 + \text{HClO}_4$) and for total Cu, Mn, Fe, Ca and Mg in the diacid 4 : 1 (HNO_3 : HClO_4). Total phosphorus and N in plant and grain were estimated from the diacid digests HNO_3 : HClO_4 and H_2SO_4 : HClO_4 .

by the method of Koenig and Johnson (1942) and Jackson (1957), respectively. The micro and secondary nutrients were estimated on atomic absorption spectrophotometer.

levels of applied zinc was non-significant. The yield of grain and straw decreased consistently due to Cd application. The response to applied Zn increased with increasing rates of Cd application.

RESULTS AND DISCUSSION

Grain and Straw Yield

Data in Table 1 reveal that Zn application enhanced grain and straw yield of wheat. The increase in yield due to applied Zn was significant only when compared with no zinc, however, the difference in increase in yield among

Copper Concentration

Application of Cd and Zn depressed Cu concentration significantly in straw and the effect of Cd $\times$ Zn interaction was also significant (Table 3). Addition of 12.5 ppm Cd enhanced Cu concentration over 0 ppm Cd which is attributed to yield reduction. Higher levels of Cd

TABLE 1
Effect of Cd and Zn application on grain and straw yield (g/pot) of wheat

Cd applied (ppm)	Zn applied (ppm)				Mean
	0	5	10	0	
Grain yield					
0	20.1	22.5	21.5	21.2	21.3
12.5	4.6	21.4	21.8	22.0	17.4
25	2.8	20.6	19.5	19.2	15.5
50	1.2	14.0	15.1	15.4	11.4
100	0.7	4.8	6.4	7.6	4.9
Mean	5.9	16.6	16.9	17.1	
Straw yield					
0	26.5	27.4	27.7	28.7	27.6
12.5	8.1	24.7	24.7	25.0	20.6
25	5.8	23.1	22.8	28.2	18.5
50	4.5	14.8	17.0	18.0	13.6
100	1.7	5.1	6.5	8.9	5.5
Mean	9.3	19.0	19.7	20.5	
C. D. at 5%	Grain yield	Straw yield			
Cd levels mean	1.0	1.1			
Zn levels mean	0.9	1.0			
Cd x Zn level	1.9	2.3			

EFFECT OF Cd AND Zn POLLUTED SOIL ON NUTRIENT COMPOSITION OF WHEAT

brought significant reduction in Cu concentration which might be due antagonistic effect of Cd on Cu availability due to same ionic species. Copper concentration decreased as a result of Zn application, however, non-significant differences existed between 5, 10 and 20 ppm Zn.

Mandal and Halder (1980) and Hulagur *et al.* (1975) made similar observations in rice and maize, respectively. Like straw, Cu in grain was depressed significantly with Zn but Cd exhibited non-significant effect (Table 2).

TABLE 2
Effect of Cd and Zn application on Cu, Mn and Fe concentration (ppm) of wheat grain

Cd applied (ppm)	Zn applied (ppm)				Mean
	0	5	10	20	
Cu					
0	10.0	10.0	9.0	8.3	9.3
12.5	10.0	10.0	7.5	8.3	8.9
25	10.8	10.0	8.3	9.1	9.5
50	11.6	9.1	8.6	8.3	9.4
100	9.1	9.3	8.3	9.1	8.7
Mean	10.3	9.5	8.3	8.6	
Mn					
0	35.4	37.4	31.2	31.2	33.8
12.5	52.1	45.8	35.4	33.3	41.6
25	58.3	45.6	41.6	45.8	47.8
50	60.5	39.5	35.4	41.5	44.2
100	41.6	37.5	31.2	37.5	36.9
Mean	49.6	41.1	35.0	37.8	
Fe					
0	95.8	79.1	79.1	75.0	82.3
12.5	95.8	87.5	83.3	75.0	85.4
25	87.5	91.6	80.0	79.1	84.5
50	79.1	87.5	71.6	67.5	76.4
100	87.5	75.0	75.0	66.6	76.0
Mean	89.1	84.1	77.8	72.6	
C. D. at 5%					
	Cu	Mn	Fe		
Cd levels mean	NS	2.8	4.7		
Zn levels mean	0.84	2.5	4.2		
Cd × Zn level	NS	5.6	9.4		

Manganese Concentration

Tissue Mn concentration increased upto 25 ppm Cd and then decreased sharply at 50 and 100 ppm Cd (Tables 2 and 3). The increase in Mn concentration with initial levels of Cd is caused by reduction in yield. Application of 100 ppm Cd over lower level resulted in marked reduction in Mn concentration. This reduction might be due to inhibited

translocation of Mn by Cd (Mahler *et al.*, 1978). The effect of Zn and Cd $\times$ Zn interaction was significant on Mn concentration of wheat shoot. Addition of Zn caused a significant reduction in Mn concentration over 0 ppm Zn mainly due to increased plant growth (Khan and Zende, 1976). The effect of Cd on Mn concentration in grain matched with that of straw, however, the influence of Zn on Mn content in grain indicated that higher

TABLE 3

Effect of Cd and Zn application on Cu, Mn and Fe concentration (ppm) of wheat straw

Cd applied (ppm)	Zn applied (ppm)				Mean
	0	5	10	20	
Cu					
0	13.3	5.8	6.6	5.8	7.9
12.5	19.2	7.5	7.5	5.8	10.0
25	14.2	5.8	6.6	5.0	7.9
50	11.6	5.8	6.6	5.0	7.2
100	7.5	5.0	5.0	5.0	5.6
Mean	13.2	6.0	6.5	5.0	
Mn					
0	87.5	40.0	41.6	56.2	56.3
12.5	162.5	74.1	87.5	87.5	102.9
25	154.1	118.3	79.2	112.5	116.0
50	125.0	79.2	104.2	66.2	93.7
100	79.2	54.2	62.5	60.4	64.0
Mean	121.6	73.2	75.0	76.6	
Fe					
0	308.3	283.3	375.0	341.6	327.0
12.5	358.3	408.3	350.0	258.3	343.7
25	333.3	391.6	208.3	258.3	297.9
50	333.3	341.6	250.0	241.6	291.6
100	308.3	316.6	233.3	275.0	283.3
Mean	328.3	348.3	289.3	275.0	
C. D. at 5%					
	Cu	Mn	Fe		
Cd levels mean	0.87	8.4	18.7		
Zn levels mean	0.78	7.5	16.7		
Cd x Zn level	1.74	16.9	37.5		

levels of Zn had a negative effect on Mn concentration in grain and possibly Zn restricted Mn translocation from shoot to grain.

Iron Concentration

The effect of Zn, Cd and Cd×Zn interaction on Fe concentration was significant (Tables 2 and 3) in grain and straw both. Shoot Fe depressed significantly at 100 ppm applied Cd when compared with 0 and 12.5 ppm Cd. Differences in shoot Fe among 25, 50 and 100 ppm Cd levels were not significant. The results are contrary to the findings of Mahler *et al.* (1978) who failed to record any depression in leaf Fe of lettuce and chard due to Cd. Application of 5 ppm Zn escalated the Fe concentration of shoot over 0 ppm Zn which showed the beneficial effect of balanced Zn fertilization on Fe uptake. Higher levels of Zn negated the Fe uptake when compared with lower levels. Almost similar trend was observed in grain (Table 3) as Cd and Zn both depressed Fe concentration. The Fe depression in shoot and grain due to Zn application is in line with the findings of Khan and Zende (1976) and Gangwar and Mann (1972).

Calcium Concentration

The effect of Cd and Cd×Zn interaction on Ca concentration of shoot and grain was non-significant (Table 4). Mahler *et al.* (1978) also observed no effect of Cd on Ca content of lettuce. Application of 5 ppm Zn caused reduction in Ca concentration due to increased growth and at higher levels of Zn there was significant increase in Ca concentration indicating a favourable effect of Zn on Ca absorption in grain. Unlike grain,

shoot Ca decreased consistently with increasing rates of Zn (Table 4). The decrease in Ca concentration at initial levels of added Zn is attributed to increased plant growth. Gupta and Gupta (1984) also observed an increase in Ca concentration due to Zn application in soybean.

Magnesium Concentration

Magnesium concentration of grain and straw (Table 4) depressed as a result of Cd and Zn application. The interaction effect was also significant. It is clearly evident that Cd antagonised Mg adsorption as the Mg concentration depressed despite reduction in yield caused by Cd. The antagonistic effect of Zn and Cd on Mg is attributed to the inhibited translocation of Mg caused by Cd and Zn mainly because of competition for the same absorption site at the root surface. The results are in agreement with the findings of Gupta and Gupta (1984) and Khan and Zende (1976) who reported similar results in soybean and wheat, respectively.

Nitrogen Concentration

It is evident from data in Table 5 that N concentration decreased significantly as a result of Zn application over 0 ppm Zn both in grain and straw. In the absence of added Cd, the N concentration increased when Zn was added. The decrease in N content is attributed to enhanced plant growth caused by Zn which is reflected by remarkable increase in N uptake. This suggested that Zn is helpful in the utilization of N. Strikingly, application of Cd increased the N content mainly due to drastic reduction in yield

TABLE 4

Effect of Cd and Zn application on Ca and Mg concentration (%) of wheat
 \ grain and straw

Cd applied (ppm)	Zn applied (ppm)				Mean
	0	5	10	20	
Ca in grain					
0	0.375	0.360	0.383	0.375	0.373
12.5	0.367	0.358	0.375	0.375	0.369
25	0.367	0.370	0.375	0.375	0.371
50	0.359	0.371	0.375	0.371	0.369
100	0.371	0.362	0.379	0.377	0.372
Mean	0.368	0.364	0.377	0.375	
Mg in grain					
0	0.100	0.080	0.082	0.073	0.084
12.5	0.098	0.083	0.074	0.060	0.080
25	0.110	0.064	0.075	0.071	0.080
50	0.088	0.067	0.079	0.069	0.076
100	0.084	0.065	0.073	0.072	0.073
Mean	0.096	0.065	0.077	0.071	
Ca in straw					
0	0.708	0.870	0.875	0.920	0.843
12.5	1.040	0.920	0.830	0.750	0.885
25	1.042	1.041	0.750	0.830	0.916
50	1.042	0.830	0.830	0.875	0.894
100	1.000	0.875	0.876	0.938	0.927
Mean	0.965	0.907	0.832	0.867	
Mg in straw					
0	0.180	0.134	0.145	0.173	0.158
12.5	0.188	0.123	0.129	0.115	0.139
25	0.178	0.115	0.085	0.089	0.117
50	0.189	0.076	0.076	0.083	0.106
100	0.169	0.071	0.061	0.077	0.094
Mean	0.181	0.104	0.099	0.107	

C. D. at 5%

	Grain		Straw	
	Ca	Mg	Ca	Mg
Cd levels mean	NS	0.001	NS	0.001
Zn levels mean	0.007	0.007	0.065	0.001
Cd × Zn levels	NS	0.002	NS	0.002

EFFECT OF Cd AND Zn POLLUTED SOIL ON NUTRIENT COMPOSITION OF WHEAT

TABLE 5

Effect of Cd and Zn application on N and P concentration of wheat grain and straw

Cd applied (ppm)	Zn applied (ppm)				Mean
	0	5	10	20	
N (%) in grain					
0	1.32	1.35	1.44	1.52	1.41
12.5	2.46	1.72	1.67	1.82	1.92
25	2.60	2.03	1.82	1.92	2.09
50	2.70	2.19	2.08	2.03	2.25
100	2.73	2.86	2.92	2.88	2.85
Mean	2.36	2.03	1.99	2.03	
P (ppm) in grain					
0	0.171	0.119	0.125	0.106	0.130
12.5	0.168	0.122	0.133	0.138	0.140
25	0.179	0.123	0.117	0.167	0.146
50	0.154	0.124	0.154	0.208	0.160
100	0.138	0.124	0.191	0.208	0.165
Mean	0.162	0.122	0.144	0.165	
N (%) in straw					
0	0.37	0.44	0.37	0.38	0.39
12.5	1.54	0.49	0.41	0.43	0.72
25	1.74	0.66	0.44	0.51	0.84
50	1.82	0.69	0.67	0.66	0.96
100	1.93	0.88	0.75	0.71	1.07
Mean	1.48	0.63	0.53	0.54	
P (ppm) in straw					
0	850	730	650	700	730
12.5	1500	790	790	740	950
25	1920	790	600	730	1010
50	1920	660	600	790	990
100	930	750	630	670	740
Mean	1420	740	650	730	

C. D. at 5%

	Grain		Straw	
	N	P	N	P
Cd levels mean	0.038	0.0076	0.014	88
Zn levels mean	0.034	0.0068	0.013	78
Cd×Zn level	0.077	0.0153	0.028	176

Phosphorus Concentration

Cadmium application consistently increased P concentration in grain while in straw it first increased and then decreased both at 50 and 100 ppm Cd levels (Table 5). The enhanced concentration of P in grain is caused by severe reduction in its yield due to Cd application. In straw the reduction at higher levels may be attributed to reduced availability of P as a result of the formation of a insoluble complex of Cd and P in the soil. Similar to the findings of Khan and Zende (1976)

application of Zn depressed the P concentration of straw mainly due to dilution effect. However, the decrease in straw at 5 ppm Zn over 0 ppm and then significant improvement over corresponding levels of Zn, suggest that Zn averted the adverse effect of Cd and helped in better absorption of P, thereby, contributing to higher P content. The interaction effect was significant which was negative with increasing rates of Zn and Cd in straw. However, it was positive in grain at higher levels of Zn.

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MONTE CARLO SIMULATION FOR STOCHASTIC MODELLING OF RANDOMIZED AGRICULTURAL PROCESSES

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ABSTRACT

Monte Carlo simulation was applied for modelling fertilizer particles (according to their sizes) as dropped at random through the orifice of fertilizer hopper of rotary fertilizer distributor. Particle size cumulative probability distributions (CDF) for urea and single superphosphate fertilizers were developed. Inverse transformation was applied on these CDF and randomized fertilizer particles of various sizes were generated. The per cent variation in the respective means and the coefficient of variations were found to be 3.013 and 4.065 for urea fertilizer and 4.379 and 3.501 for single superphosphate fertilizer.

Monte Carlo Computation is a useful technique for solving analytically difficult and time consuming engineering problems. It deals with experimental mathematics which is concerned with experiments on random processes. The technique is used for generating a large number of randomized simulations. Deterministic analysis of each simulation is then carried out to arrive at the results. Monte Carlo simulation basically generates uniformly distributed random numbers in the range (0, 1). The required simulated number can then be obtained by correlating the already generated random number with the probability distribution of the function from which the random number is required to be taken. Thus, this technique enables to generate numbers which are associated with different probability distributions. Many of the complex agricultural engi-

neering problems involving repetitive randomized processes can be solved by applying Monte Carlo simulation. This paper deals with the methodology and the application of Monte Carlo simulation technique for randomized agricultural processes. The paper is further enriched by incorporating the analysis used in random selections of fertilizer particles flowing through an orifice like that of rotary fertilizer distributors.

MONTE CARLO SIMULATION

Monte Carlo method (Deo, 1979) can be defined as that branch of Mathematics which is concerned with experiments on random numbers. Thus, sequence of random (or, presumably, pseudo-random) are assumed to be available and are subjected to transformations, investigations and comparisons in order to ascertain the

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statistical (distributional) properties resulting from such experimentation. An experiment on random number then becomes a generation of random variables, since the experimental measurements can be only transformations of the original random numbers. However, the Cumulative Distribution Function (CDF) of the random variable (rv) arising from a Monte Carlo experiment may not be of a known functional form. If the functional form $F(x)$ is known, then r repetitions of the experimentation on successive segments of the sequence of random numbers will result in r random variables, mutually independently distributed according to $F(x)$. So, r replications of the experiment will provide a random sample from $F(x)$. These replications can be used for analytically analysing a phenomenon and the outcome can be further interpreted.

MODELLING RANDOMIZED PROCESSES

The underlying principle in modelling randomized process is that though the process is random, yet it follows a well defined probability function. The probability distribution of the random sample is built up by analysing the population from which the random sample is taken. This analysis of the population leads to the rv being distributed according to some standard distributions, *i. e.* uniform, normal, weibul, etc. or some other distribution which can be made known. Once, the probability distribution of the randomized process is ascertained, inverse transformation method (Deo, 1979) is used for the random generation of the random variable. This method (Fig. 1) generates any number at random in the

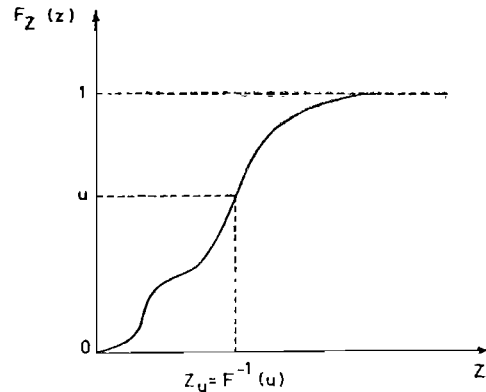


Fig. 1. Inverse transformation method to generate random number from a known probability distribution function.

interval (0,1) and takes its inverse transformation $F^{-1}(u)$ which is the desired random sample.

Uniform Distribution

It is a generalized case and is applicable if the rv is uniformly distributed (Fisz, 1966; Caplen, 1972). The cumulative distribution function (CDF) for uniform distribution is given by :

$$F_U(u) = \frac{1}{b-a} u \quad \text{-----} \quad (1)$$

$$\text{or } u = (b-a) F_U(u) \quad \text{-----} \quad (2)$$

Where

a = Lowest range of rv,

b = Maximum range of rv.

$F_U(u)$ assigns any value between (0, 1) and is generated at random. Once $F_U(u)$ is known, the random sample u is generated according to equation (2).

Normal Distribution

It is applicable if the population from which rv is to be drawn, is normally distributed (Papoulis, 1965; Fisz, 1966).

MONTE CARLO SIMULATION

Box Muller transformation is used to generate the randomized sample. This transformation uses the relation :

$$s = (-2 \log_e n_1)^{\frac{1}{2}} \cdot \cos(2\pi n_2) \quad \dots(3)$$

where

n_1 and n_2 are two uniform random numbers in the range (0, 1)

s is the desired sample from the standardized normal distribution with known standard deviation (SD) and arithmetic mean (AM)

$$\text{So, } u = (s) (\text{SD}) + \text{AM} \quad \dots (4)$$

Obviously, u is the desired random sample.

Weibul Distribution

It is applicable if the population from which rv is to be drawn is weibully distributed. Of the various standard non-negative probability distributions, the weibul distribution is the easiest to use because the mean and the coefficient of variation are determined independently by two separate parameters. The CDF is given by :

$$F_U(u) = 1 - e^{-(-u)^\beta / \alpha} \quad \dots(5)$$

$$u = (\alpha (-\ln(1 - F_U(u))))^{1/\beta} \quad \dots(6)$$

Where, α and β are the distribution parameters. It is assumed that the lower bound of rv is zero. Once $F_U(u)$ is known, random sample is generated according to equation (6).

Known Probability Distribution

If the distribution does not fit into any of the standardized probability distribution, the cumulative distribution function is determined, may

be in parts. The random sample is then generated in the same manner, using inverse transformation method. In fact, many of the randomized processes might not agree to fit into a standardized distribution and it is convenient to build up best fitted distribution and then to generate the random samples accordingly.

APPLICATIONS : MODELLING RANDOMIZED FERTILIZER PARTICLE

Urea Fertilizer

The study was undertaken to model the fertilizer particles (according to their size) as dropped at random through the orifice of fertilizer hopper of rotary fertilizer distributor. Particle distribution of the fertilizer was determined by sieve analysis (Table 1) using sieve no. 4, 8, 14, 28, 48 and 100. Cumulative distribution vs. diameter of fertilizer particles when plotted on a simple scale is shown in Fig. 2. Curve fitting was done to draw relationship between the cumulative distribution function and the diameter of the fertilizer particle. However, a single curve could not be fitted and the relation-

TABLE 1

Sieve analysis of urea fertilizer

Sieve No.	Dia. of sieve opening (mm)	Mass retained (g)	Per cent finer
4	4.669	0	100.00
8	2.362	2.25	99.41
14	1.168	312.5	18.25
28	0.589	40.0	7.86
48	0.295	17.0	3.44
100	0.147	10.25	0.78
Pan	—	3.1	0

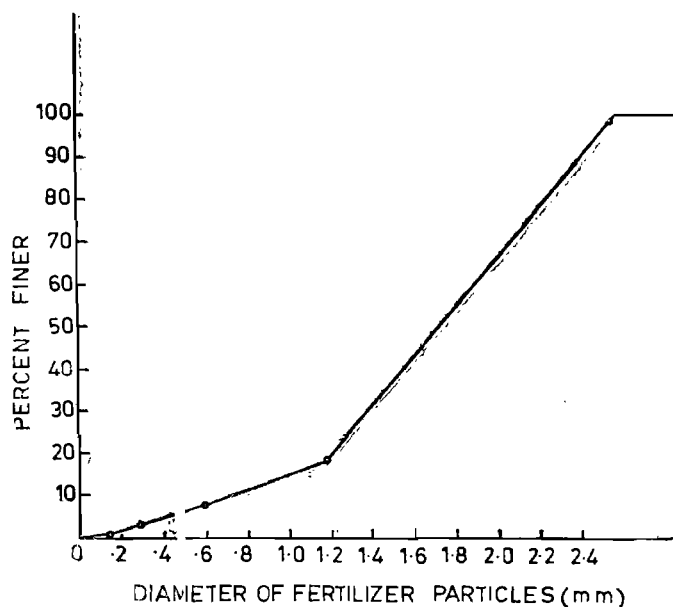


Fig. 2. Cumulative distribution function vs. diameter of particles for urea fertilizer.

TABLE 2

Comparison between the fertilizer particle size of input distribution and generated distribution

S. No.	Fertilizer	Parameter	Input distribution	Generated distribution	Per cent variation
1.	Urea fertilizer	Mean	1.560	1.513	3.013
		Coefficient of variation	35.270	33.836	4.065
2.	Single super-phosphate fertilizer	Mean	2.078	1.987	4.379
		Coefficient of variation	35.930	34.672	3.501

ship was established in two parts. The cumulative distribution was given by :

$$\begin{aligned}
 F(x) &= 0, & x < 0 \\
 F(x) &= .1643 x^{1.4927} & 0 \leq x < 1.2274 \\
 F(x) &= .6812 x - .6131 & 1.2274 \leq x \leq 2.3681 \\
 F(x) &= 1, & x > 2.3681
 \end{aligned}$$

In order to model randomized fertilizer particles, Computer programme was developed as given in Fig. 3. The programme generated any random number in the range (0, 1) and then took its inverse transformation from the particle size cumulative distribution function of urea fertilizer. Thus, 5000 fertilizer particles

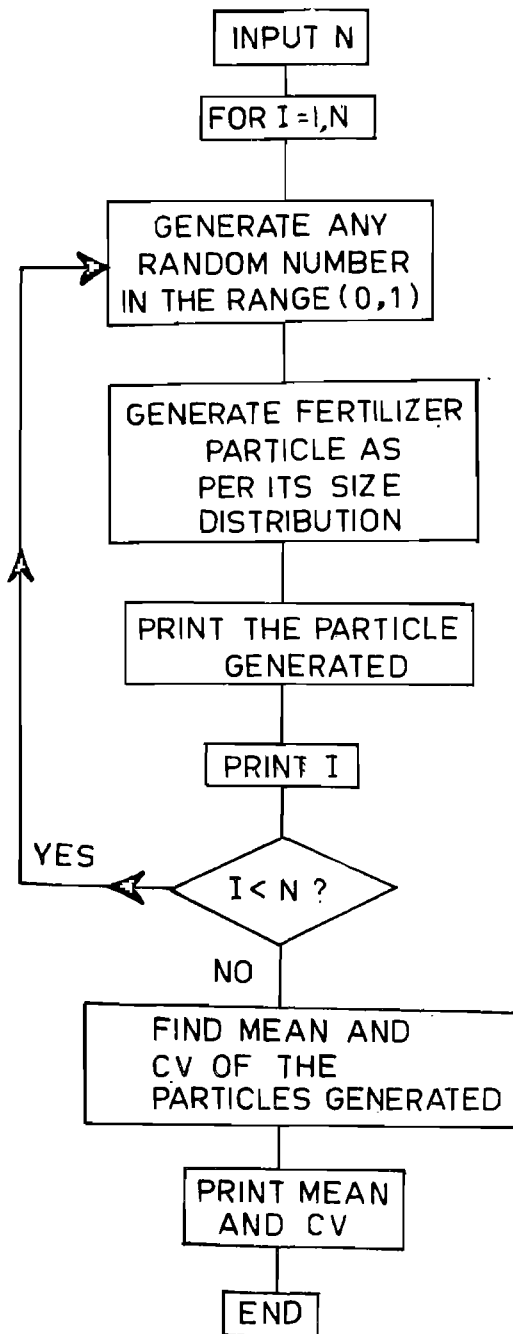


Fig. 3. Flow chart for random generation of fertilizer particles of various sizes.

TABLE 3

Sieve analysis of single superphosphate fertilizer

Sieve No.	Dia. of sieve opening (mm)	Mass retained (g)	Per cent finer
4	4.669	2.0	99.5
8	2.362	165.0	57.5
14	1.168	167.0	16.5
28	0.589	45.5	5.125
48	0.295	13.0	1.875
100	0.147	6.5	0.250
Pan	—	1.0	—

were generated at random. As it was felt that any relationship based on such a large number of particles would give a fairly representative result, mean and coefficient of variation for the particles generated were also calculated. A comparison between the mean and coefficient of variation of the input distribution and the generated distribution is given in Table 2. The variation in the respective means and the coefficient of variations between the input distribution and the generated distribution were found to be 3.013 and 4.065 per cent which were well below 5 per cent.

Single Superphosphate Fertilizer

Data of sieve analysis of single superphosphate fertilizer are given in Table 3. Cumulative Distribution Function (per cent finer) vs. diameter of fertilizer particle, plotted on a semi-log scale is shown in Fig. 4. While finding curve of best fit, it was found that the fertilizer particles were distributed according to weibul distribution. The weibul parameters were

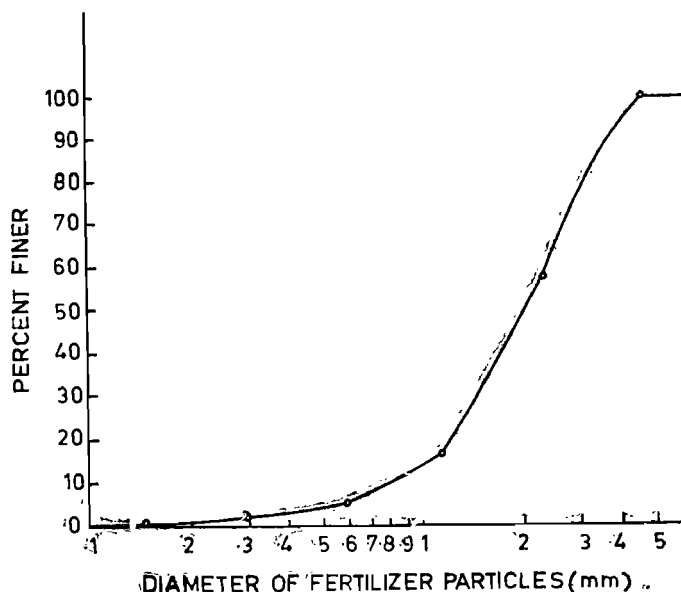


Fig. 4. Cumulative distribution function vs. diameter of particles for single superphosphate fertilizer (semi-log scale).

calculated The particle size CDF was given by :

$$F(x)=0, \quad x > 0$$

$$F(x)=1-e^{-(x^{2.104})/6.014} \quad 0 \leq x \leq 4.609$$

$$F(x)=1, \quad x > 4.669$$

Computer programme as developed in Fig. 3 was used to generate large number

of fertilizer particles at random. Thus, 5000 fertilizer particles were generated at random and the mean and coefficient of variation was found out. The comparison is given in Table 2. The variation in the respective means and coefficient of variations between the input distribution and the generated distribution was found to be 4.379 and 3.501 per cent.

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HETEROSIS IN RELATION TO COMBINING ABILITY IN HULLED AND HULL-LESS CROSSES OF BARLEY

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ABSTRACT

Heterosis was studied in relation to gca and sca effects in 15×3 line $\times$ tester mating design, involving hulled and hull-less genotypes of barley. Highest heterosis of 159.38, 47.19, 41.06 and 30.71 per cent was observed over better parent for grain yield/plant, grain weight/spike, spike length and grains/spike, respectively. Mean performance of the crosses showed close association with the sca effects indicating that selection of the crosses based on heterotic response is equally effective. Crosses exhibiting high *per se* performance, heterosis and sca effects for grain yield involved parents of either high $\times$ high or high $\times$ average gca effects.

With the recent realization of the possibility of producing F_1 hybrids on a large scale, increasing attention has been given to heterosis in self-pollinated crops. The breeders of self-pollinated crops are concerned to obtain sufficient heterosis in characters of economic importance and possibility to fix such heterosis in pure breeding lines. A large number of reports on heterosis in the crosses involving hulled $\times$ hulled types of barley are available, but reports on the relative performance of F_1 crosses involving hulled and hull-less types are scanty. The relative amounts of gca and sca effects play a vital role in planning the most appropriate breeding programme.

MATERIAL AND METHODS

Fifteen barley lines including hulled (BG 1, BG 105, BG 108, BH 39, DL 70, DL 65, DL 120, DL 301, K 147, RD 103,

RD 224, ER 41, karan 5, P 267) and hull-less (K 1112) types were crossed with three hull-less testers (karan 18, IB 65 and DL 344) in line $\times$ tester mating design. The parents and F_1 's were sown with three replications in a layout suggested by Arunachalam (1974). The distance between rows and plants was 30 and 10 cm, respectively. Observations were recorded on five randomly selected plants for effective tillers/plant, spike length, grains/spike, grain weight/spike, 1000-grain weight and grain yield/plant. Heterosis (%) was calculated over mid parent and better parent. Combined analysis of parents and crosses was done as suggested by Arunachalam (1974), and for combining ability analysis model given by Kaushik *et al.* (1984) was used.

RESULTS AND DISCUSSION

Analysis of variance for the characters studied indicated significant genetic differ-

ences among parents and hybrids. The variations due to parents and hybrids were highly significant for the characters studied indicating significant heterotic response. The gca and sca mean squares were also significant for all the characters. The degree and direction of heterosis varied greatly for different characters and crosses (Table 1). Out of 45 crosses, the number of crosses that showed desirable significant heterosis over better parent were 16, 17, 23, 15 and 14 for spike length, grains/spike, grain weight/spike, 1000-grain weight and grain yield/plant, respectively. None of the crosses showed significant heterosis over better parent for effective tillers/plant, while five crosses showed significant heterosis over mid parent. The crosses which have shown high heterosis and sca effects are presented in Table 2. Cross RD 103 × DL 344 exhibited highest heterosis for grain yield/plant (159.38%), 1000-grain weight (53.67%) and grains/spike (30.71%). Highest heterosis for characters grain weight/spike (47.19%) and spike length (41.06%) was observed in

crosses ER 41 × IB 65 and ER 41 × karan 18, respectively. In addition to cross RD 103 × DL 344, crosses BG 1 × karan 18 and RD 224 × karan 18 also recorded significant heterosis for grain yield/plant, spike length, grains/spike, grain weight/spike and 1000-grain weight suggesting major contribution of these components to heterotic yield. The highest heterosis for effective tillers/plant (29.89%) over mid parent was observed only in cross DL 301 × IB 65. This shows that this character contributed least heterosis for grain yield/plant. High heterosis for grain yield and its components has also been reported by Upadhyaya and Rasmusson (1967) and Verma and Gulati (1976). In an autogamous crop like barley where the exploitation of male sterility is rather difficult, the breeding procedures are restricted to the development of pure lines only. Therefore, it is suggested that the parents having high gca effects for yield (RD 224, DL 120 and karan 18) can be used in the breeding programme by using the appropriate breeding procedures like recurrent selec-

TABLE 1
Analysis of variance for various quantitative characters in barley

Source of variation	D. F.	Mean squares					
		Effective tillers/plant	Spike length	Grains per spike	Grains weight per spike	1000-grain weight	Grain yield per plant
Replications	2	1.17	0.54	36.07	0.09	0.50	4.83
Genotypes	62	28.71**	2.75**	182.31**	0.76**	0.62**	188.50**
Parents	17	29.82**	3.19**	187.79**	0.50**	1.04**	133.33**
Hybrids	44	28.21**	2.47**	130.79**	0.71**	0.38**	208.90**
Parents vs. hybrids	1	31.87**	7.42**	2407.05**	7.76**	3.96**	229.23**
Error	124	1.55	0.16	5.78	0.03	0.05	8.83

**Significant at 1% level.

HETEROSIS IN BARLEY

TABLE 2

Four best crosses for *per se* performance, heterosis and sca effects in line×tester cross in barley with mean performance and gca effects (in parentheses)

Character	<i>Per se</i> performance	% Heterosis		sca effect
		Mid parent	Better parent	
1	2	3	4	5
Tillers/plant	RD 103×DL 344 (18.3, A×H)	DL 301×IB 65 (29.88, L×L)	DL 301×IB 65 (13.1, L×L)	RD 103×DL 344 (4.5, A×H)
	BG 1×karan 18 (17.0, A×H)	karan 5×karan 18 (24.0, H×H)	karan 5×IB 65 (10.2, H×L)	BG 1×karan 18 (3.8, A×H)
	DL 120×DL 344 (16.0, H×H)	karan 5×IB 65 (23.3, H×L)	RD 103×DL 344 (6.5, A×H)	DL 65×IB 65 (2.9, L×L)
	BH 39×karan 18 (15.6, H×H)	BG 1×karan 18 (17.6, A×H)	BG 1×karan 18 (5.3, A×H)	DL 120×IB 65 (2.1, H×L)
Spike length	RD 103×DL 344 (10.0, H×L)	ER 41×karan 18 (58.1, A×H)	ER 41×karan 18 (41.0, A×H)	DL 120×IB 65 (1.4, A×A)
	DL 120×IB 65 (10.0, A×A)	ER 41×IB 65 (36.3, A×A)	K 1112×karan 18 (23.1, A×H)	P 267×IB 65 (1.4, A×A)
	karan 5×karan 18 (9.9, H×H)	karan 5×karan 18 (30.0, H×H)	DL 301×IB 65 (19.9, A×A)	DL 301×IB 65 (1.3, A×A)
	DL 301×IB 65 (9.7, A×A)	karan 5×IB 65 (23.5, H×A)	ER 41×IB 65 (18.9, A×A)	RD 103×DL 344 (1.2, H×L)
Grains/spike	P 267×IB 65 (84.7, L×H)	RD 103×DL 344 (33.6, A×L)	RD 103×DL 344 (30.7, A×L)	P 267×IB 65 (13.6, L×H)
	DL 70×IB 65 (81.2, H×H)	K 1112×karan 18 (31.2, L×A)	BG 1×karan 18 (23.6, A×A)	RD 103×DL 344 (11.5, A×L)
	DL 120×IB 65 (79.2, A×H)	BG 1×karan 18 (30.4, A×A)	RD 224×DL 344 (18.8, A×L)	DL 120×IB 65 (6.8, A×H)
	ER 41×IB 65 (78.6, A×H)	DL 65×DL 344 (21.4, H×L)	BG 105×karan 18 (16.7, L×A)	DL 65×DL 344 (6.4, H×L)
Grain weight/ spike	DL 120×IB 65 (4.1, A×H)	RD 103×DL 344 (55.2, A×L)	ER 41×IB 65 (47.1, H×H)	DL 120×IB 65 (0.8, A×H)
	ER 41×IB 65 (4.1, H×H)	BG 1×karan 18 (53.7, A×A)	BG 1×karan 18 (44.5, A×A)	P 267×IB 65 (0.5, A×H)
	BG 1×karan 18 (3.5, A×A)	ER 41×IB 65 (50.5, H×H)	P 267×IB 65 (37.3, A×H)	ER 41×IB 65 (0.5, H×H)
	RD 224×IB 65 (3.5, A×H)	BG 108×DL 344 (45.6, H×H)	DL 120×IB 65 (37.1, A×H)	K 147×karan 18 (0.5, L×A)
1000-grain weight	DL 301×karan 18 (48.6, H×A)	RD 103×DL 344 (59.5, H×L)	RD 103×DL 344 (53.6, H×L)	RD 103×DL 344 (0.5, H×L)
	RD 103×DL 344 (48.5, H×L)	RD 103×IB 65 (37.6, H×H)	RD 103×IB 65 (34.9, H×H)	BG 105×IB 65 (0.3, L×H)
	P 267×karan 18 (48.1, H×A)	P 267×karan 18 (33.2, H×A)	RD 103×karan 18 (29.5, L×A)	P 267×karan 18 (0.2, H×A)
	K 147×IB 65 (46.7, H×H)	DL 301×karan 18 (31.3, H×A)	karan 5×karan 18 (29.5, L×A)	BG 1×IB 65 (0.2, A×H)

contd.

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1	2	3	4	5
Grain yield/plant	BG 1 × karan 18 (45.2, H × H)	RD 103 × DL 344 (173.0, A × H)	RD 103 × DL 344 (159.3, A × H)	RD 103 × DL 344 (15.8, A × H)
	RD 103 × DL 344 (44.2, A × H)	BG 1 × karan 18 (118.1, H × H)	BG 1 × karan 18 (100.7, H × H)	DL 120 × IB 65 (14.8, H × L)
	RD 224 × karan 18 (43.1, H × H)	RD 224 × karan 18 (97.9, H × H)	RD 224 × karan 18 (75.0, H × H)	BG 1 × karan 18 (11.7, H × H)
	BG 108 × karan 18 (40.3, H × H)	BG 108 × karan 18 (89.6, H × H)	BG 108 × karan 18 (70.9, H × H)	P 267 × IB 65 (8.1, L × L)

H=High, A=Average, and L=Low general combiners.

tion or the approach suggested by Redden and Jensen (1974).

From Table 2 it is seen that atleast two crosses were common for all the characters for *per se* performance and sca effects which suggested positive association between them and selection of high sca can be based indirectly on high *per se* performance. Such crosses can be exploited in segregating generations by simple selection. Multiple crosses involving these F_1 's can also be attempted

followed by selection in advance generations as *per se* performance will not be stabilized in further segregating generations. Crosses BG 1 × karan 18 and RD 103 × DL 344 exhibited high *per se* performance, heterosis and sca effects for grain yield. These crosses involved parents of either high × high or high × average gca effects, therefore it is expected that desirable segregants will be thrown in subsequent generations from these crosses.

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PRODUCTIVITY, RETURNS AND WATER-USE EFFICIENCY WITH INPUT MANAGEMENT IN DRYLAND GUAR

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ABSTRACT

A field study on input management in guar in dryland for two years showed that productivity of improved variety with weeding and recommended fertilizer increased by 54% while it was only 20% in case of local variety. However, local variety was found superior to improved variety under poor management (without weeding and fertilizer application). Management in guar with weeding, fertilizer, and weeding+fertilizer, in improved variety gave Rs. 515/-, Rs. 736/- and Rs. 692/- per ha more returns over local variety with these input managements. Improved variety grown with management of weeding+fertilizer gave the maximum water-use efficiency of 36.6 kg-cm/ha in 1984 and 19.9 kg-cm/ha in 1985.

Guar (*Cyamopsis tetragonoloba* L.) has been identified to be the high yielding, most remunerative and efficient dryland crop (Singh, 1981). It has many industrial uses and also fetch good market rate as compared to other kharif crops grown in the dryland areas. The present study was taken up to evaluate the effect of different input managements on the seed yield and returns of guar in dryland aridisols in South-West Haryana.

MATERIAL AND METHODS

The experiment was conducted in a randomised block design with four replications at Dry Farming Research Centre, Bawal, Haryana, in the kharif seasons of 1984 and 1985 on a loamy sand soil having pH 7.6, 0.27% carbon, 8 kg available P and 280 kg available K

per hectare. The experiment consisted of eight different treatments, viz. (i) local variety of guar (non-descriptive variety having variable seed size, black-brownish grain colour), (ii) improved variety of guar HG-75, (iii) local variety+weeding, (iv) improved variety+weeding, (v) local variety+recommended fertilizer, (vi) improved variety+recommended fertilizer, (vii) local variety+recommended fertilizer+weeding, and (viii) improved variety+recommended fertilizer+weeding. The sowing dates were 3 July in 1984 and 13 July in 1985. Recommended fertilizer dose applied was $N_{15} + P_{16}$ kg/ha. The whole amount of N through urea as well as P through super phosphate was drilled 4 to 5 cm below seed level. The crop was seeded @ 20 kg/ha at 30 cm rows apart and thinned at 20 days crop stage to maintain

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plant to plant distance of 12.5 cm. The moisture in 1 m soil profile at seeding time was 120 mm in 1984 and 123 mm in 1985. The water expense (cm/1 m) under different treatments was calculated from the data of moisture depletion from the soil profile and the rainfall (Table 1) received during the crop season. The monetary returns of different treatments were worked out taking into account only the cost of treatments involved.

TABLE 1
Rainfall (mm) during crop season

week	Rainfall	
	1984	1985
27	30.4(3)	20.2(2)
28	53.9(4)	36.3(5)
29	29.8(1)	80.0(6)
30	9.0(2)	97.8(4)
31	36.7(3)	92.8(2)
32	—	24.6(3)
33	29.1(4)	37.0(2)
34	22.8(2)	2.0(1)
35	109.0(4)	—
36	34.7(4)	—
37	—	4.8(1)
38	—	7.6(2)
39	—	6.5(2)
40	—	76.0(3)
41	—	9.4(3)
Total rainfall	355.4(27)	495.0(36)

Figures in parentheses are rainy days.

RESULTS AND DISCUSSION

Seed Yield

Input management in guar brought significant variation in seed yield during both the years of study. Local variety outyielded (by 106 kg/ha) the improved variety of guar on mean basis under controlled conditions. Adoption of input

management in both the varieties increased the seed yield though response was more in improved variety. More yield of local variety without any input management is attributed to its wide stability (stability is most desirable character of any variety for dryland agriculture) under varying dryland conditions while larger response to input management in improved variety was due to incorporation of genetic architecture of responsiveness to fertilizer and other agronomic management points. Thus, local variety with recommended dose of fertilizer + weeding gave 20% higher seed yield over no fertilizer and no weeding, while improved variety with fertilizer + weeding gave 54% more mean seed yield over no weeding and no fertilizer application. A good response to weeding and fertilizer management in guar grown in dryland has also been reported by Singh (1978). During 1984, more seed yields were recorded as compared to 1985, though the rains during crop season were more in 1985 (Tables 1 and 2). It is because there was no rain after 36th meteorological week in 1984, thus stored moisture in soil profile was utilized for fruiting and good maturity of the crop. While in 1985, rains after 36th meteorological week resulted in more succulent and vigorous vegetative growth of guar bearing less fruiting which resulted in less yield as compared to year 1984. Local variety showed greater adaptability to variable rainfall situations as compared to improved variety due to greater varietal stability of local variety. Similar findings were reported by Singh and Singh (1986) from dryland aridisols of Bawal (Haryana).

GUAR WITH INPUT MANAGEMENT

TABLE 2
Productivity, returns, water-expenditure and water-use efficiency (WUE) with input management

Treatment	Seed yield (kg/ha)		Economics (Rs./ha)			Water expense (cm)		W. U. E.			
	1984	1985	Mean	Value of seed	Cost of treatment	Returns	Profit over local variety	1984	1985		
										1984	1985
T ₁ —Local variety	965	434	699	2097.00	60.00	2037.00	—	27.0	38.0	35.7	11.4
T ₂ —Improved variety (HG 75)	805	382	593	2075.50	70.00	2005.00	(-)32.00	26.6	36.5	30.2	10.5
T ₃ —Local variety + weeding	1020	538	779	2337.00	360.00	1977.00	—	27.4	38.4	37.2	14.0
T ₄ —Improved variety + weeding	1016	648	832	2912.00	370.00	2542.00	(+)565.00	27.1	38.8	37.5	16.7
T ₅ —Local variety + fertilizer	900	421	660	1980.00	461.40	1518.60	—	27.6	38.1	32.5	11.0
T ₆ —Improved variety + fertilizer	897	662	779	2726.50	471.40	2255.10	(+)736.50	27.3	39.2	32.8	16.9
T ₇ —Local variety + weeding + fertilizer	994	668	831	2493.00	711.40	1781.60	—	28.0	39.6	35.5	16.8
T ₈ —Improved variety + weeding + fertilizer	1034	792	913	3195.50	721.40	2474.10	(+)692.50	28.2	39.8	36.6	19.9
C. D. at 5%	219	232	160								

Monetary Returns

Local variety of guar fetched Rs. 32/ha more over improved variety due to higher yield obtained (Table 2), though due to undesirable colour and size of local variety, it fetched less price in market. Management in guar with weeding, fertilizer and weeding+fertilizer in improved variety when compared with local variety gave Rs. 565, Rs. 736 and Rs. 692 per ha more returns, respectively over the latter due to good responsiveness to the management points, while it lacked with local variety which showed poor response.

Water-Use

Under different treatments, water expense (cm) varied from 26.6 to 28.2 and 36.6 to 39.8 cm/m during 1984 and 1985, respectively (Table 2). Higher values during latter year may be attributed to more kharif rains (Table 1). Among different treatments maximum water

expense was observed with improved variety grown with recommended fertilizer+weeding, while minimum water expense was recorded with improved variety without any management point. Application of fertilizer and weeding tended to increase the water expense which may be due to more depletion of soil moisture by fast growing plants due to fertilizer use.

Water-use efficiency under different treatments was greatly affected by the seed yield as there was less variation in water expense. Application of recommended fertilizer+weeding gave the maximum water-use efficiency of 36.6 kg-cm/ha in 1984 and 19.9 kg-cm/ha during 1985.

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MOISTURE RETENTION AND STORAGE CHARACTERISTICS OF SOILS IN THE SIWALIK FOOT HILLS OF HARYANA

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ABSTRACT

Moisture retention and storage characteristics of 53 soil samples collected from 11 soil profiles, exposed all over the district, have been described. Typical moisture retention curves for some of the representative soil textures have been drawn. Physiography of the area and the texture of different horizons in the soil profile mainly governed the moisture retention and storage capacity. Soils which qualified for a fine loamy particles size class for family groupings retained higher amounts of available moisture as compared to those which qualified for coarse loamy.

In most of the areas of Haryana, particularly in the north eastern plains, the variability of crop yields from year to year is caused mostly, if not entirely, by the discrepancy between the moisture levels in the soil profiles and moisture requirements of the crop plants. Thus, for the formulation of water management practices and for the efficient use of the limited supply of irrigation water, the knowledge of moisture release pattern and storage capacity of the soils of that area is essential. The present study was, therefore, undertaken to make a detailed study of the moisture retention characteristics and the storage capacity of the soils of Ambala

MATERIAL AND METHODS

Soil profiles were exposed at 11 different locations all over Ambala representing various physiographic units—hills, piedmont plains and lower plains, as shown in Fig. 1. Classification of the

various soil profiles according to Soil Taxonomy is also shown in Table 1. Detailed description of the soil profiles has been given elsewhere (Dinesh Kumar, 1987) Soil samples were collected horizonwise from each profile, air-

TABLE 1
Profile sites, landforms and soil
classification

Profile site	Landforms	Soil classification
Madhna	Hills	Udic Ustochrept
Morni	-do-	Typic Udorthent
Nagal	Piedmont plains	Udic Ustochrept
Bilaspur	-do-	Udic Ustochrept
Kularpur	-do-	Udic Ustochrept
Kot	-do-	Typic Ustifluent
Ramgarh	-do-	Typic Ustochrept
KGK	Plains	Typic Ustifluent
Ambala		
Dhin	-do-	Udic Ustochrept
Keil	-do-	Aquic Ustorthent
Buria Farm	-do-	Udic Haplustalf

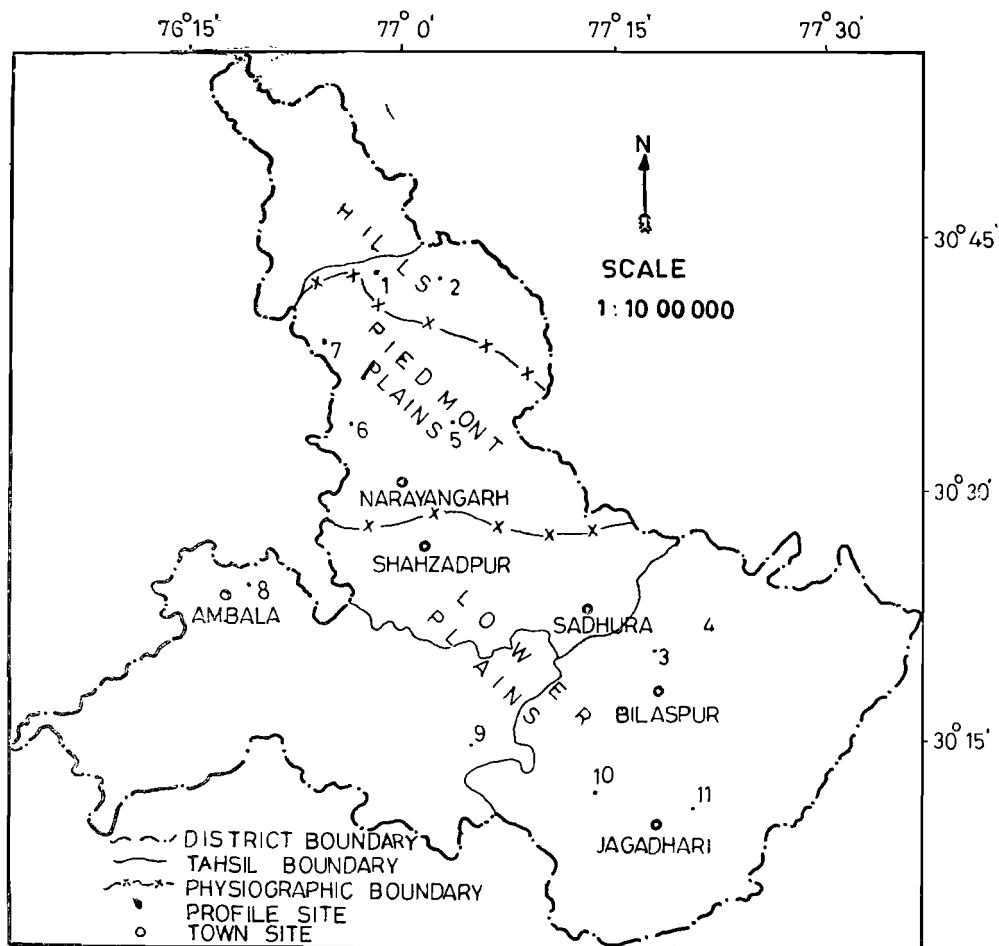


Fig. 1. Index and physiography map of Ambala.

dried and passed through 0.5 mm sieve for chemical analysis and 2.0 mm sieve for physical analysis. Organic carbon estimation was done by Walkley and Black's rapid titration method (Jackson, 1958). Mechanical analysis was carried out by International Pipette Method (Piper, 1966). The use of ceramic pressure plate and pressure membrane was made for estimating moisture retained at various tensions (Richards, 1956). Samplesatura-

ted with normal sodium acetate (pH 7.0) and made salt free by repeated washings with alcohol were leached with normal ammonium acetate (pH 7.0) and sodium was determined in the leachate with flame photometer, to estimate cation exchange capacity (Jackson, 1958).

RESULTS AND DISCUSSION

From the data of physical and chemical analyses, presented in Table 2,

SOILS IN THE SIWALIK FOOT HILLS OF HARYANA

TABLE 2

Physico-chemical characteristics of soils

Depth (cm)	Mechanical composition (%)			O. C. (%)	pH	CEC (me/ 100 g soil)	ESP
	Sand	Silt	Clay				
1	2	3	4	5	6	7	8
HILLS							
Madhna							
0-12	78.9	11.6	9.5	0.30	7.1	5.90	2.50
12-34	78.7	11.3	10.0	0.32	7.0	7.30	1.80
34-45	72.4	10.8	16.8	0.13	7.5	9.40	3.90
45-73	67.6	13.2	19.2	0.13	7.2	14.00	2.60
73-156+	62.4	16.7	20.9	0.06	7.0	18.60	1.20
Morni							
0-13	46.9	36.8	16.3	0.50	8.6	13.20	20.98
13-50	88.3	6.5	5.2	0.01	8.8	4.00	30.70
50-95	87.4	5.8	6.8	0.01	8.7	4.80	24.30
PIEDMONT PLAINS							
Nagal							
0-14	78.6	10.9	10.5	0.30	8.0	6.50	4.10
14-20	73.2	11.6	15.2	0.19	7.3	6.70	2.60
20-85	68.6	12.2	19.2	0.11	7.1	8.20	1.80
85-131	66.6	15.8	17.6	0.08	7.2	8.30	2.30
Bilaspur							
0-14	78.8	12.6	8.6	0.09	7.3	5.00	3.60
14-27	77.4	13.0	9.6	0.07	7.1	5.20	2.90
27-49	56.3	29.8	13.9	0.06	7.0	6.50	2.80
49-62	62.5	19.3	18.2	0.01	7.2	7.40	3.10
62-85	74.4	15.6	10.0	0.01	7.4	5.40	3.80
85-175	84.2	11.6	4.2	0.03	7.8	3.90	12.80
Kularpur							
0-16	85.2	6.9	7.9	0.26	7.2	7.20	3.10
16-46	78.1	10.3	11.6	0.20	7.0	6.73	2.70
46-87	58.7	28.7	12.6	0.09	7.3	8.00	3.40
87-120	80.6	9.9	9.5	0.03	7.0	6.50	2.60
120-152	88.6	5.3	6.1	0.03	7.4	5.00	3.40

contd.

DINESH KUMAR ET AL.

1	2	3	4	5	6	7	8
Kot							
0-14	87.0	6.1	6.9	0.05	8.5	5.00	3.40
14-45	85.8	6.4	7.8	0.14	8.3	5.39	3.30
45-67	85.2	7.6	7.2	0.15	8.4	5.40	3.30
67-87	61.4	33.1	5.5	0.05	8.2	4.60	3.20
87-152 ⁺	86.7	5.1	8.2	0.01	8.1	5.60	3.00
Ramgarh							
0-13	80.8	11.0	8.2	0.12	8.3	5.00	13.40
13-57	77.1	12.7	10.2	0.03	7.8	7.00	11.10
57-75	79.4	9.1	11.5	0.03	7.6	8.04	10.90
75-95	78.4	11.2	10.4	0.03	7.5	8.32	10.40
95-131	53.7	30.0	16.3	0.03	7.4	12.10	8.00
131-155	65.1	26.7	8.2	0.03	8.2	7.00	11.20
PLAINS							
KGK, Ambala							
0-13	26.9	36.9	36.2	0.33	7.5	20.40	4.03
13-76	12.1	38.6	49.3	0.26	8.5	34.10	7.00
76-88	73.4	7.4	19.2	0.01	8.7	15.10	8.60
88-110	83.7	8.7	7.6	0.05	9.0	6.00	12.60
110-127	65.2	19.6	15.2	0.03	8.9	10.30	10.80
127-151	92.9	2.5	4.6	0.01	8.6	3.90	8.40
151-160 ⁺	10.5	42.5	47.0	0.01	7.8	35.60	5.20
Dhin							
0-20	56.7	24.5	18.8	0.32	7.8	14.80	2.20
20-40	55.0	26.9	18.1	0.14	7.9	12.10	2.50
40-83	51.2	20.0	28.8	0.08	7.4	17.10	1.30
83-175	88.1	4.1	7.8	0.01	8.1	4.90	4.30
Keil							
0-13	29.1	38.3	32.6	0.34	7.6	19.60	21.80
13-51	12.3	39.9	47.8	0.19	8.8	34.60	22.70
51 ⁺	8.8	72.3	18.9	0.11	7.5	16.50	19.45
Buria Farm							
0-10	69.0	22.4	8.6	0.31	7.4	7.80	2.10
10-24	71.2	16.9	11.9	0.25	7.5	9.50	2.40
24-44	69.2	18.5	12.3	0.19	7.1	10.10	1.50
44-90	49.9	21.6	28.5	0.16	7.0	21.00	1.20
90-145	50.9	21.6	27.4	0.14	7.2	20.60	1.60

SOILS IN THE SIWALIK FOOT HILLS OF HARYANA

TABLE 3

Moisture retention and storage characteristics of soils

Depth (cm)	Per cent moisture retained by weight at various tensions (atm.)				Available water by weight (1/3-15) (%)
	0.3	1.0	5.0	15.0	
1	2	3	4	5	6
HILLS					
Madhna					
0-12	10.6	6.6	4.5	3.3	7.3
12-34	11.2	7.2	4.9	3.7	7.5
34-45	16.8	10.2	5.8	4.0	12.8
45-73	22.9	16.1	9.2	7.7	14.0
73-156 ⁺	24.1	16.5	10.5	7.8	14.4
Morni					
0-13	23.9	16.8	7.6	6.2	17.7
13-50	5.4	4.3	2.3	1.2	4.2
50-95	5.8	5.1	3.4	1.4	4.4
PIEDMONT PLAINS					
Nagal					
0-14	11.8	7.7	5.9	4.3	7.5
14-20	13.3	8.0	6.2	4.6	8.7
20-85	21.2	17.3	8.8	7.3	13.9
85-131	21.0	17.0	8.6	7.2	13.8
Bilaspur					
0-14	12.8	9.9	5.9	2.9	2.9
14-27	13.3	10.1	6.3	1.2	10.1
27-49	20.9	14.3	8.0	5.0	15.9
49-62	27.9	15.4	8.7	7.3	20.6
62-85	15.5	10.3	6.6	3.3	12.2
85-175	7.3	6.7	4.3	1.8	5.5
Kularpur					
0-16	7.1	5.6	3.5	2.8	4.3
16-46	10.7	8.9	4.8	3.2	7.5
46-87	11.2	9.2	5.0	3.5	7.7
87-120	9.2	5.9	3.7	3.0	6.2
120-152	4.4	2.4	2.0	1.3	3.1

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1	2	3	4	5	6
Kot					
0-14	4.7	2.5	1.9	1.5	3.2
14-45	6.0	3.0	2.1	2.0	4.0
45-67	5.7	2.8	2.0	1.8	3.9
67-87	7.7	3.8	3.2	3.0	4.7
87-152 ⁺	6.3	3.1	2.2	2.1	4.2
Ramgarh					
0-13	7.0	4.7	2.8	1.0	6.0
13-57	9.5	5.6	3.8	2.0	7.5
57-75	12.6	6.2	4.2	3.0	9.6
75-95	9.2	5.5	3.6	1.8	7.4
95-131	19.4	17.5	6.0	4.9	14.5
131-155	18.2	13.5	5.8	4.0	14.2
PLAINS					
KGK, Ambala					
0-13	33.4	27.0	17.0	11.2	22.2
13-76	41.1	32.2	20.9	14.9	26.2
76-88	14.6	13.0	8.6	5.9	8.7
88-110	6.8	6.1	5.2	1.6	5.2
110-127	15.9	14.4	8.9	6.1	9.8
127-151	4.3	2.4	2.1	1.1	3.2
151-160 ⁺	43.6	32.9	22.6	16.2	27.4
Dhin					
0-20	20.2	17.0	11.6	6.5	13.7
20-40	19.8	15.0	10.1	6.0	13.8
40-83	23.2	17.9	13.4	9.2	14.0
83-175 ⁺	6.1	3.5	2.5	1.3	4.8
Keil					
0-13	30.9	28.7	20.1	7.9	23.0
13-51	35.4	30.9	25.0	9.4	26.0
51 ⁺	40.6	31.4	26.0	10.8	29.8
Buria Farm					
0-10	13.5	9.1	6.5	4.0	9.5
10-24	16.8	10.1	7.3	4.6	12.2
24-44	17.4	12.9	8.8	4.8	12.6
44-90	22.6	16.7	13.1	8.7	13.9
90-145	21.8	16.2	12.7	8.4	13.4

it is evident that the amount of clay and silt increased with depth in soil profiles from hills down to plains. The values for cation exchange capacity and exchangeable sodium percentage ranged from 3.9 to 35.1 me/100 gm of soil and 2.8 to 30.7, respectively. All the soil samples had a pH value more than 7.0. Organic carbon followed more or less a regular decrease with depth except in stratified soil profiles.

A perusal of the data in Table 3 indicates that the amount of moisture retained by a sample decreased as the suction increased, and this decrease was more in coarse textured than in fine textured soil samples. In most of the soil profiles, the moisture retained at any particular tension, as well as the available moisture increased with depth in the profile. This was due to the corresponding increase in the amounts of silt and clay fractions with depth. Significant correlations were observed between moisture retentions at different tensions (0.3, 1.0, 5.0 and 15.0 bar), available water capacity and various soil constituents (clay, silt, O.C.). The influence of clay and silt contents on retention was higher at higher tension (15 bars) than at lower tension (0.3 bars). This observation is corroborated by the correlation studies which show that the r value between clay content and moisture retention at 15 bars was 0.92** in comparison to that obtained at 0.3 bars (0.88**). Organic carbon and cation exchange capacity bore also significant positive correlations with available water, *i.e.* 0.27* and 0.56**, respectively. Similar results were also reported by Ahuja (1981) and Shanwal (1985) in different parts of Haryana.

Considering 10, 19 and 25 cm/m as the lower limits for low, medium and high categories of available water, respectively, the soil profiles from Kularpur and Kot; Madhna, Morni, Nagal, Ramgarh, Dhin and Buria; Bilaspur, KGK-Ambala and Keil qualified for low, medium and high categories of available water, respectively, as shown in Fig. 2. Kularpur and Kot profiles, retained comparatively low moisture due to coarse texture (sand dune areas).

In addition to the available water retaining capacity, the moisture release pattern of a soil is an important factor in scheduling irrigations. Moisture release pattern for these soils was studied and moisture retention curves for various textural classes, *viz.* sand, loamy sand, sandy loam, silt loam, loam, sandy clay loam, clay loam, silty clay and clay were drawn (Fig. 3). The nature of curves for different soils differed with regard to the amount of water held at various tensions and the slope of a curve over the entire range seemed to be governed mainly by the texture of the soil. A critical look at the curves reveals that the influence of texture was felt less at lower tensions than that obtained at higher tension. A greater part of the available moisture is available only within a low tension range. Moisture retention curves presented for a few alluvial soils of India by Ali *et al.* (1966) showed that most of the moisture is released within a tension of 1 to 2 atm. In present study also, the available moisture depletion was more than two third of the total, when the tension increased from 1/3rd to 5 atmospheres. At this tension, coarse loamy soils practically did not have much water to supply to plants, as they originally held only low

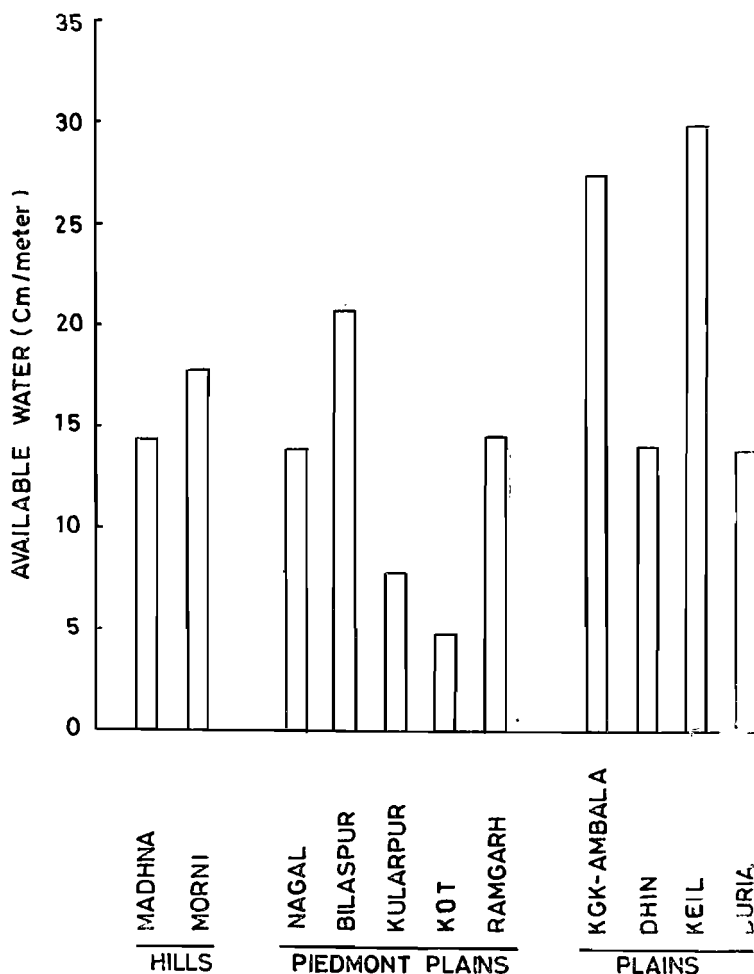


Fig. 2. Available moisture storage capacity of soils

to medium amounts of available water. On the other hand, fine loamy soils (Morni, Bilaspur, Ramgarh, KGK-Ambala and Keil profiles, could maintain a fair supply of water to plants even at high tensions

Based upon the above inference, the soils which qualified for a coarse loamy textural grouping at the family level, needed an irrigation system which ensured light but more frequent irrigations,

during the whole cropping period. If such soils are heavily irrigated, there will be only wastage of water because (i) these soils are not able to retain much of water and hence most of the water will be drained away, and (ii) most of the available water will be depleted even at low suctions. On the other hand, irrigation can be planned at longer intervals with heavy amount of water in case of fine loamy soils, during the entire cropping period.

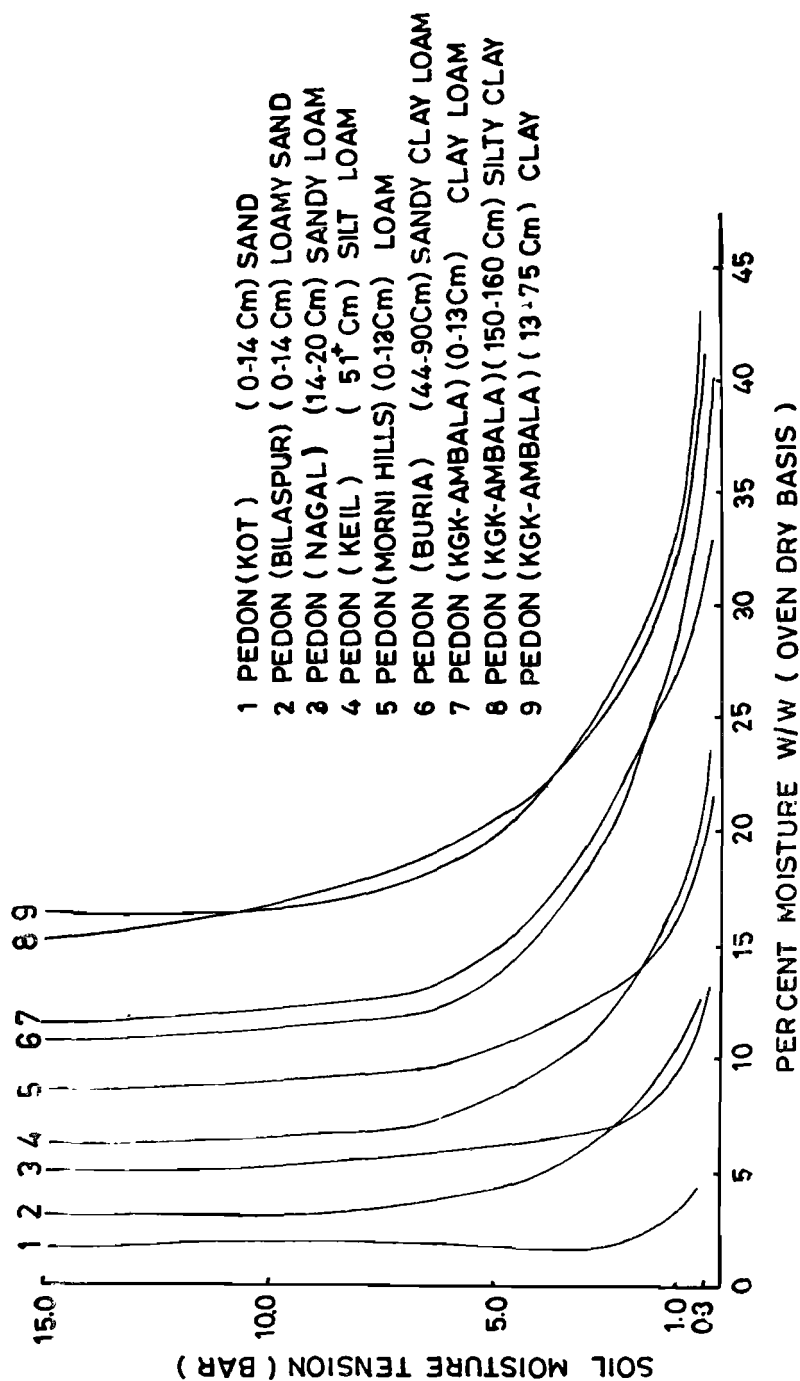


Fig. 3. Moisture retention characteristics curves of soils varying in texture.

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PERFORMANCE OF NEW VARIETIES OF GARLIC (*ALLIUM SATIVUM* L.)

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ABSTRACT

Seven varieties of garlic tried during 1985-86 and 1986-87 for their growth and yield performance, showed that varieties among themselves did not differ significantly in height and number of leaves per plant. However, variety HG-1 attained maximum height 89.3 cm and number of leaves 90.9 per plant. Varieties with dark green leaves were more severely infected with purple blotch and stemphyllium as compared to varieties with light green leaves. Sel-10 was more severely infected than others. Variety HG-1 produced highest yield of bulbs (195.4 and 180.0 q/ha), weight per bulb and weight of clove during both the years.

Garlic cultivation has been encouraged in India both in Home gardening and on commercial lines due to its multi use like medicinal, spices, pickles, etc. (Pandey and Singh, 1987). In Haryana, garlic is gaining increasing popularity during the recent years on account of its higher returns, least problematic cultivation and better storage quality. There is a notable lack of information regarding the varietal aspects of this crop under different agro-climatic conditions. However, All India Coordinated Vegetable Improvement Project has identified local material from different parts of the country. The present study was carried out to find out the potentiality of several newly evolved garlic varieties in relation to various yield attributes.

MATERIAL AND METHODS

The trial was conducted at the Vegetable Research Farm, Haryana Agricultural

University, Hisar, during 1985-86 and 1986-87. The experiment was laid out in a randomised block design having seven varieties, viz. HG-1 from Hisar, G-1 and G-41 from Associated Agriculture Development Foundation, Delhi, I. C. 49373 and I. C. 49383 from N. B. P. G. R., Delhi and Sel-2 and Sel-10 from Rahuri, Maharashtra, replicated three times. The planting of cloves was done on the flat bed by dibbling 3 to 4 cm depth the sprouting face of the clove facing upward just covered with soil in rows 15 cm apart at interplant distance of 10 cm in a row, on 4 October in 1985 and 25 September in 1986. The soil of the field was sandy loam containing organic carbon 0.50%, available nitrogen 153 kg/ha, available P_2O_5 36 kg/ha, available K_2O 613 kg/ha and pH 8.1.

The fertilizer was applied at the rate of 80 kg N, 50 kg P_2O_5 and 25 kg K_2O /ha. The whole quantity of phosphorus

(Single super phosphate), potash (Muriate of potash) and one-third nitrogen through calcium ammonium nitrate was applied at the time of planting and the remaining two-third nitrogen was given as 2 splits at 30 days and 45 days after sprouting of cloves. The first irrigation was given just after planting. Other irrigations, weeding, hoeing and plant protection measures were done as per Package of Practices (Anonymous, 1986).

The observations on growth (plant height, number of leaves) were recorded at full maturity stage. The data on disease incidence (purple blotch and stemphyllium) were recorded at 7-day intervals after appearance of disease. Harvesting was done on 10 May in 1985-86 and 6 April in 1986-87. Weight of bulbs, number and weight of cloves and yield of bulbs were recorded after curing of bulbs in shade for a week in order to obviate moisture variation.

RESULTS AND DISCUSSION

The data in Table 1 reveal that var. HG-1 had the maximum height and

number of leaves. However, differences on this character among the varieties were found non-significant. Hari Om and Srivastava (1976) also did not observe significant differences while comparing the locally selected garlic clones.

It was observed that varieties having dark green leaves were affected severely with purple blotch and stemphyllium (Table 1). The disease started appearing from middle of February. The minimum disease per cent was observed in variety HG-1 followed by G-1 during both the years. The disease was maximum in Sel-10.

Varieties differed significantly in yield, weight of bulb and weight of 50 cloves, but there was no significant difference in number of cloves per bulb (Table 2). Highest yield was obtained with variety HG-1 during both the years followed by G-1 and it was significantly higher than rest of the varieties. The highest yield in variety HG-1 was mainly because of higher bulb and clove weight as compared to rest of the varieties. Varietal variations on these traits were also

TABLE 1
Varietal performance on growth and disease incidence

Variety	Plant height (cm)		Number of leaves/plant		Colour of leaves	Disease incidence (%) (Purple blotch and stemphyllium)	
	1985-86	1986-87	1985-86	1986-87		1985-86	1986-87
HG-1	89.3	90.9	11.2	11.5	Green	7.7	4.3
G-1	81.0	79.8	11.0	10.7	Green	11.3	6.0
G-41	77.6	77.4	9.9	10.0	Green	46.7	56.6
I.C. 49373	76.9	76.7	9.7	9.8	Dark green	80.0	93.0
I.C. 49383	78.9	79.3	10.7	10.5	Dark green	70.0	63.3
Sel-2	85.7	85.2	9.5	10.3	Dark green	83.0	63.3
Sel-10	73.6	73.8	10.6	10.3	Dark green	93.0	100.0
C. D. at 5%	NS	NS	NS	NS	—	17.6	18.4

PERFORMANCE OF GARLIC VARIETIES

TABLE 2

Varietal performance on yield and yield attributes

Variety	Yield (q/ha)		Weight of bulb (g)		No. of cloves/bulb		Weight of 50 cloves (g)	
	1985-86	1986-87	1985-86	1986-87	1985-86	1986-87	1985-86	1986-87
HG-1	195.4	180.0	29.3	28.0	25.2	27.0	59.7	57.0
G-1	168.7	136.0	25.3	22.0	26.0	24.3	52.0	43.3
G-41	146.5	118.0	22.6	18.0	23.2	22.2	46.3	37.0
I.C. 49373	119.9	124.0	18.0	19.0	23.3	26.8	37.0	39.6
I.C. 49383	137.6	136.0	20.7	21.0	24.7	25.8	42.3	42.0
Sel-2	93.2	120.6	14.0	18.0	24.5	29.9	29.9	38.3
Sel-10	106.6	110.6	16.0	17.0	22.9	23.0	33.0	35.0
C. D. at 5%	19.3	22.5	7.6	3.6	NS	NS	11.74	7.09

observed by Hari Om and Srivastava (1979) and Andrade *et al.* (1982) while (1976), Korla and Rastogi (1979), Moenir comparing some selected varieties.

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RESEARCH NOTE

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TOLERANCE OF WHEAT CULTIVARS TO DICLOFOPMETHYL

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(Accepted : June 8, 1988)

Diclofopmethyl has been successfully used for the control of wild oats in many countries (Qureshi and Vanden Born, 1979; Sharma and Vanden Born, 1983; Anonymous, 1985). However, before recommending this herbicide for general use by the farmers, it is essential to know the relative susceptibility of wheat cultivars to this herbicide.

A field experiment was conducted at the Research Farm of Haryana Agricultural University, Hisar, during the winter season

of 1986–87. Twelve wheat cultivars (Table 1) were evaluated against diclofopmethyl at 1.0 and 2.0 kg/ha and an untreated control. The treatments were replicated thrice in a split plot design. The experimental soil was sandy loam, medium in organic carbon and low in N, P and high in K and was slightly alkaline in reaction (pH 8.1). Wheat cultivars were sown on November 14, 1986 in rows spaced 25 cm apart. Each variety comprised 6 m × 0.75 m area. Recommended dose of fertilizer (N, P and ZnSO₄)

TABLE 1

Earheads and grain yield of wheat as influenced by diclofopmethyl application

Varieties	Number of earheads/meter row			(Dose kg/ha)	Grain yield (kg/ha)		
	1.0	2.0	Control		1.0	2.0	Control
DWL 5023	90.5	90.5	91.5		5292	5252	5413
WH 147	92.3	84.0	103.2		4807	4303	5413
WH 452	80.5	72.3	86.7		4262	3959	5151
WH 291	89.5	88.0	91.0		4464	4313	4557
WH 423	70.8	73.5	86.5		5050	4302	6181
WH 416	93.0	76.0	95.2		5454	4343	5676
WH 283	96.5	90.5	97.5		4080	4040	4363
HD 2285	88.3	83.3	94.5		4444	4383	5373
HD 2329	88.0	78.0	95.7		5272	4686	5272
HD 2009	87.5	68.0	88.2		4201	4161	4666
Raj 1972	100.5	102.0	103.5		4969	5171	6060
PBW 34	90.3	81.8	96.7		4949	4887	5233
Mean	88.96	82.31	94.18		4770	4483	5280
C. D. at 5%				Dose	Variety	D × V	
				363	441	394	

TOLERANCE OF WHEAT TO DICLOFOPMETHYL

was added during crop season. Herbicide was applied 33 days after sowing of crop, using 650 litre water/ha. Number of earheads per meter row length was recorded just before the harvest of crop and is presented as average of three replications. The grain yield data were subjected to analysis of variance.

Maximum grain yield of different wheat cultivars was observed in plots where no herbicide was applied (Table 1). Application of diclofopmethyl at 1.0 kg/ha significantly reduced the grain yield of WH 147, WH 452, WH 423, HD 2285,

Raj 1972 and HD 2009 when compared with control. In rest of the cultivars there was no significant yield reduction at 1.0 kg/ha. On the other hand diclofopmethyl at 2.0 kg/ha resulted in significantly low yield of WH 147, WH 452, WH 423, HD 2285, HD 2329, WH 416, Raj 1972 and HD 2009 than control plots. The effect of diclofopmethyl on grain yield was manifested by its effect on number of earheads/meter row length (Table 1). In rest of the cultivars, though there was slight reduction in grain yield but it was not significant as compared to control plots.

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RESEARCH NOTE

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SCOPULA ALBIFLAVA WARREN (GEOMETRIDAE : LEPIDOPTERA) DAMAGING GROUNDNUT CROP IN HARYANA

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Groundnut, *Arachis hypogaea* L., is an important oilseed crop in India. It is attacked by an array of insect-pests but *Scopula albiflava* Warren (Geometridae : Lepidoptera) is comparatively newer addition to this list (Nayar *et al.*, 1976). The larvae of this pest (full grown 2-2.5 cm) were found feeding on the foliage of groundnut while remaining near the ground level. When disturbed, they feign death by rolling themselves. During kharif 1984, a considerable number of this pest was found attacking the groundnut crop at Hisar, where as many as 15-20 larvae per metre-row length of the crop were observed feeding. Literature revealed that no efforts for controlling this pest on groundnut have been made anywhere. An experiment, hence, was conducted to study the efficacy of various insecticides against *S. albiflava* on this crop.

Groundnut crop variety 'MH-1' spanish bunch was grown in the field following normal recommended agronomical practices. Twelve insecticides (Table 1) were tested against this insect in thrice replicated trial laid out in randomised block design. The insecticidal sprays were given with Knap sack sprayer fitted

with triple action nozzle using 500 litre spray material per hectare. No spray was given in control plots. The following day 10 larvae of this pest were collected from each plot and brought to the laboratory for rearing separately in battery jars. These larvae were provided with fresh food (treated) daily brought from their respective plots and observations on mortality were recorded.

Treatments with methyl parathion 0.05%, chlorpyrifos 0.04% and decamethrin 0.007% offered some mortality of this pest on the second day after spray (Table 1). However, on third day endosulfan 0.07%, methyl parathion 0.05%, chlorpyrifos 0.04%, cypermethrin 0.01% and decamethrin 0.007% and permethrin 0.01% provided above 66.6% mortality of *S. albiflava* larvae. Similar results were observed on fourth and fifth days after spray. Based on the final observation (15th day after spray) decamethrin 0.003% and 0.007% and cypermethrin 0.01% were placed in the group of best insecticides (affording 100 per cent mortality) against *S. albiflava* on groundnut. The second best group of insecticides included endosulfan 0.07%, methyl parathion 0.05%, chlorpyrifos

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PEST CONTROL IN GROUNDNUT

TABLE 1

Efficacy of various insecticides for the control of *Scopula albiflava* on groundnut

Treatment	No. of Larvae examined	Per cent mortality (days after)				
		2	3	4	5	15
Carbaryl 0.2%	30	0.0(1.81)*	0.0(1.81)*	26.6(30.79)*	26.6(30.79)*	33.3(35.27)*
Chlorpyrifos 0.04%	30	20.0(26.07)	66.6(54.78)	90.0(75.00)	90.0(75.00)	90.0(75.00)
Cypermethrin 0.01%	30	0.0(1.81)	93.3(81.14)	93.3(81.14)	100.0(90.00)	100.0(90.00)
Decamethrin 0.003%	30	0.0(1.81)	30.0(33.00)	100.0(90.00)	100.0(90.00)	100.0(90.00)
Decamethrin 0.007%	30	20.0(26.07)	100.0(90.00)	100.0(90.00)	100.0(90.00)	100.0(90.00)
Endosulfan 0.07%	30	0.0(1.81)	73.3(59.00)	83.3(66.64)	83.3(66.64)	90.0(71.66)
Fenvalerate 0.01%	30	0.0(1.81)	30.0(33.00)	80.0(63.43)	80.0(63.43)	90.0(75.05)
Methamedophos 0.04%	30	0.0(1.81)	0.0(1.81)	50.0(45.00)	63.3(52.86)	90.0(71.66)
Methyl parathion 0.05%	30	6.6(12.89)	73.3(50.00)	83.3(66.64)	83.3(66.64)	90.0(71.66)
Permethrin 0.01%	30	0.0(1.81)	76.6(61.21)	76.6(61.21)	76.6(61.21)	80.0(64.00)
Phenthoate 0.05%	30	0.0(1.81)	0.0(1.81)	0.0(1.81)	0.0(1.81)	0.0(1.81)
Phosalone 0.05%	30	0.0(1.81)	6.6(12.89)	50.0(45.08)	50.0(45.08)	50.0(45.06)
Quinalphos 0.05%	30	0.0(1.81)	33.3(34.92)	66.7(53.06)	66.7(55.07)	80.0(64.00)
Control	30	0.0(1.81)	0.0(1.81)	0.0(1.81)	0.0(1.81)	0.0(1.81)
C. D. at 5%		(7.18)	(11.52)	(12.77)	(11.77)	(10.60)

*Figures in parentheses are $\sqrt{\frac{1}{n+1}}$ values.

0.04%, methamedophos 0.04% and fenvalerate 0.01%. Barring phenthoate 0.05%, all the treatments, however, proved better than control.

A larval parasite (*Microplitis* sp; Braconidae : Hymenoptera) was observed parasitising 10% population of *S. albiflava* under field conditions.

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A STUDY OF INTERGENERATION CORRELATIONS IN FOUR WHEAT CROSSES

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Since the proportion of plants with favourable gene combination decreases rapidly with advancing generation, therefore, selection needs to be exercised as early as possible, starting from F_2 generation onwards. However, the effectiveness of early generation selection for yield depends on the ability to identify superior yielding plants in early generations and on the persistence of this superiority in the subsequent generations. A high correlation between the performance of the plants selected in early generations and the performance of their progeny in later generation is a requirement for early generation selection. Keeping this in view, present study of intergeneration correlations was undertaken to measure the effectiveness of early generation selection for yield in bread wheat.

During rabi 1985-86 season, a large, precisely space-planted F_2 populations consisting of about 1800 plants in each of four wheat crosses, viz. Exotic 37 $\times$ Sonalika (Cross 1), WL 711 $\times$ HD 2285 (Cross 2), Exotic 112 $\times$ WH 291 (Cross 3) and WH 147 $\times$ HD 2285 (Cross 4) were grown for exercising visual selection. From each of four F_2 nurseries, about 200 visually screened plants were scored for

four traits, viz. grain yield per plant, effective tillers per plant, grain number per ear and 1000-grain weight. After observing the data on these two traits, viz. tillers and yield per plant, finally 47 F_2 plants, from each of four crosses, having higher values of yield and effective tillers were selected. The seeds of these 47 F_2 plants in each cross were grown in F_3 progeny rows alongwith the parents in a randomized block design with three replications at Haryana Agricultural University Research Farm during 1986-87 season. The row to row distance was kept 23 cm and plant to plant 10 cm. Ten randomly selected competitive plants from each of F_3 progenies per replication were scored for number of effective tillers per plant, grain number per ear, 1000-grain weight (g) and grain yield per plant (g). The phenotypic correlations between F_2 parent plants and their corresponding F_3 progeny means were computed using Pearson's product moment method.

The correlations between F_2 parent plant and their corresponding F_3 progenies means for yield and its three important component traits in four wheat crosses are given in Table 1. The intergeneration correlations were significant for all the charac-

INTERGENERATION CORRELATIONS IN WHEAT

TABLE 1

Correlation coefficients (r F_2/F_3) in four wheat crosses

Trait	Cross			
	1	2	3	4
Tillers/plant	0.47**	0.39**	0.33*	0.43**
Grains/ear	0.29*	0.32*	0.24 NS	0.21 NS
1000-grain weight (g)	0.44**	0.35*	0.39*	0.36*
Grain yield/plant (g)	0.34*	0.41**	0.27 NS	0.31*

1=Exotic 37 $\times$ Sonalika; 2=WL 711 $\times$ HD 2285; 3=Exotic 112 $\times$ WH 291 and 4=WH 147 $\times$ HD 2285

* $P=0.05$

** $P=0.01$

tillers in all the four crosses except for grains per ear and grain yield in cross 3 and for grains per ear in cross 4. The results of the present study indicate that selection of plants having higher value for both yield and number of effective tillers per plant simultaneously in precisely spaced F_2 nurseries has some effect on the yield of F_3 progenies since there was significant correlation between F_2 and F_3 yields in three out of four wheat crosses studied. Knott (1972) found that visual selection for grain yield in spaced F_2 population was effective and reflected in F_3 progenies. Pawar *et al.* (1986) in their earlier study also observed significant correlations between F_2 plants and their F_3 progenies. However, Mc Ginnis and Shebeski (1968) obtained non-significant correlations between F_2 and F_3 yields. In addition, the correlation between F_2 plant and F_3 progenies for number of effective

tillers per plant was highly significant for all the four crosses studied indicating thereby that selection of plants having higher tillering potential in F_2 nurseries was also desirable. Briggs and Shebeski (1968) were also able to increase yielding capacity of F_3 lines by selecting the vigorous and high tillering F_2 plants.

Hence, on the basis of present study, it can be suggested that selection of plants having higher value of yield as well as tillers, both, in precisely spaced F_2 population may be effective for increasing the yielding capacity of F_3 progenies. However, from the data in Table 1, 1000-grain weight and number of effective tillers also appear to be quite effective. Therefore, greater emphasis should be laid on these components while making selections in wheat breeding programme.

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EFFECT OF TEMPERATURE ON PHENOLOGY OF WINTER MAIZE

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Temperature, being an index of sensible heat of atmosphere, is an important parameter influencing the growth and development of different phenophases. It influences the rate of photosynthate formation, respiration losses, and translocation of photosynthates. It has been reported that yield potential of winter maize (*Zea mays* L.) is higher by 30 to 40 per cent as compared to the kharif season crop due to favourable micrometeorological conditions (Abu, 1983; Singh, 1986) apart from lesser insect pest, disease and weed infestation. The present study has, therefore, been taken up to assess the influence of temperature on development of different phenophases in winter maize.

A pot experiment was conducted during the rabi season of 1986 wherein maize (cv. Pratap) was sown on 6 January, 1986. Daily observations on leaf and node appearance, leaf and stem growth, appearance of tasselling, silking and reproduction phenophases were recorded in six tagged pots. The daily heat units were calculated using 5°C as base temperature for winter maize. The pots were irrigated at an interval of 2 days.

Total cumulative heat units required for the initiation of different phenophases

TABLE 1

Number of days after sowing (DAS) and cumulative heat units for different phenological events in winter maize

Phenological occurrence	DAS	Cumulative heat units (day °C)
Germination	19	134
First leaf	20	141
First tiller	35	269
First node	68	671
Flag leaf	84	909
Tasselling	101	1246
Silking	105	1336
Grain filling	114	1555
Maturity	131	1994

have been given in Table 1. The data reveal that upto the vegetative growth, grain filling and maturity stages cumulative heat units of 1246, 1555 and 1994 day °C, respectively, are required for winter maize at Hisar. These heat units determine the maximum amount of heat required by maize plant when water was not a limiting constraint. Knowing these heat unit requirements of winter maize, possibility of growing in other zones of the state can be estimated and length of growing season can be determined depending on the diurnal temperature

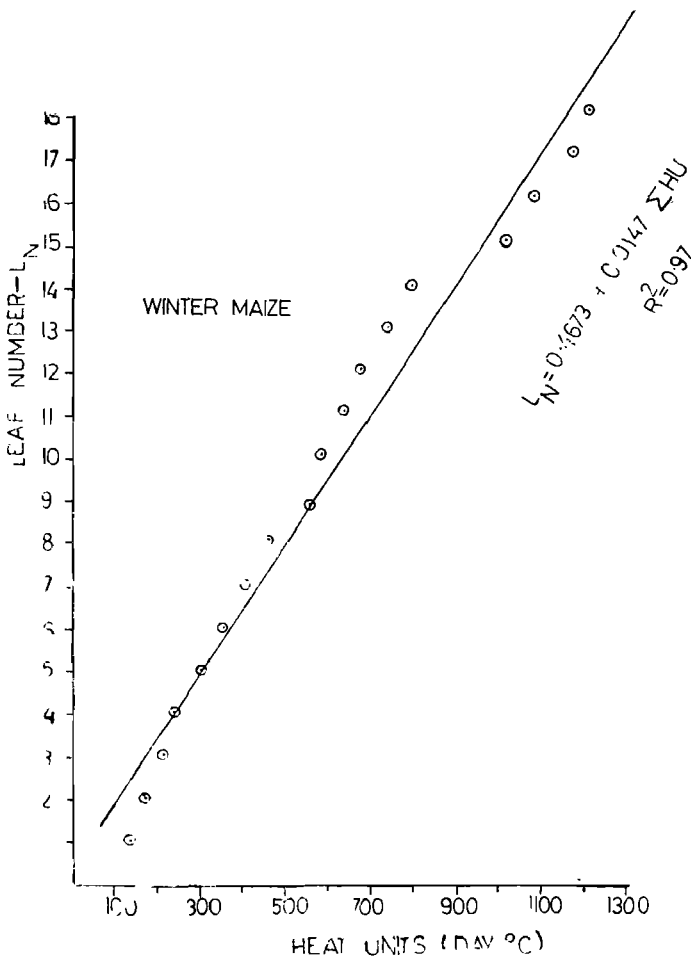


Fig. 1. Cumulated heat units in relation to leaf number.

pattern of the region. The likely date of occurrence of different phenophases in these regions can also be assessed.

Fig. 1 shows a strong linear relation between leaf appearance and cumulated heat units indicating that leaf appearance is also controlled by the prevailing temperature. Data in Table 2 indicate that the node length attains a maximum for a particular value of cumulated heat

units and when cumulated heat units exceed this limit, the excess heat energy is utilised for the growth of next node and the process continues. Further, the energy use for the growth of different nodes in winter maize also shows that their growth required varying amount of heat units. For example—for the growth of third node (quantified with maximum length) 160 heat units are required while for 7th node 39 heat units and for 12th

EFFECT OF TEMPERATURE ON PHENOLOGY OF MAIZE

TABLE 2

Heat units requirement for node appearance, maximum length of node and node growth period in winter maize

Node No.	Cumulative heat units (day °C) for the nodes		
	Appearance	Attaining maximum length	Growth period
1	670.6	1016.9	289
2	850.0	1389.8	494
3	971.0	1489.8	654
4	1080.0	1500.8	737
5	1140.0	1533.4	805
6	1202.0	1533.4	862
7	1316.0	1578.9	901
8	1336.0	1629.2	1954
9	1386.0	1675.3	1010
10	1412.0	1828.4	1103
11	1442.0	1937.8	1224
12	1675.3	1937.8	1311
13	1828.4	1937.8	1404

node 87 heat units are required. whereas first node needed 289 heat units. The heat unit requirement for each nodal development seems to have a direct bearing in the dry matter accumulation needed for its maximum growth.

The cumulative heat units for the development of different nodes are also linearly related. With the help of these regression functions using the daily cumulated heat unit values during the growing season, the prediction of occurrence of different phenophases, viz. germination, leaf appearance, node appearance, attaining maximum length of each node, development of each node, appearance of tillers, flag leaf, tasselling, silking, soft dough and maturity in winter maize can be accurately predicted with the use of prevailing air temperature data.

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EXPECTATION AND PERFORMANCE OF WOMEN LABOUR AND LANDLORDS IN PADDY CULTIVATION IN SELECTED VILLAGES OF HARYANA

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ABSTRACT

Women labourer's expectation in paddy cultivation differed significantly from the expectation of their landlords. There was also significant difference between perceived/evaluated performance of women labour and landlords in all the three aspects—performance of work, inadequate training and unsatisfying working conditions.

Expectation and performance—the two concepts have diverse meaning in relation to the role of an incumbent. Expectation is anticipation and actualization in the imagination of coming events in relation to the objective of aspiration (Learch, 1985); on the other hand performance is the completion of an intended or promised action and the observable exercise of a skill. There have been several studies which bring out a wide gap between expectation and performance in any role. Expectation and performance as far as employee and employer are concerned remain almost at two poles, moreover in situations where expectations of an employee and employer are related to farm operations where large number of women labour is employed. Though women labour is engaged in cultivation of different crops but the situation is more plightful in paddy cultivation. The present paper attempts to study the expectation and performance of women labour and landlords in paddy cultivation.

METHODOLOGY

Out of four main districts under paddy cultivation in Haryana, viz. Karnal, Kurukshetra, Ambala and Sonapat, two districts—Kurukshetra and Karnal were selected at random. Thanesar block from Kurukshetra district and Karnal block from Karnal district were selected. Umri and Mirzapur villages from Thanesar block and Kunjpura and Mohammadpur villages from Karnal block were selected purposively due to easy accessibility. For the selection of respondents out of the four selected villages, two exhaustive lists of women labour and landlords who had more than 10 acres of land were prepared. From the lists of labour and landlords, a proportionate sample was drawn from each village to make the total of women labour respondents as 200 and landlords as 120. Duly pre-tested close ended interview schedule was constructed to meet the objectives of the study.

RESULTS AND DISCUSSION

The data in Table 1 reveal that there was significant difference between mean scores of women labour and landlords expectation in all the four aspects, viz. wages, recognition, working conditions and interpersonal relationship (Z value=2.762, 5.567, 4.1892 and 22.4028, respectively), thereby, confirming the fact that women labour's expectation differed significantly from the expectation of their landlords in paddy cultivation.

During data collection it was revealed from the labour that since they had to walk to the place of work and no facility was provided by the landlords for conveyance it became very difficult to abide by the timings and more so when they had to complete the work of looking

after the children before reaching the place of work. In absence of any proper facility/consideration from landlords, inspite of ill health women had to carry their small children to the place of work. The low wages compared to men also resulted in poor expectation from the landlords. On the other hand the landlords either did not feel any necessity to increase the wages or were not in a position to do so because of pressure of their own union. The landlords were only concerned with the amount of work they were supposed to get in return for wages given to labour and nothing beyond it. Thus, the relationship of the labour with the employers was only restricted to as worker.

Data in Table 2 indicate the differential self perceived/evaluated performance of women labour and landlords

TABLE 1

Differential expectation of women labour and landlords engaged in paddy cultivation

S. No.	Expectation aspects	Mean	S. D.	Z. cal. at 5% level of significance
1.	Wages			
	Women labour	6.09	0.377	2.762*
	Landlords	6.37	1.008	
2.	Recognition			
	Women labour	5.45	0.985	5.567*
	Landlords	4.62	1.835	
3.	Working conditions			
	Women labour	7.93	1.286	4.1892*
	Landlords	8.55	1.857	
4.	Interpersonal relationship			
	Women labour	7.50	2.024	22.4028*
	Landlords	10.67	1.186	

Z tab. at 5% level of significance=1.96

No. of respondents was 200 and 120 in case of women labour and landlords, respectively.

TABLE 2

Differential performance of women labour and landlords engaged in paddy cultivation

S. No.	Performance aspects	Mean	S. D.	Z. cal. at 5% level of significance
1.	Performance of work			
	Women labour	9.82	1.536	24.063*
	Landlords	5.33	3.252	
2.	Inadequate training			
	Women labour	4.66	2.965	3.2953*
	Landlords	4.17	0.869	
3.	Unsatisfying working conditions			
	Women labour	7.02	1.261	13.19*
	Landlords	4.41	3.958	

Z tab. at 5% level of significance=1.96.

No. of respondents was 200 and 120 in case of women labour and landlords, respectively.

engaged in paddy cultivation. The data indicate that there was significant difference between women labour and landlords perceived/evaluated performance in all the three aspects, viz. performance of work, inadequate training and unsatisfying working conditions (Z value= 24.063, 3.2953 and 13.19). It confirms the fact that in all the three aspects of performance, women labour's performance differed significantly from the evaluated performance of their landlords.

The women labour was of the opinion that they performed their duties to the best of their capacity. They felt that at no stage of any operation of paddy

cultivation, any skill training is required to improve their performance. On the other hand the landlords felt that at no stage unskilled labour performed their duties satisfactorily and require skill training. Majority of women labour perceived high level of performance, whereas their landlords evaluated low level of performance of women labour engaged in paddy cultivation.

The difference between the mean score (using Z test) of women labour and landlords in relation to expectation and performance was found to be significantly different.

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APPEARANCE AND DISAPPEARANCE OF REFLEXES IN INFANTS (0-3 MONTHS)

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ABSTRACT

The reflexes (withdrawal, palmar grasp, moro, sucking and rooting) in the infants with the birthweight below 2.5 kg and above 2.5 kg were studied for three months from birth. The study revealed that all the reflexes were present at birth in infants with birthweight above 2.5 kg. The sucking and rooting reflexes were absent at birth in female infants with birthweight less than or equal to 2.5 kg. The palmar grasp and moro disappeared by three months in all the infants, except female infants with birthweight less than or equal to 2.5 kg. The withdrawal and sucking reflexes were present even on the 90th day in all the infants. The rooting reflex disappeared only in male infants with birthweight above 2.5 kg.

Reflex is the simplest form of involuntary response to a certain stimulus such as touch, prick, etc. According to Vaughan and Mckaya (1975) a larger number of primitive reflex can be elicited during the first three months of life. The presence of the new born reflexes at birth and their gradual disappearance later on serve as indicators to neurological development. Their absence in the new born indicates some interference with the sub-cortical grey matter and brain system activity. Persistence of the reflexes for example, the moro, babinski, palmar grasp, etc. beyond certain period indicates some sort of intracranial disorder or lack of cortical control over the sub-centres. Thus, the presence or absence of the reflexes at birth and also their stages of disappearance are very useful in indicating the rate of development of the child.

MATERIAL AND METHODS

A longitudinal study of the withdrawal, palmar grasp, moro, sucking and rooting reflexes among 64 infants from birth to three months was carried out during the period of September 1984 to June 1985. For the study, 32 male and 32 female babies born at local, private and municipality hospitals were selected. Minimum number of subjects was studied because of limited time of the student researcher. Equal number of males and females was selected, but equal number of low birthweight and normal birthweight could not be studied because during the period of study there were not many cases of low birthweights in Dharwad, and also some very weak prematures did not survive, hence only 9 male and 17 female infants with birthweight equal or less

than 2.5 kg and 23 male and 15 female infants with birthweight above 2.5 kg were included in the study.

The moro reflex was graded on the day of birth according to Gorden's method (1929). Kalra *et al.* (1968) and Sohi and Dayal (1977) methods were adopted to measure palmar grasp, sucking and rooting reflexes. The withdrawal reflex was graded by stimulating the sole of the infant's foot with finger; the response obtained was leg flexion and was graded as follows :

Grade 0—Reflex absent,

Grade 1—Slight movement of the foot when stimulated,

Grade 2—Slight flexion of the leg when stimulated, and

Grade 3—Strong flexion of the leg when stimulated.

The infants were tested for these reflexes after every 15 days upto three months. The intensity of the reflexes was graded as follows :

Grade 0—Reflex absent,

Grade 1—Reflex poor,

Grade 2—Reflex fair, and

Grade 3—Reflex very strong.

The mean reflex scores for each visit were calculated separately for males and females in the two groups of the sample with birthweight 2.5 kg and below, and above 2.5 kg. The investigator was trained by a doctor (Child Specialist) of private Nursing Home, Dharwad.

The reliability was tested on 17% of the sample. The scores were verified for three times. The scores were correlated and their significance was tested by 't' test. The results of the correlation were found to be significant at 1 per cent for withdrawal, moro, palmar grasp and sucking reflexes. For rooting reflex it was significant at 5 per cent, indicating that the scoring was reliable.

RESULTS AND DISCUSSION

Presence and Absence of Reflexes

The data of each reflex from the day of birth upto three months are shown in Tables 1-7. From the data in Table 1 it is evident that the withdrawal reflex was absent in 3.1% of the low birthweight infants at birth. The mean scores were maximum on the 15th day in case of male infants with birthweight above 2.5 kg (Table 3), whereas in case of female infants the scores were maximum at the day of birth and continued to remain upto the 15th day and later on decreased. In case of male infants with low birthweight, the mean scores were maximum on 30-45 days, whereas in low birthweight female infants the scores were maximum on 45th day and decreased later on. The withdrawal reflex was present even on the 90th day in all the cases (Table 3).

Palmar grasp was absent in 12.5% of the low birthweight infants at birth (Table 1). The mean scores were maximum for children weighing above 2.5 kg at the day of birth itself and continued to remain upto 15 days (Table 4), whereas the mean scores were maximum on 30th day and 45th day in low birth weight males and females, respectively and

REFLEXES IN INFANTS

TABLE 1
Percentage of reflexes absent from birth to 60th day

S. No.	Reflex	At birth			15th day			30th day			45th day			60th day		
		NBW	LBW	T	NBW	LBW	T	NBW	LBW	T	NBW	LBW	T	NBW	LBW	T
1.	Withdrawal	0.0	3.1	3.1	0.0	1.6	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.	Palmar grasp	0.0	12.5	12.5	0.0	6.3	6.3	0.0	3.1	3.1	0.0	1.6	1.6	0.0	1.6	0.0
3.	Moro	0.0	10.9	10.9	0.0	4.7	4.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.	Sucking	7.8	39.1	46.9	0.0	23.4	23.4	0.0	10.9	10.9	0.0	0.0	0.0	0.0	0.0	0.0
5.	Rooting	20.3	29.7	50.0	0.0	18.8	18.8	0.0	4.7	4.7	0.0	1.6	1.6	0.0	1.6	0.0

TABLE 2
Percentage of reflexes present on 75th and 90th day

S. No.	Reflex	75th day		90th day	
		NBW	LBW	NBW	LBW
1.	Withdrawal	100.0	100.0	100.0	100.0
2.	Palmar grasp	56.2	93.7	40.6	78.1
3.	Moro	45.3	90.6	42.2	65.6
4.	Sucking	100.0	100.0	98.4	100.0
5.	Rooting	56.2	96.9	50.0	87.5

NBW = Normal birthweight babies (N=38)

LBW = Low birthweight babies (N=26)

T = Total (64)

TABLE 3

Mean scores of withdrawal reflex in infants

Days	Male infants		Female infants	
	≤2.5 kg (N=9)	>2.5 kg (N=23)	≤2.5 kg (N=17)	>2.5 kg (N=15)
0 (At birth)	1.78±0.79	2.83±0.48	1.47±0.84	2.87±0.33
15	2.00±0.82	2.96±0.20	1.59±0.77	2.87±0.33
30	2.11±0.57	2.78±0.41	1.83±0.70	2.67±0.47
45	2.11±0.57	2.26±0.53	1.88±0.58	2.13±0.49
60	1.78±0.42	1.87±0.37	1.82±0.51	1.93±0.44
75	1.33±0.47	1.57±0.49	1.47±0.49	1.47±0.49
90	1.22±0.42	1.17±0.38	1.47±0.49	1.27±0.44

TABLE 4

Mean scores of palmar grasp reflex in infants

Days	Male infants		Female infants	
	≤2.5 kg (N=9)	>2.5 kg (N=23)	≤2.5 kg (N=17)	>2.5 kg (N=15)
0 (At birth)	1.56±1.16	2.87±0.33	1.06±0.93	2.87±0.33
15	1.78±1.13	2.87±0.33	1.35±0.90	2.87±0.49
30	2.11±0.73	2.52±0.49	1.53±0.77	2.53±0.49
45	2.00±0.47	1.78±0.50	1.59±0.59	2.00±0.51
60	1.56±0.68	1.17±0.48	1.53±0.49	1.33±0.47
75	0.89±0.56	0.17±0.37	1.12±0.58	0.33±0.47
90	0	0	0.82±0.70	0

TABLE 5

Mean scores of moro reflex in infants

Days	Male infants		Female infants	
	≤2.5 kg (N=9)	>2.5 kg (N=23)	≤2.5 kg (N=17)	>2.5 kg (N=15)
0 (At birth)	1.56±1.06	2.78±0.50	1.18±0.85	2.93±0.24
15	2.00±0.94	2.78±0.41	1.71±0.82	2.73±0.44
30	2.11±0.31	2.13±0.44	1.94±0.41	2.13±0.49
45	1.44±0.49	1.39±0.48	1.71±0.45	1.53±0.49
60	1.00±0.00	1.09±0.28	1.06±0.23	1.07±0.24
75	0.67±0.47	0.04±0.20	0.82±0.38	0.13±0.33
90	0	0	0.29±0.45	0

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TABLE 6

Mean scores of sucking reflex in infants

Days	Male infants		Female infants	
	≤2.5 kg (N=9)	>2.5 kg (N=23)	≤2.5 kg (N=17)	>2.5 kg (N=15)
0 (At birth)	0.11±0.31	1.69±0.74	0	1.87±1.02
15	0.78±0.78	2.26±0.79	0.35±0.47	2.40±0.80
30	1.33±0.94	2.65±0.56	0.76±0.54	2.73±0.57
45	1.67±0.66	2.69±0.46	1.35±0.47	2.53±0.49
60	1.89±0.73	2.43±0.49	1.65±0.58	2.27±0.44
75	1.89±0.56	1.69±0.46	2.00±0.00	1.93±0.44
90	1.78±0.41	1.09±0.40	1.88±0.32	1.60±0.48

TABLE 7

Mean scores of rooting reflex in infants

Days	Male infants		Female infants	
	≤2.5 kg (N=9)	>2.5 kg (N=23)	≤2.5 kg (N=17)	>2.5 kg (N=15)
0 (At birth)	0.33±0.47	1.43±1.01	0	1.60±1.08
15	0.89±0.87	2.30±0.68	0.52±0.49	2.40±0.80
30	1.33±0.66	2.30±0.62	1.12±0.58	2.33±0.59
45	1.56±0.49	1.65±0.56	1.52±0.60	1.93±0.24
60	1.33±0.47	1.22±0.41	1.65±0.47	1.53±0.49
75	0.78±0.41	0.17±0.37	1.29±0.45	0.53±0.61
90	0.11±0.31	0	1.06±0.23	0.40±0.48

decreased later on. This reflex was found to disappear completely on the 90th day in all the cases except low birthweight female infants (Table 4).

The moro reflex was absent in 10.9% of the low birthweight infants at birth (Table 1). The mean scores were maximum for infants (male and female) weighing above 2.5 kg on the day of birth itself, whereas in case of low birthweight infants the means were maximum on the 30th day and decreased later on.

They were found to disappear in all the cases on the 90th day except the female infants with low birthweight (Table 5).

The sucking reflex was absent in 46.9% of the infants at birth (Table 1). The mean scores were maximum on 30th day for female infants and on the 45th day for male infants with birthweight above 2.5 kg, whereas in low birthweight infants the scores were maximum on 60-75 days for male infants and on 75th day for female infants. However, this reflex was

found to persist even on the 90th day in all the cases (Table 6).

At birth the rooting reflex was not exhibited by 50% of the infants (Table 1). The mean scores reached a maximum on the 15th day in infants with birthweight above 2.5 kg. In case of low birthweight male infants the scores were maximum on the 45th day and in low birthweight female infants the scores were maximum on 60th day and decreased later on. However, it disappeared only in male infants above 2.5 kg birthweight (Table 7).

Hence from the above data it can be concluded that the low birthweight infants took a longer time to mature and their rate of development was also comparatively slower than infants with birthweight above 2.5 kg. Among the infants with low birthweights the male infants were faster in maturation compared to the female infants. They also reached the maximum mean scores earlier than females.

According to Vaughan and Mckaya (1975), Biehler (1976) and Craig (1983) these above reflexes are present at birth in mature infants. The infant with birthweight less than 2.5 kg is considered as immature (Kher *et al.*, 1962). In the present study the withdrawal, palmar grasp, moro, sucking and rooting reflexes were present on the day of birth itself in case of normal infants. Only 7.8 and 20.3 per cent normal birthweight infants did not exhibit the sucking and rooting reflexes, respectively at birth. Out of 7.8 and 20.3 per cent of normal birthweight infants 3.1% of the infants were born to mothers with illness and the others were

born with assisted delivery (Caesarean, forcep, breech, vacuum). Hence, this factor may have influenced the reflex score at birth. By 15th day these infants had also developed the sucking and rooting reflexes (Table 1). Regarding low birthweight infants, a few infants did not exhibit the reflexes at birth. This is because infants below 2.5 kg are immature. From the data in Table 1 it can be seen that the protection reflexes, *viz.* the withdrawal and moro were first to appear in the low birthweight infants. Only 10.9% of the infants did not exhibit the moro reflex and 3.1% did not exhibit the withdrawal reflex at birth. The next reflex that appeared in the low birthweight infants was the sucking reflex. It was present in a few low birthweight infants at birth, but in 10.9% it was not present even on the 30th day. The palmar grasp and rooting reflexes appeared in the low birthweight infants after the appearance of sucking reflex. Though these were present at birth itself in few low birthweights, in others these developed after a long period. However, by 30-45th day all the low birthweight infants had developed the withdrawal, palmar grasp, moro, sucking and rooting reflexes.

Regarding the disappearance of the reflexes, by 90th day 0, 81.3, 92.2, 1.6 and 62.5 per cent of withdrawal, palmar grasp, moro, sucking and rooting reflexes had made their disappearance, respectively. This shows that moro disappeared first in the infants, next were the palmar grasp and rooting reflexes. But the sucking and withdrawal reflexes were found to persist even on the 90th day in almost all the cases (Table 2). This shows that a higher percentage of low birthweight

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children had also developed normally without any implications of neurological impairment.

From the study it can be concluded that birthweight of the infant plays a major role in the appearance and disappearance of reflexes. The infants with birthweight 2.5 kg and below had poor reflex score at births when compared to the normal infants. In most of the low birthweights the sucking and rooting reflexes were absent at birth. But these

reflexes developed by 15th day, and were present in all the infants by 60th day. The withdrawal, palmar grasp and the moro reflexes had appeared at birth in all the infants with normal birthweight.

The palmar grasp, moro and the rooting reflexes disappeared earlier in case of normal birthweight infants when compared to the low birthweights. Only the withdrawal and sucking reflexes had not disappeared by 90th day in most of the cases.

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PER CENT YIELD, MEAT CONTENT, BONE CONTENT AND PROXIMATE COMPOSITION OF GOAT PRIMAL CUTS

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ABSTRACT

Study was conducted to estimate per cent yield, proportion of meat and bone yield and proximate composition of seven primal cuts, *viz.* shoulder, foreshank, brisket, rack, breast, loin and leg using adult spent Beetal $\times$ Black Bengal crossbred goats. The per cent yield of different primal cuts of cold carcass yielded higher for shoulder, foreshank, rack and loin but less for brisket, breast and leg in males as compared with females. The highest yield was recorded for leg cut in both the sexes followed by shoulder, foreshank, rack, loin, breast and brisket. The meat : bone ratio in male was higher than female. The lean meat production for most of the cuts of males was superior. The results of per cent yield of cut up parts, meat content, bone content, meat : bone ratio including moisture, fat, protein and ash per cent showed significant ($P < 0.05$) difference among certain cuts of a particular sex as well as certain particular cuts between two sexes. However, no significant difference could be noticed with respect to per cent yield of cut up parts and ash per cent when overall sex means were taken into consideration.

There are good prospects to utilise the specific wholesale and retail cuts out of the carcass in developing countries. In India, the literature pertaining to goat primal cuts is scanty. Joshi (1979), Khan and Sahni (1979) and Khan (1979) studied the per cent yield of different cuts out of goat carcasses. But little information is available regarding the meat : bone ratio and proximate composition of the specific meat cuts. Such basic information is essential to study the cost economics of special meat items developed from different meat cuts. The present study was conducted to know the per cent yield, meat content, bone content and proximate composition of goat primal cuts.

MATERIAL AND METHODS

Five adult Beetal $\times$ Black Bengal crossbred goats of each sex of age group between 2 to 3 years were taken at a time to conduct the experiment. Slaughtering was done as per the standard procedure mentioned by Gerrard (1964). Each carcass was splitted mechanically, by using meat and bone cutting machine, into seven primal cuts, *viz.* shoulder, foreshank, brisket, rack, breast, loin and legs as per the procedures laid down by Levie (1979). Per cent yield of the individual cut up part was recorded with respect to the cold carcass weight. Per cent meat and bone contents of each primal cut in relation to cold carcass

weight were recorded. Meat : bone ratio of cut up part was also recorded. Samples collected from cut up parts were stored for 15 days at -10°C for proximal analysis. Moisture, fat and ash contents of the samples were estimated as per Kramlich *et al.* (1973) method and protein content by AOAC (1975) method. The results were analysed statistically (Steel and Torrie, 1960) and interpreted.

RESULTS AND DISCUSSION

Per cent yield of different primal cuts, *viz.* shoulder, foreshank, brisket, rack, breast, loin and legs in male and female carcasses has been given in Table 1. The highest yield was recorded for legs in both the sexes followed by shoulder, foreshank, rack, loin, breast and brisket. The leg cut in Jamnapari goats reported by Khan (1979) and Khan and Sahni (1979) and shoulder cut in Barbari goats reported by Joshi (1979) are in similarity with the findings of present study. The difference in the yield of other cuts might be due to difference of breed. Significant ($P < 0.05$) difference in the yield of most of the cuts between sexes except rack and loin cuts was observed in the present study. Within the same sex, the per cent yield of different cuts varied significantly ($P < 0.05$) among themselves except rack and loin in male carcasses and rack, breast and loin in females.

The per cent meat content of shoulder, foreshank, rack and loin cuts was higher in male but lower in brisket, breast and leg to that of female (Table 1). The level of lean meat was higher in Philip-pines native goats as per Arganosa *et al.* (1977) which may be due to breed and

age variation. Males yielded significantly ($P < 0.05$) better lean meat cuts than females. The male carcasses yielded significantly ($P < 0.05$) lower bone per cent compared to females. The proportion of meat yield in meat : bone ratio was significantly ($P < 0.05$) higher in male carcasses than that of females in relation to all the cut up parts.

The moisture, fat, protein and ash per cent of different primal cuts were in the range of 72.67-76.59, 3.23-13.37, 18.64-21.23 and 1.03-1.76 in male, whereas 63.75-74.18, 5.37-16.53, 17.18-19.79 and 1.05-1.51 in female carcasses, respectively (Table 2). The per cent moisture level was higher and fat level was lower in male as compared to female. In most of the cuts the protein per cent was higher in male. The trend of ash per cent was not very remarkably differentiable. The report of Gopalan *et al.* (1980) in goat meat indicated 74.21% moisture, 21.4% protein, 3.6% fat and 1.1% ash which are in almost similarity with the present study for overall mean of different primal cuts. It was observed that the moisture and fat content were highly variable and protein and ash content were more or less similar in different cut up parts. As the degree of fatness increased in the carcass, there was decrease in the moisture content of the meat. This was evident from the brisket cut of both male and female carcasses which gave the highest fat content and lowest moisture content compared to other cut up parts.

The differences between sexes, parts and their interactions in relation to proximate composition of different primal cuts, show that there was significant ($P < 0.05$)

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TABLE 1
Distribution yield of goat primal cuts

Cut up part	Per cent yield of cut up part			Per cent meat yield			Per cent bone yield			Meat : bone ratio		
	Male	Female	Parts mean	Male	Female	Parts mean	Male	Female	Parts mean	Male	Female	Parts mean
Shoulder	eB 23.53 ±0.25	dA 21.12 ±0.37	e 22.32 ±1.20	fB 15.45 ±0.56	eA 11.64 ±0.24	e 13.54 ±1.90	fA 7.25 ±0.42	eB 9.11 ±0.23	e 8.18 ±0.93	cB 2.17 ±0.18	bA 1.28 ±0.01	b 1.72 ±0.44
Fore Shank	dB 17.25 ±0.18	cA 15.30 ±0.41	d 16.27 ±0.97	eB 11.52 ±0.40	dA 9.35 ±0.11	d 10.43 ±1.08	dA 5.34 ±0.36	dA 5.59 ±0.17	d 5.46 ±0.12	cB 2.22 ±0.24	cA 1.68 ±0.03	c 1.95 ±0.27
Brisket	aA 3.75 ±0.30	aB 5.76 ±0.16	a 4.75 ±1.00	aA 1.94 ±0.27	aA 2.67 ±0.30	a 2.30 ±0.36	aA 1.57 ±0.11	aB 2.93 ±0.25	a 2.25 ±0.68	aB 1.25 ±0.17	aA 0.96 ±0.19	a 1.10 ±0.14
Rack	cA 9.90 ±0.42	bA 9.07 ±0.27	c 9.48 ±0.41	cB 5.68 ±0.47	bA 3.82 ±0.08	b 4.75 ±0.93	cA 3.72 ±0.22	cB 4.89 ±0.17	c 4.30 ±0.58	bB 1.57 ±0.20	aA 0.78 ±0.02	a 1.17 ±0.39
Breast	bA 6.41 ±0.32	bB 8.11 ±0.19	b 7.26 ±0.85	bA 4.37 ±0.26	cA 4.70 ±0.24	b 4.53 ±0.16	aA 1.51 ±0.16	aB 3.23 ±0.22	a 2.37 ±0.86	dB 2.96 ±0.22	cA 1.50 ±0.17	d 2.23 ±0.73
Loin	cA 9.50 ±0.30	bA 8.90 ±0.28	c 9.20 ±0.30	dB 7.02 ±0.32	cA 4.84 ±0.20	c 5.93 ±1.09	bA 2.67 ±0.20	bB 3.97 ±0.10	b 3.32 ±0.65	deB 3.18 ±0.28	abA 1.22 ±0.03	d 2.20 ±0.98
Leg	fA 28.45 ±0.37	B 30.84 ±0.47	f 29.64 ±1.19	gA 20.26 ±0.66	fA 20.68 ±0.48	f 20.47 ±0.21	eA 7.23 ±0.32	fB 9.95 ±0.06	e 8.59 ±1.36	dB 2.84 ±0.23	dA 2.08 ±0.05	e 2.46 ±0.38
Sex mean	A 14.11 ±3.48	A 14.16 ±3.41		B 9.46 ±2.49	A 8.24 ±2.40		A 4.18 ±0.93	B 5.67 ±1.06		B 2.31 ±0.27	A 1.36 ±0.17	

Means with similar small letter columnwise and capital letter row-wise are not significantly ($P < 0.05$) different.

TABLE 2
Proximate composition of goat primal cuts

Cut up part	Moisture (%)			Fat (%)			Protein (%)			Ash (%)		
	Male	Female	Parts mean	Male	Female	Parts mean	Male	Female	Parts mean	Male	Female	Parts mean
Shoulder	cb 74.84 ±0.47	cdA 72.36 ±0.29	c 73.60 ±1.24	aA 3.58 ±0.31	aB 6.19 ±0.37	a 4.88 ±1.30	abA 19.70 ±0.31	cA 19.79 ±0.31	b 19.74 ±0.04	aA 1.14 ±0.15	aA 1.05 ±0.13	a 1.09 ±0.04
Foreshank	dB 76.59 ±0.68	eA 74.18 ±0.28	d 75.38 ±1.20	aA 3.23 ±0.21	aB 5.37 ±0.44	a 4.30 ±1.07	aA 18.64 ±0.59	abA 18.72 ±0.17	a 18.68 ±0.04	aA 1.03 ±0.13	aA 1.09 ±0.09	a 1.06 ±0.03
Brisket	aA 64.13 ±0.83	aA 63.75 ±0.97	a 63.94 ±0.19	cA 13.37 ±0.77	dB 16.53 ±1.28	d 14.95 ±1.58	bb 20.50 ±0.53	aA 17.83 ±0.28	a 19.16 ±1.33	cB 1.76 ±0.13	bA 1.51 ±0.08	e 1.63 ±0.12
Rack	cb 74.48 ±0.48	cA 72.30 ±0.60	bc 73.39 ±1.09	aA 3.93 ±0.29	bB 7.95 ±0.50	b 5.94 ±2.01	abB 19.86 ±0.46	aA 17.94 ±0.24	a 18.90 ±0.96	bB 1.31 ±0.09	aA 1.08 ±0.06	a 1.19 ±0.11
Breast	bB 73.02 ±0.63	bA 70.60 ±0.64	b 71.81 ±1.21	aA 4.17 ±0.40	cB 9.50 ±1.20	c 6.83 ±2.66	cB 21.23 ±0.59	abA 18.43 ±0.67	b 19.83 ±1.40	aA 1.17 ±0.09	aA 1.17 ±0.07	a 1.17 ±0.06
Loin	bB 72.67 ±0.39	cA 71.60 ±0.69	b 72.13 ±0.53	bA 5.27 ±0.52	cB 9.56 ±0.68	c 7.41 ±2.14	abB 20.05 ±0.39	aA 17.18 ±0.46	a 18.61 ±1.43	bA 1.31 ±0.14	bA 1.31 ±0.06	b 1.31 ±0.07
Leg	cb 74.47 ±0.51	cdA 72.79 ±0.54	c 73.63 ±0.84	abA 4.57 ±0.57	aB 5.81 ±0.53	ab 5.19 ±0.62	aA 19.07 ±0.45	cA 19.79 ±0.25	ab 19.43 ±0.36	aA 1.22 ±0.13	aA 1.19 ±0.06	a 1.20 ±0.01
Sex mean	B 72.88 ±1.53	A 71.08 ±1.29		A 5.44 ±1.34	B 8.70 ±1.46		B 19.86 ±0.32	A 18.52 ±0.37		A 1.28 ±0.09	A 1.20 ±0.06	

Means with similar small letter columnwise and capital letter row-wise are not significantly ($P < 0.05$) different.

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differences for moisture content between sexes in case of all the cuts except brisket and between overall sex means. Most of the cuts within the same sex also differed significantly among themselves. The results pertaining to fat per cent showed that there was a significant ($P < 0.05$) difference between sexes of all the primal cuts as well as between overall sex means. Data in relation to protein per cent gave the evidence that there was significant ($P < 0.05$) difference between sexes for brisket, rack, breast and loin cuts and also there was significant

difference between overall sex means. Most of the cuts did not differ significantly when parts mean were considered. While considering ash per cent, it was indicated that most of the cuts between sexes as well as the overall sex means did not differ significantly ($P < 0.05$). On the other hand, there was significant difference between sexes for the cuts like brisket and rack. It was also observed that most of the cuts did not differ significantly in respect of ash content when parts mean was considered.

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RESEARCH NOTE

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EFFECT OF HATCHING EGG SANITATION ON HATCHABILITY OF JAPANESE QUAIL (*COTURNIX COTURNIX JAPONICA*) EGGS

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Hatchability of Japanese quail (*Coturnix coturnix japonica*) eggs is found to be comparatively low, partly due to difficulty in locating cracked and soiled eggs since they have tinted appearance. Dry cleaning and or dipping in or spraying antibiotics or antiseptics solutions have been the methods attempted to improve hatchability. Gupta and Rao (1970) observed 1% Savlon (Hospital concentrate) to be better in improving hatchability than other germicidal solutions. Baraboi and Joncuk (1969) have shown that UV rays of 3000 Å do not penetrate the shell of eggs, for 3650 Å penetration was 0.25 to 0.35% and with a wavelength of 4050 Å it was between 1.8 and 2.2%. An attempt was made to find out the effect of spraying or dipping in Savlon and also of exposure to Ultra-violet rays at a wave length of 3650 Å on hatchability of Japanese quail eggs.

Hatching eggs for this study were collected from Japanese quails of the same hatch maintained in multi-tier breeder cages under standard managerial conditions. A male : female ratio of 1 : 3 was maintained and eggs were collected from 21 to 30 weeks of their age. Soon

after collection the eggs were distributed equally to five different groups and treated differently. Savlon (Hospital concentrate) was used at 1% concentration for spraying over broader end or both ends or for dipping. One group was exposed to ultra-violet rays 3650 Å for 30 sec and other group was maintained as control without any treatment. Water at 25°C was used for spraying and dipping. Eggs collected over a week were stored at $18^{\circ} \pm 2^{\circ}\text{C}$ and set for hatching on seventh day. A total of 20,700 eggs were utilised for the study. Standard hatchery managerial procedures were adopted and data on total hatchability and per cent weaklings were recorded. Unhatched eggs were broken open to record apparent infertiles, dead-germs and dead-in-shells. Different hatches served as replicates and per cent values were converted into Arcsin angles and analysed as per Snedecor and Cochran (1976).

Mean values on different hatchability parameters under different treatments are presented in Table 1. Significant differences were not observed between different treatments in any of the parameters studied. Per cent hatchability on total

HATCHABILITY OF JAPANESE QUAIL EGGS

TABLE 1

Per cent hatchability of Japanese quail eggs under different treatments

Parameters Treatment	Hatchability		Infertiles	Dead-germs	Dead-in shells	Weakling
	On total eggs	On fertile eggs				
Control	41.97±3.07	78.35±6.21	46.42±2.40	5.39±0.38	6.21±0.51	1.32±0.25
Savlon 1%						
Spraying on broader end	39.53±4.52	76.55±5.49	48.35±3.19	6.03±0.95	6.08±0.82	1.51±0.21
Spraying on both ends	40.87±3.91	77.61±6.28	47.34±2.82	6.10±0.72	5.69±0.74	1.38±0.26
Dipping	41.88±4.38	76.70±5.98	45.39±3.27	6.07±0.83	6.65±0.73	1.25±0.29
Exposure to Ultra- violet rays 3650 Å°	40.72±3.84	76.46±6.22	46.74±2.87	6.63±0.79	5.90±0.99	1.43±0.53

eggs varied from 39.53 in the Savlon sprayed eggs (over broader end) to 41.97 in control group. Per cent hatchability on fertile eggs ranged from 76.46 to 78.35 while per cent infertiles observed were 45.39 to 48.35. Hence, neither Savlon treatments (spraying or dipping) nor exposure to Ultra-violet rays seemed to have any effect in terms of better hatchability or reduced incidence of dead-germs, dead-in-shells or weaklings.

Earlier findings of Gupta and Rao (1970), Montgal *et al.* (1976), Gajendran

(1978) and Srinivasan (1986) on improvement of hatchability of chicken eggs upon spraying or dipping in Savlon (Hospital concentrate) cannot be relied upon to yield similar results with Japanese quail eggs.

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EFFECT OF HERBICIDES TREATMENTS ON NITROGEN AND SUGAR CONTENTS OF WHEAT AND LENTIL PLANTS

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ABSTRACT

Nitrogen content decreased in wheat (var. WH-157) plant during growth when treated with 2, 4-D. In wheat shoot 4.62% nitrogen was observed at 30 days in terbutryne (1.25 kg a.i./ha) treated plots. Increase in nitrogen content in wheat plant during different stages of growth was observed in hand weeding as compared to control (no weeding). There was an increase in nitrogen content of wheat root at 30 days in different herbicides treatments except nitrofen. Total sugar reduced in wheat plant during growth in herbicide treated plots in comparison to hand weeding. Nitrogen and total sugars in lentil plants during growth increased in hand weeding. The variation in sugar was statistically significant between the herbicides treatments. A significant increase in nitrogen in lentil roots during growth in bifenox treated plots was observed when compared to control and hand weeded plots. These herbicides affected nitrogen and sugar levels in wheat and lentil plants adversely.

Wheat and lentil, the major crops of rabi season suffer from a number of weed species due to competition for growth nutrients. Weeds reduce the yield and quality of crop (Sugha, 1979). Prometryne has been reported to give good weed control and increase the yield of legumes by decreasing competition between crop and weeds (Prakash and Singh, 1970, 1973; Singh *et al.*, 1973; Prakash and Pahwa, 1977). Mani (1975) showed varying magnitudes of nitrogen depletion by weed growth in wheat, pea, rice, maize and sorghum fields. Herbicides used for weed control affect different metabolic processes of the plant

which in turn affect growth. Therefore, the present study was undertaken to study the effects of herbicides treatment on nitrogen and sugar contents in wheat and lentil plants.

MATERIAL AND METHODS

Wheat (var. WH-157) and lentil (var. L 9-12) were sown on 21 Nov. and 14 Nov., respectively, at the Research Farm of Haryana Agricultural University, Hisar. The experiment was laid out in a randomised block design with four replicates in plot size of 5×4 metres. Spraying of herbicides was done on 24 Nov. and 16

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Nov., respectively using 1000 litres of water per hectare. The treatments consisted of simazine (0.25, 0.50 and 0.75 kg a.i./ha), fluorodifen (0.50, 0.75 and 1.00 kg a.i./ha), metribuzin (sencors 0.25 kg a.i./ha) and bifenox (mowdown, 0.50, 0.75 and 1.00 kg a.i./ha) in lentil; and terbutryne (1.25 and 1.50, kg a.i./ha), nitrofen (TOK 1.00 and 1.50 kg a.i./ha) in wheat as pre-emergence and nitrofen (1.00 and 1.50 kg a.i./ha) and 2, 4-D (0.50 kg a.i./ha) in wheat as post-emergence. Hand weeding and control (no weeding) were also maintained. Samples were collected on 30th, 60th and 90th day after sowing. Shoots, roots and earheads were separated and air dried first and then oven dried and ground separately.

Nitrogen was estimated according to AOAC (1970). Total soluble sugars were estimated by phenol reagent method (Dubois *et al.*, 1956) and reducing sugars by the method of Somogyi (1952). CRD statistical analysis was done.

RESULTS AND DISCUSSION

Nitrogen content increased in wheat plant during growth of hand weeded plants as compared to control, where no weeding was done (Table 1). Nitrogen content in shoot at 30 days increased in all the herbicides treatments as compared to control, while there was decrease in nitrogen content in root except at 1.25 kg a.i./ha terbutryne treatment. Highest

TABLE 1

Effect of herbicides treatment on nitrogen content (per cent) in wheat

Treatment	Dose (a.i. kg/ha)	Days after sowing						
		30		60		90		
		Shoot	Root	Shoot	Root	Shoot	Root	Earhead
Control		3.92	1.54	2.94	0.98	2.10	2.10	1.82
Hand weeding		4.20	1.96	3.22	1.40	2.24	2.52	1.82
Terbutryne	1.25	4.62	1.82	3.50	1.54	2.24	1.82	1.54
-do-	1.50	4.06	1.54	3.64	1.26	2.10	1.54	1.68
Nitrofen	1.00	4.06	1.40	2.38	1.26	1.82	1.82	1.96
-do-	1.50	4.06	1.40	2.94	0.98	2.10	1.54	2.10
-do- (PE)	1.00*	—	—	3.08	1.26	2.38	1.96	1.96
-do- (PE)	1.50*	—	—	2.94	0.84	2.10	1.54	1.84
2, 4-D (PE)	0.50*	—	—	2.80	0.84	1.82	1.40	1.82
F Values		40.71	46.25	47.52	8.66	40.09	271.48	51.39
Significance between treatments		**	**	**	**	**	**	**

*Significant at 5 per cent.

**Significant at 1 per cent.

PE—Post-emergence application.

amount (3.64%) of nitrogen content in shoot at 60 days was observed in the case of terbutryne treated plots (1.50 kg a.i./ha). There was increase in nitrogen content of wheat shoots at 60 days as compared to the control except in 2, 4-D and nitrofen (1.00 kg a.i./ha as pre-emergence) treated plots; while the same amount of nitrogen was observed in shoot at 1.50 kg a.i./ha nitrofen treated plots both as pre-emergence and post-emergence treatments. Similar trend was observed in the case of wheat root at 60 days. There was decrease in nitrogen content of shoot at 90 days at 1.00 kg a.i./ha nitrofen and 2, 4-D treated plots as compared to the control, while in other treatments there were no major changes. Nitrogen content in root at 90 days decreased in all the herbicides treatments. There was wide variation of nitrogen content in earheads at 90 days due to different herbicide treatments. Herbicides treatments do affect the biochemical component in plant system during growth. Metabolism of nitrogen and phosphorus was affected by triazines in horse bean and wheat crops (Darbent and Rudzenska, 1976; Declaire *et al.*, 1976). Statistical significance was observed in between the herbicide treatments.

There was increase in total soluble and reducing sugars in plant parts during growth in hand weeded plot as compared to control (no weeding) (Table 2). Total soluble sugars in shoot at 30 days ranged from 4.0 to 10.0 per cent and the reducing sugars from 0.20 to 1.85 per cent with terbutryne (1.25 kg a.i./ha) and nitrofen (1.00 kg a.i./ha) as pre-emergence treatments, while in root

the values ranged from 2.00 to 6.32 per cent and 0.15 to 1.42 per cent amongst different types of treatments, respectively.

Total soluble sugars in shoot and root at 60 days increased due to herbicide treatment as compared to the control, except in high doses of terbutryne treated plots. Treatment with herbicides markedly reduced competition between crop and weeds for nutrients with concomitant increase in carbohydrates in wheat during growth due to synthesis of carbohydrates from its precursors. Nearly the same trend in reducing sugars in shoot and root at 60 days was observed. At 90 days there was reduction of total soluble sugars in shoot with different treatments except an increase in terbutryne (1.50 kg a.i./ha) treated plot. There was an increase in reducing sugars in shoot in herbicide treated plots as compared to that in control. Soluble sugars decreased in root at 90 days as compared to the control and hand weeding plots with the exception in nitrofen treated (1.50 kg a.i./ha) plots. Herbicides treatments affect the metabolism and mobilization of carbohydrates from one part to another (Strbac *et al.*, 1967).

There was an increase in nitrogen content in lentil plant parts during growth in hand weeded plots as compared to control (Table 3). There was no marked change in nitrogen content in shoot at 30 days while in root nitrogen content varied from 1.68 to 3.78 per cent among different herbicides treatments. Nitrogen content, however, decreased in shoot at 60 days except in hand weeding (5.46%) and simazine (0.50 kg

TABLE 2
Effect of herbicides treatment on total soluble and reducing sugars (per cent) in wheat

Treatment	Dose (a.i. kg/ha)	Days after sowing											
		30				60				90			
		Shoot		Root		Shoot		Root		Shoot		Root	
		TS	RS	TS	RS	TS	RS	TS	RS	TS	RS	TS	RS
Control		7.50	1.05	3.30	0.50	6.18	0.35	2.95	0.15	16.60	1.60	4.50	0.22
Hand weeding		8.32	1.42	6.32	0.85	8.16	0.65	4.00	0.23	19.30	2.00	4.67	0.30
Terbutryne	1.25	4.00	0.35	3.82	0.15	7.00	0.30	3.18	0.15	12.54	2.60	2.50	0.10
-dn-	1.50	5.50	0.20	2.00	0.15	6.67	0.50	2.50	0.10	18.64	2.40	3.50	0.15
Nitrofen	1.00	10.00	1.85	5.00	1.00	7.50	0.22	4.32	0.15	10.74	2.84	2.07	0.20
-do-	1.50	5.30	1.72	5.32	1.42	8.50	0.42	7.66	0.20	12.34	3.30	4.67	0.10
-do- (PE)	1.00	—	—	—	—	7.08	0.30	3.67	0.10	9.34	3.34	3.18	0.15
-do- (PE)	1.50	—	—	—	—	7.50	0.42	7.50	0.15	11.30	3.12	3.07	0.20
2, 4-D (PE)	0.50	—	—	—	—	7.00	0.35	4.50	0.20	11.00	3.60	3.67	0.10

F Values 540.76 260.46 417.51 78.88 44.14 11.90 387.12 3.44 607.16 11.55 343.16 8.78

Significance between treatments

*Significant at 5 per cent.

**Significant at 1 per cent.

PE—Post-emergence application.

TS—Total soluble sugars.

RS—Reducing sugars.

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TABLE 3

Effect of herbicides treatment on nitrogen content (per cent) in lentil

Treatment	Dose (a.i. kg/ha)	Days after sowing					
		30		60		90	
		Shoot	Root	Shoot	Root	Shoot	Root
Control		4.62	2.80	5.18	2.80	3.36	2.24
Hand weeding		4.76	2.94	5.46	3.08	3.92	2.38
Simazine	0.25	4.62	2.80	5.18	3.36	4.06	2.38
-do-	0.50	4.62	2.38	5.32	3.50	3.78	1.68
-do-	0.75	4.76	1.68	4.48	3.22	3.64	1.54
Fluorodifen	0.50	4.48	2.52	5.18	3.08	4.06	1.96
-do-	0.75	4.48	1.82	4.76	2.66	3.08	2.10
-do-	1.00	4.62	3.22	5.46	2.38	3.36	1.68
Metribuzin	0.25	4.34	3.08	5.04	2.80	2.94	1.96
Bifenox	0.50	4.20	2.94	4.76	3.08	3.78	2.54
-do-	0.75	4.20	3.78	4.43	3.38	3.50	2.54
-do-	1.00	4.35	3.22	4.76	3.22	3.08	2.40
F Values		3.30	9.01	0.98	13.75	1.17	8.26
Significance between treatments		**	**	NS	**	NS	**

**Significant at 1 per cent.

NS— Not significant.

a.i./ha) (5.32%) treatments when compared with control, while no change in nitrogen content was observed in simazine (0.25 kg a.i./ha) and fluoro-difen (0.50 kg a.i./ha) treated plots. Nitrogen content at 90 days in shoot and root also varied due to herbicides used in treatments. The effects due to the use of different herbicides are significant.

Increase in total soluble and reducing sugars in plant parts of lentil during growth in hand weeded plots as compared to control was observed (Table 4). At 30 days, total soluble as well as reducing sugars increased in shoot in all the herbicides treated plots except

bifenox (mowdown) treated plots where a decrease in sugar content was observed. At 60 days, total soluble sugars in shoot varied from 6.50 to 11.32 per cent among different herbicides treatments, while reducing sugars varied from 0.35 to 2.15 per cent. The differences in reducing sugars in root at 60 days amongst the different herbicide treatments are statistically significant. At 90 days, total soluble sugars in shoot increased with the exception of simazine (0.75 kg a.i./ha) treated plots as compared to that in control while same amount of total soluble sugars was observed in bifenox (0.75 kg a.i./ha) treated plots. Pahwa and Prakash (1980) have reported that

TABLE 4
Effect of herbicides treatment on total and reducing sugars (per cent) in lentil

Treatment	Dose (a.i. kg/ha)	Days after sowing											
		30				60				90			
		Shoot		Root		Shoot		Root		Shoot		Root	
		TS	RS	TS	RS	TS	RS	TS	RS	TS	RS	TS	RS
Control		7.86	1.20	3.67	0.30	10.00	0.35	4.50	0.15	9.30	2.10	4.67	0.20
Hand weeding		7.90	1.60	4.32	0.45	10.70	0.45	4.65	0.20	10.60	2.52	4.82	0.35
Simazine	0.25	9.65	1.30	3.80	0.50	8.18	1.50	4.32	0.30	9.65	2.80	4.50	0.45
-do-	0.50	10.00	1.35	3.35	0.57	10.95	1.35	3.40	0.30	10.34	2.15	4.16	0.30
-do-	0.75	10.00	2.25	3.67	0.30	8.00	1.45	4.67	0.15	8.32	2.10	3.67	0.35
Fluorodifen	0.50	9.65	1.50	3.50	0.20	6.50	0.45	3.00	0.15	10.30	3.02	4.16	0.40
-do-	0.75	9.17	1.60	4.50	0.15	10.30	1.95	4.67	0.10	15.00	6.80	6.68	0.15
-do-	1.00	9.00	1.45	4.67	0.25	8.32	0.90	4.50	0.15	10.64	4.40	6.50	0.20
Metribuzin	0.25	8.32	1.35	4.67	0.18	11.32	2.15	4.85	0.10	11.69	4.45	4.75	0.15
Bifenox	0.50	6.68	0.90	3.67	0.25	7.15	0.65	3.35	0.15	10.00	5.20	4.16	0.57
-do-	0.75	6.85	1.00	5.16	0.30	10.00	1.15	5.00	0.15	9.30	3.90	5.37	0.35
-do-	1.00	7.50	1.20	4.16	0.35	9.65	0.80	4.20	0.20	9.65	3.30	6.50	0.30
F Values		24.78	10.10	35.98	6.03	79.35	169.36	54.66	24.68	242.74	278.81	105.88	21.67
Significance between treatments		**	**	**	**	**	**	**	**	**	**	**	**

**Significant at 1 per cent.

TS—Total soluble sugars.

RS—Reducing sugars.

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treated seedlings of pea had more nitrogen and phosphorus than untreated seedlings. Herbicide treatments affect the plant metabolism and reduce the competition between crops and weeds

for nutrients. It is, thus, very essential to study the effect of herbicides on plant metabolism and quality of food/feed, when used to control weeds.

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COMBINING ABILITY ANALYSIS FOR YIELD AND ITS ATTRIBUTES IN LEAF RUST RESISTANT STOCKS OF WHEAT

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ABSTRACT

The combining ability analysis in an 11×11 half diallel set in F_1 and F_2 generations of wheat was performed for six characters, viz. grain yield per plant, spikes per plant, grains per spike, 1000-grain weight, spike length and plant height. Both additive and non-additive effects were found to be important in the expression of various characters studied in F_1 and F_2 generations. However, predictability ratio was high only for 1000-grain weight, spike length and plant height both in F_1 and F_2 generations. Variety WH 283 was found general combiner in F_1 generation. Exploitation of this variety alongwith P 1523 was advocated. In F_2 generation *gca* effects were found to be related with mean performance for spikes per plant, 1000-grain weight and spike length. But *sca* effects were related with mean performance of the crosses for all the characters except plant height. Cross combinations WH 331 $\times$ P 1501, WH 337 $\times$ WH 331 and WH 291 $\times$ P 1501 appeared to be promising which may be exploited for improvement of traits of economic importance.

Information on the combining ability of leaf rust resistant genetic stocks is important for effective breeding programme in wheat. It is, therefore, necessary to assess the genetic potential of the leaf rust resistant parents by estimating their combining ability before they are used in a hybridization programme aimed at combining resistance and high grain yield in wheat.

MATERIAL AND METHODS

Eleven genetic stocks of wheat alongwith their 55 F_1 and 55 F_2 combinations from one way diallel cross formed the material for the present study. All these stocks except Agra local, which is

universally susceptible, were known for their field resistance to leaf rust in three seasons, at different locations, viz. Karnal, Kaul, Wellington and Hisar. The material was grown in a randomized block design with three replications during 1984-85. The plot size was a single row of one metre length with plant to plant and row to row distance of 10 and 30 cm, respectively. Ten competitive plants from each parent and the F_1 and 30 plants from each F_2 in each replication were taken randomly for recording data on characters like grain yield per plant (g), spikes per plant, grains per spike, 1000-grain weight (g), spike length (cm) and plant height (cm). Combining ability analysis was carried

COMBINING ABILITY ANALYSIS IN WHEAT

out following Griffing (1956) for model 1, method 2. The predictability ratio was calculated as suggested by Baker (1978) to assess the progeny performance in early generations.

RESULTS AND DISCUSSION

Analysis revealed significant variance for parents and crosses, for all the characters studied. Mean squares due to general combining ability (*gca*) and specific combining ability (*sca*) were significant in F_1 and F_2 populations for all the characters studied reflecting that both additive and non-additive genetic components were involved in the inheritance of all the traits. The predictability ratio suggested greater importance of additive genetic variance and, therefore, greater predictability for 1000-grain weight, spike length and plant height depending upon both F_1 and F_2 gene-

rations (Table 1). The F_2 generation showed the decline in the magnitude of *sca* variances for grain yield per plant, spikes per plant and grains per spike. Such results have also been reported by Thombre *et al.* (1983). Decline in estimates of *sca* variances in F_2 is possibly attributed to the reduction of dominance from F_1 to F_2 for these characters.

An overall appraisal of the *gca* effects (Table 2) showed that there was no similar pattern for general combining ability effects for all the traits in F_1 and F_2 generations. This was also indicated by Khurana *et al.* (1983). Based on F_1 studies, WH 283 proved to be a good parent for grain yield per plant, spikes per plant, grains per spike, 1000-grain weight and plant height. Similarly P 10015 was a good parent for spikes per plant, grains per spike, 1000-grain

TABLE 1

Components of combining ability and predictability ratios in diallel analysis

Component	Character					
	Grain yield/ plant	Spikes/ plant	Grains/ spike	1000-grain weight	Spike length	Plant height
σ^2_{gca}						
F_1	3.14	0.91	4.80	5.99	0.17	58.68
F_2	0.65	0.65	8.03	4.92	0.14	30.46
σ^2_{sca}						
F_1	42.11	6.26	17.55	5.21	0.02	32.15
F_2	10.42	1.80	15.77	6.83	0.22	50.43
Predictability ratio						
$\frac{2\sigma_g^2}{2\sigma_g^2 + \sigma_s^2}$						
F_1	0.12	0.22	0.56	0.69	0.94	0.78
F_2	0.11	0.42	0.50	0.58	0.56	0.54

TABLE 2

Estimates of general combining ability effects of parents for different traits in F_1 and F_2 (in parentheses) diallel progenies in wheat and rank correlations of mean performance with *gca* and *sca* effects

Parents	Grain yield/ plant	Spikes/plant	Grains/spike	1000-grain weight	Spike length	Plant height
WH 283	3.25** (-1.39**)	0.51** (-0.64**)	1.97** (-1.15**)	1.00** (-0.11)	0.06 (-0.26**)	-2.29** (-3.97*)
WH 291	0.07 (-0.01*)	0.06 (-0.80**)	0.42 (0.87)	0.18** (-1.79**)	-0.28** (-0.33**)	-2.66** (-4.23*)
WH 337	-1.69** (-1.22**)	-1.58** (-0.39)	-1.93** (0.06)	1.60** (1.17**)	-0.16** (0.08)	1.00* (0.95)
WH 167	1.14** (0.78)	-0.47** (-0.42)	0.29 (-1.49**)	3.59** (3.90**)	0.51** (0.44**)	1.77** (2.46)
WH 331	-1.88** (-0.18)	0.70** (0.05)	-1.01** (4.19)	-4.68** (-3.67**)	-0.34** (-0.19*)	-7.04** (-5.45**)
P 1438	1.08** (0.13)	0.42* (0.17)	-0.65* (-2.04**)	1.37** (0.06)	0.47** (0.56**)	-2.2** (-0.56)
P 1501	-0.11 (1.46**)	-9.91** (-0.65**)	4.32** (5.06**)	-2.06** (0.02)	-0.83** (-0.66**)	-4.80** (-3.90*)
P 10015	0.34 (-0.08)	0.33* (-0.88)	2.06** (0.32)	0.66** (0.70)	0.83** (0.44**)	2.32** (0.64)
P 1486	-3.01** (0.12)	-0.45** (1.15**)	-3.91** (0.43)	-2.60** (-2.78**)	-0.11 (0.11)	-3.55** (-2.41)
P 1523	-0.88** (1.09**)	-0.65** (0.83**)	-1.06* (-5.77)	-2.68** (3.04**)	0.01 (0.12)	-3.81** (0.95)
Agra local	1.29** (-0.01)	2.04** (1.58**)	-0.49 (-5.87**)	-0.37 (-0.53)	-0.15** (-0.32**)	21.42** (15.52**)
SE (gi)	0.26 (0.45)	0.16 (0.24)	0.30 (0.61)	0.22 (0.43)	0.05 (0.08)	0.39 (1.68)
SE (gi-gj)	0.39 (0.67)	0.24 (0.36)	0.45 (0.91)	0.33 (0.64)	0.08 (0.12)	0.59 (2.49)
Rank correlation of mean						
with <i>sca</i> effects	0.938**	0.624**	0.764**	0.799**	0.540**	0.277
with <i>gca</i> effects	0.445	0.873**	0.600	0.910**	0.819**	0.363

*Significant at 5 per cent.

**Significant at 1 per cent.

weight and spike length. P 1438 was a good parent for spikes per plant, 1000-grain weight, spike length and plant height. Thus, inclusion of these parents in wheat breeding programme will be useful as these can nick well with other parents for more than two characters simultaneously.

F₂ studies revealed that P 1523 was a good general combiner for grain yield per plant, spikes per plant, 1000-grain weight and plant height. Similarly WH 157 was good general combiner for 1000-grain weight and spike length, P 1438 for spike length and plant height, WH 331 and P 1501 for grains per spike and plant height. So these parents can give better segregants for different characters.

From the data in Table 2 it is evident that the parents showing best general combining ability effects for a particular character in F₂ deviated from those estimated from the F₁ data. Good combining ability in F₁ indicated the performance of two parents when brought together in

one combination. This may be because of the dispersed genes in the parents. Moreover, good combining ability in F₂ generation indicated the ability of the parents to throw transgressive segregants. Considering the significance of rank correlation coefficient between the *gca* effects of parents and their means, it appeared that *per se* performance as such might give an indication of the *gca* of the parents involved for spikes per plant, 1000-grain weight and spike length. However, the mean performance was correlated with *sca* effects for all the characters except for plant height in F₂ generations. This showed that *per se* performance of crosses can give an idea of the *sca* effects of crosses involved in F₂ generations. Both *per se* performance and *sca* effects showed that for improvement of different characters, different crosses will have to be used. However, the cross combinations WH 331 × P 1501, appeared to be desirable for grain yield per plant, spikes per plant, grains per spike and 1000-grain weight simultaneously.

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RESEARCH NOTE

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STUDIES ON RODENT POPULATION STRUCTURE AND TRAP INDEX IN THE FIELDS OF HARYANA STATE

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Agarwal and Khanna (1983) have described Haryana State substantially comprising arid or semi-arid belt with brackish ground water, semi-dry monsoonal climate and erratic rainfall. Since the inception of the State, much emphasis has been laid on small irrigation projects and the increased irrigation potentials, thus, for have opened up various issues of ecological importance. The present studies have been focussed on the inter-relationship of murid population with the changing soil type and vegetation all through Haryana State. The exploratory belt, therefore, runs from the South-western districts through North-eastern parts to the most Eastern ones of the State.

Based upon the quantitative impact of changing land-use the studies on rodent population structure and trap index were carried out in the fields of various districts of Haryana State (Fig. 1). The latter included Prahaladgarh village of Bhiwani, Nimbi village of Mahendragarh, Daultabad village of Gurgaon, outskirts of Rohtak, Gangwa village of Hisar, Air force station of Sirsa, Ramray village of Jind, Kunjpura village of Karnal and Singhawala village of Ambala. Following Prakash (1962), at each trapping point,

two trap lines were fixed of the available habitats, viz. waste land, crop land and ruderal complex. None of the present explored areas included rocky habitat. Two trap lines about 15 m apart were laid parallel to each other in almost similar habitat so as to avoid harbouring different densities of the species under study. Each trap line consisted of 30 traps at 10 m interval (Prakash *et al.*, 1971). Both Snap as well as Sherman traps were used. The trap lines were run for three nights and peanut butter was used as a bait. The rats collected were removed early in the morning and thereafter at a four hourly interval till evening. The trap index was calculated following Barnett and Prakash (1975) as follows :

$$I = \frac{M}{x.t}$$

Where

x = Number of traps used in a trap line,

t = number of nights during which traps were set,

M = total number of animals trapped.

Rodent population structure and trap index revealed by trappings conducted in the fields of various districts of the State through years 1982-87 are given in

RODENT POPULATION OF HARYANA STATE

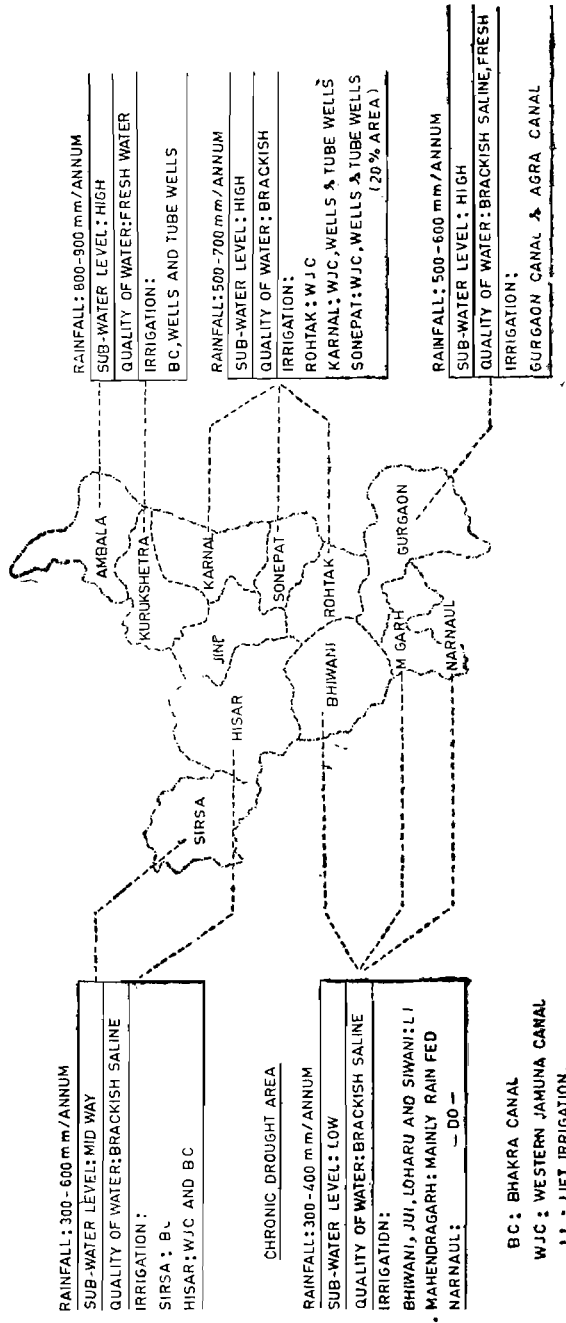


Fig. 1. Geo-climatic zones of Haryana State.

TABLE 1
Murid population structure and trap index in Haryana State

Trapping point (season)	Habitats available	Murids trapped with percentage frequency					Trap index	
		<i>T. indica</i>	<i>M. hurlianae</i>	<i>M. M.</i>	<i>M. M.</i>	<i>R. rattus</i>	<i>R. m. melitana</i>	<i>B. bengalensis</i>
Prahaladgarh village Bhiwani (Rabi season)	Waste land Crop land Ruderal	17.1 45.9 —	7.3 — —	— 29.1 —	— — 24.0	— — 68.0	43.9 25.0 —	31.7 — 8.0
Nimbi village Mahendragarh (Rabi season)	Waste land Crop land Ruderal	32.1 46.8 —	50.0 — —	— — —	— — 34.8	— — 65.2	— — —	17.9 29.2 —
Daultabad village Gurgaon (Rabi season)	Waste land Crop land Ruderal	38.5 55.6 —	38.5 7.4 —	— 11.1 —	— — —	— — 46.7	23.0 25.9 —	— — 46.7
Outskirts Rohtak (Rabi season)	Waste land Crop land Ruderal	28.6 — —	23.8 — —	— 63.2 —	— — 21.4	— — 78.6	— — —	47.6 36.8 —
Gangwa village Hisar (Rabi season)	Waste land Crop land Ruderal	30.5 66.7 —	69.5 24.2 —	— 9.1 —	— — 32.0	— — 56.0	— — —	— — 12.0
Opp. Air Force Station, Sirsa (Rabi season)	Waste land Crop land Ruderal	35.3 36.0 —	64.7 — —	— 16.0 —	— — 43.5	— — 34.8	— — —	— 28.0 41.7
Ramray village Jind (Rabi season)	Waste land Crop land Ruderal	48.8 48.7 —	19.5 10.8 —	31.7 — —	— — 42.3	— — 57.7	— 24.3 —	— 16.2 —
Kunipura village Karnal (Zaid season)	Waste land Crop land Ruderal	80.0 30.0 —	20.0 — —	— — —	— — —	— — 80.9	— 18.2 —	— 51.4 19.1
Singhawala village Ambala (Kharif season)	Waste land Crop land Ruderal	45.5 — —	18.1 — —	— — —	— — 40.0	— — 50.0	— 66.7 —	36.4 33.3 —
								10.0

RODENT POPULATION OF HARYANA STATE

Table 1. South-western districts, viz. Bhiwani, Mahendragarh and Narnaul invariably include chronic drought areas where rainfall ranges between 300 mm and 400 mm per annum. They have been facilitated with lift irrigation schemes since 1969. The rodent population complex in these areas has depicted a blending of the forms befitting both to mesic and xeric habitats. North-eastern (Hisar and Sirsa districts) and South-eastern (Gurgaon and Rohtak districts) parts of the State have advantageous agro-climatic conditions where the irrigation has been aided up with proliferating canal system. Here the annual rainfall ranges between 300 mm and 600 mm. Consequently, the introduction of canals and application of new technologies have resulted in an increased production of food grains vis-a-vis increase in the intensity and variety of rodent population in the State. The sandy plains have been converted into crop fields with the result merion gerbils have migrated out due to mass destruction of their complex burrows and their number has, thus, been reduced (Fitzwater and Prakash, 1969). The State has, therefore, undergone much changes with respect to soil characteristics, vegetation, land use and habitat during the past nearly two

decades which have affected the original native biota. The catches conducted in the North-eastern and South-eastern parts have revealed a reduction in the level of infestation by the xeric forms. Prakash (1978) has already described such quantitative impact of changing land-use pattern on the rodent communities in part of the Indus Basin and reported replenishment of rodent fauna.

In the Eastern parts (Karnal, Jind, Kurukshetra and Ambala districts) of the State, the irrigation has been facilitated with wells and tubewells since there is availability of fresh ground water. The latter's over-exploitation has, thus, resulted in the falling of water table. These areas also receive comparatively a heavy rainfall ranging between 500 mm and 900 mm. The present explorations carried out in these areas have revealed much replacement of xeric species with mesic forms.

The average trap indices obtained from different habitats available in various districts of the State have indicated the field murid population to be well under manageable extent since it figures below five in each case.

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CHEMICAL WEED CONTROL IN WINTER MAIZE (*ZEA MAYS* L.)

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ABSTRACT

Post-emergence 2, 4-D at 0.50 kg/ha applied at 55 DAS, or pre-emergence atrazine at 0.75 kg/ha gave season long weed control in winter maize. Cyanazine and alachlor were not effective. Cob length, cob girth and grains/cob were significantly higher in plots treated with 2, 4-D (0.50 kg/ha) or atrazine (0.75 kg/ha) or three hand weedings as compared to alachlor or cyanazine treated plots. Maize with a yield of 4304 kg/ha in weed free check produced 4055 kg/ha in atrazine (0.75 kg/ha) treated plots and 4057 kg/ha in 2, 4-D (0.50 kg/ha) treated plots. The average grain yield in the weedy check was 1790 kg/ha.

Growing of maize during the winter season with 30 to 40 per cent higher yield than kharif maize (Narang, 1984) has opened new vistas for the development of its cultural practices. During the month of December and January, winter maize remains dormant but weeds grow profusely in the absence of any canopy cover. In the present study, an attempt was made to evaluate the performance of different herbicides for controlling weeds in the winter maize.

MATERIAL AND METHODS

A field experiment was conducted during the winter season in 1985 and 1986 at Haryana Agricultural University, Hisar. The experimental field was sandy loam with a pH of 8.0 and 0.4% organic carbon. Variety Ageti-76 was sown at a row spacing of 75 cm using 15 kg seed/ha. Fertilizers, irrigations and insecticides

were applied according to the recommended package of practices. Atrazine (2-chloro-4 (ethyl-amino) -6- (isopropyl-amino)-S-triazine) and cyanazine (2-chloro-4-(1-cyano-1-methylethylamino)-6-ethylamino-1, 3, 5-triazine) each at 0.25, 0.50 and 0.75 kg/ha, alachlor (2-chloro-2', 6-diethyl-N-(methoxymethyl) acetanilide) at 1.0, 1.5 and 2.0 kg/ha and 2, 4-D (2, 4-dichlorophenoxyacetic acid) at 0.5 kg/ha were compared with three hand weedings done at 30, 60 and 90 days after sowing (DAS), weedy and weed free checks. All herbicides except 2, 4-D were applied pre-emergence with a knapsack sprayer using 750 litre water/ha. 2, 4-D was applied post-emergence at 55 DAS. Number/m² and dry weight (g) of total weeds and *Chenopodium* were recorded at 60 and 120 DAS and also at harvest with the help of 0.5×0.5 m quadrates.

RESULTS AND DISCUSSION

Effect on Weeds

Weed population averaged over years in the weedy check revealed that *Chenopodium album* L. constituted more than 90% of the total population. Other weeds present in the field were *Lathyrus aphaca* L., *Vicia sativa* L. and *Phalaris minor* L. Retz. The population of total weeds in plots where three hand weedings were given was significantly lower than the weedy check at all the stages (Table 1). The control of *Chenopodium* was significantly higher when plots were treated with atrazine at 0.75 kg/ha or with 2, 4-D at 0.50 kg/ha. The effect of herbicides applied at sowing was more in 1985 than in 1986 (Table 2). In 1985, sowing was done after a pre-sowing irrigation but in 1986 sowing was done on the conserved moisture. Less soil moisture at the time of sowing in 1986 was responsible for low efficiency of atrazine. The dry matter accumulation by total weeds and by *Chenopodium* (Tables 1 and 2) was more in the atrazine treated plots than in the 2, 4-D treated crop. Graf *et al.* (1982) also advocated an excellent control of weeds with 2, 4-D in winter maize. Combination of alachlor with atrazine (1.0+0.5 kg/ha) was not as effective as atrazine alone at 0.75 kg/ha or 2, 4-D at 0.5 kg/ha.

Effect on Crop

Winter maize did not pick up its growth until 90 DAS. The crop remained dormant due to low temperature during January and February. The growth of the crop in terms of dry matter

accumulation was very fast between 90 to 120 DAS. The growth of weeds upto 60 DAS was more as compared to maize (Tables 1 and 2). The extensive development of root system of weed plants during this period or even earlier in the treatments where the control was poor might have allowed weeds to absorb more nutrients and moisture from the soil. Therefore, low dry matter accumulation by maize in plots treated with cyanazine or alachlor and in the weedy check was mainly because of severe competition by weeds. The yield attributing characters including length and girth of cobs and number of grains per cob were markedly higher, where dry weight of weeds was lower (Table 3). Average data of both years indicate that in the plots treated with 2, 4-D the number of grains/cob, length and girth of cobs were 43.0, 37.0 and 23.3 per cent higher than the weedy check, respectively. In the treatments where dry weight of weeds was more at the time of tasselling, weeds particularly *Chenopodium album* produced more number of branches from the upper axillary buds and suppressed the maize plant through competition. Alachlor or cyanazine application produced similar yield to that obtained in the weedy check. Rest of the treatments resulted in significantly higher yield over weedy check. The shelling percentage was seriously affected by the presence of weeds in the weedy check. The increase or decrease in the shelling percentage was well supported by the increase or decrease in various yield attributes (Table 3) and the effect of treatments on the dry weight of weeds (Tables 1 and 2).

TABLE 1
Population and dry matter of total weeds as influenced by herbicides applied in maize (average of two years)

Treatment	Herbicide rate (kg/ha)	Time of application	Population (No./m ²)*			Dry matter (g/m ²)		
			60 DAS	90 DAS	At harvest	60 DAS	90 DAS	At harvest
Cyanazine	0.25	Pre	7.78	6.78	6.78	110.3	367.8	230.6
Cyanazine	0.50	Pre	7.45	5.80	6.22	84.0	319.4	183.4
Cyanazine	0.75	Pre	6.64	5.26	5.42	69.0	276.0	140.6
Alachlor	1.00	Pre	7.33	6.27	6.10	78.4	351.0	160.8
Alachlor	1.50	Pre	6.58	5.74	5.58	57.8	289.6	126.2
Alachlor	2.00	Pre	5.85	5.14	5.00	43.0	242.8	104.8
Atrazine	0.25	Pre	12.07	5.92	6.08	54.8	253.9	117.6
Atrazine	0.50	Pre	7.86	4.98	5.10	44.4	222.0	82.2
Atrazine	0.75	Pre	5.68	4.44	4.58	18.4	148.0	41.8
Atrazine + Alachlor	0.25 + 1.00	Pre	6.48	5.14	5.36	41.2	235.6	104.5
Atrazine + Alachlor	0.50 + 1.00	Pre	5.42	4.48	4.76	23.0	193.0	62.0
2, 4-D	0.50	Post	2.48	3.90	5.00	6.2	63.2	26.5
Hand weeding		30, 60 and 90 DAS	6.00	3.60	3.62	15.2	51.6	29.0
Weedy check			8.96	7.12	7.10	123.0	441.7	242.2
Weed free			1.00	1.00	1.00	0.0	0.0	0.0
L. S. D. at 5%			1.25	1.16	0.54	11.6	12.1	16.3

DAS—Days after sowing; Pre—Pre-emergence; Post—Post-emergence.

*Only transformed values obtained from $\sqrt{x+1}$ are presented in the table.

TABLE 2
Population and dry matter of *Chenopodium album* L. as influenced by herbicides applied in maize
(average of two years)

Treatment	Herbicide rate (kg/ha)	Time of application	Population (No./m ²)*			Dry matter (g/m ²)		
			60 DAS	120 DAS	At harvest	60 DAS	120 DAS	At harvest
Cyanazine	0.25	Pre	7.52	5.76	3.18	94.4	316.3	221.0
Cyanazine	0.50	Pre	7.24	4.96	2.58	63.6	252.8	174.6
Cyanazine	0.75	Pre	6.26	4.46	2.44	42.4	219.5	128.0
Alachlor	1.00	Pre	7.04	4.98	2.94	61.2	285.3	150.4
Alachlor	1.50	Pre	6.40	4.78	2.66	44.6	233.2	118.4
Alachlor	2.00	Pre	5.66	4.54	2.40	40.4	187.8	98.8
Atrazine	0.25	Pre	6.28	5.00	2.52	42.3	207.8	129.9
Atrazine	0.50	Pre	5.90	4.36	2.04	42.1	232.9	87.4
Atrazine	0.75	Pre	5.28	3.86	1.66	18.8	116.6	41.3
Atrazine + Alachlor	0.25 + 1.00	Pre	6.00	4.36	2.36	37.9	187.5	111.3
Atrazine + Alachlor	0.50 + 1.00	Pre	5.06	3.88	1.85	19.1	135.2	53.7
2, 4-D	0.50	Post	2.22	1.84	1.52	2.00	13.0	19.0
Hand weeding		30, 60 and 90 DAS	5.62	2.66	1.60	8.9	70.7	30.4
Weedy check			8.66	5.90	4.68	103.6	442.5	236.8
Weed free			1.00	1.00	1.00	0.0	0.0	0.0
L. S. D. at 5%			1.12	0.90	0.40	10.8	12.5	16.6

DAS—Days after sowing; Pre—Pre-emergence; Post—Post-emergence.

*Only transformed values obtained from $\sqrt{X+1}$ are presented in the table.

WEED CONTROL IN WINTER MAIZE

TABLE 3
Effect of different treatments on dry matter accumulation, yield attributes and the grain yield of winter maize
(average of two years)

Treatment	Herbicide rate (kg/ha)	Time of application	Dry matter/plant (g)		Number of grains/ cob	Length of cob (cm)	Girth of cob (cm)	Grain yield (kg/ha)	Shelling percent- age
			60 DAS	120 DAS					
Cyanazine	0.25	Pre	0.35	32.06	106.96	214.6	10.6	1880	64.0
Cyanazine	0.50	Pre	0.38	37.30	125.01	241.0	12.3	2477	70.6
Cyanazine	0.75	Pre	0.39	39.42	132.00	248.2	12.8	2639	71.9
Alachlor	1.00	Pre	0.36	35.68	119.86	227.3	11.2	2305	65.0
Alachlor	1.50	Pre	0.41	42.24	168.46	260.6	12.8	2916	71.7
Alachlor	2.00	Pre	0.42	43.96	176.18	279.4	13.4	3112	75.2
Atrazine	0.25	Pre	0.39	39.76	152.70	304.1	13.0	3029	69.4
Atrazine	0.50	Pre	0.46	45.00	194.16	360.6	15.5	3793	78.1
Atrazine	0.75	Pre	0.48	47.30	199.94	367.9	15.7	4055	80.4
Atrazine + Alachlor	0.25 + 1.00	Pre	0.41	40.00	158.22	329.1	13.7	3441	70.9
Atrazine + Alachlor	0.50 + 1.00	Pre	0.48	46.66	199.10	363.2	15.9	3979	77.8
2, 4-D	0.50	Post	0.42	47.56	200.92	367.0	15.9	4057	79.7
Hand weeding		30, 60 and 90 DAS	0.47	47.56	203.20	364.7	15.5	4131	78.5
Weedy check			0.32	29.05	100.74	210.4	10.0	1790	63.2
Weed free			0.51	50.06	206.28	376.3	16.3	4304	83.0
L. S. D. at 5%			0.01	4.34	8.64	21.3	1.3	483	5.1

DAS — Days after sowing; Pre — Pre-emergence; Post — Post-emergence.

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PERFORMANCE OF URDBEAN/MUNGBEAN GENOTYPES AS INTERCROPS IN PIGEONPEA

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ABSTRACT

Field experiments were conducted during two successive kharif seasons of 1984 and 1985 to explore the possibilities of growing urdbean and mungbean as intercrops between two rows of pigeonpea, normally spaced at 60 cm apart (row to row). Urdbean and mungbean as intercrops produced significantly higher pigeonpea equivalent than sole pigeonpea. Amongst urdbean, T₆ was rated to be higher yielder (8.31 q/ha) than the rest of genotypes. Less average grain yield (6.50 q/ha) was recorded under JU 77-41. Amongst mungbean genotypes, MH 309 was rated superior yielder (9.25 q/ha) closely followed by Pusa 105 (9.00 q/ha). Lowest grain yield (6.36 q/ha) was recorded with genotype PS-16. On the basis of gross income obtained with different treatments, maximum returns of Rs. 8047/ha followed by Rs. 7635/ha were obtained with intercrops of mungbean genotype MH 309 and urdbean genotype Pant U-19, respectively over the gross return recorded with other treatments. Moreover, minimum gross return of Rs. 3388/ha was obtained from that treatment where sole pigeonpea was grown.

Pigeonpea has traditionally been a whole year crop with low yield potential as compared to cereals. Now, with the availability of short duration and high yielding varieties of pigeonpea, it has given opportunity to sustain its production. Initially (upto 50-60 days) the growth of these short duration varieties is quite slow with very little lateral spread. Since, the optimum row spacing for these varieties of pigeonpea is 50-60 cm, a lot of space remains unutilized and the same is quickly covered by the kharif weeds to the disadvantage of pigeonpea. There is, thus, a need based scope to grow crops simultaneously differing in growth habit, adaptation and root system in such a way that they accommodate each other with

least competition. Therefore, an experiment was conducted to see the feasibility of growing urdbean/mungbean as intercrops with early maturing variety of pigeonpea (*Cajanus cajan* L. cv. Manak).

MATERIAL AND METHODS

The experiment was conducted for two consecutive kharif seasons of 1984 and 1985 at Haryana Agricultural University Research Farm, Hisar. Soil of the experimental plot was sandy loam, low in N content (0.3%), medium in available P₂O₅ (32 kg/ha) and high in available K₂O (425 kg/ha) with pH value of 8.3. In all, ten treatments were tested in a randomized block design, replicated three times.

One line of intercrop (urdbean/mungbean) was also sown in between two rows of pigeonpea, spaced at 60 cm apart. Urdbean (*Vigna mungo* L.) genotypes, viz. T₉, Pant U-19, UG 218 and JU 77-41 and mungbean (*Vigna radiata* L.) genotypes, viz. MH 309, PDM 11, K 851, Pusa 105 and PS-16, were sown as intercrops as an individual treatment between two rows of pigeonpea. Sowing of intercrops was done on the same day when pigeonpea was sown. A basal dose of 18 kg N and 46 kg P₂O₅/ ha was drilled at the sowing time. Pigeonpea was sown on July 18 and July 8 during 1984 and 1985, respectively. Pre-sowing irrigation was applied during kharif 1985 as no rains were received upto sowing time. Pigeonpea was sown in lines by adopting *kera* method of sowing, while urdbean/mungbean was sown simultaneously between two lines of pigeonpea with the help of *pora* method of sowing. Only one spray of endosulfan was done against pod borer at pod development stage.

Mungbean genotypes, viz. PS-16, MH 309 and K 851 were harvested on September 22 and September 10, whereas PDM 11 and Pusa 105 were harvested on

October 8 and October 21 during 1984 and 1985, respectively. Urdbean genotype Pant U-19 was harvested earlier on September 28 and September 15 while T₉, UG 218 and JU 77-41 were harvested on October 5 and October 16 during 1984 and 1985, respectively. Harvesting of sole pigeonpea was done on December 6 and November 14 during 1984 and 1985, respectively. The precipitation distribution and mean minimum and maximum temperatures during different stages of crop growth were recorded. During kharif 1984 and kharif 1985, total precipitation was recorded to be 331.2 mm and 334.8 mm, respectively. During 1984, September rains were received which affected the yield of intercrops. Distribution of rains during 1985 was recorded to be beneficial for good harvest of intercrops (Fig. 1). The produce of intercrops was converted into pigeonpea equivalent on the basis of prevailing market price of both urdbean and mungbean. After converting the intercrops into pigeonpea equivalent, the gross return (Rs./ha) was calculated keeping in view the prevailing market prices of seed pigeonpea and pigeonpea sticks.

$$\text{Pigeonpea equivalent} = \frac{\text{Grain yield of intercrop} \times \text{Prevailing market price of the commodity}}{\text{Prevailing market price of the pigeonpea}}$$

RESULTS AND DISCUSSION

Data were collected on yield attributes, grain yield of sole pigeonpea and grain yields of intercrops (Table 1).

Pigeonpea

Intercropping of urdbean and mungbean influenced the grain yield of pigeon-

pea significantly but with varying magnitude (Table 1). During 1984 and 1985, plots intercropped with mungbean genotype Pusa 105, produced significantly lowest average yield of pigeonpea (7.04 q/ha), whereas depression in grain yields of pigeonpea was recorded by the margins of 34.27, 26.80 and 20.45 per cent in

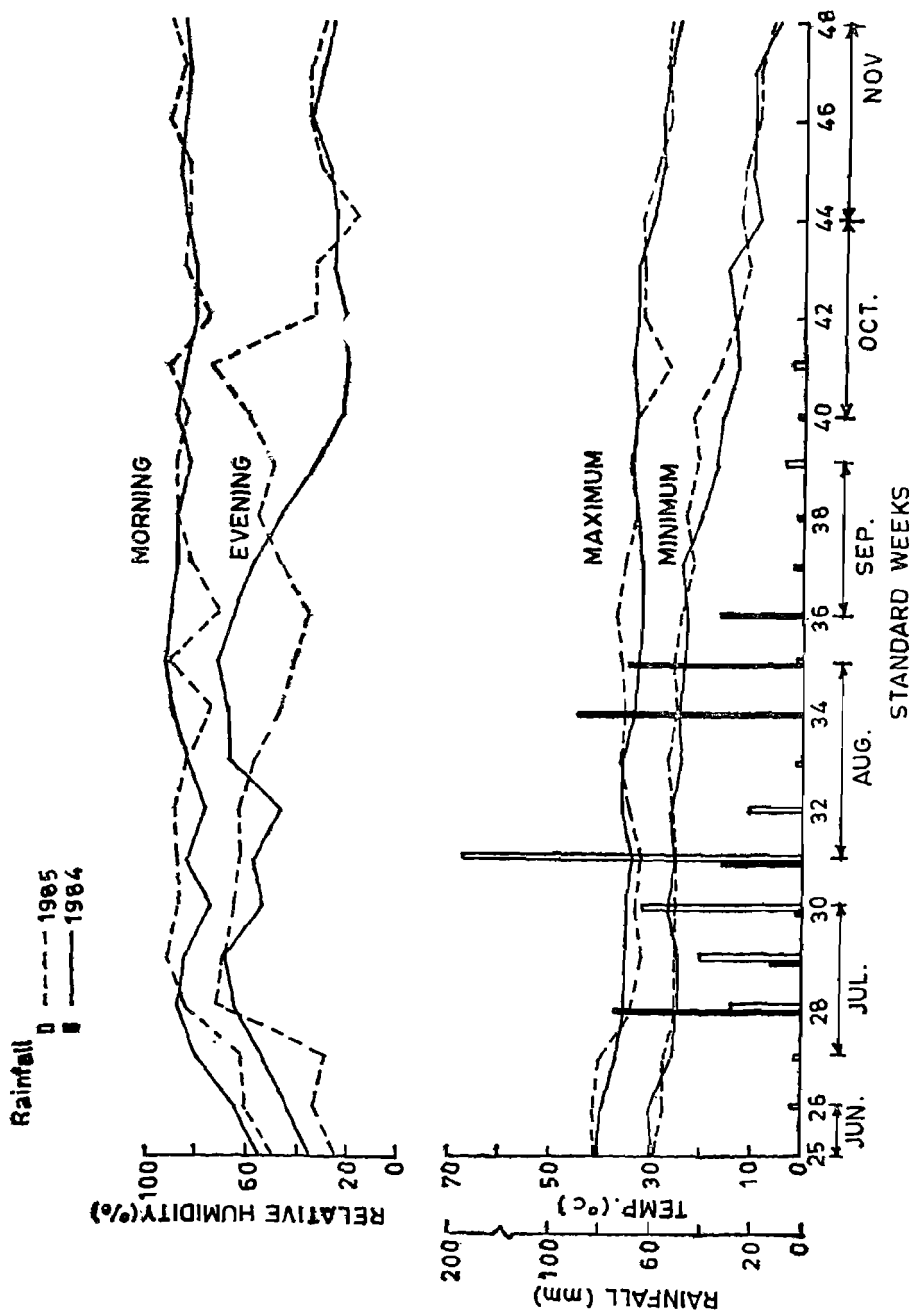


Fig. 1. Meteorological data during the crop season.

TABLE 1
Yield of sole pigeonpea and intercrops, pigeonpea equivalent and gross return (Rs/ha) as influenced by intercropping of urdbean/mungbean

Treatment	Grain yield of pigeonpea (q/ha)			Grain yield of intercrops (q/ha)			Pigeonpea equivalent (q/ha)			Gross return (Rs./ha)			Index of gross return (%)
	1984	1985	Mean	1984	1985	Mean	1984	1985	Mean	1984	1985	Mean	
Pigeonpea sole	10.75	10.67	10.71	—	—	—	10.75	10.67	10.71	3575	3201	3388	100.00
Pigeonpea + T ₂	10.56	10.60	10.58	2.53	14.09	8.31	14.69	23.01	18.85	4752	10083	7418	118.99
Pigeonpea + Pant U-19	13.06	13.46	13.26	2.29	11.87	7.08	16.79	19.38	18.09	5417	9852	7635	125.35
Pigeonpea + UG 218	10.90	11.35	11.13	3.90	11.18	7.54	17.27	18.26	17.77	5510	8883	7196	112.39
Pigeonpea + JU 77-41	9.25	10.06	9.65	3.07	9.93	6.50	14.26	16.21	15.24	4563	7881	6222	83.64
Pigeonpea + MH 309	10.62	11.01	10.81	3.85	14.64	9.25	17.03	24.40	20.72	5470	10623	8047	137.81
Pigeonpea + PDM 11	9.75	10.54	10.41	3.85	12.01	7.93	16.16	20.01	18.02	5158	9165	7161	111.36
Pigeonpea + K 851	7.06	8.62	7.84	3.77	10.39	7.08	13.31	17.31	15.34	4289	7779	6034	78.09
Pigeonpea + Pusa 105	6.06	8.02	7.04	4.06	13.95	9.00	12.79	23.25	18.02	4081	9831	6731	98.67
Pigeonpea + PS-16	7.25	9.79	8.52	2.79	9.93	6.36	11.88	16.55	14.22	3866	7872	5869	73.22
S. Em±	0.12	0.34	—	—	—	—	—	—	—	42.16	108.16	—	—
C. D. at 5%	0.35	0.99	—	—	—	—	—	—	—	122.35	313.89	—	—
Market price of grain (Rs./q)	Pigeonpea Rs 300/-			Urdbean Rs. 500/-			Mungbean Rs. 500/-						
Market price of dry sticks of pigeonpea=Rs. 5/- per quintal													

those plots where Pusa 105, K 851 and PS-16 were sown as intercrops. It was observed that inclusion of urdbean genotype Pant U-19, stimulated the grain yield of pigeonpea upto 23.8% over the grain yield recorded with sole pigeonpea (10.71 q/ha), while rest of the treatments were recorded at par with control. Stimulation in yield of pigeonpea due to urdbean genotype Pant U-19 taken as intercrop, was ascribed to the growth habit of this genotype as it grows close to the soil and makes almost no competition with main crop of pigeonpea. Kaul and Sekhon (1974) also reported the stimulative effect of urdbean when sown as intercrop in pigeonpea.

It was observed that intercropping of mungbean genotypes depressed the grain yield of pigeonpea in comparison with intercropping of urdbean genotypes. Reduction in grain yield of pigeonpea with mungbean genotypes was assigned to the growth habit of latter which grow tall with more lateral spread and thus compete with the sole pigeonpea for light, moisture and nutrients, resulting into lesser number of pods/plant and lesser number of grains/pod of the pigeonpea. The results are in full agreement with the findings of Gupta *et al.* (1979) and Singh *et al.* (1981).

Intercrops

Intercropping of mungbean genotype MH 309 yielded 9.25 q/ha in addition to the pigeonpea grain yield (10.81 q/ha); followed by the grain yields of 9.0, 8.31, 7.93, 7.54, 7.08, 7.08, 6.50 and 6.36 q/ha, recorded under Pusa 105, T₉, PDM 11, UG 218, Pant U-19, K 851, JU 77-41 and PS-16, respectively. The intercrop yields

harvested during kharif 1984 were comparatively lesser than the grain yields obtained during kharif 1985. Sowing date, thus, affected the intercrops yield and the less yields during kharif 1984 were obtained as the crop was sown late on July 18. Another reason of low yields of intercrops might be assigned to the light rains at grain development stage during kharif 1984 which resulted into regrowth of the intercrops and, thus, the process of grain development was disturbed as the available food for grain development was forced to divert towards vegetative part rather than towards grain development. Ali *et al.* (1981) reported the adverse effect of late rains received either at pod development or at grain development stages over the grain yields of intercrops of mungbean/urdbean. They also reported the disadvantage of delayed sowing on the grain yield of intercrops over the grain yields under normal/optimum date of sowing.

Pigeonpea Equivalent

Maximum pigeonpea equivalent (20.72 q/ha) was recorded with intercropping of mungbean genotype MH 309 than rest of the genotypes of mungbean or urdbean sown as intercrops (Table 1). Second highest pigeonpea equivalent was recorded with intercropping of T₉ and Pant U-19 genotypes of urdbean (18.85 and 18.09 q/ha, respectively). Moreover, more pigeonpea equivalent was recorded with all the treatments over the grain yield obtained with sole pigeonpea (10.71 q/ha). Sowing of urdbean/mungbean as intercrops was found to be higher yielder per unit time per unit area than the sowing of sole pigeonpea as also reported by Singh and Singh (1980), Singh *et al.*

(1981) and Singh (1982). Higher pigeonpea equivalents were also reported by these workers under intercropping of mungbean/urdbean than sole pigeonpea.

Gross Return

It is seen from the money values presented in Table 1 that significantly higher returns/ha (Rs. 5510, Rs. 5470 and Rs. 5417) were recorded with intercropping of urdbean genotype UG 218, mungbean genotype MH 309 and urdbean genotype Pant U-19, respectively over the income received under rest of the treatments. Moreover, because of non-significant differences amongst these three treatments, these were rated at par with each other. Significantly lowest income (Rs. 3575/ha) was noticed with sole pigeonpea. Higher income was recorded during kharif 1985 than during kharif 1984 which was only due to better grain yields obtained under intercropping of mungbean/urdbean. Significantly more return (Rs. 10623/ha) was recorded with intercropping of mungbean genotype MH 309 over average gross returns received with rest of the treatments. Intercropping of urdbean genotypes T₉ and Pant

U-19 was also found significantly superior over the average gross income obtained with other treatments, except the income recorded with intercropping of mungbean genotype MH 309. Non-significant differences were recorded amongst the income obtained under intercropping of mungbean genotype MH 309, urdbean genotypes T₉ and Pant U-19. Significantly lowest return (Rs. 3201/ha) was obtained with sole pigeonpea.

Indexes of gross return (%) were more under intercropping over the index of gross return recorded with sole pigeonpea (100% as base index). More indexes of gross return were recorded in the range of 73.22 to 137.81 per cent over the gross return index registered with sole pigeonpea. Roy *et al* (1981), Tomer *et al*. (1984) and Umrani *et al*. (1984) also reported higher income with intercropping of mungbean/urdbean over sole pigeonpea.

On the basis of two year findings, it could easily be concluded that for obtaining more average return, urdbean/mungbean should be intercropped along with pigeonpea.

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EFFECT OF CYCOCEL AND ALAR ON VEGETATIVE GROWTH, FLOWERING, FRUIT-SET, YIELD AND TOMATO LEAF CURL RATING IN TOMATO VARIETIES

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ABSTRACT

Experiments were conducted to study the effect of Cycocel and Alar on growth, flowering, fruit set and severity of tomato leaf curl virus (TLCV) in HS-101 and HS-102 varieties of tomato during autumn of 1985 and 1986. Cycocel @ 200 ppm reduced the plant height and increased the number of branches when applied at 3-4 true leaf stage on nursery. It also increased the number of flowers per cluster, resulted in early fruit set, hastened ripening of fruits, increased number and weight of fruits per plant, reduced the tomato leaf curl severity (%) and number of white flies per plant 45 days after transplanting in both the tomato varieties tested.

Application of plant growth substances to seedlings and foliage has proved beneficial in regulating growth, flowering, fruit set and yield of tomato (Pandita *et al.*, 1986). Further, information on the effect of plant growth substances on tomato leaf curl virus, a serious disease of tomato in autumn season (spread by insect-vector white fly), is yet not available in the literature. Cycocel treatment has been reported for reducing the severity of yellow vein mosaic virus in okra (Arora *et al.*, 1988) and population of oleander aphid (*Aphis nerii* Boyer) in Brussel's sprouts (Tahori *et al.*, 1965). Therefore, alongwith other growth, flowering and yield characteristics, the study of the effect of Cycocel and Alar on tomato leaf curl incidence in tomato varieties HS-101 and HS-102 (determinate types) being severely affected, was carried out.

MATERIAL AND METHODS

Present investigations were carried out at the Vegetable Research Farm, Haryana Agricultural University, Hisar, during autumn-winter seasons (August to December) of 1985 and 1986. Seeds of HS-101 and HS-102 varieties were sown on 10 and 14 July and the seedlings after treatment were transplanted on 6 and 9 August in 1985 and 1986, respectively. A randomised block design was adopted keeping two tomato varieties and combination of two nursery stages (1-2 and 3-4 true leaf stages) and two concentrations of each chemical, *viz.* Cycocel (2-chloroethyl trimethyl ammonium chloride) or CCC and Alar (Succinic acid-2, 2 dimethyl hydrazide) or SADH, both at 200 ppm and 400 ppm making a set of 18 treatments including control in three replications

RESPONSE OF TOMATO TO CCC AND ALAR

during both the years. The plot size for each treatment was 4.0 m × 1.2 m accommodating 12 plants per treatment. The seedlings in the different nursery stages were thoroughly sprayed with aqueous solutions of growth retardants. Observations were recorded on growth, flowering, fruit set, yield (early and total yield) and disease incidence. The per cent disease severity was calculated by following formulae of Banerjee and Kalloo (1987):

Per cent disease severity =

$$\frac{\text{Number of diseased plants}}{\text{Total number of plants observed}} \times 100$$

All the plants were observed individually. Only two classes, *i. e.* with TLCV symptoms and without symptoms were made and they were represented as diseased and healthy, respectively. Diseased plants were identified as stunted, leaflets thickened, malformed and chlorotic streaks on the stem. Even a slight infection due to TLCV was considered as diseased plant. Number of white flies per plant was counted with

the help of counting box with simple glass on it. Simple randomised block design Anova was adopted for statistical analysis of data. The meteorological observations (temperature and rainfall) during the period of study are given in Table 1.

RESULTS AND DISCUSSION

Growth Characteristics

Since the performance in both the years was consistent, the results have been explained on average basis of two years and varieties. Both the concentrations of Cycocel and Alar applied at different stages of plants in nursery beds significantly reduced height (Table 2). The plants were taller in untreated control of both the varieties, whereas least plant height was recorded with Alar 400 ppm when applied at 3-4 true leaf stage (TLS). Higher concentration of Cycocel was instrumental in the reduction of height which confirmed the findings of Tiessen (1962) in tomato. Reduction of plant height with Cycocel treatment could be ascribed to its effect on divisional activity (Sachs and Kofranek,

TABLE 1
Weather data during the study period

Month	Temperature (°C)				Total rainfall (mm)	
	1985		1986		1985	1986
	Max.	Min.	Max.	Min.		
July	35.1	26.1	34.8	24.9	0.0	2.14
Aug.	34.9	25.9	35.6	24.3	0.0	2.42
Sep.	35.4	23.0	35.5	21.0	0.0	1.07
Oct.	31.6	15.7	32.5	17.2	0.0	24.60
Nov.	23.4	10.0	29.1	10.6	0.0	0.0
Dec.	22.4	7.9	21.3	3.7	0.0	0.0

TABLE 2
Effect of CCC and Alar on growth, flowering and fruit setting in tomato varieties HS-101 and HS-102 during autumn-winter seasons of 1985 and 1986

Treatment	Plant height (cm)		No. of branches		No. of flowers		Days to first fruit set		No. of fruits set 20 days						
	HS-101	HS-102	Av.	per plant	HS-101	HS-102	Av.	per cluster	HS-101	HS-102	Av.				
(pp.n)	HS-101	HS-102	Av.		HS-101	HS-102	Av.		HS-101	HS-102	Av.				
Control (untreated)	61.8	69.7	65.7	5.9	6.2	6.1	3.6	4.2	3.9	52	50	51.0	3.9	4.7	4.3
CCC 200 (1-2 TLS)	47.6	58.7	53.2	7.1	6.3	6.7	4.1	4.7	4.4	46	43	44.5	5.8	5.1	5.5
CCC 400 (1-2 TLS)	49.1	48.6	48.9	7.7	5.9	6.8	4.7	5.2	5.0	45	46	45.5	5.3	6.3	5.8
CCC 200 (3-4 TLS)	49.8	51.6	50.7	8.7	9.3	9.0	4.9	5.3	5.1	40	42	41.0	7.4	8.3	7.9
CCC 400 (3-4 TLS)	52.3	47.9	50.1	6.1	6.4	6.3	5.0	4.7	4.9	40	44	42.0	6.4	7.0	6.7
Alar 200 (1-2 TLS)	39.9	47.3	43.6	4.2	4.8	4.5	4.3	3.9	4.1	57	49	53.0	2.1	4.1	3.1
Alar 400 (1-2 TLS)	47.6	59.8	53.7	5.2	3.9	4.6	4.2	4.0	4.1	59	54	56.5	3.1	3.7	3.4
Alar 200 (3-4 TLS)	51.6	47.0	49.3	5.7	4.0	4.9	3.7	4.9	4.3	60	63	61.5	1.9	2.9	2.4
Alar 400 (3-4 TLS)	41.7	41.9	41.9	6.1	5.1	5.6	4.0	3.1	3.6	64	67	65.5	2.4	4.3	3.4
Average	49.0	52.6		6.3	5.8		4.3	4.5		51.8	50.9		4.3	5.2	
S.Em	1.73	1.49		0.56	1.02		0.002	0.001		1.77	1.58		0.92	0.97	

1963). There were significant differences in the number of branches due to treatment (Table 2). Application of Cycocel @ 200 ppm at 3-4 true leaf stage in the nursery produced maximum number of branches while Alar 200 ppm applied at 1-2 true leaf stage resulted into the least number of branches. All Cycocel treatments were better than Alar in increasing the number of branches per plant which was in consonance with the findings of Bryan (1970) in tomato.

Flowering and Fruit Set

Maximum number of flowers per cluster (Table 2) was obtained when the seedlings were treated with Cycocel 200 ppm at 3-4 true leaf stage. These results support the findings of Nourai and Harris (1983) who obtained reduced flower abortion and increased number of flowers per cluster with cycocel soil drenching in tomato. Abdul *et al.* (1978) also reported similar results in tomato. Treatment of seedlings with Cycocel 200 ppm at 3-4 true leaf stage in both the varieties significantly stimulated earlier first fruit setting (40 days in HS-101 and 42 days in HS-102) as compared to untreated control of HS-101 and HS-102 (52 and 50 days, respectively). Alar @ 400 ppm when sprayed at 3-4 true leaf stage delayed first fruit set as compared to remaining treatments. Early fruit set with Cycocel treatment was due to advance anthesis which was also reported by Read (1967) in tomato. Significantly high and maximum fruit set recorded after 20 days of flowering was with Cycocel 200 ppm when applied at 3-4 true leaf stage and vice versa was the case with Alar 200 ppm when applied at 3-4 true leaf stage (Table 2).

However, Marisiddaiah and Gowda (1978) recorded maximum fruit set with Alar 2000 ppm than Cycocel in tomato. In the present study, all Alar treatments reduced the fruit set as compared to untreated control which confirms the findings of Abdalla and Verkerk (1970) in tomato. Increased fruit set with Cycocel nursery treatment was due to increase in number of flowers per cluster (Genchev *et al.*, 1979) in tomato plants.

Fruit Yield

Fruits ripened significantly earliest with Cycocel 400 and 200 ppm when applied at both the true leaf stages (Table 3). Fruits of untreated control plants ripened approximately 8-9 days late while spraying Alar 400 ppm at 3-4 true leaf stage delayed fruit ripening by about 21 days when compared to above best treatments. Early fruit ripening with Cycocel 200 ppm (3-4 TLS) was due to early fruit set (Table 2) which confirmed the reports of Read and Fieldhouse (1970) in tomato. Significantly higher early yield was obtained in both the varieties from Cycocel application when applied at 200 ppm at 3-4 true leaf stage of nursery (Table 3). It was further observed that all the Alar treatments gave poor early yield when compared to Cycocel treatments which confirmed the results of Appezzato and Castro (1985). Lowest early yield was recorded from Alar @ 200 and 400 ppm when applied at 3-4 true leaf stage of nursery. Significantly highest number of fruits per plant was recorded with Cycocel application @ 200 ppm at 3-4 true leaf stage in both the varieties as compared to untreated plants. Lowest number of

TABLE

Effect of CCC and Alar on fruit ripening, yield and tomato leaf curl virus (TLCV)
1985

Treatment (ppm)	Days to ripen			Early yield (kg/plant)*			Number of fruits		
	first five fruits						per plant		
	HS-101	HS-102	Av.	HS-101	HS-102	Av.	HS-101	HS-102	Av.
Control (untreated)	71	68	69.5	0.15	0.19	0.17	37.9	44.2	41.1
CCC 200 (1-2 TLS)	67	57	62.0	0.24	0.26	0.25	46.5	49.3	47.9
CCC 400 (1-2 TLS)	65	57	61.0	0.27	0.30	0.29	40.1	51.4	45.8
CCC 200 (3-4 TLS)	62	60	61.0	0.53	0.49	0.51	52.1	56.9	54.5
CCC 400 (3-4 TLS)	65	63	64.0	0.31	0.26	0.29	41.7	48.0	44.9
Alar 200 (1-2 TLS)	69	71	70.0	0.11	0.13	0.12	32.7	31.3	32.0
Alar 400 (1-2 TLS)	79	74	76.5	0.21	0.27	0.24	41.1	27.4	34.3
Alar 200 (3-4 TLS)	79	78	78.5	0.09	0.11	0.10	30.8	29.7	30.3
Alar 400 (3-4 TLS)	85	80	82.5	0.13	0.07	0.10	33.1	37.2	35.2
Average	71.3	67.5		0.23	0.23		39.6	41.7	
S. Em	1.58	1.38		0.003	0.002		2.40	2.09	

*Total of first five pickings made upto the end of October in both the years.

fruits was harvested from Alar 200 and 400 ppm applied at 3-4 true leaf stage and 1-2 true leaf stage in HS-101 and HS-102, respectively. Increase in number of fruits with Cycocel treatment was due to increase in the number of branches, flowers per cluster and percentage of fruit set (Read and Fieldhouse, 1970). However, Smirnov (1978) obtained the maximum fruit set with seedling treatment with Cycocel due to good root system and short stocky plants, which were physiologically more active to produce more fruits. Significantly highest total yield was obtained in both the tomato varieties (Table 3) when 200 ppm Cycocel was applied on nursery at 3-4 true leaf stage. All Alar treatments gave poor yield and the lowest

being due to 200 ppm of Alar applied at 3-4 true leaf stage which confirmed the findings of Appezzato and Castro (1985) in tomato. The increased total yield with Cycocel 200 ppm at 3-4 true leaf stage was mainly due to increased branching, flowers per cluster, early and better fruit set.

Disease Severity

The percentage of TLCV severity and number of white flies were recorded 45 days after transplanting (Table 3). Lowest severity of TLCV was noticed when Cycocel 200 ppm was applied at 3-4 true leaf stage, in both the varieties, whereas maximum disease severity was recorded in Alar 200 ppm applied at 3-4

RESPONSE OF TOMATO TO CCC AND ALA

3

rating in tomato varieties HS-101 and HS-102 during autumn-winter seasons of and 1986

Total yield (kg/plant)			Tomato leaf curl virus rating (%)			Number of white flies per plant		
HS-101	HS-102	Av.	HS-101	HS-102	Av.	HS-101	HS-102	Av.
1.08	1.27	1.18	79.6	81.0	80.3	40.3	42.8	41.6
1.53	1.39	1.46	59.1	60.3	59.7	32.7	30.1	31.4
1.50	1.62	1.56	47.7	64.5	56.1	29.2	24.7	27.0
1.99	2.01	2.00	33.4	47.4	40.4	13.7	10.9	12.3
1.29	1.72	1.51	62.9	54.5	58.7	34.0	30.3	32.2
1.09	1.24	1.17	64.3	79.9	72.1	37.0	47.8	42.4
1.27	1.19	1.23	76.1	62.3	69.2	54.2	39.9	47.1
1.01	1.00	1.01	89.1	74.5	81.8	52.8	43.7	48.3
1.17	1.29	1.23	71.3	70.0	70.7	49.1	47.7	48.4
1.33	1.41		64.8	66.0		38.1	35.3	
0.001	0.001		5.97	7.81		2.17	2.01	

true leaf stage. Cycocel 200 ppm application at 3-4 true leaf stage significantly reduced white flies (*Bemisia tabaci*) population (Table 3), thereby, resulting in low disease severity. Probably reduced disease severity with Cycocel treatment may also be due to hardening of cell wall.

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ELEMENTAL DISTRIBUTION AND THEIR ASSOCIATIONS IN SOILS IN THE SIWALIK FOOT HILLS OF HARYANA

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ABSTRACT

Three reference pedons from the soils of Ambala (Haryana) representing the hills, piedmont plains and plains, have been analysed for total Si, K, Na, Ca, Mg, Fe, Al, Zn, Cu and Mn content. Si is the predominant element in these soils followed by Al, Fe, Ca, K, Mg and Na in the same order of abundance. Mn, Zn and Cu are present in traces. Si is negatively correlated with majority of the elements. Significant positive correlation co-efficients have been observed amongst K, Al and Fe and between Ca and Mg. The role of soil separates and organic matter in controlling the distribution of these elements has been evaluated.

MATERIAL AND METHODS

The alluvium derived soils of Ambala district have been reported to exhibit varying degrees of pedogenesis (Kumar, 1987). Although the nature of parent material has been shown to influence elemental status of soils (Lal and Biswas, 1973), the exact role of pedogenic processes in controlling the potential nutrient reserves of such alluvium derived soils is not clearly understood. Information is scanty about the elemental status and their associations in these soils. The present study was, therefore, undertaken to determine the amount of total Si, Al, Fe, K, Na, Ca, Mg, Zn, Cu, and Mn in three landforms (hills, piedmont plains and plains) of Ambala to evaluate possible elemental associations in these soils and assess the role of organic matter, particle size distribution and soil forming processes on the distribution of these elements.

Description of Soil

Twelve typical pedons from Ambala district, representing hills, piedmont plains and lower plains landforms (belonging to soil groups : Typic Udothent, Udic Ustochrept and Udic Haplustalf, respectively) were selected for this study. The pertinent data of only three profiles are presented in Table 1. The hills exhibited highly stratified parent material and lack of profile development. The soils of piedmont plains and plains are well drained and are characterised by ustic soil moisture regime. They show progressive degrees of profile differentiation with the development of a cambic horizon in the piedmont plains and an argillic horizon in the lower plains. The mineral assemblage of these soils include quartz, muscovite, biotite, feldspar, kaolinite, vermiculite, montmorillonite, metahalloysite, hydrobiotite and chlorite.

TABLE 1

Some soil properties of hills, piedmont and plain profiles

Landform	Horizon	Depth (cm)	Organic carbon (%)	Mechanical composition (%)		
				Sand ($>50\mu$)	Silt ($2-50\mu$)	Clay ($<2\mu$)
Hills	A ₁	0-13	0.50	46.9	36.8	16.3
(Typic Udorthent)	II C ₁	13-50	0.01	88.3	6.5	5.2
(Morni)	II C ₂	50-95	0.01	87.4	5.8	6.8
Piedmont plain	A _p	0-14	0.30	78.6	10.9	10.5
(Udic Ustochrept)	B ₂₁	14-20	0.19	73.2	11.6	15.2
(Nagal)	B ₂₁	20-85	0.11	68.6	12.2	19.2
	C	85-131	0.08	66.6	15.8	17.6
Plain	A _p	0-10	0.31	69.0	22.4	8.6
(Udic Haplustalf)	B ₁	10-24	0.25	71.2	16.9	11.9
(Buria Farm)	B _{21t}	24-44	0.19	69.2	18.5	12.3
	B _{22t}	44-90	0.16	49.9	21.6	28.5
	B _{23t}	90-145	0.14	50.9	21.6	27.5

Analytical Techniques

For total silicon determination, sodium carbonate fusion method was adopted. The soil samples were fused with sodium carbonate, dissolved in hydrochloric acid, and analysed for Si.

For estimating the elements other than silicon, HF fusion of soil was done. In this fusion, a known amount of soil sample was mixed with 48% HF in a platinum crucible and kept it on sand-bath till dryness. The above fused material was dissolved in 6 N HCl and was diluted with distilled water. This was used for estimating Fe, Al, Mn, Zn, Cu, Ca, Mg, Na and K. Fe, Mn, Cu and Zn were estimated by Atomic Absorption Spectrophotometry (Varian Techn—...AA 120). Aluminium was determined colorimetrically (Jackson, 1973). Sodium

and potassium were estimated by flame photometry and calcium and magnesium by Erichrome black-T method as described by Black (1965).

RESULTS AND DISCUSSION

Distribution of Elements

The distribution of Si, Al, Fe, Ca, Mg, Na, K, Mn, Cu and Zn in the soils studied is shown in Table 2. Silicon is the most abundant element in the soils of hills and piedmont plains and comprises about two-third of the total mineral matter on oxide basis. Other dominant elements include Al, Fe, Ca, K and Mg which occur in the same order of abundance. The possible reason of Si abundance in hills and piedmont might be the higher content of quartz in the parent material (Ahuja, 1981). With the time, weathering of parent material had probably

TABLE 2
Total elemental analyses of hills, piedmont and plain profiles

Landform	Horizon	Depth (cm)	SiO ₂	Al ₂ O ₃	FesO ₃	MnO	CuO (%)	ZnO	CaO	MgO	Na ₂ O	K ₂ O
Hills (Typic Udonthent) (Morni)	A ₁	0-13	72.10	12.50	3.50	0.05	0.020	0.02	3.50	1.50	0.75	2.34
	II C ₁	13-50	82.80	8.80	1.80	0.02	0.010	0.01	2.60	1.00	0.44	0.90
	II C ₂	50-95	81.70	7.90	2.80	0.03	0.020	0.02	2.60	1.00	0.83	1.30
Piedmont plain (Udic Ustochrept) (Nagat)	A _p	0-14	78.50	11.10	2.50	0.03	0.007	0.02	2.20	0.50	0.56	1.82
	B ₂₁	14-20	78.20	14.80	1.50	0.02	0.007	0.02	1.80	0.50	0.50	1.48
	B ₂₂	20-85	79.50	19.80	3.10	0.03	0.007	0.02	2.40	0.50	0.56	1.98
	C	85-131	76.40	12.70	3.60	0.03	0.100	0.02	2.20	1.30	0.48	1.87
Plain (Udic Haplustalit) (Buria Farm)	A _p	0-10	75.50	14.00	3.10	0.03	0.007	0.02	2.50	0.50	1.13	1.47
	B ₁	10-24	76.60	12.20	2.50	0.05	0.007	0.05	3.10	1.20	1.04	1.34
	B _{21t}	24-44	74.50	15.40	3.10	0.03	0.007	0.02	1.60	0.80	0.88	1.28
	B _{22t}	44-90	76.10	10.80	3.90	0.06	0.007	0.02	2.40	1.80	1.05	2.07
	B _{31t}	90-145	77.20	13.60	3.70	0.03	0.020	0.02	1.60	0.90	0.58	1.20

caused decrease in silica content in the lower plains. In the soils of hills and plains, the amount of silica content either remained uniform with depth or exhibited no particular trend and this might be attributed to sedimental deposition.

In the soils of lower plains, the Fe_2O_3 content increased with depth indicating leaching of free iron oxides along with finer fractions. Al_2O_3 also increased with depth in the soils of plains and, in general, its distribution trend was opposite to that of silica.

None of the trace elements (Mn, Zn and Cu) showed regular variations with depth. The lack of definite trend in the depthwise distribution of Cu, Zn and Mn even in the piedmont plains and lower plains, lends an indirect support to the generally accepted hypothesis that only an advanced stage of weathering and consequently a high degree of profile differentiation produces a significant pattern of trace element distribution in a soil profile (Swaine and Mitchell, 1960; Hodgson, 1963).

The correlation coefficients between various attributes of all the profiles are presented in Table 3. A perusal of the data reveals that silica is negatively correlated with all other elements possibly due to quartz being its main form in these soils, the crystal structure of which does not contain any other element in appreciable amount (Keith and Tuttle, 1952). Its highly negative correlation coefficients with Al and K are due to the presence of micas and K-feldspars in these soils (Kumar, 1987). In these minerals, as the trivalent Al replaces

tetravalent Si in the tetrahedral net work, the accompanying increase in negative charge is balanced by introduction of K in the crystal structure (Dear *et al.*, 1966). Since iron was not differentiated into ferrous and ferric forms, it is very difficult to speculate its likely associations with other elements. However, its correlation coefficients with Al in these pedons seem to be due to the formation of their secondary oxides and hydroxides. In fact, Fe-Mn nodules, the crystallinity of which could not be established by X-ray diffraction, were observed in some horizons of the soils (Sidhu *et al.*, 1976). The high correlation coefficient between Ca and Mg is consistent with their co-occurrence in several minerals, especially carbonates (Dear *et al.*, 1966).

Influence of Particle Size Distribution and Organic Matter

Sand fraction controls the amount of silicon in the soils (Table 3). This is due to accumulation of quartz in sand-sized particles which results in opposite effect so far as most of the other elements are concerned. The absence of appreciable accumulation of the elements in B₂₁ horizon of plains (Table 2) and low correlation coefficient between clay and other attributes (Table 3) suggest the insignificant effect which the processes of eluviation and illuviation can have on the depth-wise distribution of these elements, except Fe and K wherein some modifications could be expected. These observations are at variance with the earlier reports wherein silt and clay fractions have been found to control the distribution of some essential plant nutrient elements (Meelu and Randhawa, 1973).

TABLE 3
Correlation coefficient (r) matrix based on (13×13) samples × attributes sets

	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	MnO	CuO	ZnO	CaO	MgO	Na ₂ O	K ₂ O	Sand	Silt	Clay
Al ₂ O ₃	** -0.91												
Fe ₂ O ₃	** -0.61	** 0.48											
MnO	NS	NS	NS										
CuO	NS	NS	NS	NS									
ZnO	NS	NS	*	NS	NS								
CaO	** -0.58	*	0.35	NS	NS	*							
MgO	*	NS	0.50	NS	NS	NS	** 0.53						
Na ₂ O	NS	NS	NS	NS	NS	** 0.55	NS	NS					
K ₂ O	-0.69	** 0.42	** 0.48	NS	NS	NS	** 0.57	** 0.44	NS				
Sand	** 0.68	** -0.47	** -0.53	NS	NS	** -0.55	** -0.56	** -0.53	** -0.34	** -0.57			
Silt	** -0.62	** 0.43	** 0.48	NS	NS	** 0.43	** 0.55	** 0.50	NS	** 0.45	** -0.92		
Clay	** -0.61	** 0.41	0.54	NS	NS	** 0.54	** 0.45	** 0.46	*	** 0.52	** -0.88	** 0.62	
Organic carbon	NS	NS	NS	NS	NS	*	NS	NS	*	NS	*	*	*
						0.28			0.34		-0.31	0.28	0.38

*Significant at 5% level of significance

**Significant at 1% level of significance

The organic matter content of the soils is low (Table 1) and does not show significant correlation with any of the element except Zn and Na. This suggests the poor influence of organic matter in controlling the total elemental content of these soils, probably because of its low amount in these soils.

From the study, it may be concluded that the soils of hills generally reflect the sedimentary composition of parent mate-

rial, whereas the soils of piedmont plains and plains exhibit some pedochemical changes which have taken place after deposition of the alluvium. Leaching (as influenced by topography, time and climate, especially rainfall) appears to be the most important process responsible for causing differentiation in these pedons and in controlling the modification which have taken place in total elemental content of their parent material during pedogenesis.

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INFLUENCE OF PLANTING DATES AND WEED REMOVAL ON CHICKPEA (*CICER ARIETINUM* L.)

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ABSTRACT

Field experiments were conducted on chickpea during winter seasons of 1982-83 and 1984-85. Density of weeds increased significantly with the corresponding increase in the planting date from 5 Nov. to 5 Dec. in both the years. The density of *V. sativa* and *C. album* increased and decreased with the advancement of planting date, respectively. Weed removal once at 45 DAS reduced the density and dry weight of weeds significantly than other treatments. Maximum dry weight of weeds was recorded with 5 Nov. planting which decreased significantly with the delay in planting during both the years. Dry matter accumulation, number of branches and pods per plant were maximum when chickpea was planted on 20 Nov. These attributes decreased following early or late planting than 20 Nov. Weeding once at 45 DAS, resulted in significantly better attributes than removing weeds once at 15 or 30 DAS. Maximum grain yield was obtained with 20 Nov. planting followed by 5 Nov. and 5 Dec. plantings during both the years.

The new production technology involves the use of high yielding varieties and costly inputs like fertilizer. These conditions stimulate growth of crop as well as weeds. The weeds which emerge with crops like *C. album*, *V. sativa*, *L. aphaca*, *A. tenuifolius*, etc., are posing a great threat to pulse production (Balyan and Bhan, 1984). The losses caused by weeds in chickpea exceed 50 per cent (Anon., 1980, 1981; Ahlawat *et al.*, 1981). The magnitude of yield loss depends upon the intensity and type of weed flora. It is, therefore, imperative to provide weed free environment to produce more yield.

Various cultural and chemical methods have been used by different workers in

chickpea (Kolar *et al.*, 1979; Ahlawat *et al.*, 1981; Balyan and Bhan, 1984). However, weed emergence pattern with different planting dates has not been studied. In the present investigation an attempt has been made to study the weed emergence with different planting dates and the effect of weed removal treatments on weeds and chickpea crop.

MATERIAL AND METHODS

Field experiments were carried out at the Research Farm of Haryana Agricultural University, Hisar during winter seasons of 1982-83 and 1984-85 on sandy loam soil of medium fertility having pH 8.0 and organic matter 0.4 per cent. Fifteen

treatment combinations comprising three planting dates, viz. 5 Nov., 20 Nov. and 5 Dec., with five weed control treatments viz. weedy check, weed free, weed removal once at 15, 30 and 45 DAS were replicated three times in a split plot design. The gross and net plot sizes were 6 m × 3 m and 5 m × 2 m, respectively.

Chickpea variety C-235 was planted by kera method (behind the hand driven plough) and harvested on 4 and 11 April in 1983 and 1985, respectively. Doses of 25 kg N through urea, 60 kg P₂O₅ through single super phosphate and 25 kg ZnSO₄ per ha were applied uniformly to all the plots. Weeds were removed by hand with the help of khurpi. Two sprays of endosulfan 35 EC were done at 15 days interval to prevent the attack from pod borer during both the years.

Weed density was recorded 75 DAS by placing a quadrat (50 cm × 50 cm) randomly at three spots in a plot. The dry weight of weeds and crop plants, number of branches, number of pods per plant and grain yield of chickpea were recorded at harvesting stage in both the years. The data on total weed density as well as of dominant weeds like *V. sativa* and *C. album* were transformed to $\sqrt{n+1}$ and then analysed statistically. There was heavy incidence of blight during 1982-83 season.

RESULTS AND DISCUSSION

Weed Flora

The dominant weeds of the experimental field were *Chenopodium album* L. and *Vicia sativa* L. *Lathyrus aphaca* L., *Asphodelus tenuifolius* L., *Anagallis*

arvensis L., *Fumaria parviflora* Lamk. and *Convolvulus arvensis* L. were minor weeds.

Effect of Weeds

V. sativa was major weed and constituted about 54, 62 and 78 per cent and 46, 56 and 76 per cent of the total weed flora under three planting dates during both the years, respectively. *C. album* was next highest and comprised 32 and 31 per cent in the 5th Nov. sowing during both the years and its magnitude decreased with subsequent planting dates. Weed density increased significantly with the corresponding advancement in the planting date during both the years (Fig. 1). With the delay in weed removal once from 15 to 30 and 45 DAS, density of weeds reduced significantly.

The maximum dry weight of weeds was recorded in 5 Nov. planting which decreased significantly with the successive delay in planting date (Fig. 1). Like weed density, maximum weed weight was recorded in weedy check plots which decreased significantly following weed removal treatments. Removal of weeds once at 45 DAS resulted in significantly lower weed weight than other weed removal treatments. *C. album* constituted about 77% of the total weed weight in 5 Nov. planting which decreased with delay in planting during both the years (Table 1). *V. sativa* had second maximum weight in 5 Nov. planting which increased gradually reaching 68 and 78 per cent of the total weed weight in 5 Dec. planting during both the years, respectively. Removal of weeds once at 45 DAS registered significant reduction in the individual weed weight when compared to removing

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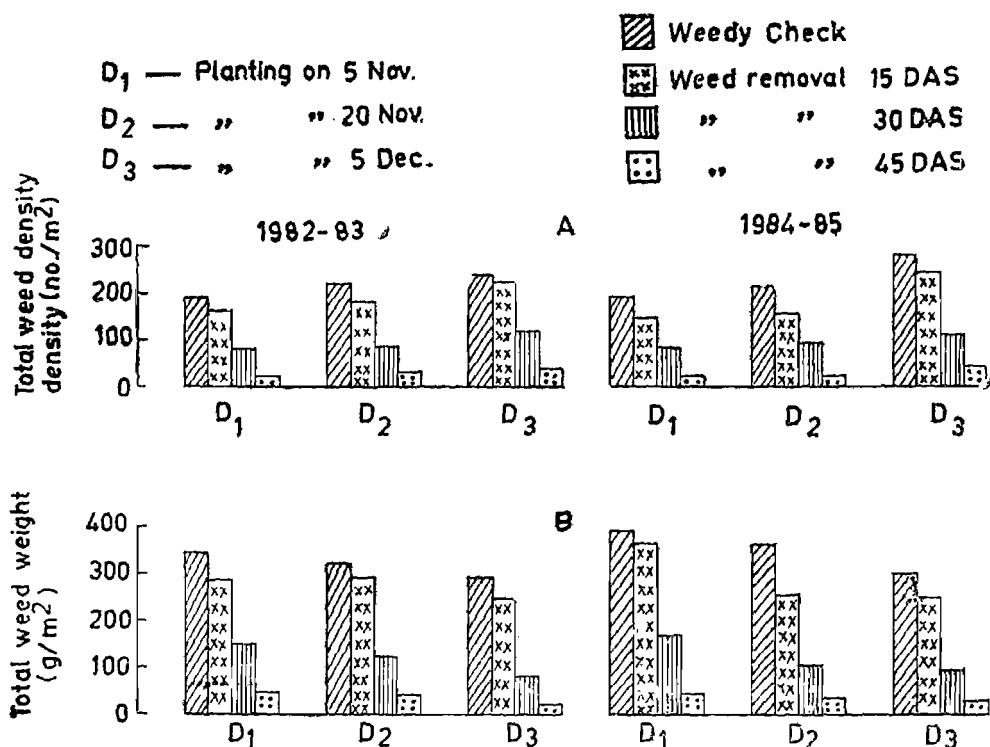


Fig. 1. Effect of planting dates and weed removal treatments on density and dry weight of weeds. LSD values at 5% for weed density were 3.6, 4.4, 13.7 in 1982-83, 10.8, 15.2, 44.9 in 1984-85; and for dry weight 4.08, 4.32, 7.49 in 1982-83, 4.26, 4.06, 7.04 in 1984-85 for dates, weed control treatments and their interactions, respectively.

weeds once at 15 or 30 DAS in both the years.

Effect on Crop

Planting of chickpea on 20 Nov. resulted in maximum dry weight, number of branches and pods per plant which decreased significantly following 5 Nov. or 5 Dec. planting (Table 2). Maximum growth and yield attributes of chickpea were recorded under weed free environment during both the years. Weed removal once at 45 DAS produced satisfactory

dry weight, number of branches and pods per plant when compared with weed free control. However, these parameters reduced significantly when weeds were removed 15 or 30 DAS. Weed removal at either stage resulted in significant variation in these parameters with different planting dates.

Maximum grain yield of chickpea, *i. e.* 484 and 2245 kg/ha in 1982-83 and 1984-85 seasons was obtained with 20 Nov. planting followed by 5 Nov. planting and minimum in 5 Dec. planting (Table 2).

TABLE 1

Planting Date	Density (No./m ²)				Dry weight (g/m ²)			
	1982-83		1984-85		1982-83		1984-85	
	<i>V. sativa</i>	<i>C. album</i>	<i>V. sativa</i>	<i>C. album</i>	<i>V. sativa</i>	<i>C. album</i>	<i>V. sativa</i>	<i>C. album</i>
5 Nov.	(42.0) 6.32*	(28.44) 5.74	(48.0) 5.95	(29.08) 4.74	21.9	131.1	30.4	148.3
20 Nov.	(58.8) 7.47	(19.96) 4.46	(59.7) 6.61	(24.7) 4.47	47.8	69.8	51.5	79.7
5 Dec.	(94.0) 9.54	(6.72) 2.56	(104.3) 8.93	(7.3) 2.55	101.5	9.5	90.6	11.6
L. S. D. at 5%	0.71	0.83	0.28	0.38	2.63	4.52	0.66	1.89
Weed Control								
Weedy check	(144.0) 11.74	(43.83) 6.33	(159.5) 12.55	(42.5) 6.41	108.2	172.3	121.6	185.6
Weed free	(0) 1.00	(0) 1.00	(0) 1.00	(0) 1.00	0	0	0	0
Weed removal 15 DAS	(110.7) 10.23	(27.8) 4.84	(117.5) 10.70	(34.7) 5.71	93.5	161.1	109.9	145.5
30 DAS	(54.0) 6.89	(16.93) 3.80	(59.3) 7.63	(21.3) 4.57	32.5	43.5	44.0	56.6
45 DAS	(9.6) 3.29	(3.3) 1.84	(16.9) 3.93	(3.2) 1.91	6.8	7.7	11.8	11.6
L. S. D. at 5%	0.62	0.73	0.24	0.31	5.14	6.01	2.37	2.49
L.S.D. for interaction	0.98	1.14	0.41	0.54	9.33	10.16	4.11	4.33

*Original weed counts are in parentheses which were transformed to $\sqrt{n+1}$.

EFFECT OF PLANTING DATES AND WEED REMOVAL ON CHICKPEA

TABLE 2

Growth and yield of chickpea as influenced by planting dates and weed removal treatments

	Dry matter (g/plant)		Number of branches/plant		Number of pods/ plant		Grain yield (kg/ha)	
	1982-83	1984-85	1982-83	1984-85	1982-83	1984-85	1982-83	1984-85
Planting Date								
5 Nov.	10.02	19.82	6.27	7.47	6.66	25.75	425	2030
20 Nov.	10.96	21.04	6.77	7.67	7.63	28.03	484	2245
5 Dec.	8.40	17.28	5.82	6.98	6.09	22.67	406	1352
L. S. D. at 5%	0.70	1.17	0.25	0.15	0.33	0.34	NS	265
Weed Control								
Weedy check	5.68	10.96	2.43	2.63	2.73	15.01	286	1147
Weed free	13.24	25.03	8.90	10.57	10.29	33.38	561	2620
Weed removal								
15 DAS	7.50	16.67	5.30	6.27	4.50	20.85	477	1595
30 DAS	10.49	20.49	6.84	7.83	7.25	26.47	443	1857
45 DAS	12.15	23.74	7.94	9.57	9.19	31.73	475	2159
L. S. D. at 5%	0.27	0.44	0.24	0.29	1.75	2.24	151	176
L. S. D. for interaction	0.47	0.76	NS	NS	3.08	3.84	NS	305

The differences during first season were non-significant, however, during later season, these were significant. The non-significant differences during first season were because of the occurrence of wilt and root knot diseases, which resulted in extremely poor yield of crop. Among weed control treatments, highest grain yield was recorded under weed free conditions which was significantly better than other treatments. Delay in weeding, i. e. 45 DAS produced good yield which was statistically better than removing them early and keeping unweeded throughout crop season. The interactions between planting dates and weed removal treatments were found significant in 1984-85. Removing weeds at either stages or keeping weed free produced significantly

better yield of chickpea under 20 Nov. planting than planting at other two dates. Pahuja *et al.* (1975) and Balyan and Bhan (1984) also obtained satisfactory control of weeds and better growth and yield attributing characters and consequently better yield of chickpea with hand hoeing or weeding at 30 and 45 or 50 DAS.

It can be concluded from this study that to avoid yield losses in chickpea because of the competition caused by maximum emergence of most competitive, tall and fast growing weed like *C. album*, chickpea should be planted around 20 Nov. and to get better yield atleast one hand weeding at 45 DAS should be done.

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HETEROSIS AND COMBINING ABILITY IN BREAD WHEAT

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ABSTRACT

Heterosis in relation to combining ability effects in a 8×8 diallel, involving diverse genotypes of wheat, was studied. Nine and eight crosses exhibited significant heterobeltiosis for grain yield with 33.19 (WH 147 $\times$ HW 517) and 51.82 (HD 2285 $\times$ WH 291) per cent in timely and late sown plantings, respectively. Number of tillers, total biomass and number of grains per ear were found to be major contributors for heterotic yield. The ranking of best crosses on the basis of heterotic response and *sca* effects were different. The selection of crosses based on heterotic response as against *sca* effects has been realized. The best crosses, in general, involved additive $\times$ dominance or dominance $\times$ dominance type of gene interactions.

The number of tillers, total biomass, number of grains per ear and 1000-grain weight are considered as main component characters in wheat. For an appropriate and efficient breeding programme particularly for main component characters of grain yield in wheat, it is necessary to have information on the relative amount of combining ability effects which are useful in selecting the parents and desirable cross combinations. In the present paper an attempt has been made to have the information on the above aspects by studying heterosis in relation to general combining ability (*gca*) and specific combining ability (*sca*) effects.

MATERIAL AND METHODS

Eight homozygous lines, viz. HD 2285, WH 147, WH 291, WH 283, CPAN 1907, CPAN 1830, HD 2009 and HW 517 of bread wheat (*Triticum aestivum* L.) were

crossed in a diallel fashion, excluding reciprocals. The resulting 28 hybrids along with their parents were grown in a one row plot with spacing of 30 and 15 cm between and within rows, respectively, in a randomized block design with three replications in two environments (timely sown and late sown). Observations were recorded for days to heading, plant height (cm), tiller number, total biomass (g), number of grains per ear, 1000-grain weight (g) and grain yield per plant (g) on five competitive plants per plot. Heterosis (%) was calculated over better parent (heterobeltiosis). The analysis on combining ability was subjected to Method 2 Model 1 of Griffing (1956).

RESULTS AND DISCUSSION

Highly significant variations among parents and crosses were observed for all the characters in both the environments

except in case of parents for 1000-grain weight in late sown condition which was non-significant. The variations due to parents vs. crosses (tested at one degree of freedom) were significant for all the characters except for days to heading in both the environments and total biomass and grain yield in timely sown environment, indicating thereby significant heterotic response (Table 1).

The mean squares due to *gca* and *sca* were significant for all the traits except for 1000-grain weight in late sown condition where *sca* variances were non-significant (Table 2). Both additive and non-additive components of genetic variation were important but the additive variation was relatively of higher magnitude for all the traits. Further, the ratio of *gca* and *sca* variances as suggested by Baker (1978) indicated the preponderance of additive gene effects in all the attributes except tiller number, total biomass and grain yield, for which high values of general predictability ratio, partial dominance and high heritability estimates were recorded. Therefore, it is likely that the presence of dominance and linkage disequilibrium might have resulted into an over-estimation of non-additive components. Under such a situation population improvement followed by recurrent selection to accumulate desirable genes and to facilitate the breaking of linkages would be more appropriate as suggested by Frey (1975) in self-pollinated crops.

The number of hybrid combinations for heterobeltiosis was maximum (16 for timely sowing and 13 for late sowing) for 1000-grain weight (Table 2). Highly significant crosses for grain yield were

observed for nine and eight crosses, ranging upto 33.19 and 51.82 per cent heterotic response in WH 147 $\times$ HW 517 and HD 2285 $\times$ WH 291 crosses in timely and late plantings, respectively. On the contrary Rehman (1978) observed little heterosis for late plantings in wheat. It is interesting to note that the highest heterosis 33.19% in timely sown environment had WH 147 and HW 517 parents which are recommended for normal sown condition and 51.82% in late sown environment had HD 2285 and WH 291 parents which are recommended for late sown condition. The above two crosses also had significant heterosis for number of tillers and total biomass, suggesting thereby major contribution of these two components to heterotic yield. This confirmed the earlier findings of Sindhu and Singh (1975) and Sharma *et al.* (1986) in wheat.

The best crosses were selected on the basis of heterotic response and also on the basis of *sca* effects for yield and its components in timely sown (Table 3) and late sown (Table 4) environments. A perusal of Table 3 indicated that (i) for grain yield the two crosses were common in both comparisons but only one cross occupied the same position, (ii) for tiller number there were two common crosses though the ranking occupied by them was different, (iii) for total biomass, four crosses were common and their ranking was different, (iv) for number of grains per ear and 1000-grain weight, only three crosses were common and the position occupied by them was different in both comparisons except for one cross for number of grains per ear. Similarly from Table 4, it was calculated that (i) it was

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TABLE 1
Analysis of variance for the experiment in timely and late sown conditions

Source	d. f.	Environment	Mean squares					1000- grain weight	Grain yield/ plant
			Days to heading	Plant height	Tiller number	Total biomass	No. of grains/ ear		
Replications	2	Timely sown Late sown	1.84 2.01	99.39** 4.05	15.49** 2.14	1151.70** 105.18	80.16** 30.91	5.55* 7.40	137.31** 26.46
Genotypes	35	Timely sown Late sown	17.86** 14.32**	56.22** 54.78**	6.05** 12.11**	497.63** 416.15**	99.15** 177.50**	25.43** 44.64**	36.18** 104.37**
Parents	7	Timely sown Late sown	34.38** 22.15**	69.98** 60.87**	12.51** 8.67**	848.94** 435.52**	94.40** 211.88**	34.43** 27.20	60.41** 64.89**
Crosses	27	Timely sown Late sown	14.15** 12.83**	52.79** 47.38**	3.55** 12.52**	424.02** 409.00**	91.87** 168.00**	15.88** 47.12**	31.24** 116.76**
Parents vs. crosses	1	Timely sown Late sown	2.45 0.03	52.71** 212.00**	28.42** 24.87**	25.85 485.74**	329.01** 191.74**	220.21** 90.62*	0.003 45.97*
Error	70	Timely sown Late sown	0.99 1.71	3.26 2.83	0.78 1.51	29.10 39.90	7.56 22.50	1.55 16.01	3.18 9.30

*, ** Significant at 5 and 1 per cent, respectively.

TABLE 2

Source	d. f.	Environment	Days to heading	Plant height	Tiller number	Total biomass	No. of grains/ear	1000-grain weight	Grain yield/plant
			Mean squares						
<i>gca</i>	7	Timely sown	42.63**	110.69**	4.22**	292.90**	110.12**	72.72**	24.51**
		Late sown	39.47**	134.04**	2.56**	272.85**	153.59**	87.13**	60.53**
<i>sca</i>	28	Timely sown	1.83**	4.13**	1.47**	134.12**	7.94*	1.61**	8.95**
		Late sown	1.89**	4.28**	4.40**	105.33**	14.94*	6.82	28.35**
Error	70	Timely sown	0.33	1.09	0.26	9.70	2.52	0.52	1.06
		Late sown	0.57	0.94	0.50	13.29	7.49	5.33	3.09
<i>gca : sca</i> ratio		Timely sown	2.82	3.61	0.12	0.23	1.99	6.62	0.30
		Late sown	2.95	3.99	0.05	0.17	1.96	5.49	0.23
General predictability ratio		Timely sown	0.85	0.88	0.39	0.31	0.80	0.93	0.37
		Late sown	0.85	0.89	0.10	0.25	0.79	0.92	0.31
Degree of dominance		Timely sown	0.83	0.70	1.18	1.44	0.57	0.73	1.37
		Late sown	0.87	0.72	2.77	1.82	0.71	0.72	2.54
Heritability (H_n)		Timely sown	0.82	0.84	0.35	0.30	0.73	0.90	0.34
		Late sown	0.81	0.86	0.09	0.23	0.66	0.71	0.29
Number of significant desirable crosses for heterobeltiosis		Timely sown	3	3	1	2	9	16	9
		Late sown	0	2	5	7	2	13	8
Range of heterobeltiosis		Timely sown	-3.22 to 10.22	-4.09 to 12.74	-37.63 to 6.78	-47.06 to 30.90	-19.65 to 40.39	-9.20 to 15.07	-45.25 to 33.19
		Late sown	-1.84 to 6.75	-5.81 to 16.00	-45.41 to 18.90	-34.54 to 29.73	-33.59 to 11.44	-9.50 to 15.07	-53.40 to 51.82

*, ** Significant at 5 and 1 per cent respectively.

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TABLE 3

Best five crosses selected on the basis of heterotic response and sca effects along with gca effects of the parents involved (in parentheses) in timely sown condition

Character	Heterosis		Mean performance	sca effects		r values
Tiller number	6.78**	CPAN 1907 x HW 517	(L x L)	9.47	1.63**	WH 283 x CPAN 1830 (H x H)
	-0.52	WH 283 x CPAN 1830	(H x H)	12.87	1.48**	CPAN 1830 x HW 517 (H x L)
	-2.26**	HD 2009 x HW 517	(A x L)	8.67	1.06*	CPAN 1907 x HW 517 (L x L)
	-7.86**	CPAN 1907 x HD 2009	(L x A)	9.77	1.05*	HD 2285 x CPAN 1907 (H x L)
	-8.80**	WH 147 x HW 517	(L x L)	8.87	0.83*	WH 283 x CPAN 1907 (H x L)
Total biomass	30.90**	CPAN 1907 x HD 2009	(L x L)	77.67	26.01**	WH 147 x HW 517 (A x L)
	14.04**	WH 147 x HW 517	(A x L)	89.33	18.35**	HD 2285 x CPAN 1907 (H x L)
	2.50	WH 291 x CPAN 1907	(L x L)	68.33	16.20**	CPAN 1830 x HW 517 (H x L)
	0.00	WH 283 x CPAN 1830	(H x H)	84.33	15.37**	CPAN 1907 x HD 2009 (L x L)
	-0.40	CPAN 1830 x HW 517	(H x L)	84.00	8.20**	WH 283 x CPAN 1830 (H x H)
Number of grains/ear	40.39**	WH 147 x HD 2009	(A x A)	76.93	18.12**	WH 147 x HD 2009 (A x A)
	18.44**	WH 147 x CPAN 1830	(A x L)	64.67	6.35**	WH 291 x CPAN 1907 (A x L)
	15.83**	WH 147 x CPAN 1907	(A x L)	62.93	6.12**	WH 147 x CPAN 1830 (A x L)
	13.50**	WH 283 x CPAN 1907	(A x L)	61.67	6.06**	CPAN 1830 x HW 517 (L x H)
	11.70**	WH 291 x CPAN 1907	(A x L)	64.93	5.67**	HD 2285 x CPAN 1830 (A x L)
1000-grain weight	15.07**	WH 291 x HD 2009	(L x L)	48.67	5.25**	WH 147 x WH 291 (H x L)
	12.61**	CPAN 1907 x CPAN 1830	(H x A)	52.40	3.47**	HD 2285 x WH 291 (H x L)
	9.17**	WH 291 x CPAN 1907	(L x H)	50.80	3.08**	CPAN 1907 x CPAN 1830 (H x A)
	9.07**	WH 147 x WH 291	(H x L)	54.53	2.60**	CPAN 1907 x HD 2009 (H x L)
	8.16**	HD 2285 x WH 291	(H x L)	52.13	2.50**	HD 2285 x WH 283 (H x H)
Grain yield/plant	33.19**	WH 147 x HW 517	(L x L)	26.22	6.15**	WH 147 x HW 517 (L x L)
	14.56**	WH 283 x CPAN 1830	(L x H)	29.63	4.60**	HD 2285 x CPAN 1907 (H x L)
	11.06**	WH 147 x WH 291	(L x L)	22.02	4.35**	WH 283 x CPAN 1830 (L x H)
	9.50**	WH 147 x HD 2009	(L x L)	22.51	3.81**	CPAN 1830 x HW 517 (H x L)
	7.70**	WH 147 x CPAN 1907	(L x L)	20.89	2.30*	CPAN 1907 x HD 2009 (L x L)

*, ** Significant at 5 and 1 per cent, respectively.

H = High, A = Average, and L = Low general combiners.

In bold are the common crosses for heterosis and sca effect.

r = Correlation value between heterotic response and sca effect.

TABLE 4

Best five crosses selected on the basis of heterotic response and *sca* effects along with *gca* effects of the parents involved (in parentheses) in late sown condition

Character	Heterosis		Mean performance	<i>sca</i> effects		<i>r</i> values
Tiller number	18.90**	HD 2285 × WH 291	(H × A)	16.57	2.77**	HD 2285 × WH 291 (H × A)
	16.58**	WH 291 × CPAN 1830	(A × A)	14.30	2.57**	HD 2285 × CPAN 1907 (H × A)
	16.27**	HD 2285 × CPAN 1907	(H × A)	16.20	2.45**	HD 2009 × HW 517 (H × L)
	4.45**	WH 283 × CPAN 1907	(A × A)	14.87	2.40**	WH 283 × CPAN 1907 (A × A)
	3.83**	HD 2285 × CPAN 1830	(H × A)	14.47	1.79**	WH 291 × HW 517 (A × L)
Total biomass	29.73**	WH 283 × CPAN 1907	(A × A)	80.00	17.74**	HD 2285 × WH 291 (H × L)
	26.53**	WH 291 × CPAN 1830	(L × L)	62.00	16.97**	CPAN 1830 × HW 517 (L × L)
	18.06**	HD 2285 × WH 291	(H × L)	89.33	16.27**	WH 283 × CPAN 1907 (A × A)
	16.49**	CPAN 1830 × HW 517	(L × L)	75.33	13.01**	HD 2009 × HW 517 (L × L)
	10.81*	WH 283 × CPAN 1830	(A × L)	68.33	11.31**	HD 2285 × CPAN 1830 (H × L)
Number of grains/ear	11.44**	WH 283 × CPAN 1830	(A × A)	61.07	8.86**	HD 2285 × WH 291 (H × L)
	5.65**	CPAN 1907 × CPAN 1830	(A × A)	61.07	6.54**	WH 283 × CPAN 1830 (A × A)
	3.21	HD 2285 × CPAN 1830	(H × A)	58.33	6.41**	CPAN 1907 × CPAN 1830 (A × A)
	1.49**	WH 283 × HD 2009	(A × A)	69.00	5.93**	CPAN 1830 × HW 517 (A × L)
	1.00**	HD 2285 × WH 291	(H × L)	60.97	4.43**	WH 283 × HD 2009 (A × A)
1000-grain weight	15.23**	WH 291 × HD 2009	(L × L)	45.40	4.45**	WH 147 × WH 291 (H × L)
	13.47**	WH 147 × WH 291	(H × L)	50.53	3.87**	WH 147 × HW 517 (H × A)
	11.89**	WH 147 × HW 517	(H × A)	50.27	3.76**	CPAN 1830 × HD 2009 (L × L)
	10.86**	CPAN 1830 × HD 2009	(L × L)	45.60	3.15**	WH 283 × HW 517 (H × A)
	8.21**	WH 291 × CPAN 1907	(L × A)	47.40	2.91**	HD 2285 × WH 291 (H × L)
Grain yield/plant	51.82**	HD 2285 × WH 291	(H × L)	38.36	10.68**	HD 2285 × WH 291 (H × L)
	33.07**	WH 283 × CPAN 1907	(A × L)	31.20	8.58**	WH 283 × CPAN 1907 (A × L)
	32.74**	HD 2285 × CPAN 1907	(H × L)	33.54	7.42**	WH 147 × WH 291 (H × L)
	21.18**	HD 2285 × CPAN 1830	(H × L)	30.62	6.88**	CPAN 1830 × HW 517 (L × L)
	9.72**	WH 147 × WH 291	(H × L)	34.85	6.65**	HD 2285 × CPAN 1907 (H × L)

*, ** Significant at 5 and 1 per cent, respectively.

H=High, A=Average, and L=Low general combiners.

In bold are the common crosses for heterosis and *sca* effect.

r=Correlation value between heterotic response and *sca* effect.

only the grain yield where four crosses were common in both comparisons and the ranking occupied by only two crosses was the same, (ii) for tiller number, total biomass, number of grains per ear and 1000-grain weight each, three crosses were common though the ranking occupied by them was different except two crosses for tiller number. It seems that ranking on the basis of heterotic response is not reflected by the ranking based on *sca* effect. The data in Tables 3 and 4 showed that most of the crosses which were superior in heterotic effect were also having high *sca* effects though in most of the cases their position was changed under two parameters. The rank correlation computed between heterotic response and the *sca* effect was positive and significant for all the characters in both the environments, suggesting that heterosis can give the idea about *sca* effects present. Some crosses showing high mean performance for grain yield and its components did not show high *sca* effect. High *sca* denotes, undoubtedly a high heterotic response but this may be due to very poor performance of the parents in comparison to their hybrids. With the same amount of heterotic effect, the *sca* effect may be less where the mean performance of the parents are higher. Because of non-fulfilment of some of the assumptions involved in the model, these estimates may be biased. This again suggested that selection of the cross-combination based on heterotic response would be more realistic rather than on the basis of *sca* effects as also advocated by Ahmad *et al.* (1979).

In timely sown environment (Table 3) except for one cross each for tiller number,

total biomass and 1000-grain weight between high $\times$ high general combiners produced high *sca* effects, while in all other cases in timely sown and all the cases in late sown environment (Table 4), the crosses between high $\times$ low, average $\times$ average, average $\times$ low and low $\times$ low were the best. This indicated that in the present study high gene interaction for best crosses for most of the traits is accountable to additive $\times$ dominance or dominance $\times$ dominance type of gene effects. However, several theories have been put forward to explain the genetic basis of heterosis in crop plants but the dominant linked gene hypothesis (Jones, 1917) has found favour now a days in self-pollinated crops to explain the phenomenon. In wheat, standard heterosis upto 25% has been reported for grain yield and its components. Both additive and non-additive gene effects have been suggested to explain heterosis in these reports. However, dispersion of alleles as one of the major causes of heterosis cannot be ruled out as evidences are now forthcoming which support dispersion of complementary genes as one of the major causes of heterosis (Pooni and Jinks, 1981; Singh and Singh, 1984). The hybrids with high heterotic response and high *sca* effect involving one good and other poor general combiner could produce desirable segregants if dispersion of alleles acted in the same direction to maximize desirable plant attributes. Thus, some kind of intermating may be adopted for the exploitation of heterosis for obtaining desirable segregants in such crosses as also suggested by Sharma *et al.* (1986).

In autogamous crops like wheat where the exploitation of male sterility is rather

difficult. the breeding procedures are restricted in the development of pure lines only. Therefore, the parents like HD 2285, HD 2009, WH 147, WH 283 and CPAN 1830 having high *gca* effects for yield and other important component traits can be utilized in the future breeding programme and by using the appropriate breeding procedures like recurrent selection, the desirable gene and genotypic frequency may be increased.

HD 2285 × WH 291 with highest mean, heterosis and *sca* effects for grain yield was found to be the best hybrid combination capable of producing highest

transgressive segregants. The parents involved in this cross were of high × low general combiners. The manifestation of heterosis for tiller number, total biomass and number of grains per ear seemed to be responsible for increased grain yield in this cross. The other combinations involved significant/poor *sca* effect and high × low or average × low or low × low general combiners, the heterosis may be due to dominance or epistatic gene effects. Therefore, these cross-combinations are suitable for heterosis breeding and may not be suitable for further exploitation in segregating generations.

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INFLUENCE OF ZINC APPLICATION ON THE PHOSPHORUS NUTRITION IN MAIZE (*ZEA MAYS* L.)

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ABSTRACT

Effect of zinc application on the phosphorus nutrition of various plant parts was examined at three growth stages of maize grown in a zinc deficient soil under greenhouse conditions. Plants showing severe Zn deficiency symptoms were stunted and had a very high P concentration in different plant parts. Dry weights of shoots were the highest at 5 ppm Zn at 6, 8 and 10 weeks crop growth. P concentration of leaf blades and shoot of maize was substantially decreased with increasing levels of Zn.

The results also showed that a proper balance between Zn and P nutrition is essential for plant growth. A high concentration of P in tissues resulting in higher P/Zn ratio appears to be responsible for reduction in dry matter yield in maize due to Zn shortage. A P/Zn ratio of more than 200 in plant tissue had an adverse effect on plant growth.

Studies on P-Zn relationship showed that their utilization by plant depends upon each other's level in the soil/nutrient solution (Takkar *et al.*, 1976; Loneragan *et al.*, 1979, 1982). It has generally been observed that the depressing effect of P on Zn was much more pronounced than that of Zn on P in maize (Gattani *et al.*, 1976; Takkar *et al.*, 1976). According to Deb and Zeliang (1976) application of Zn (10 to 30 kg/ha) decreased the P content of wheat plants, but in rice plants the P content showed a significant increase at the level of 10 kg Zn/ha. High levels of soil P have been reported to aggravate the appearance of zinc deficiency in plants (Takkar *et al.*, 1976; Loneragan *et al.*, 1979).

However, no particular emphasis has been laid on the effect of zinc application on the phosphorus nutrition at various stages of plant growth. This is important for areas that are low in available phosphorus.

Keeping the above facts in view, the present study was undertaken under greenhouse conditions to examine the effect of zinc application on the phosphorus concentration in various plant parts at three stages of maize grown in a zinc deficient soil.

MATERIAL AND METHODS

A greenhouse experiment was conducted using Balsamand sand (Typic

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Torripsamment) of pH 8.3 containing 4.2 ppm Olsen's P and 0.36 ppm DTPA extractable Zn. The soil was non-calcareous and very low (0.05%) in organic carbon content. Polythene lined earthen pots filled with 5 kg of well mixed air dried soil were used for growing the plants. The treatments consisted of graded levels of Zn, i.e. 0, 1.25, 2.5, 5, 10, 20 and 40 ppm as $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$ (in addition to the original 0.36 ppm DTPA extractable Zn content of soil). Each treatment was replicated nine times in a completely randomized block design to provide triplicate sets (per treatment) for three sampling dates. A basal dose of N, P, K, Mg, Fe, Mn and Cu was applied at the rate of 100, 50, 50, 10, 5, 5 and 1 ppm, respectively. All the chemicals used were of analytical grade. Specific treatments and the basic inputs were mixed uniformly with the entire bulk of dry soil and then filled in the pots. The pots were irrigated with distilled water throughout the period of investigation. Eight healthy seeds of maize (*Zea mays* L.) var. Ganga Hybrid-5 were sown in each pot. Thinning was done after one week keeping only four plants per pot. Typical characteristic zinc deficiency symptoms were noticed after three weeks of sowing in the control pots. A second dose of 25 ppm N was applied to each pot after four weeks of sowing.

Out of nine replications, three were selected at random from each treatment and were harvested at 6, 8 and 10 weeks after sowing. At each sampling date, 3rd, 4th and 5th leaf (blades only) were harvested by clipping the leaf blade without leaf sheath in sequence down-

ward from the main stem. The remaining above ground whole plant was also harvested. Plant samples were washed successively in acidified distilled and redistilled water and dried at 60-70° for 72 hours. Dry matter yields were recorded. Samples were ground in a Wiley Mill having stainless steel parts. Each plant sample was digested in an acid mixture of HNO_3 and HClO_4 in the ratio of 5 : 1. Phosphorus content in plant digest was determined colorimetrically as described by Jackson (1967) and Zn was determined by atomic adsorption spectrophotometry.

RESULTS AND DISCUSSION

Dry Weight of Plants

Dry weights of tops at 6, 8 and 10 (Table 1) weeks revealed that major difference was between added Zn and no added Zn. Maximum response at all the three sampling periods was obtained with 5 ppm Zn. There was practically no difference in the Zn response pattern among the treatments receiving Zn except for a significant difference between 5 and 40 ppm Zn at 6 weeks growth. An application of 5 ppm Zn to soil resulted in about 230, 183 and 117 per cent higher dry weight of shoots over that of control at 6, 8 and 10 weeks of crop growth, respectively. Shukla *et al.* (1978) and Safaya and Gupta (1979) also reported similar results. Typical symptoms of Zn deficiency were noted in control when the plants were about three weeks old.

Phosphorus Concentration in Plants

Zinc fertilization had considerable influence on degree of P accumulation

ZINC AND PHOSPHORUS IN MAIZE

TABLE 1

Dry weight of top and phosphorus concentration in leaf blades and shoot of maize in relation to applied Zn at 6, 8 and 10 weeks of growth

Zn applied (ppm)	Dry weight of top (g/pot)	P concentration (%)			Shoot
		Leaf blade			
		3	4	5	
6 weeks					
0	10.3	0.39	0.42	0.41	0.43
1.25	32.5	0.26	0.27	0.22	0.28
2.50	33.1	0.25	0.25	0.22	0.27
5	34.1	0.25	0.24	0.20	0.26
10	31.7	0.24	0.23	0.20	0.25
20	31.5	0.23	0.22	0.19	0.25
40	29.7	0.23	0.23	0.18	0.24
S. Em. $\pm$	1.08	0.008	0.010	0.008	0.008
C. D. at 5%	3.3	0.03	0.03	0.02	0.03
8 weeks					
0	22.4	0.26	0.29	0.28	0.32
1.25	58.8	0.24	0.24	0.22	0.20
2.50	62.1	0.22	0.24	0.20	0.19
5	63.5	0.21	0.24	0.19	0.20
10	62.9	0.21	0.22	0.18	0.18
20	61.3	0.20	0.22	0.17	0.18
40	60.5	0.20	0.22	0.18	0.17
S. Em. $\pm$	2.74	0.006	0.011	0.009	0.008
C. D. at 5%	8.5	0.02	0.03	0.03	0.03
10 weeks					
0	42.4	0.23	0.22	0.23	0.23
1.25	81.9	0.17	0.15	0.17	0.14
2.50	86.8	0.17	0.15	0.13	0.12
5	92.1	0.15	0.15	0.14	0.11
10	91.4	0.14	0.14	0.14	0.10
20	87.3	0.14	0.13	0.13	0.11
40	86.5	0.13	0.13	0.11	0.10
S. Em. $\pm$	3.63	0.009	0.014	0.008	0.011
C. D. at 5%	11.2	0.03	0.04	0.03	0.03

in various parts of maize plant. In control, concentration of P was maximum which was approximately two-fold than at 40 ppm Zn (Table 1). High levels of P in leaves have been postulated to induce zinc deficiency, rendering Zn physiological inactive within them (Leece, 1978). Other workers (Loneragan *et al.*, 1979, 1982) have shown that when plants were treated with high levels of P at low Zn they accumulated unusually high concentrations of P in their leaves and predicted that these high P concentrations are toxic producing symptoms resembling Zn deficiency. A highly significant reduction in P concentration was observed at all the levels of applied Zn in comparison to zero Zn. Shoot had more P than the leaf blades at all the Zn levels although the differences were rather small. Within the Zn treatments, decrease in P concentration was less in comparison to reduction at 1.25 ppm from that of zero Zn. The depression in P concentration in blades 3, 4 and 5 and shoot at 1.25 ppm Zn over that of 0 ppm Zn was 33, 36, 47 and 35 per cent, respectively. The reduction in P concentration was partly due to increase in dry matter production with 1.25 ppm Zn.

The adverse effect of Zn on concentration of P in different plant parts was also evident at 8 and 10 weeks periods of growth. The highest P concentration was noted at zero Zn level. In general, P concentration decreased with increasing Zn levels in various plant parts at all the three stages of growth. However, the differences in P concentration with the levels of Zn from 2.5 to 40 ppm, were not significant in different leaf

blades and shoot at last two growth stages of plant. Also, considerable reduction in the P concentration of vegetative parts occurred from 6 to 10 weeks of growth, which may be attributed to dilution effect due to increased dry matter production. These results confirmed the adverse effect of Zn directly on P.

These results also showed that a proper balance between Zn and P nutrition is essential for plant growth and will actually determine the total yield potential. Prasad *et al.* (1971) and Takkar *et al.* (1976) emphasized the need for Zn and P balance for maximum yields. The depressive effect of Zn on P was also reported by several workers (Prasad *et al.*, 1971; Deb and Zeliang, 1976) in many crops.

On the contrary, Wallace *et al.* (1982) reported that P concentration was lower in Zn-deficient leaves than in leaves without symptoms, which is unusual. The results of the present study clearly revealed that both decreased P concentration (antagonism) and increased growth rate (dilution) in Zn fertilized plants accounted for the decrease in their P concentration.

P-Zn Ratios in the Plant

The P/Zn ratios of leaf blades and shoot at 6, 8 and 10 weeks of growth were remarkably reduced with increasing level of Zn application (Table 2), a condition conducive for better plant growth.

The results are also in agreement with the findings of Gupta and Dabas (1983)

ZINC AND PHOSPHORUS IN MAIZE

TABLE 2

Effect of Zn application on P : Zn ratio in maize at 6, 8 and 10 weeks of growth

Zn applied (μ m)	P : Zn ratio			
	Leaf blade			Shoot
	3	4	5	
6 weeks				
0	201	205	215	226
1.25	176	182	177	210
2.5	158	131	122	165
5	97	93	87	106
10	58	57	51	58
20	35	32	30	39
40	24	26	21	26
8 weeks				
0	210	254	226	267
1.25	186	202	185	192
2.5	142	145	150	142
5	123	140	123	125
10	77	75	66	67
20	51	62	48	46
40	30	35	31	28
10 weeks				
0	203	237	193	250
1.25	143	185	167	189
2.5	114	144	124	111
5	90	97	90	71
10	65	65	70	50
20	54	47	52	40
40	27	30	27	25

who reported that P/Zn ratio was substantially reduced in leaves, petioles and stems of berseem with increase in Zn levels, and P/Zn ratio in control was several fold higher than Zn treated plants.

It, thus, seems likely that when the P : Zn ratio was less than 200, plants were healthy, whereas in deficient plants with well-developed symptoms, ratio

exceeded 200. The present critical P/Zn ratio value is greater than 154 reported in earlier study by Prasad *et al.* (1971) for 6 weeks of maize growth and lower than that of 280 (Reddy *et al.*, 1973). Similarly, Dwivedi *et al.* (1975) have shown that P/Zn ratio of maize leaves at 15 and 60 days growth stages was more than 310 and 260, respectively. Safaya and Gupta (1979) and Loneragan *et al.* (1982) reported that zinc deficient

plants may accumulate P and other nutrients to unusually high levels in their leaves, leading to suggestions that Zn-deficient plants may lose control over their absorption mechanism.

Thus, a high concentration of P in tissues resulting in higher P/Zn concentration ratio appears to offer a better

explanation for reduction in dry weights of maize shoots due to Zn deficiency.

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THREE NEW SPECIES OF GENUS *ACANTHASPIS* AMYOT & SERVILLE (HETEROPTERA : REDUVIIDAE : REDUVIINAE)

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ABSTRACT

Three new species of *Acanthaspis* Amyot & Serville of the subfamily Reduviinae (Reduviidae) have been described from India. Detailed description of the genus, and two other species, viz. *A. rugulosa* Stal and *A. flavipes* Stal together with appropriate illustrations has also been given.

The subfamily Reduviinae (=Acanthaspidinae) was described from India by Distant (1904). Besides the genus *Acanthaspis* Amy. & Serv., he included 17 other genera in it. Pant (1953) enlisted nine Indian species in the genus *Acanthaspis* from the collection at Forest Research Institute, Dehra Dun. Taxonomic studies on Reduviinae conducted at Haryana Agricultural University, Hisar (Haryana, India) reveal the occurrence of three undescribed reduviid bugs belonging to the genus *Acanthaspis*. Detailed account of *A. flavipes* Stal and *A. rugulosa* Stal is also given in this paper. Besides, the male pygophores, claspers, abdominal terga and sterna have been illustrated.

All the measurements are the average of five specimens (wherever available) and are in millimetres.

Genus *Acanthaspis* Amyot & Serville

Platyeris (Part) Burmeister, 1835, *Handb. Ent.* 2 : 233.

Acanthaspis

Tetroxia

Mardania

Plynus (Subgenus) Stal, 1874, *Enum. Hem.* 4 : 71.

Type species : *Acanthaspis flavoraria* Hahn.

Body elongate. Head porrect, elongate, longer than broad but shorter than

Amyot & Serville, 1843, *Hem.* p. 336; Stal, 1865, *Hem. Afr.* 3 : 122 & 126; Stal, 1874, *Enum. Hem.* 4 : 65; Distant, 1904, *Faun. Brit. Ind.* Rhynchota, 2 : 257; Pant, 1953, *Ind. For. Leaf.* 121 : 123; Xiao, C-y et al., 1981, *Hemi-Het.* (In Chinese) p. 390.

Amyot & Serville, 1843, *Hem.* p. 334.

Stal, 1859, *Ofv. Vet.-Ak. Forh.* p. 189.

pronotum; tylus long, prominent, overlapped distally by short and broad jüga; eyes prominent and bulging; width across eyes more than anterior margin of pronotum; preocular length less than postocular length; a median longitudinal sulcation extending from in front of ocelli to base of tylus, lateral margins of sulcation carinate; ocelli prominent, situated on small circular area, closer to each other than to eyes; 'neck' distinct and shining; antenniferous tubercles prominent; bucculae short extending posteriorly and meeting beneath labium; antennae inserted closer to eyes than to tip of tylus; first antennal segment extending much beyond apex of head, third segment longest; labium short, curved, robust not reaching anterior coxae; labial segments I & II subequal, III smallest. Pronotum broader at base than long, with distinct transverse depression before middle; lateral margins sinuate, anterior margin concave, posterior margin straight medially; anterior pronotal lobe small, convex with distinct narrow dorsal 'collar'; anterior pronotal angles tuberculously prominent; posterior pronotal lobe large; posterior pronotal angles generally spinose; prosternum sulcate, meso- and metasternum carinate; scutellum triangular, central depression shallow with prominent margins, apex produced into spine; each prothoracic leg with moderately incrassated femur and distal tibial fossula spongiosa; tarsi three segmented, distal segment longest; arolium absent; adults either macrop- terous or brachypterous. Abdomen amplified medio-ventrally with a pair of small median carinae (Fig. 1, MC) extending from first to third tergum; scent gland openings (SGO) at anterior

mesal margins of terga IV, V and VI (Fig. 1); sutures between terga II & III, III & IV and IV & V curved posteriorly from laterad to meson; tergum VII much enlarged and rugulose posteriorly in males, tergum VIII of females narrow and sclerotised (Fig. 1) while membranous in males; connexivum of tergum (DC) II triangular, III-VII almost rectangular; first pair of abdominal spiracles located at antero-lateral angles of incompletely fused terga I & II, remaining spiracles (6 pairs) situated ventrally, inner to ventral connexiva (Fig. 2); ventral connexivum (VC) VII incompletely distinct; abdominal sutures between sterna V & VI and VI & VII directed anteriorly near mesal margins; sternum VII largest.

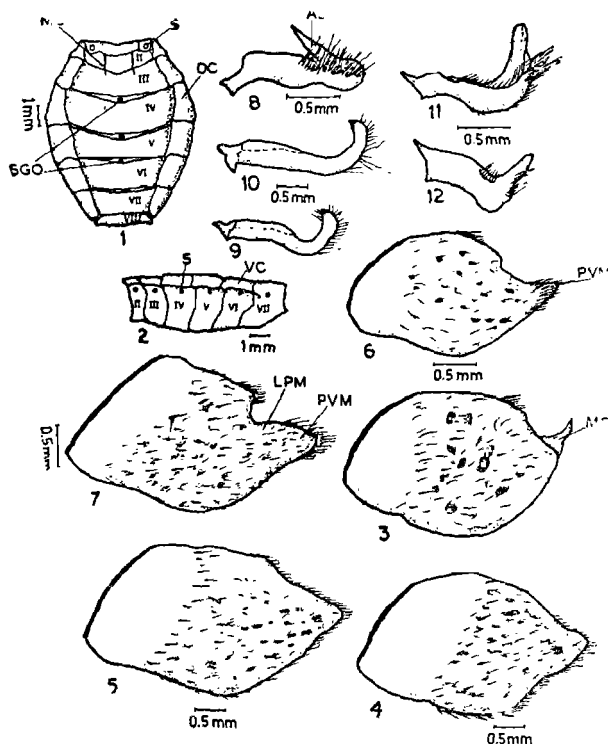
Male pygophore enlarged (Figs. 3-7) with dorsally located anterior and posterior pygophoral openings; postero-ventral pygophoral margin prominent medially and recurved; lateral margins with small projections and recurved into pygophore. Claspers (Figs. 8-12) with prominent apical spine (AS) and hairs.

Acanthaspis maculatus sp. nov.

Adults brachypterous; body black, granulate and sparsely hairy; dorsum and venter of head, thorax and abdomen black, connexiva with alternate yellow and black spots, dorsally and ventrally; labial segments I and II black, III dark brownish; antennal segments I & II black, III & IV brownish; legs black with distal ends to tibiae and tarsi light brownish; each hemelytron brachypterous black with a basal and a distal yellowish spots.

Head longer than wide; postocular area twice as long as preocular length;

NEW SPECIES OF GENUS ACANTHASPIS



Figs. 1-12. 1—Abdomen of *Acanthaspis maculatus*, dorsal view; 2—Abdomen of *A. maculatus*, lateral view; 3—Pygophore of *A. maculatus*, lateral view; 4—Pygophore of *A. niger*, lateral view; 5—Pygophore of *A. hisarensis*, lateral view; 6—Pygophore of *A. flavipes*, lateral view; 7—Pygophore of *A. rugulosa*, lateral view; 8—Clasper of *A. maculatus*, lateral view; 9—Clasper of *A. niger*, lateral view; 10—Clasper of *A. hisarensis*, lateral view; 11—Clasper of *A. flavipes*, lateral view; 12—Clasper of *A. rugulosa*, lateral view.

AS—apical spine, DC—dorsal connexivum, LPM—lateral pygophoral margin, MC—median carina, MS—median spine, PVM—postero-ventral pygophoral margin, S—spiracle, SGO—scent gland openings, VC—ventral connexivum.

preocular length, 0.55; postocular length, 1.10; eyes more enlarged ventrolaterally; lateral margins of median sulcation of head carinate, meet anteriorly; head length, 2.55; width across eyes, 2.20; interocular distance, 0.75; interocellar distance, 0.25.

Pronotum wider than long; anterior pronotal lobe sculptured; posterior pronotal lobe densely granulate, rugulose

and with central, longitudinal incomplete shallow sulcation; anterior pronotal angles tuberculously and posterior pronotal angles spinosely prominent; discal tubercles of posterior pronotal lobe absent; pronotal length, 3.30; width, 4.15; apical scutellar spine elongate, obliquely ascending dorso-posteriorly, without hairs; length scutellum, 0.80; width, 1.30.

Abdomen not carinate medio-ventrally; paired small median carinae (MC) extending beyond abdominal tergum II (Fig. 1); abdominal length, 9.15.

Labium not reaching prothoracic coxae; labial segment III much shorter than segment I; length labial segments : I, 1.00; II, 1.00; III, 0.40; antennae pilose, antennal I incrassated, III slightly more than twice the length of antennal I; length antennal segments : I, 1.90; II, 2.75; III, 3.85; IV, 1.80; legs pilose; femora of mesothoracic legs moderately incrassated, their tibiae with distal fossula spongiosa; wings small pad-like, reaching abdominal segment II.

Male pygophore (Fig. 3) more convex medio-ventrally; postero-ventral pygophoral margin (PVM) slightly prominent medially and recurved; a pointed and elongated median spine (MS) projecting postero-ventrally; clasper (Fig. 8) elongate with downwardly projecting long and pointed apical spine (AS), tufts of elongated hairs near apex and base of epical spine.

Total length : ♂♂, 15.00; ♀♀, 15.50

Holotype : ♂, INDIA : HARYANA : HISAR

In Haryana Agricultural University Collection.

Paratypes : 3 ♂♂ & 3 ♀♀, same data as holotype.

Distribution : At present known from Hisar (Haryana), India.

Remarks :

Acanthaspis maculatus resembles *A. niger* in having brachypterous wings in the adult stage while the other three species under reference, viz. *A. flavipes*,

A. rugulosa and *A. hisarensis* are macropterous. *A. maculatus* can be further distinguished from *A. niger* by the following characteristics : Alternate yellow and black spots are present above and beneath on connexiva of *A. maculatus* while *A. niger* has uniformly black coloured connexiva. The pronotum is without discal tubercles and scutellar spine is without hairs in former species while pronotal discal tubercles and hairy scutellar spine are present in latter species. The hemelytron has basal and distal yellow spots in *A. maculatus* while only one broad yellow spot is on hemelytron of *A. niger*. Pygophore of *A. maculatus* has elongate median spine and clasper with downwardly projecting elongated apical spine, while the pygophore of *A. niger* is without median spine and its clasper is of different shape and size.

Acanthaspis niger sp. nov.

Adults brachypterous; body black and granulate, more pilose ventrally, connexiva black; antennal segments I & II black, III & IV light brownish; labial segments I & II black, III dark brown; legs black, tarsi brownish; each hemelytron short with broad yellow spot near centre of wing touching costal and apical margins; clavus and basal area of hemelytron black.

Head much longer than wide; preocular length less than postocular length; preocular length, 1.00; postocular length, 1.40; eyes almost equal in shape and size both dorsally and ventrally; lateral margins of median sulcation of head carinate, meet anteriorly; head length, 3.20; width across eyes, 2.15; intero-

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cular distance, 0.90; interocellar distance, 0.25.

Pronotum much wider than long; anterior pronotal lobe deeply sculptured; posterior pronotal lobe thickly granulate, rugulose and with small, central, longitudinal incomplete shallow sulcation; anterior pronotal angles conspicuous, tuberculosely prominent and posterior pronotal angles spinosely prominent; a pair of small discal tubercles of posterior pronotal lobe present; pronotal length, 3.70; width, 5.00; apical scutellar spine elongate, obliquely ascending dorso-posteriorly with many elongate hairs; length scutellum, 1.40; width, 2.00.

Abdomen not carinate medio-ventrally; paired small median carinae (MC) extending upto abdominal tergum II; abdominal length, 10.60.

Labium not reaching prothoracic coxae; labial segment III less than 1/2 of the segment I; length labial segments : I, 1.20; II, 1.20; III, 0.50; antennae pilose; antennal segment I incrassated, III & IV thin and thread-like, extending much beyond tip of tylus, segment III twice as long as antennal I; length antennal segments : I, 1.80; II, 3.20; III, 3.60; IV, 1.80; legs pilose; mesothoracic legs with moderately incrassated femora and distal tibial fossula spongiosa; small pad-like brachypterous wings extending slightly beyond abdominal tergum II.

Male pygophore (Fig. 4) convex medio-ventrally; postero-ventral pygophoral margin (PVM) broadly prominent medially and recurved; median spine absent; clasper (Fig. 9) sickle-shaped

with elongate distal hairs, apical spine (AS) of clasper small but acute.

Total length : ♂, 17.50; (♀, not available).

Holotype : ♂, INDIA: KARNATAKA: MYSORE

In Haryana Agricultural University Collection.

Distribution : Known from Mysore (Karnataka, India) at present).

Remarks :

Acanthaspis niger resembles *A. maculatus* in having brachypterous adults and separated from the other three macropterous species, viz. *A. flavipes*, *A. rugulosa* and *A. hisarensis*. *A. niger* can easily be distinguished from *A. maculatus* by the following characters : In *A. niger* posterior pronotal lobe has a pair of small distinct discal tubercles and hairy scutellar spine; hemelytron with only one broad yellow spot, extending from centre, touching costal and apical margins and uniformly black coloured connexiva, above and beneath. While the discal tubercles of posterior pronotal lobe are absent, scutellar spine is without hairs; each hemelytron is with two yellow spots and alternate yellow and black spots are present on connexiva, above and beneath in *A. maculatus*. Moreover, the pygophore of *A. niger* is without median spine and each clasper is sickle shaped with acute apex.

Acanthaspis flavipes Stal

Acanthaspis flavipes Stal, 1855, *Ofv. Vet.-Ak Forh.* p. 187;

Reuter, 1881, *Act. Soc. Sc. Fenn.* 12 : 325; Distant, 1904, *Faun. Brit. Ind. Rhynchota* 2 : 262; Pant, 1953, *Ind. For. Leaflet* 121 : 123.

Acanthaspis quinquespinosa var. *flavipes* Stal, 1874, *Enum. Hem.* 4 : 72.

Acanthaspis geminata (var.) Reuter, 1881, *Act. Soc. Sci. Fenn.* 12 : 325.

Adults macropterous; body black, granulate and sparsely pilose; head, scutellum and pronotum black, except posterior half of posterior pronotal lobe, either yellow uniformly or with black, broad streak extending partially or completely from anterior part of posterior pronotal lobe; venter of thorax and abdomen dark brown to blackish, abdomen pale dorsally; connexiva with alternate black and yellow spots, above and beneath; antennal segment I yellowish, segments II-IV light brownish; labium and legs yellowish and pilose; each hemelytron black with a small elliptical basal yellow spot and another yellow spot near base of membrane touching costal margin but not reaching anal margin.

Head much longer than wide; preocular length shorter than postocular length; preocular length, 0.65; postocular length, 0.90; eyes rather enlarged laterally; lateral margins of median sulcation of head carinate, distinct and not meeting anteriorly; head length, 2.30;

width across eyes, 1.85; interocular distance, 0.70; interocellar distance, 0.20.

Pronotum wider than long; anterior pronotal lobe lightly sculptured; posterior pronotal lobe granulate, not rugulose and without central longitudinal sulcation; anterior pronotal angles tuberculously and posterior pronotal angles spinosely prominent; a pair of small, discal tubercles of posterior pronotal lobe present; pronotal length, 3.25; width, 4.50; apical scutellar spine elongate, pointed, obliquely ascending dorso-posteriorly, without hairs; length scutellum, 1.40; width, 2.00.

Abdomen not carinate but amplified medio-ventrally; paired small median carinae extending slightly beyond tergum II; abdominal length, 9.60.

Labium not reaching prothoracic coxae; labial segment III more than five times shorter than segment I; length labial segments : I, 1.10; II, 1.00; III, 0.20; antennae pilose except segment I, somewhat incrassated, antennal III more than two and a half times longer than antennal I; length antennal segments : I, 1.60; II, 3.70; III, 4.30; IV, 1.90; legs pilose; femora of mesothoracic legs moderately incrassated, their tibiae with distal fossula spongiosa; wings well-developed and extending slightly beyond abdominal tip.

Male pygophore (Fig. 6) convex medio-ventrally; postero-ventral pygophoral margin (PVM) distinctly prominent medially and recurved; median spine absent; clasper (Fig. 11) curved medially, apical spine (AS) broad and large with

numerous elongate hairs near apex and along margin.

Total length : ♂♂, 15.15; ♀♀, 16.50.

Distribution : Haryana (Hisar), Punjab, Maharashtra (Bombay), Uttar Pradesh (Dehra Dun, Siwaliks, Thano, Chakhata Range of Haldwani and Pathri in Saharanpur), West Bengal (Memari).

Remarks :

A. flavipes can be easily separated from other two macropterous species, viz. *A. rugulosa* and *A. hisarensis* in having yellow coloured posterior part of the posterior pronotal lobe with a pair of small, distinct discal tubercles and hemelytron with two yellow spots. In *A. rugulosa* and *A. hisarensis*, the pronotum is uniformly black, posterior pronotal lobe with discal tubercles and hemelytron with only one yellow spot. The pygophore and claspers of *A. flavipes* are characteristically distinct from those of the other reduviid species under study.

Acanthaspis rugulosa Stal

Acanthaspis rugulosa Stal, 1863, *Ann. Soc. Ent. Fr.* p. 49; Stal, 1874, *Enum. Hem.* 4 : 73; Distant, 1904, *Faun. Brit. Ind.* Rhynchota 2 : 264; Pant, 1953, *Ind. For. Leaflet* 121 : 123.

Adults macropterous; body blackish, granulate, pilose ventrally; head, pronotum and scutellum black; venter of

thorax dark brown; abdomen pale both dorsally and ventrally, light brownish to blackish laterally; connexiva with alternate yellow and black spots, above and beneath; antennal segment I black, others brownish; labium brownish; legs yellowish; each hemelytron black with a broad yellow spot towards base of clavus touching the costal margin but not reaching the anal margin.

Head much longer than broad; preocular length half than postocular length; preocular length, 0.50; postocular length, 1.00; eyes enlarged ventrolaterally; lateral margins of median sulcation of head carinate, distinct and not meeting anteriorly; head length, 2.20; width across eyes, 1.50; interocular distance, 0.70; interocellar distance, 0.30.

Pronotum wider than long; anterior pronotal lobe lightly sculptured; posterior pronotal lobe thickly granulate, rugulose and without central longitudinal sulcation; anterior pronotal angles not prominent and posterior pronotal angles slightly prominent; discal tubercles of posterior pronotal lobe absent; pronotal length, 3.60; width, 4.90; apical scutellar spine small, straight, posteriorly directed and without hairs; length scutellum, 1.10; width, 1.20.

Abdomen strongly carinate medio-ventrally; paired small, median carinae not extending beyond abdominal tergum II; abdominal length, 11.20.

Labium not reaching prothoracic coxae; labial segment III more than thrice shorter than segment I; length labial segments : I, 1.10; II, 1.10; III, 0.30; antennal I incrassated, III more than two

and half times longer than antennal I; length antennal segments : I, 2.20; II, 4.00; III, 5.80; IV, 0.60; mesothoracic legs with moderately incrassated femora and distal tibial fossula spongiosa; wings well-developed and reaching apex of abdomen.

Male pygophore (Fig. 7) convex medio-ventrally; ventro-posterior pygophoral margin (PVM) broadly prominent medially and recurved; median spine absent; clasper (Fig 12) curved beyond middle, apical spine (AS) elongate and narrow distally, tufts of hairs near apex and along inner margin.

Total length : ♂♂, 17.00; ♀♀, 19.40.

Distribution : Haryana (Hisar), Madhya Pradesh (Chitrakote), Maharashtra (Bombay), Uttar Pradesh (Dehra Dun), West Bengal.

Remarks :

A. rugulosa can be distinguished from other macropterous species under reference, i. e. *A. flavipes* and *A. hisarensis* on the basis of small, straight and posteriorly directed apical scutellar spine, medio-ventral strong carination of abdomen and distinct male pygophore and clasper (Figs. 7 and 12).

Acanthaspis hisarensis sp. nov.

Adults macropterous; body black, granulate and longly pilose; head black with a yellowish small spot lateral to each ocellus; dorsum and venter of thorax, abdomen and connexiva black; antennal segments I and II black while III

and IV light brownish; legs black, tarsi, pale brownish; each hemelytron black with broad transverse band-like yellow spot, near base of membrane.

Head much longer than wide; pre-ocular length shorter than postocular length; preocular length, 1.20; postocular length, 1.50; eyes enlarged laterally; lateral margins of median sulcation of head carinate and terminate anteriorly in distinct projections; head length, 3.60; width across eyes, 2.25; interocular distance, 0.80; interocellar distance, 0.20.

Pronotum much wider than long; anterior pronotal lobe deeply sculptured; posterior lobe thickly granulate, rugulose and without central longitudinal sulcation; discal tubercles of posterior pronotal lobe absent; anterior pronotal angles broadly spinose and posterior pronotal angles distinctly spinosely prominent; pronotal length, 4.70; width, 6.00; apical scutellar spine elongate, obliquely ascending dorso-posteriorly, with long hairs; scutellar length 1.40; width, 2.00.

Abdomen not carinate medio-ventrally; paired small median carinae extending beyond tergum II; abdominal length, 11.70.

Labium not reaching prothoracic coxae, labial segment III more than three and a half times smaller than segment I; length labial segments : I, 1.50; II, 1.50; III, 0.40; antennae densely pilose; antennal I incrassated, III more than twice the length of I; length antennal segments : I, 2.00; II, 3.50; III, 4.40, IV, 2.00; mesothoracic legs with moderately incrassated femora and distal tibial

NEW SPECIES OF GENUS ACANTHASPIS

fossula spongiosa; wings well-developed extending upto tip of abdomen. Remarks :

Male pygophore (Fig. 5) convex medio-ventrally; postero-ventral pygophoral margin (PVM) prominent medially and recurved; median spine (MS) absent; clasper (Fig. 10) elongate almost sickle-shaped, with long hairs near distal end; apical spine small but acute.

Total length : ♂♂, 20.00 (♀, not available)

Holotype : ♂, INDIA : HARYANA : HISAR

In Haryana Agricultural University Collection.

Paratype : 1 ♂; same data as holotype.

Distribution : At present known from Hisar (Haryana), India.

Acanthaspis hisarensis sp. nov. is a macropterous species and thus distinct from brachypterous reduviid species, viz. *A. maculatus* and *A. niger*. *A. hisarensis* can easily be distinguished from *A. flavipes* and *A. rugulosa* in having a small yellowish spot lateral to each ocellus on head, hairy apical scutellar spine, black legs & connexiva and distinct male pygophore & claspers (Figs. 5 and 10).

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EVALUATION OF TORIA GENOTYPES FOR STABILITY AND ADAPTATION

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ABSTRACT

Thirty toria genotypes, studied for stability and adaptation, were grown in six environments and observed for seven characters, viz. plant height, days to 50% flowering, days to maturity, reproductive period, biological yield, 1000-seed weight and seed yield per plant. Whereas, significance of both additive and non-additive components of $G \times E$ was depicted for seed yield, significant additive $G \times E$ component was noticed only for plant height, 1000-seed weight and days to 50% flowering indicating thereby the possibility of making predictions across environments. Highly significant, non-additive component of $G \times E$ expressed for days to maturity, reproductive period and biological yield per plant revealed non-reliability of such estimates to make predictions. Genotypes TK 8403, TH 69 and 'Sangam' possessed average stability for seed yield per plant. TH 80 with highest mean for plant height and biological yield per plant showed its specific adaptation to rich environments. The genotype 'Shamgarh'—stable for days to flowering, was found to be specifically suited to low yielding environments.

In Haryana, rapeseed and mustard are the major oilseed crops accounting for about 94.72% of the total area under oilseeds and 95.67% of the total production. Average yield of rapeseed and mustard in Haryana is about 797 kg per hectare (1986-87). Toria, an important oilseed crop of this group is assuming great importance in paddy belt of the State, as it fits well in toria-wheat rotation. Identification of stable and early maturing varieties with less than 100 days maturity is required. In the present study, an attempt was made to identify stable varieties having suitability to prolifer under

varying agro-climatic conditions in the State.

MATERIAL AND METHODS

Thirty indigenous toria genotypes collected from Haryana, Punjab, Uttar Pradesh, Assam and West Bengal were grown in six environments at three locations (Hisar, Karnal and Kaul) and on two sowing dates (6 and 20 September, 1985). In all the six environments (E_1 to E_6) each of the thirty genotypes were sown in rows 4 meter long 30 cm wide, with 15 cm plant to plant distance and replicated thrice in randomised block

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design. Observations on five randomly selected plants were recorded on plant height, days to 50% flowering, days to maturity, reproductive period, biological yield, 1000-seed weight and seed yield per plant. The data were subjected to analysis of variance following the technique adopted by Panse and Sukhatme (1967) and stability analysis as per model given by Eberhart and Russell (1966).

RESULTS AND DISCUSSION

Genotypic Variation and the Environmental Response

The analysis of variance computed for seven traits revealed presence of significant variability among genotypes and environments. Whereas, environment 1 indicated favourable varietal response, environment 6 was unfavourable for seed yield per plant. Both E_1 and E_6 expressed favourable response for biological yield per plant, days to 50% flowering and days to maturity. E_3 was most favourable for plant height. In general, 6 September sowing was more favourable as compared to 20 September sowing for most of the characters under study.

Mean Performance

On the basis of mean of six environments, toria genotype TH 80 was the tallest (126.12 cm) and B 54 the shortest (88.12 cm). TH 86 was the earliest flowering (39.78 days) and TH 97 flowered late (56.55 days). Against the mean 92 days for maturity, TH 97 took 89.78 days to mature. At Hisar and Kaul locations TH 98 was the last to mature (97.11 days). The longest reproductive period

(51.61 days) was recorded for TH 91 and shortest (44.24 days) for TH 97. The tallest plants (126.12 cm) observed in TH 80 also showed highest biological yield per plant in E_3 . TH 98 which matured last of all had the boldest seeds (3.96 g/1000 seeds), followed by 3.74 g of TH 92 and 3.73 g of Sangam. Likewise TH 97, the earliest maturing variety had smallest seeds weighing 3.20 g/1000 seeds. TH 92 recorded highest seed yield per plant in E_1 , TH 80 in E_3 and TH 90 in E_6 . None of the varieties outyielded in all the six environments. On an average TK 8403 was the highest yielder (11.39 g) and 'Shamgarh' was the lowest (5.68 g).

Genotype $\times$ Environment Interactions

Mean squares due to genotypes, environments and environment (linear) were highly significant for all the characters (Table 1) which indicated the scope and reliability for prediction across environments. The significant mean sum of squares due to environments plus genotype $\times$ environment interaction (GE) for all the characters except days to maturity, reproductive period and biological yield per plant depicted variable genotypic response to a wide range of environments. The existence of significant pooled deviation values for days to maturity, reproductive period, biological yield per plant, 1000-seed weight and seed yield per plant depicted presence of non-linear (unpredictable) component of GE. The presence of highly significant to significant, linear (additive) component of GE for plant height, days to 50% flowering, 1000-seed weight and seed yield per plant exhibited possibility of making predictions across environments for these characters. Although a sizeable unpredictable com-

TABLE 1
Analysis of variance for stability in toria

Source	d. f.	Plant height	Days to flowering	Days to maturity	Reproductive period	Seed yield	1000-seed weight	Biological yield/plant
Genotype	29	849.69**	57.54**	462.89**	66.24*	9.73*	0.25	187.34
Environment	5	1108.42**	2694.01**	4516.91**	1652.31**	166.01**	6.46**	1478.36**
Environment + (Genotype x environment)	150	72.68	109.44	241.60	93.90	9.68	0.45	153.21
Environment (Linear)	1	5478.65**	13461.33**	22552.86**	8150.02**	829.73**	32.25**	7385.48**
Genotype x environment (Linear)	29	69.29**	28.44*	84.62	11.96	5.85*	0.44**	133.73
Pooled deviation	120	28.31	17.75	93.64**	46.57**	3.77*	0.18**	97.64**
Pooled error	348	84.07	51.27	18.72	16.52	2.87	0.16	94.44

*Significant at 5% level

**Significant at 1% level

ponent of GE still remained for the remaining traits, yet it was possible to predict for some of genotypes when taken individually (Perkins and Jinks, 1968).

Previous studies in toria revealed that it is possible to identify stable genotypes for seed yield and related traits. Singh and Gupta (1983) and Singh *et al.* (1984) identified several genotypes for seed yield and days to maturity. The genotype TCSU-2 was stable and possessed highest mean for seed yield. In the present study TK-8403—the highest yielder, was found to possess average stability for seed yield and plant height; below average stability for days to flowering, days to maturity and 1000-seed weight; and above average stability for reproductive period but was unstable for biological yield per plant. Another genotype TH 90, found unstable for the seed yield, was stable for days to flowering, days to maturity and reproductive period. It possessed above average stability for plant height and below average stability for 1000-seed weight. TH 84 ranking third in seed yield, possessed average stability for days to flowering, days to maturity and reproductive period. This genotype possessed above average stability for biological yield and below average stability for 1000-seed weight. Among the other important genotypes, TH 97 showed above average stability for days to flowering and was unstable for days to maturity. TH 86 showed above average stability for days to maturity and reproductive period. TH 93, stable for days to flowering, days to maturity and reproductive period, showed above average stability for seed yield. TH 88 possessed average stability for days to maturity and reproductive period

and above average stability for days to flowering. TH 69, a mediocre seed yielding genotype (15.94 g against overall mean of 16.12 g), was stable for days to flowering, days to maturity and 1000-seed weight and unstable for reproductive period and biological yield per plant. These genotypes may be utilized in future breeding programmes.

Varietal Classification and Adaptation

Classification of 12 outstanding toria genotypes based on their highest mean performance, most responsive and stable behaviour under varying agro-climatic conditions, is given in Table 2. A perusal of the data showed that TH 80 possessing highest mean for plant height and biological yield per plant was most responsive to plant height and seed yield per plant and was specifically adapted to high

TABLE 2

Classification of genotypes indicating highest mean, most responsive and most stable nature for various characters

	Genotypes		
	Highest mean	Most responsive	Most stable
Plant height	TH 80	TH 80	T 9
Days to 50% flowering	TH 86 (early)	TH 87	B 54
Days to maturity	TH 97 (early)	Shamgarh	TH 69
Reproductive period	TH 91	TGC-2	TH 83
Biological yield/plant	TH 80	TH 93	None
1000-seed weight	TH 98	None	TH 93
Seed yield/plant	TK 8403	TH 80	T 9

yielding environments. TK 8403 with highest seed yield per plant (11.39 g) and average stability was adapted to all environments. TH 97, most responsive for days to 50% flowering, was earliest to mature in 98.78 days and possessed average stability for seed yield per plant. Likewise, TH 93 with above average mean for seed yield per plant was most responsive for biological yield per plant and 1000-seed weight and was specifically adapted to rich environments. TH 86

earliest in flowering (39.78 days), and maturing in 92 days expressed unstable performance for seed yield per plant. T 9 a prereleased variety of the State and stable for yield showed below average mean for seed yield per plant. 'Shamgarh' and B 54 of this category were most stable for days to 50% flowering and days to maturity, respectively. TH 83 stable for reproductive period specifically suited to low yielding environments.

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COMBINING ABILITY ANALYSIS FOR PLANT VIGOUR, GRAIN YIELD AND ITS COMPONENTS IN *DURUM* WHEAT (*TRITICUM DURUM* DESF.)

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The use of the concept of combining ability helps in choosing proper parents for hybridization. This is particularly significant in autogamous crops like *durum* wheat which is widely used in specific food products and is suitable for water stress areas. Thus, combining ability analysis was conducted in a 7×7 diallel (one way hybrid) on plant vigour (20 and 40 days after sowing), plant height, number of grains/spike and grain yield/plant. Among parents, DWL-5023, Raj-911, Raj-1555 and Jori-69 were dwarf and A 9-30-1, Meghdoot and Bijaga-yellow were tall cultivars. All possible F₁ hybrids, alongwith parents were grown in a complete randomised block design with three replications during rabi 1983-84 at Research Farm of Haryana Agricultural University, Hisar. Data were recorded on each progeny/genotype for various characters. Combining ability analysis was performed following Model-1 and Method 2 of Griffing (1956).

The analysis indicated wide differences among genotypes for all the

characters studied. The additive gene action was higher in magnitude than the dominance component for all the traits studied (Table 1). Gupta and Ahmad (1979) also reported similar results in macaroni wheat. The parents with high *gca* effects were Meghdoot for plant vigour at 20 and 40 days, number of grains/spike and grain yield/plant; Bijaga-yellow for plant vigour at 20 and 40 days; Raj-911 for plant vigour at 40 days, dwarfness and number of grains/spike; DWL-5023 for dwarfness; and A 9-30-1 for grains/spike and grain yield/plant. Hence, these parents should be exploited for improving respective traits in *durum* wheat (Table 2). The crosses with high *sca* effects were Bijaga-yellow × Meghdoot for early vigour at 20 days and grain yield/plant; and Raj-911 × Jori-69 for plant vigour at 40 days and dwarfness. Hence, these hybrids should be utilized for effecting further improvements in these traits (Table 2). However, crosses with high *sca* effect may not necessarily involve any good general combiner, as also reported by Prabhu and Sharma (1984).

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TABLE 1
Combining ability variances in *durum* wheat

Source	df	Mean squares				
		Plant vigour (cm)		Plant height (cm)	No. of grains/spike	Grain yield/plant (g)
		20 days	40 days			
<i>gca</i>	6	2.80**	7.53**	3493.41**	30.26**	85.89**
<i>sca</i>	21	1.07**	4.84**	1059.04**	24.38**	42.65**
Error	54	0.33	0.29	19.06	4.95	20.08
<i>gca : sca</i>	—	2.60 : 1	1.55 : 1	3.29 : 1	1.24 : 1	2.01 : 1
h^2	—	45.34	42.84	45.93	0.061	36.58
<i>r(gca, per se)</i>	—	0.54	0.78**	0.50	0.78**	0.53
<i>r(sca, per se)</i>	—	0.93**	0.97**	0.89**	0.91**	0.95**

* $P \leq 0.05$; ** ≤ 0.01

TABLE 2
Best parents and crosses based on respective *gca*, *sca* effects and their *per se* performance in *durum* wheat

Based on	Plant vigour (cm)		Plant height (cm)	No. of grains/spike	Grain yield/plant (g)
	20 days	40 days			
<i>gca</i>	6(0.7**)	2(1.4**)	2(—7.1**)	5(2.4**)	5(5.7**)
effects	7(0.4**)	6(0.7**)	1(—5.3**)	6(1.2)	6(2.2**)
			4(—4.5**)		
<i>per se</i>	1(20.0)	2(38.8)	3(93.7)	6(57.7)	5(36.2)
performance	6(19.3)	6(36.4)	4(95.9)	4(55.4)	4(27.5)
(parents)	7(18.6)	3(34.9)	1(98.8)	2(53.6)	6(25.1)
<i>sca</i>	6×7(1.2**)	1×3(3.6**)	1×2(—9.7**)	1×5(10.8**)	1×6(10.9**)
effects	3×4(1.2**)	4×6(3.2**)	2×4(—9.5**)	3×5(8.3**)	6×7(9.1**)
	5×7(1.1**)	5×6(2.0**)			3×5(6.9**)
<i>per se</i>	2×6(20.6)	2×7(38.8)	1×2(104.7)	2×5(86.4)	1×6(45.5)
performance	6×7(20.4)	4×6(37.9)	2×4(105.7)	5×7(80.8)	3×5(39.3)
(crosses)	4×7(19.1)	1×3(37.5)	4×6(127.1)	3×5(66.7)	2×5(38.5)

* $P \leq 0.05$; ** ≤ 0.01

1—DWL-5023, 2—Raj-911, 3—Raj-1555, 4—Jori-69, 5—A-9-30-1, 6—Meghdoot 7—Bijaga-yellow.

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Moreover, to exploit both additive and non-additive gene effects biparental intermating of selects in early generations of some promising crosses, population improvement (Frey, 1975) and diallel selective mating system (Jensen, 1970) need to be followed. Such schemes may also, by breaking some undesirable linkage, release some desirable segregants.

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ASSOCIATION IN SEGREGATING POPULATION OF BREAD
WHEAT UNDER DROUGHT CONDITIONS

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Studies of yield components based on fixed genotypes have limitations in extrapolation with regard to genotypes in segregating populations where the selection is actually practised. Therefore, the present study was conducted to work out correlations as well as direct and indirect effects of some quantitative characters on grain yield in F_2 generation of bread wheat under drought conditions.

Eight exotic lines, viz. GP-106, PC-110, PC-431, 12059, 12124, 12163, 13332 and 13335, mostly derived from winter $\times$ spring crosses (Table 1), were crossed with four drought tolerant wheat varieties, viz. IWP-72, C-306, WH-331 and WL-410. Two F_1 's failed to germinate. F_2 populations of remaining 30 crosses were grown in a randomised block design with three replications at Wheat Breeding Station, Ambala under moisture stress conditions. Each population, comprising about 500 plants, was grown in 10 rows plot of 5 m length with 30 cm between and 10 cm within row spacings. Observations were recorded on 30 competitive plants per plot for six traits, viz. plant height (cm),

TABLE 1

Parentage of exotic lines involved
in crosses

Designation	Parentage
GP-106	CMH 76-1048-CMH74A.75.4 $\times$ CMH76.1084
PC-110	Not available
PC-431	Not available
12059	MAYA'S'-SPRW'S' $\times$ SAP'S'/BOC'S'
12124	TTR'S'-JUN'S'
12163*	YD'S'-ZZ'S' $\times$ PVN
13332	VEERY'S'-Aurifer
13335*	[(FKM(FR-KAD-GB) (2) BB-CHAZ] EMU'S'

*Cross combination not successful with C-306.

spikes/plant, spike length (cm), grains/spike, 1000-grain weight (g) and grain yield/plant (g). The correlations and path coefficients were computed following Dewey and Lu (1959).

Grain yield was positively correlated with all traits, except 1000-grain weight (Table 2). Among other traits, grains/spike were positively associated with plant height, spikes/plant and spike

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length. Plant height was positively correlated with spikes/plant too. It was interesting to note that 1000-grain weight, commonly believed to be the most important selection index criterion, showed no association with grain yield. Lack of association between 1000-grain weight and grain yield might be due to a compensating effect involved in the use of plant assimilates to produce seeds (Evans and Wardlaw, 1976). In con-

sonance to the present findings, Ahmed *et al.* (1978), Campbell and Davidson (1979), Fischer and Wood (1979), Srivastava *et al.* (1980), Yadav and Sethi (1981) and Bhuller *et al.* (1985) reported grain yield to be highly correlated with spikes/plant under moisture stress conditions. Positive association between plant height and grain yield under drought conditions was also reported by Chaudhary *et al.* (1985).

TABLE 2

Phenotypic (above diagonal) and genotypic (below diagonal) correlation coefficients of grain yield and its components under drought conditions in wheat

Character	Grain yield/ plant	Plant height	Spikes/ plant	Spike length	Grains/ spike	1000-grain weight
Grain yield/plant		0.746**	0.794**	0.452*	0.565**	0.090
Plant height	0.919		0.720**	0.321	0.423*	-0.051
Spikes/plant	0.920	0.858		0.317	0.487**	0.009
Spike length	0.395	0.401	0.322		0.857**	-0.109
Grains/spike	0.566	0.583	0.617	0.847		-0.165
1000-grain weight	0.297	-0.017	0.027	-0.161	-0.084	

*, **Significant at 5 and 1 per cent, respectively.

TABLE 3

Direct and indirect effects of various characters on grain yield under drought conditions in wheat

Character	Plant height	Spikes/ plant	Spike length	Grains/ spike	1000-grain weight	Genotypic correlation	Phenotypic correlation
Plant height	0.428	0.578	0.168	-0.250	-0.005	0.919	0.746**
Spikes/plant	0.367	0.673	0.135	-0.264	0.009	0.920	0.794**
Spike length	0.172	0.217	0.429	-0.363	-0.051	0.395	0.452*
Grains/spike	0.249	0.416	0.356	-0.429	-0.026	0.566	0.565**
1000-grain weight	-0.007	0.018	-0.068	0.036	0.318	0.297	0.090
Residual	0.030						

*, **Significant at 5 and 1 per cent, respectively.

The perusal of path analysis (Table 3) revealed that spikes/plant had the largest direct and indirect contribution in grain yield having positive correlation with it. Therefore, selecting plants with more spikes/plant should form primary criterion in the present set of material. Plant height, spike length and 1000-grain weight were other components exerting a substantial direct effect on grain yield. Bhuller *et al.* (1985) also suggested that under rainfed conditions maximum stress

may be laid on spikes/plant, grain weight and plant height. Maximum effect of grains/spike on grain yield was via other characters followed by plant height and spikes/plant. These results suggest to indicate that the ideotype for drought conditions should be tall with more number of spikes/plant. Thus, winter wheat which has high tillering capacity should find a place in crossing programme for evolving varieties for rainfed conditions.

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CLINICAL, GROSS AND HISTOPATHOLOGICAL EVALUATION OF TRANSTHORACIC OESOPHAGOTOMY TECHNIQUES IN CALVES

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ABSTRACT

Rotational and longitudinal oesophagotomy techniques were performed in thoracic oesophagus in twelve cow calves and evaluation was carried out by clinical, gross and histopathological means, upto three weeks. It was concluded that animals subjected to rotational oesophagotomy technique had more complications like choke, stenosis and diverticulum formation as compared to the longitudinal oesophagotomy technique.

Thoracic oesophagotomies are indicated for removal of foreign bodies (Houlton *et al.*, 1985), intraluminal obstruction (Singh and Nigam, 1980) and for experimental evaluation of oesophagotomies (Stick *et al.*, 1983; Bose and Mohanty, 1986). Present study involves the comparison of longitudinal and rotational oesophagotomy techniques in thoracic oesophagus of calves.

MATERIAL AND METHODS

Twelve calves were selected and divided into two groups. Animals were prepared for surgery by fasting for 24 h and were subjected to sedation by 6% chloral hydrate solution followed by general anaesthesia by 5% intraval sodium (thiopentone sodium) being administered intravenously till effect. Intubation was performed and positive pressure ventilation was maintained by Bird's respirator

mark 14. Observing a strict asepsis, a right sided eighth rib sub-periosteal resection was performed and thoracic cavity was entered in. The thoracic oesophagus was exteriorized and was clamped on either side by intestinal clamps. In first group, the longitudinal oesophagotomy was performed. In second group, after giving the muscle incision an undermining was carried out to separate it with mucosa and the latter was reflected and brought to the muscle incision from a 90 degree reflection site and the incision was given. Suturing involved simple interrupted sutures for mucosa and muscle in two tier using chromic catgut no. 2/0. Mucosal sutures carried knots in lumen, for both the techniques. In rotational technique the reflected mucosa was reposed back to original site after suturing. Thoracic wall wound was closed conventionally. All the animals received three litres of 5% dextrose saline solution daily for first

week, followed by succulent feed in second week and dry roughage in third week. All the animals were observed clinically also. Two animals from each group were sacrificed at weekly interval upto three weeks and tissue was collected for gross and histopathological examination. The sections were stained by H & E technique.

RESULTS AND DISCUSSION

The animals of rotational oesophagotomy group exhibited repeated vomiting after seven days when given succulent feed. The oesophagus showed diverticulum, choke and mild to severe stenosis on gross examination. Mucosal wound dehiscence and gaping were observed in second and third weeks in all the animals.

An increased tissue reaction was observed between mucosa and muscle layer. Histopathological examination further revealed marked fibrous tissue spread over a greater area, around the catgut in submucosa (Fig. 1), whereas new vessel budding and fibroblastic infiltration in muscle layer were also visible (Fig. 2) in third week. Mucosal healing was poor.

The animals of longitudinal oesophagotomy did not show any observable clinical signs except retching of neck and intermittent vomiting after 14 days in two cases when resumed to dry roughage. Such animals were discontinued roughage and were given gruel till remaining period of study. An un-complicated patency was revealed in all the three weeks following gross examination of operated

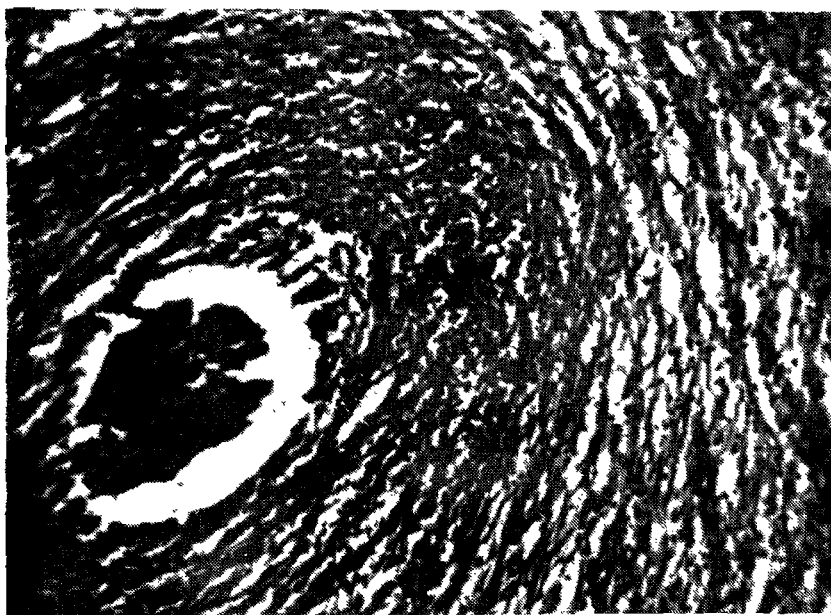


Fig. 1. Marked fibrous tissue reaction around catgut in submucosa in second week in rotational oesophagotomy group (H & E $\times 40$).

OESOPHAGOTOMY TECHNIQUES IN CALVES

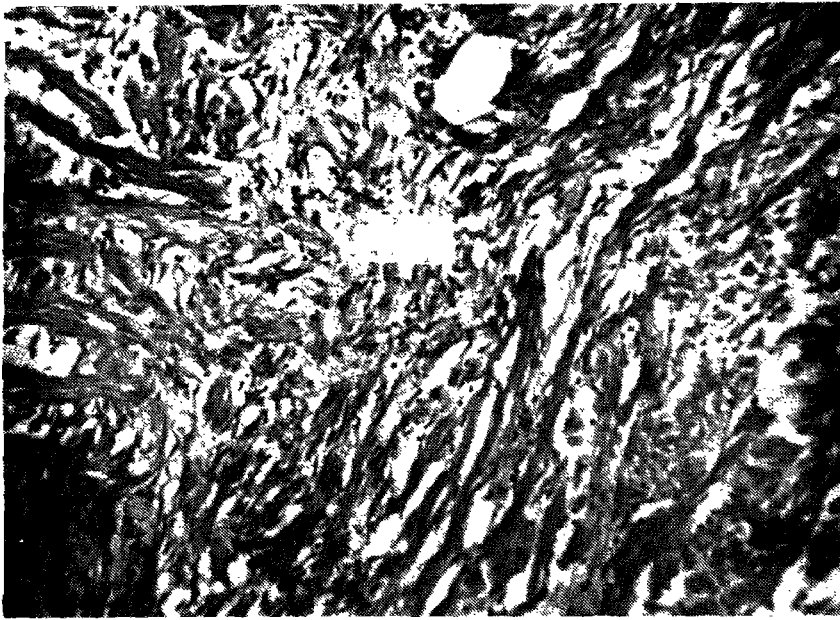


Fig. 2. Marked budding of new blood vessels and fibroblastic infiltration in muscle layer of rotational oesophagotomy group in second week.

oesophagus. Histopathological examination revealed complete mucosal healing in all the animals by second week. A slight fibrous tissue reaction was observed at submucosa.

The rotational oesophagotomy technique was similar to that used by Stick *et al.* (1983) in Ponies but it had more complications as compared to longitudinal oesophagotomy. They reported oesophageal healing as a function of diet than surgical technique but in the present report the technique differed, whereas feeding was similar. Increased fibrous tissue reaction as a result of more tissue

trauma in rotational technique might be precipitating factor as compared to longitudinal technique. It was concluded that longitudinal oesophagotomy technique proved better than rotational technique when evaluated clinically, grossly and histopathologically.

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DIFFERENTIAL EFFECT OF REGULATORS ON THE PEROXIDASE ACTIVITY AND TOTAL SOLUBLE PROTEIN CONTENTS OF ROOTS AND NODULES IN COWPEA (*VIGNA UNGUICULATA* L.)

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ABSTRACT

The roots exhibited higher peroxidase activity than nodules, whereas total soluble protein contents showed reverse trend in these organs during all the sampling stages. The peroxidase activity in both the organs increased progressively with the plant growth. As regards the total soluble protein contents, it showed initially upsurge and then decline. Treatments with regulators like kinetin, cycocel and colchicine generally increased the peroxidase activity but total soluble protein contents were affected differentially.

Legumes are the major source of protein for the mankind. Improvement of crops, apart from the traditional breeding programmes, can also be done by improving the physiological efficiency of the plants. Significant role of peroxidase in the regulation of growth and differentiation has frequently been suggested to participate in the oxidative process during the development of different organs of the plants. The changes in its activity and isoenzymes composition are characteristic for developmental stages which are organ specific (Wolter and Gordon, 1975). A possible role of peroxidase in the cessation of cell elongation is suggested by the inverse relationship of the cytoplasmic peroxidase level with the rate of growth (Birecka and Galston, 1970; Gardiner and Cleland, 1974). The inhibition of growth caused by ethylene is accompanied by increased peroxidase activity (Ridge and Osborne, 1970). The

plant growth regulators have been involved to play a major role in the processes of growth and development which envisage to improve the crop productivity. As cowpea alongwith other leguminous crops is extensively grown in this region and is most important pulse crop of India which impart major share of protein requirement of our population, it is, therefore, worthwhile to study the effect of various growth regulators on this crop.

MATERIAL AND METHODS

Plants of cowpea cv. HFC-42-1 were raised in sand culture conditions in the green-house by supplying nitrogen free nutrient solutions periodically. On the basis of experiments conducted in the laboratory and the available literature, different concentrations of kinetin (3, 6 and 9 μ g), cycocel (1, 3 and 9 mg) and colchicine (1, 2 and 4 mg) per pot were

given through rooting medium and different parameters were studied during the vegetative (55 DAS-days after sowing), flower initiation (70 DAS) and pod setting (85 DAS) stages. Peroxidase activity was determined by the method of SeEVERS *et al* (1971). The enzyme unit was defined as the amount of enzyme which caused a change of 0.1 in absorbance under the experimental condition. Specific activity was measured and defined as unit of enzyme per mg of protein. Total soluble protein was determined by the Folin-Cio-Calteau reagent (Lowry *et al.*, 1951).

RESULTS AND DISCUSSION

Peroxidase Activity

The data regarding the peroxidase activity of roots and nodules have been shown in Tables 1 and 2.

Roots. Peroxidase activity was lowest at the first sampling stage (55 DAS) and increased tremendously with the growth attaining the maximum value at the last sampling stage (85 DAS) in all the treatments. Decreasing concentrations of kinetin and colchicine were slightly beneficial, whereas CCC brought depressive effect at 55 DAS. But with the advancement of the plant age, the activity increased conspicuously with all the treatments.

Nodules. Peroxidase activity was lowest at 55 DAS and then increased at an accelerated rate with the development of the nodules and reached the maximum value at 85 DAS in the control plants. Peroxidase activity retarded with the treatments at 55 DAS but increased at later stages of plant growth.

TABLE 1

Effect of kinetin, cycocel and colchicine on peroxidase activity (Enzyme units per mg protein) of roots in cowpea

Treatment	Days after sowing		
	55	70	85
Control	71.22	441.05	862.63
Kinetin ($\mu\text{g}/\text{pot}$)			
3	78.13	800.11	1218.82
6	74.70	710.05	1117.73
9	73.31	679.60	1069.16
Cycocel (mg/pot)			
1	42.46	502.44	1310.65
3	59.88	612.24	1364.86
9	64.73	450.79	1284.28
Colchicine (mg/pot)			
1	80.23	517.91	1386.30
2	76.64	536.68	1508.74
4	72.00	616.64	1481.18
C. D. at 5%	13.29	76.64	153.89

TABLE 2

Effect of kinetin, cycocel and colchicine on peroxidase activity (Enzyme units per mg protein) of nodules in cowpea

Treatment	Days after sowing		
	55	70	85
Control	31.27	94.05	292.00
Kinetin ($\mu\text{g}/\text{pot}$)			
3	20.42	98.81	314.19
6	21.42	106.80	320.19
9	23.30	113.45	343.35
Cycocel (mg/pot)			
1	21.84	125.28	300.47
3	23.63	120.00	270.04
9	24.55	116.18	256.20
Colchicine (mg/pot)			
1	30.00	110.68	352.33
2	23.04	112.11	381.14
4	20.60	132.04	302.02
C. D. at 5%	5.22	14.19	10.00

EFFECT OF REGULATORS ON PEROXIDASE ACTIVITY

The specific activity of peroxidase increased progressively with plant growth and was higher in roots than the nodules (Tables 1 and 2). Regulator treatments generally enhanced the peroxidase activity of nodules and roots during the advanced stages of growth. Similar enhancement in peroxidase activity in tobacco pith (Davies, 1972) and in nodules of pea plants (Bharti *et al.*, 1982) has been reported with kinetin treatments. Also an increase in the peroxidase activity was detected with CCC in pea plants (Voinilo, 1969), barley seedling (Gaspar and Lacoppe, 1968) and leaves of bajra (Kumari, 1987) but Kharanyan and Vikhrevva (1975) found decreased peroxidase activity with CCC treatments.

Catalase and peroxidase play a considerable role in the growth processes of plants by controlling the auxin catabolism and affecting the level of auxin-like substances. But these enzymes have been found to vary in plants treated with growth retarding chemicals and produce divergent results, which may be explained by differences in plant material (species, organs), conditions of culturing and treatment, and assay techniques (Gaspar and Lacoppe, 1968).

Total Soluble Protein

The total soluble protein (TSP) content (mg/g fresh weight) of nodules was higher than the roots during all the sampling dates (Tables 3 and 4).

Roots. The data in Table 3 reveal that TSP content of roots was minimum at the initial stage (55 DAS) and then showed upsurge at 70 DAS and at the last sampling stage (85 DAS) it declined again in the control plants.

TABLE 3

Effect of kinetin, cycocel and colchicine on total soluble protein content (mg/g fresh weight) of roots in cowpea

Treatment	Days after sowing		
	55	70	85
Control	2.90	5.57	4.04
Kinetin (μ g/pot)			
3	2.39	2.72	2.70
6	2.92	3.90	3.75
9	3.00	4.47	4.19
Cycocel (mg/pot)			
1	3.70	4.70	4.03
3	3.00	3.35	2.91
9	2.94	3.21	2.49
Colchicine (mg/pot)			
1	5.53	4.67	4.14
2	5.60	4.74	4.35
4	5.88	4.84	4.70
C. D. at 5%	0.32	0.67	0.44

TABLE 4

Effect of kinetin, cycocel and colchicine on total soluble protein content (mg/g fresh weight) of nodules in cowpea

Treatment	Days after sowing		
	55	70	85
Control	14.81	10.10	10.00
Kinetin (μ g/pot)			
3	14.82	10.89	10.88
6	14.86	11.13	11.00
9	15.00	10.42	10.15
Cycocel (mg/pot)			
1	13.43	11.87	10.10
3	13.34	11.40	9.70
9	13.63	11.28	9.66
Colchicine (mg/pot)			
1	13.10	12.00	10.80
2	13.04	11.57	10.30
4	12.60	10.99	10.02
C.D. at 5%	0.71	0.74	0.87

Nodules. The TSP content of nodules decreased with the ageing of the plant. Regulator treatments had differential effect. Kinetin treatments enhanced the TSP of nodules being significant with 3 and 6 μg at 70 and 85 DAS. CCC and colchicine treatments depressed the TSP during early sampling date (55 DAS) but the situation was reversed at later stage (70 DAS) where these treatments showed significant enhancement over the control value.

Regulator treatments with different concentrations enhanced the TSP at various stages. Among these treatments colchicine showed the maximum effect. Treatment with 3 μg kinetin depressed the protein content of roots during all the sampling dates, whereas 6 and 9 μg decreased it at 70 DAS but had no effect during 55 DAS, when compared with the control plants. The cycocel treatments showed overall retarding effect on the protein content during 70 and 85 DAS but at 55 DAS, 1 mg cycocel enhanced it but with 3 and 9 mg treatments the values were at par with the control plants. Colchicine treatments increased the protein content of roots during 55 and 85 DAS being significant with all concentrations at 55 DAS and with 4 mg at 85 DAS but decreased significantly at 70 DAS with all concentrations as compared to the control plants.

Nandwal and Bharti (1982) showed that increasing concentration of kinetin has beneficial effect on protein content of pea nodules. Such beneficial effects of kinetin in the present investigation are in accordance with these authors. Simi-

larly, depressive effect of CCC on protein content has also been reported in *Amaranthus tricolor* (Daphne and Kolunow, 1983) and in barley leaves (Berry and Smith, 1970). But Kumari (1987) reported enhanced protein content with CCC in different plant organs of bajra and sunflower. On the other hand CCC has been reported to increase the protein content at lower concentrations (El-Takawi *et al.*, 1982) but decrease at higher concentrations (Berry and Smith, 1970; El-Takawi *et al.*, 1982). There is only single report that higher concentrations of colchicine inhibit DNA synthesis in corn seedling roots (Nooden, 1971).

The increase or decrease in protein contents under the influence of plant growth regulators may be due to their effects on synthesis and/or accelerated degradation or turnover. Cytokinin are known (Kulaeva, 1973) to be capable of causing both intensification of protein synthesis in ribosomes and increase in volume of the cell protein synthesising apparatus by promoting increase in the number of ribosomes. As cycocel treatments increased the TSP of tissues and peroxidase activity, it was suggested by Khan and Faust (1966) also that cycocel and its active analogues act by increasing the level of soluble protein or enzymes, which are either unavailable or are destructive to growth promoting system in the coleoptile and root tissue of barley. Since there are reports that colchicine affects the DNA synthesis in corn seedling roots (Nooden, 1971), its effects on protein content may be possible via template availability.

EFFECT OF REGULATORS ON PEROXIDASE ACTIVITY

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RESEARCH NOTE

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VARIABILITY IN BRASSICA GENOTYPES UNDER SIMULATED SALT AND OSMOTIC STRESS AT ISO-OSMOTIC LEVEL DURING GERMINATION

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Among environmental stresses, salt and water stress are two potential factors affecting adversely the process of germination, early seedling growth and ultimately plant stand and yield in almost all cultivated crops (Levitt, 1980). As oil seed crops have been the backbone of agriculture economy of India and in Haryana this crop is often cultivated under dry land condition, so there are more chances of its being subjected to drought. Again, the area under cultivation is also manifested with salinity/alkalinity problem which is further aggravated by underground brackish irrigation water. Currently oil seeds are receiving more attention but information is limited in case of Brassica regarding its germination and early seedling growth under salt and water stress. Therefore, attempts have been made to work out the genetic variability in Brassica genotypes in the aforesaid areas so that some of the selected lines can be further tested for their performance under these stresses.

The experiment was conducted in petridishes on 98 Brassica genotypes collected from Oil Seed Section, Haryana Agricultural University, Hisar. The seeds were surface sterilized with one per cent sodium hypochloride for five minutes and

then air dried before sowing. Ten seeds from each kind were put in sterilized petridishes (9 cm dia.) lined with Whatman filter paper No. 1. Four replicates were taken for each treatment. Each petridish was provided with 7 ml aqueous solution of varying osmotic stress, *i.e.* -0.4 MPa and -0.8 MPa prepared according to Michel and Kaufman (1973) using PEG 6000 (Polyethylene glycol) and salt stress according to USDA Hand Book No. 60 using NaCl. In control set double distilled water was used. The petridishes were enclosed in polythene bags to avoid the evaporation losses and were placed in a germinator at $25^{\circ}\pm 1^{\circ}\text{C}$. Germination counts were recorded at 24 h intervals. Length of radicle and plumule was measured after 120 h of germination. Cotyledons were separated from embryo axis, oven dried at 70°C and their dry weight was taken. The data were analysed with 1 BM computer as per standard procedure.

Both types of stresses resulted in significant reduction in per cent germination, length of radicle and plumule and finally the dry matter accumulation in embryo axis (Table 1). Such reductions during germination have been reported earlier in guar, wheat, pigeonpea and pearl millet (Kuhad

TABLE 1
Effect of iso-osmotic level of salt and water stress during germination and early growth of Brassica genotypes

Treatment	Germination (%)			Plumule length (cm)			Radicle length (cm)			Dry weight of embryo axis (mg)		
	Mean	Per cent reduction over control	CV	Mean	Per cent reduction over control	CV	Mean	Per cent reduction over control	CV	Mean	Per cent reduction over control	CV
Control 0	82.48 (60-100)	— (1.8)	12.0	2.47 (1.60-4.40)	— (2.5)	4.99	6.22 (2.85-10.80)	— (5)	4.75	14.63 (11-30)	— (3)	13
NaCl 0.4	76.09 (47-100)	7.74 (2.00)	13.0	1.52 (0.95-3.55)	38.53 (4)	8.10	2.76 (0.75-6.49)	55.62 (9)	10.68	13.75 (4-25)	60.15 (6)	14
0.8	60.18 (7-100)	27.03 (15)	16.9	0.47 (0.25-1.80)	81.19	26.50	1.06 (0.22-1.17)	82.95 (6)	27.80	6.44 (2-20)	55.98 (10)	29
PEG 0.4	80.84 (40-100)	1.97 (2.5)	12.5	0.77 (0.42-2.14)	68.80 (5)	15.90	4.69 (1.60-7.25)	24.59 (4.6)	6.28	7.36 (2-22)	49.69 (11)	26
0.8	59.64 (7-100)	27.81 (15)	17.0	0.42 (0.23-0.74)	82.98	29.20	2.35 (0.94-4.58)	62.21 (5)	12.25	3.25 (2.81)	77.78 (4)	62
C. D. at 5%	G=12.63 S= 2.83 G x S=28.24			G=0.034 S=0.152 G x S=0.341			G=0.366 S=0.829 G x S=0.820			G=11.41 S= 2.56 G x S=25.37		

Values in parentheses are the range of 98 genotypes.
G — Genoty pas
S — Stress

et al., 1982, 1987; Kuhad and Garg, 1984; Kuhad and Sheoran, 1987) under iso-osmotic salt and water stress. At iso-osmotic level, radicle length was more sensitive to salt stress where mean percentage reduction over control was 55 and 82 at -0.4 MPa and -0.8 MPa, respectively. However, osmotic effect proved more deleterious to plumule length. Since the radicle is the site of absorption of water and salt, reason for greater reduction in radicle length under salt stress could be due to accumulation of Na^+ and Cl^- ions to the toxic level but no such effect has been reported under PEG induced osmotic stress. During germination, imbibition of water is the first step. Therefore, mobilization of reserve material starts from cotyledons to embryo axis. Since PEG induced osmotic stress is known to inhibit imbibition more than that of salt stress, lesser food material is being translocated towards the embryo axis. Most of the food material is being diverted towards the radicle growth under osmotic stress. Therefore, lesser amount is available for plumule growth. For dry matter accumulation in embryo axis, mean reduction over control under osmotic stress was significantly higher as compared to salt stress, thus suggesting more toxicity of osmotic effect. Variability in per cent germination was almost identical in both

types of stresses, but this was different in terms of early seedling growth such as plumule and radicle length and dry weight of embryo axis. Coefficient of variance (CV) was calculated to indicate the unaccounted error in recording of data. Values of CV were relatively higher under stress treatments. However, it was within reasonable limit under normal conditions. From these results it is clear that lot of variability exists in Brassica germplasm as far as their germination and early seedling growth under salt and water stress are concerned. Genotypes PR 2001 and RH 7387 (*B. juncea*) were found to be relatively better tolerant to both salt and water stresses. For salt stress tolerance, genotypes RH 7859, RH 832, RH 30, RH 842 (*B. juncea*) and H 1110-1 (*B. napus*); and for water stress tolerance, genotypes EC 129126, RC 1433 (*B. napus*), RH 8110 (*B. juncea*), YSPb (*B. campestris*), and CAR-2 (*B. carinata*) showed relatively better performance during germination and early growth. It will be worth testing some of these lines under field conditions.

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EFFECT OF ZINC AND MANGANESE APPLICATION ON DRY MATTER YIELD AND UPTAKE OF NUTRIENTS IN PADDY (*ORYZA SATIVA* L.) UNDER UPLAND AND LOWLAND CONDITIONS

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ABSTRACT

A green-house experiment was conducted to find out the effect of Zn and Mn levels on dry matter yield, concentration and uptake of Zn, Mn and Fe in paddy under continuous and alternate flooding conditions. Zinc @ 0, 5, 10 and 20 ppm and manganese @ 0, 10, 20 and 40 ppm were applied. Dry matter yield of paddy was significantly higher under continuous flooding as compared to alternate flooding. Response of Zn and Mn on dry matter yield of shoot was observed upto 10 ppm Zn and 20 ppm Mn and further increase in their levels decreased the yields. An increase in levels of Zn and Mn increased their concentration and uptake in paddy, but reduced the concentration and uptake of Fe. Concentration and uptake of Mn and Fe, and uptake of Zn, were significantly higher under continuous flooding. However, the Zn concentration was found to be higher under alternate flooding as compared to continuous flooding.

The deficiency of zinc has now been widely observed in many parts of the world either due to low zinc supply or due to excess of manganese and iron contents in the soil. So far, very little information is available on the zinc and manganese interaction in paddy under upland and lowland conditions. In view of these facts, present investigation was undertaken to study effects of Zn and Mn application on dry matter yield, concentration and uptake of zinc, manganese and iron in paddy (*Oryza sativa* L.) under continuous and alternate flooding conditions.

MATERIAL AND METHODS

A green-house experiment was conducted in polythene lined clay pots of 25 cm dia. filled with 4 kg of silty clay loam soil of pH (1 : 2) 8.1, E_{Ce} (1 : 2) 0.54 mmhos/cm, CEC 14.21 meg/100 g, organic carbon 0.46%, available N 114 ppm, Olsen's P 10.5 ppm, available K 302 ppm, and DTPA extractable Zn, Mn and Fe (Lindsay and Norvell, 1978) 1.80, 3.43 and 8.14 ppm, respectively. All other soil properties were determined by the routine laboratory procedures as described by Kanwar and Chopra

(1967). The treatments included all possible combinations of four levels of Zn (0, 5, 10 and 20 ppm through $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$) and four levels of Mn (0, 10, 20 and 40 ppm through $\text{MnSO}_4 \cdot \text{H}_2\text{O}$). Each treatment was replicated thrice in a completely randomized design under both continuous flooding and alternate flooding and received a basal application of N, P, K and Fe at the rate of 120, 60, 60 and 5 ppm, respectively, through their reagent grade salts. Nitrogen was applied in two splits. Six healthy seedlings were transplanted in each pot and after proper setting, four plants per pot were kept for observations. Standing water of 3 cm was maintained in the pots to ensure continuous flooding. In case of alternate flooding, flooding was done only when soil reached near to drying. The crop was harvested just before the emergence of earhead, washed and dried first in air and then in oven at 60°C . Plant material was digested in diacid mixture of $\text{HNO}_3 : \text{HClO}_4$ (4 : 1) and analysed for Zn, Mn and Fe by Atomic Absorption Spectrophotometer (AA 120 varian tectron model).

RESULTS AND DISCUSSION

Dry Matter Yield

It is evident from the data in Table 1 that the dry matter yield of paddy shoot increased significantly with increasing levels of applied Zn and Mn upto 10 and 20 ppm, respectively, under both continuous and alternate flooding and the yield decreased at 20 and 40 ppm Zn and Mn, respectively. Similar increase in dry matter yield with increasing levels of Zn and Mn was also reported by Subrahmanyam and Mehta (1974) and Tiwari *et al.* (1976).

The decrease in dry matter yield at higher levels of applied Zn and Mn is ascribed to the presence of higher amount of soluble Zn and Mn in the soil. There was significant increase in dry matter yield of shoot under continuous flooding in comparison to alternate flooding. These results corroborate with the earlier work of Gangwar and Mann (1972). However, the present findings are contrary to that of Weeraratna (1967). The highest (28.4%) increase in dry matter yield of shoot was obtained with 10 ppm Mn + 5 ppm Zn under continuous flooding and 17.9 per cent increase with 20 ppm Mn + 5 ppm Zn under alternate flooding. This increase in dry matter yield of paddy was due to the proper ionic balance in the plant at these levels of applied Zn and Mn. The interactions between $\text{Zn} \times \text{Mn}$, $\text{Zn} \times \text{M}$, $\text{Mn} \times \text{M}$ were found to be non-significant.

Concentration and Uptake of Zinc

Increased concentration and uptake of Zn was observed in paddy shoots at all levels of applied Zn and Mn irrespective of moisture regimes (Table 2). The present findings corroborate with the work of Shiratori *et al.* (1972) and Aymond (1973). But the application of Mn at the rate of 20 ppm decreased the Zn concentration significantly due to antagonistic relationship between them. Ishizuka and Ando (1968) also indicated that higher Mn concentration in soil markedly reduced Zn absorption by plants. There occurred significant increase in Zn concentration under alternate flooding in comparison to continuous flooding, primarily, due to more availability of applied Zn under alternate flooding. These observations are in line with those repor-

ZINC MANGANESE INTERACTION

TABLE 1
Effect of zinc and manganese levels on dry matter yield (g/pot) of paddy shoot

Mn level (ppm)	Zn level (ppm)												Final mean	
	0			5			10			20				
	C. F.	A. F.	A. F.	C. F.	A. F.	A. F.	C. F.	A. F.	A. F.	C. F.	A. F.	A. F.		
0	19.0	13.8	14.7	21.3	14.7	16.4	22.4	16.4	11.4	20.2	11.4	20.8	14.1	17.4
10	21.3	16.2	16.5	24.5	16.5	17.0	23.2	17.0	14.9	22.0	14.9	22.8	16.2	19.5
20	23.3	16.5	17.8	21.8	17.8	17.9	23.3	17.9	15.0	22.5	15.0	22.7	16.8	19.7
40	21.4	15.9	15.9	20.9	15.9	15.9	22.4	15.9	14.5	21.5	14.5	21.6	15.5	18.6
Mean	21.3	15.6	16.2	22.1	16.2	16.8	22.8	16.8	14.0	21.6	14.0	21.9	15.6	—
Final mean (Zn)	18.5			19.2			19.8			17.8				
C. D. at 5%														
Zn and Mn=0.80														
M=0.57														
Zn × Mn														
Zn × M, Mn × M } NS														
Zn × Mn × M														
C. F. = Continuous flooding														
A. F. = Alternates flooding														
M = Moisture														

TABLE 2
Effect of zinc and manganese levels on zinc concentration (ppm) in paddy shoot

Min level (ppm)	Zn level (ppm)										Final mean
	0		5		10		20		Mean		
	C. F.	A. F.	C. F.	A. F.	C. F.	A. F.	C. F.	A. F.	C. F.	A. F.	
0	26.7 (0.51)*	16.0 (0.22)	33.3 (0.71)	28.0 (0.41)	28.7 (0.87)	36.0 (0.59)	39.3 (0.80)	52.0 (0.60)	34.5 (0.72)	33.0 (0.47)	33.8 (0.59)
10	25.0 (0.55)	18.0 (0.29)	32.0 (0.78)	28.0 (0.46)	28.0 (0.65)	30.0 (0.51)	36.5 (0.80)	54.7 (0.82)	30.4 (0.69)	32.7 (0.53)	31.5 (0.61)
20	24.0 (0.59)	17.3 (0.29)	32.0 (0.70)	29.3 (0.52)	28.0 (0.65)	32.0 (0.57)	36.0 (0.81)	50.7 (0.76)	30.0 (0.68)	34.5 (0.58)	31.2 (0.61)
40	24.0 (0.52)	22.7 (0.36)	28.7 (0.60)	30.7 (0.49)	30.7 (0.69)	40.0 (0.63)	42.0 (0.83)	51.3 (0.89)	31.3 (0.68)	36.2 (0.56)	33.8 (0.61)
Mean	24.9 (0.53)	18.5 (0.29)	31.5 (0.70)	29.0 (0.47)	31.2 (0.71)	34.5 (0.58)	38.5 (0.81)	52.2 (0.76)	31.6 (0.69)	33.5 (0.52)	—
Final mean (Zn)	21.8 (0.41)		30.3 (0.58)		32.9 (0.66)		35.3 (0.78)				

*Figures in parentheses denote Zn uptake (mg/pot).

C. D. at 5%

Zn and Mn = 2.60 (0.05)

Zn × M = 1.84 (0.04)

Mn × M = NS (0.07)

Zn × Mn = NS (NS)

Zn × Mn × M = NS (NS)

ted by Shiratori *et al.* (1972). There was a significant interaction between Zn and moisture in relation to zinc concentration in plants. At 0 and 5 ppm Zn there occurred a decrease in Zn concentration under alternate flooding as compared to that of continuous flooding. But at 10 and 20 ppm applied Zn, Zn concentration increased significantly under alternate flooding in comparison to continuous flooding (Table 2). There was non-significant interaction between $Zn \times Mn$, $Mn \times M$ and $Zn \times Mn \times M$ in relation to Zn concentration in the paddy shoots. There was a slight decrease in the Zn uptake with increasing levels of Mn under continuous flooding, whereas the Zn uptake increased slightly upto 20 ppm Mn under alternate flooding. Brar and Sekhon (1976) also observed an increase in Zn uptake in paddy shoot with increased level of applied Mn. A significant increase in Zn uptake was recorded under continuous flooding as compared to that of alternate flooding, whereas Shiratori *et al.* (1972) obtained higher Zn uptake under upland conditions than lowland conditions probably due to less adsorption of Zn in the latter. A significant interaction was observed between $Zn \times Mn$, $Zn \times M$ and $Mn \times M$ with respect to uptake of Zn in paddy shoot, whereas the interaction between $Zn \times Mn \times M$ was found to be non-significant (Table 2).

Concentration and Uptake of Manganese

The Mn concentration and uptake increased significantly with increased levels of applied Mn under both the moisture regimes (Table 3). This sort of behaviour was due to more availability of Mn in the soil solution. Ghoneim *et al.*

(1974) reported that application of Mn increased the Mn uptake in plants. Manganese concentration and uptake decreased significantly by Zn application under continuous as well as under alternate flooding. This was due to ionic competition between Zn and Mn for the absorption sites which looks true in present case as Zn has strong affinity to attach to the carrier. These findings corroborate with the earlier observations of Ishizuka and Ando (1968) and Gangwar and Mann (1972). Significantly higher Mn concentration and uptake were recorded under continuous flooding in comparison to alternate flooding, obviously, due to existence of more favourable conditions either through an increase in its solubility in soil solution or by possible stimulation of root absorption of Mn. Similar results were also reported by Jha *et al.* (1975). There was highly significant interaction between $Zn \times Mn$, $Zn \times M$, $Mn \times M$ and $Zn \times Mn \times M$ with respect to Mn concentration, while these interactions were found to be non-significant in case of Mn uptake.

Concentration and Uptake of Iron

Data in Table 4 show that Fe concentration and uptake decreased significantly with increased levels of both applied Zn and Mn under both the moisture regimes. This decrease in Fe concentration and uptake was probably due to antagonistic behaviour between Fe and Zn, and Fe and Mn in the process of absorption. The effect of Mn was more pronounced than Zn in reducing Fe concentration and uptake. This was possibly due to interference in its absorption and translocation. These results are in conformity with the observations of Alam *et al.* (1966),

TABLE 3
Effect of zinc and manganese levels on manganese concentration (ppm) in paddy shoot

Mn level (ppm)	Zn level (ppm)												Final mean				
	0				5				10					20			
	C. F.	A. F.	C. F.	A. F.	C. F.	A. F.	C. F.	A. F.	C. F.	A. F.	C. F.	A. F.		C. F.	A. F.		
0	284.3 (5.41)*	84.3 (1.17)	244.7 (5.21)	71.3 (1.05)	217.3 (4.87)	75.3 (1.23)	239.7 (4.84)	97.7 (1.11)	246.4 (5.11)	82.2 (1.16)	164.3 (3.14)						
10	287.0 (6.12)	100.0 (1.62)	217.7 (5.33)	99.7 (1.64)	226.7 (5.25)	86.7 (1.47)	217.7 (4.78)	80.0 (1.19)	257.3 (5.40)	91.6 (1.48)	174.5 (3.44)						
20	287.7 (6.69)	111.0 (1.83)	226.3 (4.99)	89.0 (1.58)	231.0 (5.77)	102.0 (1.83)	253.3 (5.67)	88.0 (1.32)	294.4 (5.66)	97.5 (1.64)	173.5 (3.65)						
40	297.0 (6.36)	129.0 (2.05)	284.3 (5.94)	113.7 (1.80)	280.0 (6.28)	82.3 (1.30)	235.3 (5.06)	77.7 (1.13)	271.7 (5.90)	100.7 (1.56)	186.2 (3.71)						
Mean	288.9 (6.14)	106.9 (1.71)	243.2 (5.38)	93.4 (1.50)	238.8 (5.45)	86.6 (1.45)	236.5 (5.10)	85.5 (1.20)	251.9 (5.52)	93.0 (1.46)	—						
Final mean (Zn)	197.9 (3.93)		168.3 (3.44)		162.7 (3.45)		161.0 (3.15)										

*Figures in parentheses denote Mn uptake (mg/pot).

C. D. at 5%

Zn and Mn = 10.25 (0.37)

M = 7.25 (0.26)

Zn × M and Mn × M = 14.5 (NS)

Zn × Mn × M = 29.0 (NS)

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TABLE 4
Effect of zinc and manganese levels on iron concentration (ppm) in paddy shoot

Mn level (ppm)	Zn level (ppm)												Final mean				
	0				5				10					20			
	C. F.	A. F.	C. F.	A. F.	C. F.	A. F.	C. F.	A. F.	C. F.	A. F.	C. F.	A. F.		C. F.	A. F.		
0	138.0 (2.63)*	92.0 (1.27)	112.7 (2.40)	81.6 (1.19)	116.7 (2.61)	75.0 (1.23)	125.0 (2.53)	100.0 (1.14)	123.1 (2.55)	87.1 (1.23)	105.1 (1.89)						
10	125.0 (2.67)	87.7 (1.42)	91.7 (2.46)	75.0 (1.24)	116.5 (2.70)	100.0 (1.70)	114.0 (2.51)	62.5 (0.93)	111.8 (2.54)	81.3 (1.31)	96.5 (1.93)						
20	125.3 (2.92)	75.0 (1.24)	91.7 (2.00)	73.5 (1.30)	116.5 (2.71)	86.7 (1.55)	100.0 (2.25)	62.5 (0.94)	101.4 (2.27)	74.4 (1.25)	91.4 (1.76)						
40	125.3 (2.69)	74.0 (1.18)	89.0 (1.86)	72.0 (1.14)	87.5 (1.96)	71.5 (1.13)	98.0 (2.11)	61.0 (0.88)	99.9 (2.16)	69.6 (1.08)	84.8 (1.52)						
Mean	128.4 (2.73)	82.2 (1.32)	96.3 (2.13)	75.5 (1.22)	109.3 (2.49)	83.3 (1.40)	109.3 (2.36)	71.5 (0.99)	110.8 (2.38)	78.1 (1.22)	—						
Final mean (Zn)	105.3 (2.05)		86.1 (1.73)		97.1 (1.94)		90.4 (1.68)										

*Figures in parentheses denote Fe uptake (mg/pot).

C. D. at 5%

Zn and Mn = 4.6 (0.03)
M = 3.3 (0.08)
Zn × M and Mn × M = 6.5 (0.17)
Zn × Mn × M = 13.0 (NS)
Zn × Mn = 6.5 (NS)

Subrahmanyam and Mehta (1974) and Brar and Sekhon (1976). There was a significant increase in the Fe concentration and uptake under continuous flooding as compared to alternate flooding mainly due to the reduction of higher oxides and hydroxides of Fe into soluble form and thus, increased the availability of iron. Ghuman (1968) and Jha *et al.* (1975) also reported the same trend. There occurred a highly significant interaction

between $Zn \times Mn$, $Zn \times M$, $Mn \times M$ and $Zn \times Mn \times M$ in relation to iron concentration in the shoot, indicating thereby that Zn and Mn had additive role in decreasing the iron concentration in the plant.

The interaction between zinc and moisture influenced the uptake of iron by rice. There was non-significant interaction between $Zn \times Mn$, $Mn \times M$ and $Zn \times Mn \times M$ with respect to iron uptake.

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ENERGY BALANCE OVER CROPS OF GRAM AND RAYA

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ABSTRACT

An experiment conducted during rabi 1985-86 to study the radiation balance in pure gram, pure raya and their intercropping at flowering, pod setting and maturity stages, showed that net radiation partitioning into latent, soil and sensible heat fluxes were 60-77, 3-13 and 16-30 per cent, respectively at different stages. Sensible heat flux and soil heat flux were low at flowering stage and increased at pod setting and further on maturity stages, while latent heat flux followed opposite pattern, *i. e.* more at flowering and less at pod setting and maturity stages. Shortwave reflection was found higher in pure gram and intercrops having lesser rows of raya. Net radiation and incoming solar radiation showed strong correlation.

Accurate estimates of radiation balance above natural surfaces including soil, grassland, crops or forests are important in understanding the partitioning of net radiation into different components such as latent heat flux and soil heat flux, widely used for estimating any one of the components when others are known (Penman, 1948; Fritschen, 1965; Stanhill *et al.*, 1966; Rao *et al.*, 1986).

Brown and Covey (1966) utilized the energy budget approach to evaluate the vertical fluxes of sensible and latent heats in corn. Fritschen (1967) and Bishnoi *et al.* (1986) reported net and solar radiations relation over field crops.

The energy balance of a crop surface is of great importance supplying, as it does, the energy utilized in evapotranspiration, photosynthesis and convective heat exchange. The radiation balance

controls the potential rate of water loss, whereas its photosynthetic active radiation controls the potential rate of dry matter accumulation. The details of radiation balance are important for understanding interactions between crop plants and radiation environment. Short-wave reflectivity (albedo) is important to know the radiations entering the crop surface.

This paper presents relationship between net and incoming solar radiation, and estimation of albedo and energy balance components, *i.e.* latent heat flux, soil heat flux and sensible heat flux over pure and intercrops of gram and raya at different stages (phenophases).

MATERIAL AND METHODS

An experiment was conducted at the Experimental Farm (Lat. 29°10'N, Long. 75° 46' E) during rabi 1985-86 to study

radiation balance of pure raya, pure gram and their intercrops. The various treatments were pure gram (T_1), pure raya (T_2), one row of gram and one row of raya (T_3), two rows of gram and one row of raya (T_4), four rows of gram and one row of raya (T_5) and six rows of gram and one row of raya (T_6). The various parameters like net radiation, incoming solar radiation, soil heat flux, reflected radiation, air temperature and latent heat were measured at a height of one metre above the crop surface at flowering, pod setting and maturity stages of gram, raya and their intercrops at hourly interval. All inputs were supplied as per the package of practices for these crops. Net radiometer, pyranometer, albedometer, and soil heat flux plates of Medoes & Co., Australia were used. Air temperature was measured with Asmann Psychrometer.

Following formulae were used to analyse the data :

$$(i) R_n = LE + A + G$$

$$(ii) A = \frac{\beta (R_n - G)}{1 + \beta}$$

(iii) Albedo studies,

$$(iv) R_n = a + b R_s,$$

where R_n —net radiation in mW/cm^2 ,

LE —latent heat flux in mW/cm^2 ,

A —sensible heat flux in mW/cm^2 ,

G —soil heat flux in mW/cm^2 ,

β —Bowen's ratio,

R_s —total incoming short wave radiation in mW/cm^2 ; and
a and b are regression constants.

RESULTS AND DISCUSSION

Energy Balance

The diurnal trend of R_n , LE , G and A at flowering stage is depicted in Fig. 1 and per cent efficiency with actual values of these parameters is given in Table 1. It was observed that percentage of net radiation partitioned into various components like latent heat of evaporation (LE), sensible heat flux (A) and soil heat flux (G) varied in different treatments as LE (66-77 per cent), A (16-24 per cent) and G (3-7 per cent) at flowering stage of gram, but pure raya attained the physiological maturity. At gram pod setting stage LE , A and G varied from 70-74, 18-23 and 7-9 per cent, respectively, while at maturity stage these components account, respectively 60-65, 25-30 and 9-13 per cent. Results are similar as given by Rao *et al.* (1986) for cowpea and moong. LE , A and G of pure raya are 80, 26 and 4 per cent at flowering stage, and 68, 28 and 4 per cent at maturity stage, respectively.

The total net radiation available for sensible heat flux is somewhat similar at flowering and pod setting stages which increased at maturity stage while soil heat flux was low at flowering stage which increased at pod setting and further increased at maturity stage. The R_n available for LE was more at flowering stage, but it was low at pod setting stage and further it diminished rapidly at maturity as shown in Table 1. But in case of pure raya LE was more at flowering stage, followed by branching differentiation and least at physiological maturity stage while G followed opposite pattern of LE , i. e. highest at physiologi-

ENERGY BALANCE OVER GRAM AND RAYA

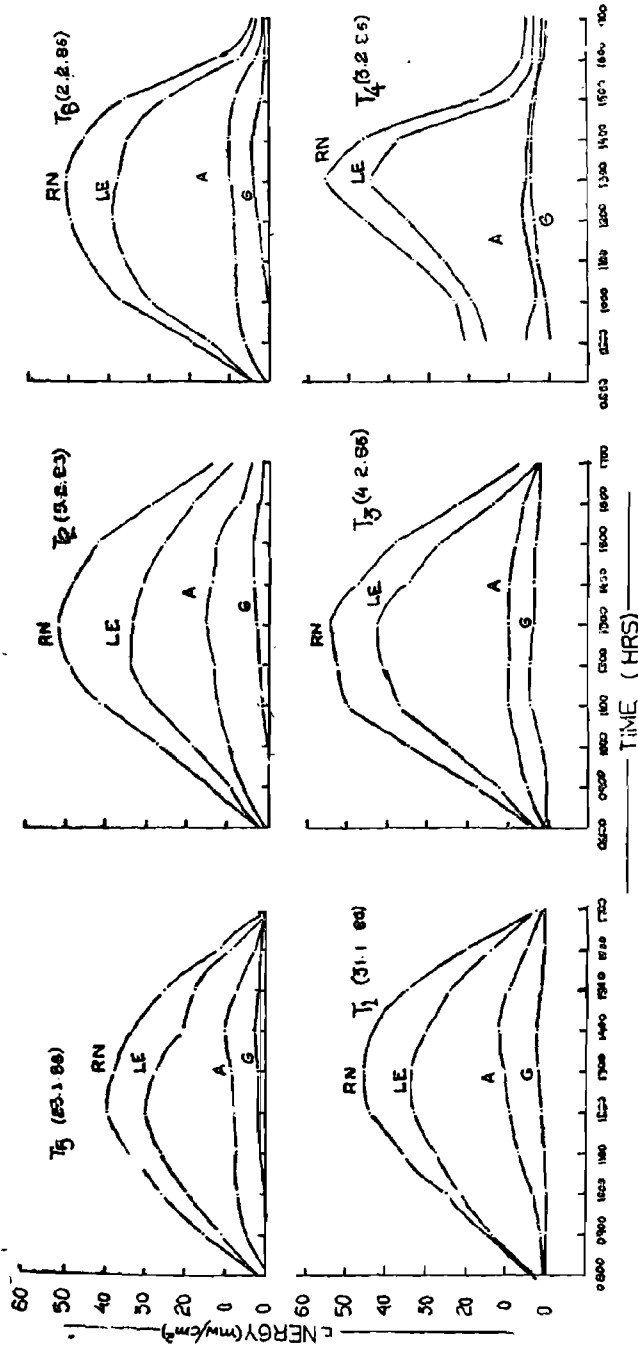


Fig. 1. Energy balance of various treatments at flowering stage.

TABLE 1
Energy balance at various growth stages of pure and intercrops of gram and raya (mW/cm²)

		T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇
Flowering	Rn	270.45	328.36	253.37	219.41	307.52	317.60	(Physiological maturity)
	LE	202.89(75)	237.74(72)	196.05(77)	187.91(72)	224.50(73)	317.6(66)	
	A	59.68(22)	68.18(21)	39.54(16)	50.86(23)	70.73(23)	93.36(29)	
	G	7.95(3)	22.83(7)	17.78(7)	10.79(5)	12.41(4)	16.64(5)	
Pod setting	Rn	370.52	278.21	392.29	393.53	400.39	157.46	(Flowering)
	LE	258.65(70)	193.65(70)	289.33(74)	280.62(71)	284.62(71)	106.79(68)	
	A	76.82(21)	64.37(23)	71.72(18)	82.28(21)	80.88(20)	44.14(28)	
	G	33.35(9)	20.19(7)	31.42(8)	30.53(8)	36.43(9)	6.53(4)	
Maturity	Rn	441.42	438.58	420.88	456.72	439.84	250.89	(Branching differentiation)
	LE	286.66(65)	263.2(60)	273.57(65)	277.41(61)	264.9(60)	169.73(68)	
	A	114.79(26)	130.85(30)	104.98(25)	137.1(30)	118.66(27)	69.84(28)	
	G	39.78(9)	43.72(10)	42.18(10)	42.3(9)	55.53(13)	10.82(4)	

Figures in parentheses are percentages of the total net energy available.

cal maturity, followed by branching differentiation and lowest at flowering stage. Variation in A followed the pattern of G.

The amount of net energy available for sensible heat flux, soil heat flux and latent heat flux was affected by various intercropping treatments.

At flowering stage, the per cent amount of net radiation utilized as latent heat flux was more in T_4 (2:1, gram:raya) treatment (77 %) which was followed by T_1 (pure gram, 75 %), T_6 (73 %), T_5 (72 %) and T_3 (72 %) while that in T_2 (pure raya) it was 66 % at physiological maturity stage which corresponds to flowering stage of gram.

At pod setting stage, LE was highest in T_4 (74 %), followed by T_6 and T_5 (71 % each), and T_1 and T_3 (70 % each). At maturity LE was more in T_1 and T_4 (65 % each), followed by T_5 (61 %) and T_6 and T_3 (60 % each).

The amount of net radiation utilized as soil heat flux (G) was more in T_4 and T_3 (7 % each), followed by T_6 (5 %), T_5 (4 %) and T_1 (3 %) at flowering stage. At pod setting stage, G was more in T_1 and T_5 (9 % each) followed by T_4 and T_6 (8 % each) and T_3 (7 %). But at maturity stage, G was more in T_6 (13 %) followed by T_3 and T_4 (10 % each) and T_1 and T_5 (9 % each).

The amount of net radiation utilized as sensible heat flux (A) was more in T_6 and T_5 treatments (23 % each), followed by T_1 (22 %), T_3 (21 %) and lowest in T_4 (16 %) at flowering stage.

At pod setting stage, A was more in T_6 (23 %) followed by T_1 and T_5 (21 % each), T_6 (20 %) and least in T_4 (18 %). But at maturity, A was more in T_5 and T_3 (30 % each), followed by T_6 (27 %), T_1 (26 %) and T_4 (25 %).

The amount of net radiation utilized as latent heat flux was higher in T_4 as compared to other treatments at all the stages which may be due to better leaf distribution throughout the canopy, better utilization of solar energy for production of photosynthates and prevailing temperature and relative humidity. It may also be due to reduced wind speed in intercrops than pure gram. Increase in latent heat flux helped to increase yield attributes and final equivalent yield to 2600 kg/ha in T_4 treatment (Table 2).

The amount of net radiation utilized as sensible heat flux was more in T_3 treatment and other intercrops except T_4 and T_1 (pure gram). This may be due to decrease turbulent mixing in intercrops which resulted in increase in A. Higher value of A in T_3 treatment may also be due to low absorption and more transmission of light to soil which raised the temperature of air within the crop geometry. Almost throughout the crop growing season the amount of net radiation utilized towards sensible heat flux was higher in T_2 treatment and this might have helped in increasing grain weight (Table 2).

The amount of net radiation utilized as soil heat flux was more in T_6 which may be due to more penetration of radiation to soil at pod setting and maturity stages and in T_3 at flowering stage.

TABLE 2
Grain yield and yield attributes of pure and intercrops of gram and raya

Treatment		Pods per plant	No. of grains per pod	1000-grain weight (g)	Yield (kg/ha)	Gram equivalent yield of both crops (kg/ha)
T ₁	G	116.4	1.17	21.84	1058.33	1058.33
T ₂	R	111.3	10.81	7.86	1098.61	1626.78
T ₃	R	159.3	12.06	6.82	1387.49	2501.77
	G	100.1	1.32	22.84	447.72	
T ₄	R	292.0	12.55	7.69	1311.11	2600.62
	G	132.9	1.30	23.12	659.27	
T ₅	R	281.7	12.39	7.39	841.97	1959.53
	G	110.6	1.30	20.99	714.20	
T ₆	R	274.3	10.26	7.60	540.27	1686.12
	G	114.9	1.31	23.10	886.22	
SEm ±	R	32.9	0.59	0.37	—	173.21
	G	6.0	0.10	0.71	—	
C. D. at 5%	R	107.3	NS	NS	—	699.20
	G	19.6	NS	NS	—	

R=Raya; G=Gram.

The amount of net radiation utilized as soil and sensible heat fluxes was more at maturity stage as compared to pod setting and flowering stages. This may be due to less area at maturity stage and also due to harvesting of raya which resulted in more exposing of soil to radiation interception. A and G are less at flowering stage due to more leaf area as compared to pod setting and maturity stages.

The amount of net radiation utilized as latent heat of evaporation was more at flowering stage than other stages. It may be because of more leaf area and more utilization of energy for photosynthesis, transpiration and evaporation.

In T₂ (pure raya) treatment, LE was more at flowering stage than branching differentiation and physiological maturity stages, which may be due to more leaf area and more utilization of energy. More leaf area might be the reason for low sensible and soil heat fluxes at flowering stage than branching differentiation and maturity stages.

Analysis at partitioning of net radiation into different components revealed that sensible heat component is most sensitive in its determination as it required very high accuracy of temperature gradient measurements. Latent heat of evapotranspiration was, however, the main component of consuming the net energy available at the crop surfaces.

Albedo of Shortwave Radiation

A part of shortwave radiation striking at the surface is reflected back to space because all shortwave radiation incident on canopy is not retained by the surface. Albedo is the upward part of the complementary radiation which depends on the absorption coefficient, scattering function and orientation of leaves and depth of the crop stand. Albedo of pure and intercrops throughout the day at pod setting stage is shown in Fig. 2. Albedo is higher at evening and morning and lowest at noon in all the treatments. This was because the radiation beam strikes the crop surface at more acute angle during morning and evening hours, thus resulting in more reflections of radiation. Albedo varied from 13.8 to 20.5 per cent at flowering stage and 13.6 to 18.2 per cent at pod setting in gram, and 15.2 to 16.5 per cent at maturity in gram (Table 3). Seasonal albedo varied from 15.2 to 18.8 per cent in different treatments. Similar variations have been reported by Davies and Buttymor (1969) and Nkemdirin (1973) for crop surface.

The albedo was higher at flowering stage in all the treatments as compared to other phenological stages (pod formation and maturity) due to higher leaf area of both crops. Albedo was lowest at maturity in both pure crops due to less ground coverage by the leaf canopies. In intercropping treatments, albedo was more at maturity than at pod setting stage. This might be due to harvesting of raya whose albedo is lesser than that of gram and little green foliage available at this stage also.

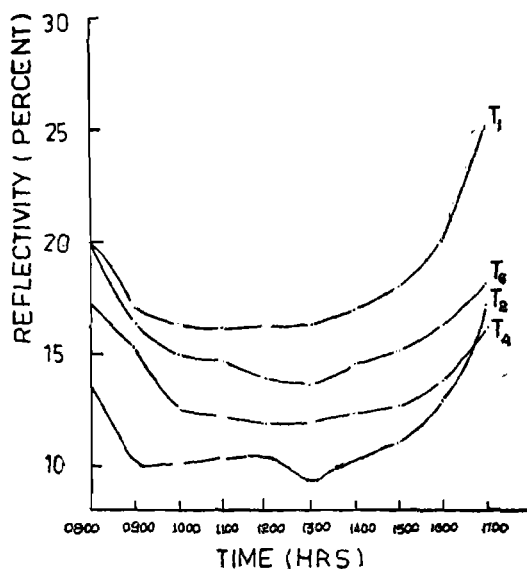


Fig. 2. Reflectivity of solar radiation at pod setting stage.

Albedo was more in T₁ which decreased with the increasing number of rows of raya in gram as presented at different stages in Table 3. Seasonal albedo was highest in T₁ (18.8%) followed by T₆ (16.6%) and T₃ (15.2%) in gram.

Albedo in T₂ was 16.2% at branching differentiation which increased at flowering stage (20.2%) and then reduced at physiological maturity (13.8%) in pure raya. Albedo of T₂ may be lower at branching differentiation due to less leaf area index, which is relatively higher at flowering stage due to higher foliage density. Again at physiological maturity stage albedo decreased due to reduction in green foliage by senescence of leaves.

TABLE 3

Albedo under pure and intercropping of gram with raya at different phenological stages

Treatment	Flowering stage	Pod setting stage	Maturity stage	Seasonal albedo
T ₁	20.5	18.2	15.6	18.8
T ₃	15.5	15.0	15.2	15.2
T ₄	17.4	13.6	15.7	15.6
T ₅	17.5	14.2	16.5	16.1
T ₆	18.0	15.6	16.3	16.6

TABLE 4

Relationship between net radiation (R_n) and shortwave radiation (R_s) at different stages of gram, raya and their intercropping ($R_n = a + b R_s$)

S. No.	Regression	R ²	Crop	Crop condition	
				Treatment	Stage
1.	$R_n = -2.354 + .574 R_s$	0.98	Bare soil	—	—
2.	$R_n = -7.608 + .582 R_s$	0.98	Raya	T ₃	5th leaf stage
3.	$R_n = -7.402 + .646 R_s$	0.99	Raya	T ₃	Branching differentiation
4.	$R_n = -4.185 + .557 R_s$	0.98	Gram	T ₂	50 per cent LAI
5.	$R_n = -2.710 + .845 R_s$	0.91	Raya	T ₂	Flowering
6.	$R_n = -1.889 + .387 R_s$	0.88	Intercrop	T ₆	Flowering
7.	$R_n = -8.290 + .392 R_s$	0.96	Gram	T ₁	Flowering
8.	$R_n = -9.239 + .678 R_s$	0.98	Intercrop	T ₆	Flowering
9.	$R_n = -2.769 + .611 R_s$	0.86	Intercrop	T ₄	Flowering
10.	$R_n = -7.583 + .670 R_s$	0.97	Intercrop	T ₃	Flowering
11.	$R_n = -7.742 + .662 R_s$	0.99	Raya	T ₃	Physiol. maturity
12.	$R_n = -8.736 + .669 R_s$	0.99	Intercrop	T ₃	Pod setting
13.	$R_n = -7.910 + .630 R_s$	0.99	Intercrop	T ₄	Pod setting
14.	$R_n = -6.316 + .755 R_s$	0.98	Intercrop	T ₃	Pod setting
15.	$R_n = -6.283 + .644 R_s$	0.98	Intercrop	T ₆	Pod setting
16.	$R_n = -7.392 + .639 R_s$	0.99	Gram	T ₁	Pod setting
17.	$R_n = -14.202 + .808 R_s$	0.98	Raya	T ₃	Harvesting
18.	$R_n = -3.759 + .582 R_s$	0.93	Raya	T ₅	Maturity
19.	$R_n = -18.704 + .716 R_s$	0.96	Raya	T ₁	Maturity
20.	$R_n = -1.945 + .596 R_s$	0.97	Raya	T ₅	Maturity
21.	$R_n = -8.080 + .603 R_s$	0.99	Raya	T ₄	Maturity

ENERGY BALANCE OVER GRAM AND RAYA

The albedo of pure gram was more than intercropping treatments at flowering and pod setting stages due to better leaf area covering the ground. But at maturity stage, the intercrops (T_4 , T_5 and T_6) showed more albedo than pure gram. Similar results were given by Mayer (1981).

Relationship between Net Radiation and Shortwave Radiation

Relationship between net radiation (R_n) and shortwave radiation (R_s) at

various growth stages of pure and inter-crops has been shown in Table 4. Linear regression equations between these two parameters can be used to estimate R_n , if net radiation data are not available, but solar radiation data are recorded as a routine meteorological parameter. The relationship between the two components shows that at different growth stages more than 86 % variations are explained. Similar results have been reported by Fritschen (1967) for barley and Rao *et al.* (1986) for pigeonpea and moong.

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EFFECT OF PACLOBUTRAZOL (PP 333) ON GROWTH, FLOWERING AND FRUIT SET IN SUMMER SQUASH (*CUCURBITA PEPO* L.) CV. HISAR SELECTION-1

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ABSTRACT

Experiments were conducted to evaluate the effect of Paclobutrazol (PP 333) in summer squash (*Cucurbita pepo* L.) cv. Hisar Selection-1 during 1985 and 1986. The concentrations used were 0, 12.5, 25, 50, 100 and 250 ppm. Spraying summer squash plants with 250 ppm of PP 333 greatly reduced shoot length, whereas branching was promoted with 100 ppm. 250 ppm of PP 333 reduced the number of node and days to appearance of first pistillate flower while sex ratio was lowered with 100 ppm. Early fruit yield by number and weight was improved with 25 and 100 ppm, respectively. Total yield by number and weight of fruits increased significantly with 100 ppm as compared to other treatments.

Plant growth inhibitors are a group of chemicals that have proved helpful in reducing vegetative growth and improving reproductive phase of plants. These chemicals have now assumed importance in horticultural crops (Pandita and Hooda, 1979). These inhibitors normally stop biosynthetic pathway of some regulators. Paclobutrazol under commercial name of PP 333 is one of the important growth retardants which not only inhibits GA biosynthesis in plants but also reduces vegetative growth and improves flowering and yield in many species (Khurana and McLaren, 1983). In the present studies effect of Paclobutrazol on growth, flowering and yield of summer squash cv. Hisar Selection-1 was observed.

MATERIAL AND METHODS

The experiments were conducted at the Vegetable Research Farm, during 1985 and 1986. Experiment was laid out in randomized block design with four replications. Each plot measured 4 m × 1.8 m with 16 plants on the raised bed. Seed sowing was done on 10 December and 8 December during 1985 and 1986, respectively. PP 333 was sprayed once before flowering (a month after seed sowing or when 6-8 true fully expanded leaves were formed). Tween-20 @ 0.05% was used as surfactant along with spray solution. In total six treatments, viz. 12.5, 25, 50, 100 and 250 ppm PP 333 including control were studied. The observations were recorded

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on main shoot length, number of branches, number of node and days to first pistillate flower appearance, sex-ratio, number and weight of fruits per plant from early and total fruit yield. Length of main shoot and number of branches were noted at the time of final harvest of the crop while number of node and days to first pistillate flower appearance sex and ratio were recorded and calculated on the basis of daily observations. Sex-ratio was calculated by counting total number of male and female flowers formed per plant. Total yield and yield per plant were calculated on the basis of sum total of all the pickings made upto the final harvest.

RESULTS AND DISCUSSION

Results have been explained on the basis of average data of two years. (Tables 1 and 2). Shoot length was significantly reduced with the increasing concentration of PP 333. Minimum shoot length was observed with 250 ppm. Reduction in shoot length in summer squash due to divisional activity has been reported by Krishnamoorthy and Sandooja (1982). Number of secondary branches per plant increased significantly with PP 333 treatments. Maximum number of branches (7.9) were observed with 100 ppm PP 333 as compared to control (4.6) which is in consonance with the reports of Arora *et al.* (1982) with ethrel 250 ppm. Significant reduction in the number of node to appearance of first pistillate flower was recorded with PP 333 treatments and its highest dose was effective and lowered the node number to 5.4 as compared to 9.4 in control. These results are in conformation with the earlier reports

of Sams and Krueger (1977) in summer squash with ethephon application. Days taken to appearance of first pistillate flower were also significantly reduced by the application of 250 ppm PP 333. Number of days was reduced to 44.4 as compared to 52.6 in untreated control. The results of present study are in conformity with the findings of Shannon and Robinson (1978) with ethephon treatment. Significant reduction in sex-ratio was observed with PP 333 application and its 100 ppm dose significantly lowered the sex-ratio to 5.1 as compared to 7.7 in control. There was a decreasing trend of sex-ratio with increase in PP 333 concentration upto 100 ppm. However, corroborative results have been reported by Seniz *et al.* (1987) in summer squash with ethrel application.

Number of fruits per plant from early yield increased significantly with 25 ppm PP 333, whereas untreated control and 12.5 ppm yielded least number of fruits per plant from early yield. However, this trend was reversed for early fruit yield by weight. 100 ppm PP 333 significantly raised the early fruit yield upto 366 g as compared to 245 g in untreated control. The response of PP 333 was similar to ethephon in improving the number of fruits set and fruit yield in summer squash (Arora *et al.*, 1988). Significant increase in total number of fruits per plant and total fruit yield (g/plant) was recorded with application of 100 ppm PP 333, whereas untreated control yielded least fruit yield by number and weight. However, beneficial effect of ethephon to improve fruit yield has also been reported by Arora *et al.* (1985) in summer squash.

TABLE 1

Effect of Paclobutrazol on vegetative growth, flowering and sex-expression of summer squash cv. Hisar Selection-1 during 1985 and 1986

Treatment (ppm)	Height of plant (cm)			Number of secondary branches per plant			Node to first pistillate flower			Days to first pistillate flower			Sex ratio			
	1985		1986	1985		1986	1985		1986	1985		1986	1985		1986	Av.
	1985	1986	Av.	1985	1986	Av.	1985	1986	Av.	1985	1986	Av.	1985	1986	Av.	
Control (unsprayed)	167	179	173	4.7	4.5	4.6	9.8	8.9	9.4	49.3	55.8	52.6	6.9	8.5	7.7	
Paclobutrazol 12.5	156	160	158	5.1	4.6	4.9	7.2	7.1	7.2	53.7	51.9	52.8	6.7	7.4	7.1	
" 25	151	149	150	6.3	5.9	6.1	7.0	6.8	6.9	49.9	50.4	50.2	6.4	7.2	6.8	
" 50	139	142	141	7.7	8.0	7.8	5.9	6.0	6.0	44.7	45.3	45.0	5.5	6.0	5.8	
" 100	127	137	132	8.4	7.4	7.9	6.2	6.1	6.2	48.0	43.8	45.9	4.9	5.3	5.1	
" 250	122	130	126	6.1	7.0	6.6	5.7	5.1	5.4	43.9	44.9	44.4	5.6	5.9	5.8	
C. D. at 5%	10.1	8.9		1.4	1.2		1.7	1.4		3.4	3.0		1.3	1.8		

TABLE 2

Effect of Paclobutrazol on early and total yield of summer squash cv. Hisar Selection-1 during 1985 and 1986

Treatment (ppm)	Number of fruits per plant from early yield		Early fruit/yield* (g/plant)	Total number of fruits per plant		Total fruit yield (g/plant)							
	Av.			Av.		Av.							
	1985	1986		1985	1986	1985	1986						
Control (unsprayed)	2.6	3.7	3.2	192	298	245	6.7	5.7	6.2	756	664	710	
Paclobutrazol	12.5	2.9	3.5	3.2	241	301	271	8.3	9.7	9.0	881	902	892
"	25	3.9	4.7	4.3	341	367	354	8.9	8.8	8.9	917	1080	999
"	50	3.1	4.4	3.8	269	367	318	9.1	8.0	8.6	1034	970	1002
"	100	4.0	3.7	3.9	384	348	366	10.4	10.7	10.6	1118	1097	1108
"	250	3.5	3.0	3.3	295	284	289	9.0	7.1	8.1	887	816	852
C. D. at 5%	0.4	1.1		29	22		2.1	1.8		92	77		

*Sum total of first five pickings made upto end of March in both the years.

RESPONSE OF PACLOBUTRAZOL ON SUMMER SQUASH

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MORPHO-PHYSIOLOGICAL CHARACTERS RESPONSIBLE FOR HIGHER PLANT YIELD UNDER DRYLAND CONDITIONS IN BRASSICAS

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ABSTRACT

Morpho-physiologically diverse twelve genotypes of Brassicas were evaluated under dryland conditions at Hisar. Character association between five main and fifteen sub morpho-physiological characters of plant yield were estimated. Simple correlation coefficients revealed significant and positive association of plant yield with harvest index and seed size. Path analysis also revealed that main components responsible for higher plant yield were harvest index and height of fertility zone. Subcomponents, days to 50% flowering, days to maturity, plant height, number of primary branches per plant, biological yield, leaf water potential, osmotic potential, turgor potential and leaf conductance contributed to plant yield via one or more main components. Concomitant selection criterion based on these characters would be most effective under dryland conditions to improve plant yield in Brassicas. Transpirational cooling at pod initiation stage will be best to screen large breeding material in the field without destroying them.

Characters depicting consistent associations do show high direct and indirect effects in causal relationship. Invariably, breeder is interested in correlations rather than causal relationship for subsequent use in selection indices. Occasionally, one fails to get desired improvement through these selection indices. Under such situations, the differences in yield are attributed to various yield characters computed through path coefficient analysis. Keeping this in view, the present investigation was undertaken to compute correlations among all the morphological and physiological characters and to compute path coefficient analysis for component characters of seed yield.

MATERIAL AND METHODS

Twelve genotypes were selected amongst 1500 available germplasm lines of Brassica for agromorpho-physiological characters with respect to drought resistance since 1979-80. It included seven genotypes of *Brassica juncea*, two of *B. carinata* and one each of *B. campestris*, *B. tournifortii* and *Eruca sativa*. These selected genotypes were sown under conserved soil moisture on 26 October, 1986 using randomised block design with three replications at Dryland Research Area of Haryana Agricultural University, Hisar (29° 10' latitude North and 75° 46' longitude East). Each

genotype was accommodated in three pairs of four metre length in furrows prepared by ridger seeder. A distance of 30 cm was kept between the rows of a pair and the pairs were spaced 60 cm apart. Plants were kept 15 cm apart in each of six rows. The sandy loam soil (49% sand, 33% silt, 18% clay and traces of Calcium carbonate) was retaining 11.5 and 1.54 per cent water at 0.1 and 15 bar tension, respectively (soil moisture content). The bulk density was 1.47 g/cubic cm. It was low in organic carbon (0.12%) and available fertility (17 kg P and 247 kg K per ha). Its pH (1 : 2 soil to water ratio) was 8.05 and EC was 0.23 mmhos per cm at 25°C.

Data were recorded on five random but competitive plants for seed yield and yield attributes. Measurements of canopy temperature (by portable infra-red thermometer, Raynger II, Raytek, U.S.A), air temperature (by YSI tele thermometer, Cole Parmer Instrument Co., Chicago, U.S.A.) and leaf diffusive conductance (by autoporometer, MKII, —T Devices, U. K.) were made concurrently at 4 to 6 spots at pod initiation of Brassicas between 1200 to 1400 h on a clear day. The diurnal measurements of leaf relative water content and leaf osmotic potential (by 5100-B vapour pressure osmometer, Wescor, U. S. A.) were performed concurrently for calculating osmotic adjustment ($1/b$). Regressions were fitted with relative water content as dependent variable [$\ln RWC = a - b \ln (\text{osmotic potential})$]. Reciprocal of slope ' b ' ($1/b$) were the measures of osmoregulation (Kumar *et al.*, 1984). Mean data over plants were used to compute corre-

lations following Singh and Chaudhary (1985). Since the characters were more, these were partitioned into main and sub components for computing direct and indirect effects (Singh *et al.*, 1987b).

RESULTS AND DISCUSSION

Sufficient variability was observed in all the 21 morphological and physiological characters included in the present investigation because of significance of mean squares for these characters. Therefore, genotypic and phenotypic correlation coefficients were calculated for all the possible character combinations. Since, genotypic and phenotypic correlations depicted similar trend and only phenotypic correlations can be tested for significance, only significant phenotypic correlations are discussed. Seed yield was positively associated with harvest index (0.52) and seed weight (0.72). None of the seven physiological components was significantly associated with it. However, these physiological components were associated among themselves. Transpirational cooling was positively associated with leaf conductance (0.79), osmotic adjustment (0.66) and turgor potential (0.66) and negatively with leaf water potential (-0.88), osmotic potential (-0.82) and canopy temperature (-1.00). Transpirational cooling was also associated negatively with days to first flower (-0.30), days to maturity (-0.35), plant height (-0.53), height of fertility zone (-0.46) and number of siliquae per plant (-0.56). The associations of all the 19 characters with canopy temperature and transpirational cooling were identical except in reverse direction. Therefore, direction

needs to be considered with great care. Actually, transpirational cooling is standardized canopy temperature.

Harvest index was positively associated with siliqua length (0.48), seed size (0.39) and leaf water potential (0.33) and negatively with days to first flower (-0.68), 50% flowering (-0.82) and maturity (-0.64), plant height (-0.42), height of fertility zone (-0.35), number of primary (-0.52) and secondary branches (-0.34) and siliquae (-0.54) per plant, biological yield (-0.64), turgor potential (-0.38), leaf conductance (-0.33) and osmotic adjustment (-0.35). Seed size, in turn, was positively associated with days to maturity (0.33), number of primary branches per plant (0.33), siliqua length (0.41), biological yield (0.32) and osmotic potential (0.37). Number of siliquae per plant was significantly and positively correlated with days to first flower (0.62), 50% flowering (0.72) and maturity (0.66), plant height (0.83), height of fertility zone (0.47), number of primary branches per plant (0.58), biological yield per plant (0.55), osmotic potential (0.47) and canopy temperature (0.56), whereas it was negatively correlated with harvest index (-0.54). Height of fertility zone was positively correlated with days to first flower (0.32), 50% flowering (0.40) and maturity (0.65), number of siliquae per plant (0.47), (biological yield (0.52), osmotic potential (0.44) and canopy temperature (0.46), and negatively with siliqua length (-0.54) and harvest index (-0.35). Number of secondary branches per plant was positively associated with days to first flower (0.58) and 50% flowering (0.43), number

of primary branches per plant (0.60) and osmotic potential (0.59), whereas negatively with harvest index (-0.34), osmotic potential (-0.29) and turgor potential (-0.48). Interestingly, siliqua length was positively associated with both number of seeds per siliqua (0.34) and seed size (0.41). However, their association (number of seeds per siliqua and seed size) was negligible (-0.052). Similar results in Brassicas were obtained by Singh *et al.* (1985, 1987a).

There were 21 different characters including seed yield per plant, 13 morphological and 7 physiological characters. It is difficult to partition all these component characters into direct and indirect effects through path coefficient analysis. Secondly, the picture will not be clear as number of direct and indirect effects will be hindering the expression of one or the other character. Hence, it was decided to partition these component characters into first order and second order characters. The characters exhibiting significant correlation with seed yield were considered first order variables/characters, *viz.* harvest index and seed size. Even the component characters like height of fertility zone, number of siliquae per plant and transpirational cooling were considered as first order variables. All the remaining characters were grouped as second order variables (Singh *et al.*, 1987b).

Path coefficient analysis of seed yield per plant with first order characters indicated that major components of seed yield were height of fertility zone and harvest index as these were contributing directly to seed yield (Table 1).

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TABLE 1

Direct and indirect effects of seed yield with first order characters*

Character	Direct	Indirect	Total	5	10	13	14	19
5	0.497	-0.233	0.264	0.497	0.084	-0.246	0.092	-0.163
10	0.178	-0.283	-0.104	0.234	0.178	-0.376	0.059	-0.200
13	0.701	-0.109	0.592	-0.174	-0.095	0.701	0.136	0.024
14	0.347	0.373	0.720	0.131	0.030	0.275	0.347	-0.063
19	0.356	-0.341	0.015	-0.227	-0.100	0.048	-0.062	0.356

*5=Height of fertility zone; 10=Number of siliquae per plant; 13=Harvest index; 14=500-seed weight; and 19=Transpirational cooling.

It was interesting to note that even direct effect of number of siliquae per plant was in the reverse direction to correlation coefficient. It clearly indicated that this character was not component of seed yield, in the present material and environment. Contribution of seed size was also non-significant. Path coefficient analysis of the second order variables on four first order variables is given in Table 2. Days to first flower and days to 50% flowering were neutralizing substantial contribution of days to maturity. However, the balance contribution of days to maturity along with biological yield were contributing directly to seed yield via height of fertility zone. Contribution of days to first flower and days to 50% flowering was completely neutralized by contribution of days to maturity via number of siliquae per plant. Therefore, highly related characters should invariably be ignored in path coefficient analysis otherwise linearity effects will be present. Plant height, number of primary branches per plant and biological yield contributed to seed yield via number of siliquae per plant. Interestingly, days to first flower and days to maturity were balancing the contribution of one another, whereas days to 50%

flowering and biological yield were contributing to seed yield via harvest index. Seed size failed to show any contribution to seed yield via siliqua length. Even contributions of days to maturity were decreased by biological yield. Therefore, components of seed size can be grouped as number of primary branches per plant, osmotic potential and biological yield. It was also interesting to note that leaf water potential and leaf conductance were, invariably, contributing in one direction, whereas contributions of osmotic potential and turgor potential were in opposite direction to seed yield via transpirational cooling (Table 3). The resultant was the net contribution or correlation coefficient of seed yield. Similarly, days to first flower and plant height were contributing in opposite direction. Therefore, main components of transpirational cooling for seed yield turned out to be days to maturity, plant height, leaf water potential, osmotic potential, turgor potential and leaf conductance.

From the foregoing discussion one can easily conclude that characters responsible for higher seed yield per plant were height of fertility zone and

TABLE 2

Direct and indirect effects of second order characters on four first order characters*

Association	1	2	3	4	6	7	8	9	12	16	17	Total
5 vs. 1	-.442	-0.153	0.720	-.002			-.009		.197	.005		0.316
2	-.411	-0.165	0.723	-.002			.035		.212	.012		0.404
3	-.392	-0.148	0.810	-.003			.077		.219	.088		0.651
4	-.179	-0.081	0.520	-.005			.147		.113	.219		0.734
8	-.009	0.013	-0.140	-.002			-.443		-.042	.079		-.0540
12	-.348	-0.140	0.710	-.003			.073		.250	-.018		0.524
16	-.006	-0.006	0.196	-.003			-.086		-.012	.364		0.437
10 vs. 1	.364	0.778	-1.097	.262	.152			-.048	.207	.005		0.823
2	.338	0.837	-1.102	.317	.134			-.041	.223	.012		0.718
3	.323	0.747	-1.235	.414	.130			-.032	.230	.085		0.662
4	.148	0.411	-0.794	.645	.065			.023	.119	.211		0.828
6	.307	0.625	-0.894	.233	.180			-.023	.182	-.035		0.575
9	.188	0.370	-0.429	-.158	.044			-.033	.084	-.092		-0.086
12	.287	0.711	-1.082	.292	.125			-.030	.262	-.017		-0.548
16	.005	0.028	-0.299	.388	-.018			.025	-.013	.351		0.467
13 vs. 1	-.500	-1.311	0.446	-.025	.201	.043	.009		.530		-.068	-0.675
2	-.465	-1.410	0.449	-.030	.178	.032	-.034		.571		-.105	-0.814
3	-.444	-1.258	0.502	-.039	.172	.021	-.074		.580		-.108	-0.638
4	-.203	-0.692	0.323	-.061	.086	-.016	-.143		.305		-.012	-0.413
6	-.421	-1.053	0.354	-.022	.238	.046	.016		.466		-.156	-0.523
7	-.290	-0.607	0.138	.013	.144	.075	.005		.189		-.007	-0.340
8	-.010	0.110	-0.087	.020	.009	.001	.431		-.111		.113	0.476
12	-.394	-1.197	0.440	-.028	.165	.021	-.071		.673		-.244	-0.635
17	-.079	-0.343	0.126	-.002	.086	.001	-.113		.380		-.431	-0.376
14 vs. 3			-0.401		.193		-.055		.487	.109		0.333
6			-0.290		.267		.012		.385	-.044		0.330
8			0.069		.010		.319		-.091	.097		0.404
12			-0.351		.185		-.053		.556	-.022		0.315
16			-0.097		-.026		.069		-.027	.448		0.367

*1=Days to first flower; 2=Days to 50% flowering; 3=Days to maturity; 4=Plant height; 5=Height of fertility zone; 6=Number of primary branches per plant; 7=Number of secondary branches per plant; 8=Siliqua length; 9=Number of seeds per siliqua; 10=Number of siliques per plant; 12=Biological yield per plant; 13=Harvest index; 14=500-seed weight (g); 16=Osmotic potential; and 17=Turgor potential.

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TABLE 3

Direct and indirect effects of second order characters* on first order character
(transpirational cooling)

Character	1	3	4	15	16	17	20	21	Total
1	0.051	-0.747	0.174	0.185	0.017	-0.290	0.300	0.014	-0.296
3	0.046	-0.841	0.275	0.006	0.279	-0.458	0.328	0.015	-0.350
4	0.020	-0.541	0.428	-0.750	0.693	-0.050	-0.322	-0.007	0.529
15	-0.004	0.002	0.143	-2.238	0.996	1.581	-1.291	-0.047	-0.858
16	0.001	-0.204	0.258	-1.935	1.152	0.899	-0.949	-0.028	-0.806
17	0.008	-0.210	0.012	1.927	-0.564	-1.836	1.282	0.052	0.671
20	0.011	-0.197	-0.098	2.066	-0.781	-1.683	1.398	0.051	0.767
21	0.012	-0.217	-0.053	1.853	-0.582	-1.702	1.273	0.056	0.640

*1=Days to first flower; 3=Days to maturity; 4=Plant height; 15=Leaf water potential; 16=Osmotic potential; 17=Turgor potential; 20=Leaf conductance; 21=Osmotic adjustment.

harvest index. Remaining first order characters, number of siliquae per plant, seed size and transpirational cooling contributed to seed yield via second order characters. Second order morphological characters, days to 50% flowering, days to maturity, plant height, number of primary branches per plant and biological yield and physiological characters, leaf water potential, osmotic potential, turgor potential and leaf diffusive conductance contributed to seed yield via one or more first order characters. Therefore, concomitant selection criterion based on these characters would be most effective under moisture stress conditions to improve seed yield in Brassicas.

Transpirational cooling contributed to seed yield via one or more characters.

Canopy temperature by portable infra-red thermometer is non destructive and faster than remaining physiological parameters. One can easily record data on 100 to 200 breeding lines within a span of 2 to 3 h. Transpirational cooling is canopy air temperature differential, *i. e.* canopy temperature minus air temperature. This recording and subtracting of air temperature removes the slight variation of the environment at mid day. However, the data should be recorded at pod initiation stage, when there is minimum exposure to soil surface since the infra-red thermometer works on thermal sensing of the objects. Thus, a breeder can easily screen large germplasm and breeding material for drought tolerance under field conditions within few days without destroying them.

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SEED PRODUCTION IN ONION AS INFLUENCED BY TIME OF BULB PLANTING AND CUT TREATMENTS

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ABSTRACT

The investigations were carried out to study the influence of three dates of bulb planting and three cut treatments given to bulb. Whole bulb planting on 16 October gave the highest number of scapes per plant and seed yield per umbel per plant and per ha during both the years and closely followed by 1 November whole bulb planting. The cut treatments given to bulb affected the yield attributes and seed yield adversely in all dates of planting, however, the differences between treatments under 16 October planting were not significant. Seed yield reduced gradually as the planting was delayed, however, significant differences were observed only under 16 November planting. The seed quality in terms of test weight and germination was not influenced by any treatment.

Seed production in onion is highly scientific and technical job and one needs years of experience to become well conversant with different aspects of seed production. The time of planting is an important factor in determining the seed yield of onion crop. If it coincides with optimum ecological conditions and provides sufficient duration for crop growth, it will lead to better development of plants and finally higher seed yield. Its importance has been reported by Singh *et al.* (1974 a, b), Lal *et al.* (1982), Singh and Singh (1984) and Mishra (1986) for different agro-climatic regions. Onion seed yield is also said to be favourably influenced by cut treatments given to bulbs before planting (Singh *et al.*, 1965; Srivastava and Adhikari, 1970) but the studies by Green (1972) and Singh *et al.* (1983) are contradictory to above observations. In

the absence of clear cut relevant information on these aspects for this region, farmers are reluctant to take up onion seed production programme. Keeping this in view, the present investigations were undertaken to find out the optimum time of bulb planting and to study the influence of bulb cut treatments on the performance of seed crop of onion.

MATERIAL AND METHODS

The study was conducted at Vegetable Research Farm of Haryana Agricultural University, Hisar, during 1985-86 and 1986-87 with onion cultivar Hisar-2. There were nine treatment combinations consisting of three dates of planting (16 October, 31 October and 15 November) and three cut treatments (whole bulb—T₁, chopping of top one-

third of bulb— T_2 , and two longitudinal incisions through the apex of bulb reaching about half way cutting each other at right angle— T_3) and was replicated four times in randomised block design. The bulbs were treated with 0.2% dithane M-45 by immersing for about 5 min before planting. The bulbs were planted at a distance of 45×30 cm.

A basal dose of 50 kg P_2O_5 /ha was uniformly applied at the time of planting. Nitrogen (50 kg/ha) was applied through CAN in three equal splits, at planting, 45 days after planting and at the time of scape initiation. Usual cultural operations and plant protection measures were adopted during the entire course of experimentation.

RESULTS AND DISCUSSION

A perusal of data presented in Table 1 indicates that seed yield per ha was highest under 16 October whole bulb (T_1) planting during both the years of experimentation (variation in seed yield was due to the occurrence of mild hail storm at the time of maturity during 1985-86). Comparable seed yield was obtained with treatments T_2 and T_3 on the same date of planting and 31 October whole bulb planting. Seed yield decreased significantly under T_2 and T_3 treatments in 31 October planting and under all treatments where the crop was planted on 15 November. The lowest seed yield in 15 November planted crop was recorded in T_3 treatment. These findings are in conformity with those of Singh *et al.* (1974), Singh (1975), Lal *et al.* (1982) and Mishra (1986) who have reported October plantings conducive to higher

seed yield. The cut treatments given to bulbs adversely affected the seed yield under all dates of planting, however, the differences between treatments under 16 October planting were not significant. The effect of cuts given to bulbs was more pronounced in later dates and significant reduction in seed yield was recorded under 31 October and 15 November plantings. The decrease in seed yield due to cut treatments has also been reported by Green (1972) and Singh *et al.* (1983), however, these observations are contrary to the reports of Singh *et al.* (1965) and Srivastava and Adhikari (1970).

Seed yield per unit area depends upon the seed quantity contributed by individual plant. In this study, seed yield per plant was recorded highest under 16 October whole bulb planting. Treatments T_2 and T_3 under this date and 31 October whole bulb planting also gave comparable seed yield per plant during both the years. The higher seed yield under these treatments may be due to more number of scapes per plant. These observations are in consistence with the findings of Green (1972) and Singh *et al.* (1983). However, seed yield per umbel was statistically comparable except 15 November planting with T_2 and T_3 treatments.

Plant growth in terms of height was better in 16 October planted crop under all treatments and 31 October whole bulb planting which was significantly superior over all other treatments in later dates. In case of cut treatments better plant growth in earliest planted crop in comparison to planting on later dates suggests that injury to lateral buds caused by cut

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TABLE 1
Effect of planting time and cut treatments on seed production in onion cv. Hisar-2

Planting date	Treatment	Plant height (cm)		No. of scapes per plant		Seed yield per umbel (g)		Seed yield per plant (g)		Seed yield (q/ha)		1000-seed weight (g)		Germination (%)	
		1985-86	86-87	85-86	86-87	85-86	86-87	85-86	86-87	85-86	86-87	85-86	86-87	85-86	86-87
16 Oct.	Whole bulb	88.0	124.1	9.4	9.8	2.08	3.16	13.09	18.97	9.43	13.69	3.64	3.89	86.3	88.7
	Chopping top 1/3	88.3	128.9	8.9	9.0	2.08	3.14	12.28	18.43	8.90	12.09	3.63	3.91	87.0	89.3
	Two cross incisions	85.3	122.9	8.7	8.9	1.97	3.02	11.87	16.64	8.86	10.79	3.55	3.86	85.7	87.6
31 Oct.	Whole bulb	80.9	120.7	9.2	9.6	2.07	3.11	12.91	18.55	9.30	13.40	3.48	3.89	84.7	89.3
	Chopping top 1/3	71.0	119.3	7.7	7.7	1.96	2.98	10.68	14.79	7.38	10.40	3.48	3.91	83.6	86.7
	Two cross incisions	69.9	116.2	7.6	7.2	1.91	2.96	10.58	13.03	7.16	9.19	3.42	3.77	85.3	87.0
15 Nov.	Whole bulb	63.4	105.4	7.9	7.8	1.94	2.91	9.63	10.49	6.11	7.11	3.36	3.70	82.3	84.0
	Chopping top 1/3	58.1	98.7	6.9	7.0	1.75	2.76	7.18	8.56	4.94	5.95	3.35	3.47	84.7	82.7
	Two cross incisions	59.2	98.4	6.6	6.8	1.63	2.59	6.96	7.09	4.27	5.13	3.42	3.39	83.0	85.3
C. D at 5%		7.6	7.4	1.6	1.9	0.27	0.18	1.65	3.58	1.62	3.06	NS	NS	NS	NS

treatments affected the plant growth. It is well known that the bulbs start sprouting in October end and early November in the store itself and the cut treatments might have injured the emerging buds and this could be the possible reason for poor performance of plants in later dates as compared to whole bulb planting. However, possible reason for significant decrease in plant height in 15 November whole bulb planting could be the short duration available for the crop growth. It could also be attributed to further reduction of bulb metabolites due to respiration and other losses as a result of prolonged storage under ambient conditions prior to planting. Number of scapes per plant was recorded maximum under 16 October whole bulb planting which was at par with cut treatments on this date and 31 October whole bulb planted crop. This indicated that better plant growth contributed in more number of scapes per plant.

This again suggests that initial loss of mother bulb tissues from cut treatments and the injury to lateral buds at planting time prevent shoots from attaining full size and resulted in fewer scapes per plant. Similar findings have been reported by Singh *et al.* (1983). Thus, the higher seed yield per ha under 16 October and 31 October whole bulb planting may be explained on the basis of better plant growth, more scapes per plant and higher seed yield per plant.

The seed quality in terms of test weight and germination percentage was not influenced by any of the treatments. Green (1972) also reported similar results. From these findings it can be concluded that cut treatment is in no way beneficial and should not be practised for onion seed production. For higher seed yield whole bulbs may be planted in the second fortnight of October.

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COMBINING ABILITY STUDIES FOR YIELD AND ITS COMPONENTS IN HULLED $\times$ HULL-LESS CROSSES OF BARLEY

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ABSTRACT

Combining ability for eight quantitative characters was studied through line $\times$ tester analysis involving 15 lines and 3 testers. Considerable amount of genetic variability among parents and their hybrids for almost all the characters was observed. The combining ability analysis revealed that variance due to lines $\times$ testers was significant for most of the characters including grain yield/plant. Among females RD 224, DL 301, DL 65, K 1112 and DL 120 and in males, Karan 18, were found to be the best general combiners for all the characters. Rank correlation coefficients showed that *per se* performance itself will not be useful in predicting the GCA effects. Among crosses, RD 103 $\times$ DL 344 and DL 120 $\times$ IB 65 were found to be the best cross combinations on the basis of specific combining ability effects. Present study advocates a selection programme included for the simultaneous exploitation of additive and non-additive gene effects for the improvement of grain yield in hull-less barley through recurrent selection.

Major portion of the barley grain produced in India is consumed by the poor people either as flour for chapati making or as parched grains to make *sattu*. Hulled barleys are high yielder but require dehusking before its consumption as human food. On the other hand, hull-less barleys are poor yielder and can be used directly for human food. The emphasis should be given for the improvement of yield of hull-less types and it is desirable to know their combining ability when crossed with hulled types. The present study was undertaken to provide a base for the further improvement of hull-less genotypes by intercrossing with hulled types.

MATERIAL AND METHODS

Fifteen female parents, *viz.* BG 1, BG 105, BG 108, BH 39, DL 70, DL 65, DL 120, DL 301, K 147, RD 103, RD 224, ER 41, Karan 5, P 267 (all hulled) and K 1112 (hull-less) were crossed with three hull-less testers, *viz.* Karan 18, IB 65 and DL 344. The material consisting of 63 progenies were grown in a randomized block design with three replications at the Haryana Agricultural University Research Farm, Hisar. The parents and F_1 's were sown in an experimental design suggested by Arunachalam (1974).

Seeds were dibbled at a distance of 15 cm in rows of 2.5 m length spaced

30 cm apart. Eight characters—days to heading, effective tillers/plant, plant height (cm), spike length (cm), grains/spike, grain weight/spike (g), 100-grain weight (g) and grain yield/plant (g), were studied on five randomly chosen competitive plants from each entry. The analysis of variance for combining ability was done by extending the model of Kempthorne (1957). Since the study was aimed to assess these parents, fixed effect model was used.

RESULTS AND DISCUSSION

Analysis of variance revealed that mean squares due to parents and hybrids were significant for all the characters, indicating the presence of considerable variation among the parents and hybrids. The partitioning of the variation among the hybrids due to general combining ability (GCA) of females and males and due to specific combining ability (SCA) of crosses showed that both lines and testers differed significantly for general combining ability for all the characters. The specific combining ability of cross combinations was also significant for all the characters (Table 1). The relative magnitude of mean squares of the testers was higher than the lines for all the characters except days to heading indicating high amount of genetic variability present among the testers as compared to lines.

The mean squares due to line $\times$ testers were significant for all the characters, revealing that different testers showed markedly different combining ability effects. Such a situation was expected since the lines as well as testers used in

the present study had wide genetic diversity. Moreover, this is suggestive of the possibility of selecting specifically good cross combinations for different traits.

The GCA effects of testers and lines are presented in Table 2. The tester Karan 18 was found to be the best general combiner in respect of grain yield/plant, days to heading, plant height and spike length. Tester IB 65 proved to be the best general combiner for grains/spike, grain weight/spike and 100-grain weight, whereas DL 344 was the best combiner for effective tillers/plant. Among the female lines RD 224, DL 120, BG 108 and BH 39 were excellent general combiners for days to heading, effective tillers/plant and spike length, BG 108 for grain weight/spike and 100-grain weight. Lines K 1112, DL 65 and DL 301 showed the highest general combining ability for effective tillers/plant, grains/spike and 100-grain weight. None of the parents among males and females was found to be the best for all the characters under study. However, Karan 18 among testers, RD 224, DL 301, DL 65, K 1112 and DL 120 among the females proved to be the good general combiners for the yield and its components. Thus, these lines merit proper consideration by the barley breeders.

Rank correlation coefficients between *per se* performance and the GCA effects were not significant for grain yield and its components except for grains/spike (Table 3). Thus, it becomes apparent that the *per se* performance itself will not be useful in predicting the GCA effects. Similar trend was observed by Solanki and Bakshi (1974), Verma and Gulati (1976) and Verma *et al.* (1981).

TABLE 1
Analysis of variance (mean squares) for combining ability in barley

Source	d.f.	Mean squares							
		Days to heading	Effective tillers/plant	Plant height	Spike length	Grains/spike	Grain weight/spike	100-grain weight	Grain yield/plant
Hybrids (Crosses)	44	29.05**	28.21**	477.16**	2.47**	130.79**	0.71**	0.38**	208.90**
Lines	14	54.05**	20.08**	954.50**	2.35**	50.22**	0.66**	0.66**	112.30**
Testers	2	32.94**	279.51**	1274.03**	3.14**	784.74**	2.69**	0.83**	1227.92**
Line x Tester	28	16.28**	14.32**	181.57**	2.48**	124.36**	0.59**	0.21**	184.41**
Error	124	0.98	1.58	9.56	0.16	5.78	0.03	0.05	8.83

** Significant at $P \leq 0.01$.

TABLE 2
General combining ability effects of lines and testers in barley

Parents	Days to heading	Effective tillers/plant	Plant height	Spike length	Grains/spike	Grain weight/spike	100-grain weight	Grain yield/plant
Females								
1. BG 1	2.45	0.19	2.04	-0.28	0.02	0.03	0.06	2.10
2. BG 105	1.67	-0.45	4.35	-0.57	-2.81	-0.17	-0.24	-5.02
3. BG 108	3.34	0.30	1.15	-0.59	-0.20	0.29	0.13	3.48
4. BH 39	1.89	1.10	6.07	-0.33	-0.58	0.16	-0.06	2.73
5. DL 70	-3.99	0.26	-15.89	-0.10	3.75	-0.10	-0.18	-1.30
6. DL 65	2.56	-3.46	17.67	0.28	4.11	0.03	0.10	-4.39
7. DL 120	-0.10	1.26	-1.59	0.03	-0.97	0.10	-0.21	5.33
8. DL 301	-3.66	-0.38	14.41	-0.15	0.64	0.26	0.34	2.43
9. K 147	2.78	-2.13	10.43	0.14	-3.04	-0.19	0.23	-3.67
10. RD 103	-1.32	0.47	-0.95	0.69	1.11	0.02	0.26	1.82
11. RD 224	-1.99	1.52	-2.60	0.77	0.54	0.10	0.05	5.50
12. ER 41	-0.88	-1.67	5.10	0.24	0.35	0.38	0.03	-1.26
13. Karan 5	-2.66	1.14	-21.11	0.68	2.84	-0.03	-0.16	-2.52
14. P 267	-1.32	-0.29	2.43	-1.00	-2.22	-0.11	0.27	-3.39
15. K 1112	1.23	2.12	7.31	0.19	-3.66	-0.76	-0.68	-1.82
S. E. (g)	0.33	0.41	1.03	0.13	0.80	0.06	0.07	0.99
Males								
16. Karan 18	-0.85	1.31	-3.71	0.21	0.61	0.04	0.05	5.08
17. IB 65	0.85	-2.87	6.09	0.08	3.83	0.22	0.09	-5.35
18. DL 344	0.00	1.56	-2.38	-0.29	-4.44	-0.26	-0.15	0.26
S. E. (g)	0.14	0.18	0.46	0.06	0.35	0.02	0.03	0.44

TABLE 3
Rank correlations of *per se* performance
and the gca effects for various
characters in barley

S. No.	Character	
1.	Days to heading	0.64**
2.	Number of effective tillers/plant	0.34
3.	Plant height	0.74**
4.	Spike length	0.12
5.	Number of grains per spike	0.47*
6.	Weight of grains per spike	0.54
7.	100-grain weight	0.26
8.	Grain yield per plant	0.23

* Significant at $P \leq 0.05$

** Significant at $P \leq 0.01$

The estimates of specific combining ability effects (data being voluminous not included in the paper) showed that crosses RD 103×DL 344, DL 120×IB 65, BG 1×Karan 18 and P 267×IB 65 had positive significant SCA effects for grain yield, effective tillers/plant, grains/spike and 100-grain weight. Three crosses, viz. Karan 5×Karan 18, K 1112×Karan 18,

and RD 224×DL 344 showed high negative SCA effects (desirable) for days to heading. Overall, two crosses, viz. RD 103×DL 344 and DL 120×IB 65 were found to be the best cross combinations in the present study. In general, parents having good combining ability did transmit their superior performance in some cases while in other cases they did not, indicating the preponderance of both additive as well as non-additive gene effects for grain yield and its components. Results are in conformity with those reported by Yap and Harvey (1971) and Nasr *et al.* (1972). However, Verma and Gulati (1976) and Verma *et al.* (1981) concluded from their study the importance of non-additive gene effects in the inheritance of grain yield. Present study also advocates a selection programme included for the simultaneous exploitation of additive and non-additive type of gene effects for the improvement of grain yield in hull-less barley. Recurrent selection procedure may be employed to concentrate desirable genes and to isolate superior pure breeding lines.

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EVALUATION OF PRE-EMERGENCE AND POST-EMERGENCE HERBICIDES IN COTTON

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ABSTRACT

Haloxypomethyl alone or as a sequential treatment with diuron was evaluated for the control of weeds in cotton. Pre-emergence application of pendimethalin at 1.25 kg/ha or pre-plant incorporation of fluchloralin at 1.25 kg/ha gave maximum control of carpetweed and barnyard grass and significantly higher yield of seed cotton as compared to weedy check. Haloxypomethyl alone at 0.312 kg/ha or as sequential treatment after diuron at 0.187 and 0.250 kg/ha proved effective against barnyard grass and gave significantly higher yield of seed cotton as compared to weedy check.

Annual weeds are a serious problem in cotton. Two hand hoeings are generally required in the absence of chemical weed control (Anonymous, 1985). Fluchloralin and pendimethalin have been successfully tried for the control of carpetweed (*Trianthema portulacastrum* L.) and barnyard grass (*Echinochloa crusgalli* L.) (Kurfakar and Khuspe, 1979). Haloxypomethyl is a foliar absorbed translocated herbicide that provides selective control of annual and perennial grasses in leguminous crops (Andersen, 1982; Hartzler and Foy, 1983; Buhler and Burnside, 1984). Until recently no post-emergence selective herbicide was available to control weeds in cotton. The objective of the investigation was, therefore, to evaluate the performance of pre-emergence and post-emergence herbicides for weed management in cotton.

MATERIAL AND METHODS

Field experiments were conducted during the rainy seasons of 1985 and 1986 at Haryana Agricultural University, Hisar. The climate is sub-tropical with hot and desiccating winds in May and June and with an average rainfall of about 400 mm which falls between the end of July and the middle of September. In both the years, the experiment was located on a sandy loam soil with a pH of 8.0 and an organic matter content of 0.4 per cent.

Cotton (cv. H-777) was sown at a spacing of 60×30 cm. Fertilizers, irrigation and insecticides were applied in accordance with the standard local practices. Sowing was done with the help of seed cotton drill on 15 May and 17 May during 1985 and 1986, respectively. Haloxypomethyl (2, 4-(3-

chloro-5-trifluoromethyl)-2-pyridinyl) oxy phenoxy propanoic acid) alone at 0.062, 0.125, 0.187, 0.250 and 0.312 kg/ha and as a sequential application at 0.094, 0.125, 0.187 and 0.250 kg/ha on 0.5 kg/ha diuron (3-(3, 4-dichloro-phenyl)-1, 1-dimethyl urea) treated plots were compared with the pre-plant application of fluchloralin (N-(2-(chloroethyl)-2, 6-dinitro-N-propyl-4-(trifluoromethyl) aniline) at 1.25 kg/ha and pre-emergence application of pendimethalin (N-(1-ethyl-propyl)-3, 4-dimethyl-2, 6-dinitro benzenamine) at 1.25 kg/ha and diuron at 0.5 kg/ha. These were compared with two control treatments: one completely unweeded and other kept entirely weed free by hand. Haloxyfopmethyl (Gallant) was applied as a post-emergence spray 50 DAS using 650 litres of water per hectare. All 14 treatments were replicated thrice in a randomized block design. Number and dry weight of weeds present were recorded after 60 and 90 DAS.

RESULTS AND DISCUSSION

Effect on Weeds

Pendimethalin and fluchloralin provided the most consistent control of carpetweed and barnyard grass (Table 1). At 60 DAS, the population of these weeds was significantly less than all other treatments of herbicides. However, at 90 DAS in 1986, differences were not significant except with haloxyfopmethyl at 0.062 and 0.125 kg/ha. Haloxyfopmethyl did not control carpetweed but barnyard grass was effectively controlled at doses higher than 0.187 kg/ha. Sequential application of haloxyfopmethyl where diuron had

been applied at sowing did not improve the control of carpetweed. However, the control of barnyard grass improved by the sequential application of haloxyfopmethyl. Haloxyfopmethyl applied alone at 0.25 or at 0.312 kg/ha or as sequential treatment on diuron treated plots provided similar population of barnyard grass to that of fluchloralin or pendimethalin treated plots. The dry weights of total weeds at 60 and 90 DAS in fluchloralin and pendimethalin treated plots were significantly less than the plots treated with diuron alone and haloxyfopmethyl alone upto 0.25 kg/ha. These studies indicate that fluchloralin and pendimethalin at 1.25 kg/ha are the best treatments for the control of both carpetweed and barnyard grass. However, in May sown cotton the emergence of barnyard grass is delayed till the rains are received. Under such situations a sequential application of haloxyfopmethyl with pendimethalin or with fluchloralin may be tried for improving the overall weed control in cotton.

Effect on Crop

Presence of weeds throughout the growing season reduced the yield of seed cotton by 32.8 and 55.1 per cent during 1985 and 1986, respectively. This was mainly because the population of weeds was more in 1986 as compared to 1985. In 1985, application of haloxyfopmethyl alone at 0.250 kg/ha, its sequential application with diuron or diuron alone at 0.5 kg/ha did not increase the yield significantly over no weeding. In 1986, all the treatments except haloxyfopmethyl alone at 0.062 kg/ha increased the yield significantly over the

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TABLE 1
Influence of haloxyfopmethyl applied alone and as a sequential treatment with diuron on population per square metre of carpetweed and barnyard grass at 60 and 90 DAS

Treatment	Herbicide rate (kg/ha)	Time of application	60 DAS		90 DAS	
			Carpetweed		Barnyard grass	
			1985	1986	1985	1986
Haloxyfopmethyl	0.062	Post	11.3	15.0	4.2	6.5
Haloxyfopmethyl	0.125	Post	11.3	14.5	4.0	6.2
Haloxyfopmethyl	0.187	Post	11.0	14.2	3.6	4.9
Haloxyfopmethyl	0.250	Post	10.7	14.1	3.4	3.9
Haloxyfopmethyl	0.312	Post	10.3	16.8	3.0	3.2
Diuron fb Haloxyfopmethyl	0.50 fb 0.094	Pre & Post	7.9	5.9	3.6	6.0
Diuron fb Haloxyfopmethyl	0.50 fb 0.125	Pre & Post	7.9	5.8	2.9	5.3
Diuron fb Haloxyfopmethyl	0.50 fb 0.187	Pre & Post	7.9	5.8	2.6	4.4
Diuron fb Haloxyfopmethyl	0.50 fb 0.250	Pre & Post	7.6	5.7	2.6	3.4
Fluchloralin	1.25	PPI	5.5	4.6	2.8	3.0
Pendimethalin	1.25	Pre	5.0	4.8	2.7	3.0
Diuron	0.50	Pre	7.8	6.0	3.3	6.0
Weed free check			1.0	1.0	1.0	1.0
Weedy check			11.3	15.4	4.5	7.5
L. S. D. ($P=0.05$)			2.1	1.9	1.0	1.3

Post — Post-emergence, Pre — Pre-emergence, PPI — Pre-plant incorporation, fb — followed by, DAS — Days after sowing.

TABLE 2
Influence of haloxyfopmethyl applied alone and as a sequential treatment with diuron on total dry weight of weeds at 60 and 90 DAS, and seed cotton yield

Treatment	Herbicide rate (kg/ha)	Time of application	Total dry weight (g/m ²)				Seed cotton yield (kg/ha)	
			60 DAS		90 DAS		1985	1986
			1985	1986	1985	1986		
Haloxyfopmethyl	0.062	Post	173.9	98.1	161.7	189.9	1571	1306
Haloxyfopmethyl	0.125	Post	158.6	96.7	150.7	184.7	1794	1529
Haloxyfopmethyl	0.187	Post	147.0	88.4	136.3	152.8	1827	1620
Haloxyfopmethyl	0.250	Post	140.9	79.0	131.7	137.6	1943	1900
Haloxyfopmethyl	0.312	Post	120.3	62.1	112.5	121.9	2017	2116
Diuron fb Haloxyfopmethyl	0.50 fb 0.094	Pre & Post	125.8	84.5	100.4	157.6	1885	1835
Diuron fb Haloxyfopmethyl	0.50 fb 0.125	Pre & Post	119.6	78.4	98.2	158.3	2050	1984
Diuron fb Haloxyfopmethyl	0.50 fb 0.187	Pre & Post	111.6	71.2	90.3	141.5	2108	2078
Diuron fb Haloxyfopmethyl	0.50 fb 0.250	Pre & Post	103.3	54.2	81.7	114.9	2141	2158
Fluchloralin	1.25	PPI	123.5	46.9	102.7	116.3	2174	2200
Pendimethalin	1.25	Pre	101.9	61.1	96.3	121.6	2235	2356
Diuron	0.50	Pre	180.8	89.7	104.7	156.6	1876	1839
Weed free check			0.0	0.0	0.0	0.0	2323	2862
Weedy check			214.8	112.6	190.3	201.2	1562	1194
L.S.D. (P=0.05)			42.7	31.0	25.5	32.8	416	406

Post—Post emergence, Pre—Pre emergence, PPI—Pre-plant incorporation, fb—followed by, DAS—Days after sowing.

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weedy check (Table 2). In this year, high population of barnyard grass might have contributed towards significant increase in the seed cotton yield. However, haloxyfop was not significantly superior to weed free check, pendimethalin or fluchloralin. Early weed competition and the uncontrolled

population of carpetweed might have contributed for efficiency of haloxyfop-methyl applied alone. The differences in the seed cotton yield between weed free check and pendimethalin or fluchloralin were non-significant. The performance of pendimethalin was better than fluchloralin.

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STUDY OF COMBINING ABILITY OVER ENVIRONMENTS IN SPRING WHEAT

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ABSTRACT

Estimates of combining ability pooled over two environments were computed for yield and its components from a 8×8 diallel in spring wheat (*Triticum aestivum* L.). Both the general (GCA) as well as specific combining ability (SCA) variances were significant for all the investigated characters, viz. days to heading, plant height, tiller number, total biomass, number of grains per ear, 1000-grain weight and grain yield per plant. The magnitude of GCA variances was higher than that of SCA variances for all the characters. The GCA $\times$ environments and SCA $\times$ environments interactions were significant for all the characters except for 1000-grain weight where GCA $\times$ environments interactions were non-significant. Parent HD 2285 was the best general combiner for yield and all its component characters and offers the best possibilities for its utilization for the development of improved lines in wheat. The cross combinations HD 2285 $\times$ CPAN 1907, HD 2285 $\times$ WH 291 and WH 283 $\times$ CPAN 1907 exhibited significantly high specific effects for grain yield and certain component traits and could be expected to throw transgressive segregants. Since the additive and non-additive gene effects were equally important for all the characters, their simultaneous exploitation using some suitable breeding approach is advocated.

Environmental fluctuations highly influence the phenotypic expression of quantitative traits. Depending upon the nature and magnitude, the genotype $\times$ environment interaction leads to bias in the estimates of gene effects and combining ability for various characters sensitive to environmental modulations. Such characters are less amenable to be improved through selection. The combining ability studies in a single environment may not provide precise information as environmental effects play an important role and greatly influence the combining ability estimates. It is, therefore, necessary to

assess the sensitivity of estimates of gene effects under variable environmental conditions so as to ensure better prediction and gain under selection. Keeping this in view, the present investigation was undertaken to derive information on the nature of combining ability operative in the inheritance of different economic characters and detect the role of environmental components on combining ability estimates.

MATERIAL AND METHODS

The eight genetically diverse lines, originating from different agro-climatic

zones of the country and included in the present investigation, were HD 2285, WH 147, WH 291, WH 283, CPAN 1907, CPAN 1830, HD 2009 and HW 517. These lines were crossed in all possible combinations (excluding the reciprocals). The 36 genotypes (8 parents and 28 F_1 's) were grown in a randomized block design with three replications in two environments, *i. e.* timely sown (16 November, 1984) and late sown (16 December, 1984). Each genotype was grown in a single row plot of 3 m length. The plant to plant and row to row spacings were kept at 15 and 30 cm, respectively. The data were collected on five randomly selected plants from each row for seven metric traits, *viz.* days to heading, plant height (cm), tiller number, total biomass (g), number of grains per ear, 1000-grain weight (g) and grain yield per plant (g). The entry means were utilized for statistical analysis. The combining ability analysis was carried out following Griffing (1956a) and the combining ability $\times$ environment interaction effects were computed following Singh (1973).

RESULTS AND DISCUSSION

The differences among progenies were highly significant for all the evaluated characters. The environmental mean squares revealed highly significant differences amongst them, indicating sufficient diversity among the measured environments. So was true with genotype $\times$ environment interactions.

The pooled analysis of variance for combining ability revealed that both the GCA as well as SCA variances were

significant. Thus, both kinds of gene effects figured important in controlling inheritance of all the characters studied. Both GCA $\times$ environments and SCA $\times$ environments interactions were significant for all the characters except GCA $\times$ environments for 1000-grain weight, indicating the sensitivity of both kinds of gene effects to the environmental variations. However, relatively higher magnitude of GCA $\times$ environment interactions for days to heading, plant height, number of grains per ear and grain yield per plant suggested a higher sensitivity of GCA to environments than that of SCA. Similar results were obtained by Paroda and Joshi (1970a, b), Paroda and Hays (1971), Sharma and Singh (1982) and Singh *et al.* (1986) for these characters. Perhaps the heterozygosity *per se* and physiological advantages attached hitherto by virtue of heterosis or enhanced metabolic rates (Sinha and Khanna, 1975) have contributed to lower sensitivity of SCA to environmental fluctuations as compared to GCA. However, for tiller number, total biomass and 1000-grain weight, the magnitude of SCA $\times$ environments interactions was higher than that of GCA $\times$ environments. This points to the desirability of obtaining combining ability estimates over diverse environments. As such, to derive valid estimates the material need to be tested over varying situations.

The pooled GCA effects (Table 1) revealed that HD 2285 was the best parent having high GCA effects not only for grain yield but also for other characters. The GCA effects mostly contribute to additive gene effects or additive $\times$ additive interaction effects

TABLE 1
General combining ability effects pooled over the environments in spring wheat

Parent	Parentage	Days to heading	Plant height	Tiller number	Total biomass	Number of grains/ear	1000-grain weight	Grain yield/plant
HD 2285	249-HD 2160/HD 2186	-1.27**	-7.05**	0.76**	9.30**	1.64**	0.69**	2.83**
WH 147	(E 4870 x C 303) x (S 339 x V 18)	2.08**	1.08**	-0.39**	3.90**	3.24**	1.40**	-0.76**
WH 291	HD 1925 x HD 832-23584	-1.31**	-0.01	-0.018	-3.36**	-2.62**	-0.60**	-0.91**
WH 283	HD 1981 x Raj 821	-1.42**	-0.59**	-0.005	-0.86	-0.36	1.20**	-0.77**
CPAN 1907	Cno-7c x Kai-Bb/Pci's	0.41**	1.47**	-0.54**	-3.32**	-0.92**	0.32*	-1.74**
CPAN 1830	Tob-Era/Tob/Cno	0.62**	0.31	0.43**	1.27	-0.45	-0.68**	0.38
HD 2009	LR 64A x Nai 60	0.45**	-2.03**	0.38**	-2.92**	-0.29	-1.75**	-0.71**
HW 517	8b-Cc/Ciano's x No. 66-Pl 62	0.66	0.83	-0.61	-5.77**	-0.26	-0.58**	-1.76**
S. E. (g)		0.14	0.21	0.13	0.71	0.33	0.15	0.24
S. E. (gr-gr)		0.21	0.32	0.19	1.07	0.49	0.23	0.37
C. D. at 5% (gr-gr)		0.41	0.63	0.37	2.10	0.95	0.45	0.73
C. D. at 1% (gr-gr)		0.54	0.82	0.49	2.76	1.26	0.59	0.95

*, **Significant at 5 and 1 per cent, respectively.

TABLE 2
Specific combining ability effects pooled over the environments for crosses good for yield and its components

Cross	Days to heading	Plant height	Tiller number	Total biomass	Number of grains/ear	1000-grain weight	Grain yield/plant
HD 2285 × WH 291	0.16	3.44**	0.80*	11.16**	4.37**	3.19**	4.16**
HD 2285 × CPAN 1907	- 2.11**	-1.41*	1.81**	12.95**	2.47*	0.56	5.63**
WH 147 × WH 291	-1.00*	0.90	-1.34**	-3.78	-1.19	4.85**	4.61**
WH 147 × HW 517	-1.00*	-1.21	-1.91**	6.79**	-2.28*	2.37**	2.46**
WH 283 × CPAN 1907	0.12	2.67**	1.67**	8.21**	2.69**	2.05**	4.40**
WH 283 × CPAN 1830	-0.62	1.67**	0.88**	6.62**	4.39**	0.96	2.13**
CPAN 1907 × HD 2009	1.21**	0.40	0.005	7.32**	-2.11*	1.58**	1.78*
CPAN 1830 × HW 517	-0.43	2.60**	1.55**	16.59**	6.00**	-0.70	5.35**
^A S. E. (s _{ij})	0.43	0.64	0.40	2.17	1.00	0.46	0.75
^A ^A S. E. (s _{ij} -s _{ik})	0.63	0.95	0.59	3.22	1.49	0.69	1.11
^A ^A S. E. (s _{ij} -s _{kl})	0.60	0.90	0.55	3.03	1.40	0.65	1.04
^A ^A C. D. at 5% (s _{ij} -s _{ik})	1.23	1.86	1.16	6.31	2.92	1.35	2.18
^A ^A C. D. at 1% (s _{ij} -s _{ik})	1.62	2.44	1.52	8.29	3.84	1.78	2.86

*, **Significant at 5 and 1 per cent, respectively.

(Griffing, 1956a, b) and represent fixable portion of genetic variation. In view of this, the parent HD 2285 offers the best possibilities of exploitation for the development of improved lines in wheat. It is suggested that the population, involving this parent (HD 2285) in a multiple crossing programme, may be developed for isolating high yielding varieties. The varieties/lines like WH 147, WH 283, CPAN 1907, CPAN 1830 and HD 2009 (Table 1) with good GCA effects for different component characters may be utilized in component breeding for effecting improvement in particular components, ultimately seeking improvement in grain yield itself.

Eight cross combinations gave significantly positive SCA effects for grain yield (Table 2). The SCA reflects dominance and epistatic components of genetic variation which are non-fixable. But inclusion of F_1 hybrids showing stable SCA and having parent (s) with good GCA, less altered by changes to environmental variations into multiple crosses, could also prove a worthwhile approach. Therefore, the cross combinations HD 2285 $\times$ WH 291 and HD 2285 $\times$ CPAN 1907 exhibited high SCA effects with good GCA effects of parents for yield could be successfully exploited for varie-

tal improvement and expected to throw stable performing transgressive segregants carrying fixable gene effects.

The present investigation revealed that additive as well as non-additive gene effects were important for all the characters. Considering the prevalence of both additive and non-additive gene effects for these characters, one or the other form of recurrent selection procedures and diallel selective mating (Jensen, 1970) might give fruitful results by capitalizing both additive as well as non-additive type of variances simultaneously for improving yield in wheat. Under such a situation delayed selection would be fruitful when the dominance component is expected to get diminished in later generations. In this situation biparental mating offers good promise to increase the frequency of genetic recombination and hasten the rate of genetic improvement (Srivastava *et al.*, 1980; Singh and Paroda, 1985). In certain populations biparental mating as well as mating of selected plants in early segregating generations could help in developing potential populations having optimum levels of homozygosity and heterozygosity. The further exploitation of such populations would lead to the development of lines possessing enhanced yielding ability.

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PERFORMANCE OF BOTTLE GOURD GENOTYPES

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Among gourds, bottle gourd (*Lagenaria siceraria* (Mol.) Standl.)—the only true gourd, is an important vegetable. Though, it is a modest source of nutrients (Seshadri, 1986), yet it is consumed by a larger section of the society. Due to great variation in shape and size of the fruits, the consumer's preference varies from one region to another. However, in Haryana the preference is for long and medium size fruits.

Considering the yield potential, low cost of cultivation and its utility as a cooked vegetable, a programme was initiated to develop a plant type, preferred by the consumers in Haryana state. Eighteen genotypes collected from different sources were evaluated in randomized block design with three replications and the plot size was kept 4.2×2.5 metres accomodating seven plants at a spacing of 60 cm. Five plants per replication were observed for recording data on various characters (Table 1).

The genotype which took minimum number of days to first female flower appearance was HBG-14 (58.4) closely followed by HBG-1, HBG-17 and HBG-15. Seven more genotypes were

at par with HBG-14 for this character. HBG-10 took maximum days (88.0) to produce first female flower. In case of HBG-2 first female flower appeared on the lowest node (13.0) followed by HBG-18 (14.7), HBG-15 (16.3), HBG-12 (16.4) and HBG-14 (16.8) which were statistically at par. In general, early female flower bearing genotypes also produced female flowers on lower nodes. As expected they were also early in bearing male flowers. The internode length of HBG-13 was minimum.

Among early genotypes, HBG-3 had significantly high number of node to first female flower (22.4) and medium vine length with highest number of fruits (8.0) and yield (6.67 kg) per plant. Other genotypes yielding at par with HBG-3, belonging to early group, were HBG-2 (6.10 kg) and HBG-4 (5.77 kg). The highest yielding genotypes exhibited narrow sex-ratio (male : female) which is desirable (Swarup, 1977). The round or bell shaped genotypes, viz. HBG-2, HBG-3, HBG-4 and HBG-17 had a narrow sex-ratio and were the highest yielder. Genotypes HBG-7, HBG-8 and HBG-9 had wide sex-ratio and yielded lower than the above mentioned genotypes in this group. It is interesting to

PERFORMANCE OF BOTTLE GOURD GENOTYPES

TABLE 1
Performance of bottle gourd lines for various characters during rainy season

Line	Fruit shape	Fruit colour	Days to first female flower	Node to first female flower	Sex-ratio (male : female)	Number* of nodes per plant	Inter-nodal** length (cm)	Length of vine at last picking (m)	Number of fruits per plant	Total yield per plant (kg)
HBG-1	Long	Light green	59.3	18.3	2.1	134	10.2	4.1	5.25	3.99
HBG-2	Bell shaped	Dark green	61.0	13.0	2.9	206	16.0	5.8	6.00	6.10
HBG-3	Round	Whitish green	61.0	22.4	2.7	155	9.9	4.2	8.00	6.67
HBG-4	Bell shaped	Whitish green	61.5	18.0	3.4	126	10.2	4.4	7.50	5.77
HBG-5	Long	Whitish green	62.9	18.7	3.0	132	11.6	3.3	5.17	3.50
HBG-6	Round with bit neck	Whitish green	74.1	24.9	3.9	275	9.6	3.6	3.84	3.38
HBG-7	Round oblong	Green	84.5	30.4	6.5	247	13.7	6.4	5.22	4.43
HBG-8	Round, bit flat	Green	80.5	22.5	6.0	224	12.7	5.8	4.00	4.44
HBG-9	Round with neck	Whitish green	81.9	28.1	5.9	299	12.3	6.8	3.67	3.42
HBG-10	Round	Dark green	88.0	31.8	2.6	247	12.1	9.0	3.50	3.79
HBG-11	Long	Whitish light green	62.4	19.3	3.8	217	10.3	4.1	5.45	3.76
HBG-12	Bell shaped	Whitish green	62.1	16.4	2.9	114	11.1	3.1	4.50	3.67
HBG-13	Long	Whitish light green	62.4	19.7	4.1	95	8.1	3.1	5.33	4.54
HBG-14	Long, little bell shaped	Light green	58.4	16.8	2.6	203	8.3	4.2	4.73	4.92
HBG-15	Long	Whitish green	59.4	16.3	2.7	193	11.1	4.2	4.61	3.69
HBG-16	Round with neck	Dark green	73.7	24.5	4.1	166	13.0	6.8	4.67	4.85
HBG-17	Round	Whitish green	59.3	17.8	3.7	199	10.1	3.6	5.84	5.20
HBG-18	Long, cylindrical	Light green	69.5	14.7	3.3	110	8.3	3.3	4.33	4.22
C. D. at 5 %			5.0	4.1	1.6	49	3.8	0.6	1.36	1.17

*Total nodes of main shoot and branches.

**Average of three nodes (1 bottom, 1 mid and 1 top per plant).

note that these genotypes having wide sex-ratio were late in flowering. Genotypes with long fruits, viz. HBG-11, HBG-13, HBG-14 and HBG-18 also had narrow sex-ratio and were high yielder, however, the magnitude of yield was somewhat lower than that of round ones. Genotype HBG-14 (long fruits) was highest yielder (4.92 kg/plant) and was at par with genotypes with bell shaped fruits, viz. HBG-2 and HBG-4. The late

genotypes such as HBG-10, HBG-7, HBG-9 and HBG-8 were more spreading and low yielder.

The study indicates that the genotypes HBG-3 (round); HBG-2 and HBG-4 (bell shaped); and the genotypes HBG-13, HBG-14 and HBG-18 with long fruits may be used in breeding programmes to develop a desired plant type with high yield.

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GENETIC DIVERGENCE STUDIES IN SUGARCANE

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The knowledge about the genetic divergence for various metric traits of a crop can serve a useful purpose in identifying diverse parents for hybridization. Such an information can be obtained through the use of multivariate analysis based on Mahalanobis' (1928) statistic. An attempt was, therefore, made to analyse the genetic divergence of 34 genotypes of sugarcane.

Twenty-eight advanced clones (CoH 1 to CoH 25, CoH 28, CoH 33 and CoH 53) from many crosses together with six commercially grown varieties (Co 1148, Co 1158, Co 7314, Co 7717, CoJ 64 and CoS 767) were planted in randomised block design with three replications in two environments, *i. e.* first week of March (normal sowing) and first week of May (late sowing), in 1984 at Research Farm of Haryana Agricultural University, Hisar with 90 cm distance between rows. Observations on two canes from each of the five random clumps of each genotype in each replication were recorded for number of millable canes per clump, cane height (cm), leaf length (cm), leaf width (cm), number of internodes per cane, internode length (cm), cane thickness (cm), single cane weight (kg), cane yield per clump

(kg), fibre content (%), brix (%), pol (%), purity (%), commercial cane sugar (%) and reducing sugars (%). Multivariate analysis using Mahalanobis' (1928) D^2 statistic was carried out as described by Rao (1952).

Based on D^2 values, the 34 genotypes could be grouped into eight clusters under normal planting and into nine clusters under late planting (Table 1) suggesting that genetic divergence was substantial. Cluster I was the biggest in both cases comprising 16 and 14 genotypes in normal and late plantings, respectively followed by clusters II and III. Except cluster I, no cluster showed high repeatability of genotypes in two plantings.

Average intra- and inter-cluster D^2 values of 34 sugarcane genotypes for 15 characters for two planting dates are presented in Table 2. In normal planting, D^2 value was maximum in cluster IV. The inter-cluster D^2 value in this planting was maximum between clusters V and VII followed by between clusters II and V suggesting that the genotypes falling in these clusters were highly divergent from each other. The minimum inter-cluster D^2 value was observed between clusters V and VIII indicating that the

TABLE 1
Clustering of 34 sugarcane genotypes grown in two environments

Cluster	Normal planting		Late planting	
	No. of genotypes	Genotypes	No. of genotypes	Genotypes
I	16	CoH 3, CoH 4, CoH 6, CoH 7, CoH 9, CoH 10, CoH 13, CoH 16, CoH 17, CoH 19, CoH 20, CoH 23, CoH 25, CoH 53, Co 1158, Co 7314	14	CoH 6, CoH 7, CoH 8, CoH 9, CoH 10, CoH 11, CoH 17, CoH 20, CoH 23, CoH 24, CoH 33, CoH 53, Co 1148, Co 7717
II	7	CoH 2, CoH 8, CoH 15, CoH 21, Co 1148, Co 7717, CoS 767	5	CoH 18, CoH 21, CoH 22, CoH 28, CoS 767
III	4	CoH 5, CoH 24, CoH 33, CoJ 64	4	CoH 16, CoH 25, Co 7314, Co 1158
IV	3	CoH 11, CoH 12, CoH 28	3	CoH 2, CoH 3, CoH 4
V	1	CoH 1	3	CoH 12, CoH 13, CoH 19
VI	1	CoH 14	2	CoH 14, CoH 15
VII	1	CoH 18	1	CoH 1
VIII	1	CoH 22	1	CoH 5
IX	—	—	1	CoJ 64

TABLE 2
Average intra- (in parentheses) and inter-cluster D² values among 34 sugarcane genotypes under normal (N) and late (L) plantings

Cluster	Planting	I	II	III	IV	V	VI	VII	VIII	IX
I	N	(111.8)	197.6	211.9	200.8	568.6	238.3	206.3	320.8	—
	L	(109.9)	197.9	174.0	259.8	207.9	197.4	577.7	197.0	224.2
II	N		(116.2)	411.1	402.6	799.5	236.9	262.5	488.6	—
	L		(113.7)	203.6	314.5	266.0	258.3	630.4	299.8	189.4
III	N			(105.2)	193.0	283.9	285.2	345.6	194.7	—
	L			(114.8)	299.9	197.5	249.2	512.2	168.2	269.5
IV	N				(117.7)	601.2	364.5	320.7	409.2	—
	L				(113.0)	216.9	387.6	320.9	242.4	268.9
V	N					(0.0)	421.6	877.1	151.5	—
	L					(108.8)	182.7	313.5	196.5	345.7
VI	N						(0.0)	428.4	229.0	—
	L						(105.2)	663.2	176.7	404.0
VII	N							(0.0)	430.8	—
	L							(0.0)	467.5	719.5
VIII	N								(0.0)	—
	L								(0.0)	418.1
IX	N									—
	L									(0.0)

TABLE 3
Cluster means for 15 traits in sugarcane under normal (N) and late (L) plantings

Cluster	Planting	Millable canes/ clump	Cane height (cm)	Leaf length (cm)	Leaf width (cm)	Inter- nodes/ cane	Internode length (cm)	Cane thickness (cm)	Single cane weight (kg)	Cane yield/ clump (kg)	Fibre content (%)	Brix (%)	Pol (%)	Purity (%)	Com- mercial sugar (%)	Reducing sugars (%)
I	N	4.2	183.7	143.5	3.5	15.9	14.5	2.5	0.9	3.5	13.8	20.5	17.7	86.3	11.8	19.7
	L	3.6	190.1	158.0	3.6	15.7	15.7	2.4	0.9	2.9	13.2	20.2	18.0	80.3	10.2	36.1
II	N	4.1	209.2	150.1	3.5	17.1	14.7	2.4	1.0	4.7	12.3	20.6	17.8	86.0	11.8	20.3
	L	3.7	181.3	153.5	3.3	15.5	14.0	2.4	0.9	2.9	13.1	20.8	17.6	85.1	11.8	43.4
III	N	4.2	180.3	147.8	3.7	16.2	14.1	2.4	0.9	3.2	16.4	21.8	18.7	86.7	11.7	22.9
	L	4.0	182.3	164.7	3.4	15.7	14.3	2.2	0.7	2.2	15.5	20.6	18.1	87.8	12.3	40.2
IV	N	3.7	169.4	162.2	3.9	19.9	15.2	2.4	0.6	2.4	14.9	18.8	15.6	81.9	10.1	23.4
	L	3.3	179.0	135.8	3.8	17.8	14.0	2.5	1.0	2.4	14.3	20.6	17.8	86.7	12.0	26.0
V	N	4.7	178.0	138.7	4.2	15.2	14.9	2.6	1.1	5.1	20.3	21.0	18.1	85.9	11.7	14.5
	L	3.5	182.3	162.3	3.9	16.4	15.8	2.4	0.7	2.4	16.9	19.1	16.4	85.7	10.8	33.2
VI	N	5.8	245.0	155.7	3.2	21.3	15.5	2.6	1.2	5.9	16.0	18.3	15.1	82.4	9.7	21.0
	L	3.2	210.8	160.2	3.6	16.9	18.4	2.3	0.8	2.8	15.4	19.8	16.8	84.8	11.0	33.8
VII	N	4.1	198.0	130.0	4.5	16.4	15.0	2.3	0.8	3.4	12.0	21.2	18.6	87.0	12.4	34.2
	L	3.4	195.3	137.9	4.3	17.5	13.4	2.7	0.8	3.8	19.1	20.5	17.4	85.2	11.5	21.9
VIII	N	4.8	204.0	138.3	3.5	17.3	14.2	2.8	1.2	5.0	17.7	21.3	19.2	90.0	13.1	26.8
	L	3.5	219.3	163.5	3.1	16.6	16.5	2.6	0.8	2.3	15.0	22.8	19.7	86.6	13.3	33.3
IX	N	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	L	3.2	158.3	139.5	3.7	15.1	12.0	2.0	0.5	2.2	11.0	20.9	18.2	87.0	12.2	40.9

genotypes falling in these clusters were least divergent.

sugars were found in clusters VII and V, respectively.

In late planting, the maximum intra-cluster D^2 value was exhibited by cluster III. Inter-cluster D^2 value was maximum between VII and IX clusters. The genetic divergence between clusters VI and VII and clusters II and VII was also high. The minimum genetic divergence was observed between III and VIII clusters.

The cluster means of normal and late plantings for 15 characters are given in Table 3. Considerable differences in the cluster means were observed for almost all the characters. In normal planting, cluster VI with single genotype (CoH 14) had maximum number of millable canes, cane height, number of internodes per cane, internode length, single cane weight and cane yield per clump. Maximum mean values for brix, pol, purity, commercial cane sugar and cane thickness were observed in cluster VIII with only one genotype (CoH 22). Minimum fibre content and reducing

In late planting, cluster VII with single genotype (CoH 1) had highest mean values for leaf width, cane thickness and cane yield per clump and minimum value for reducing sugars. Similarly, maximum mean values for cane height, brix, pol and commercial cane sugar were exhibited by cluster VIII having genotype CoH 5. This cluster also had high mean values for leaf length, internode length and cane thickness. Highest mean values for millable canes per clump, leaf length and purity per cent were exhibited by cluster III and for number of internodes per cane and single cane weight by cluster IV. Cluster IX having only one genotype (CoJ 64) had lowest fibre content. These results indicate that the genotypes CoH 1, CoH 5, CoH 14 and CoH 22 were most divergent. These genotypes may be exploited in sugarcane breeding programmes for creating desirable genetic variability and evolving superior varieties.

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DISTRIBUTION OF MICRONUTRIENTS IN SOME SOILS AND RICE PLANTS OF HARYANA

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Rice growing is becoming more important during monsoon season in irrigated areas of Haryana because of its higher yield potential and better price. Rice-wheat is the most popular cropping pattern and it has not reached its production potential in wet land conditions. The problem of micronutrient deficiency or toxicity, if not properly understood timely could adversely impinge rice production. Soil and plant analyses are valuable diagnostic tools in identifying micronutrient abnormalities, if any. The purpose of the present study was to locate potential problem areas in rice growing districts of Haryana where one or more micronutrient elements might be deficient or in excess.

Thirty-seven sample pairs of soil and rice plants from rice growing districts of Haryana, viz. Karnal, Kurukshetra, Sonapat and Hisar were collected. Sampling plot size was about 10 × 10 m and fresh plant material was collected from various places of the sampling plot. Rice plants were sampled at mid-tillering stage. The uppermost fully expanded leaf blade, which was separated at the culm, was collected from 6 to 10 hills. Leaves were washed with 0.1 N HCl followed by two rinsings

with distilled water. All plant samples were air-dried in a glass-house and oven-dried at 65°C for 48 h. For soil sampling, a minimum of 6-10 sub-samples were collected from various parts of the sampling plot. Estimations of tissue Zn, Fe, Cu and Mn concentrations were made in the dried plant material after digestion with a HNO₃ and HClO₄ mixture (5 : 1), by Atomic Absorption Spectrophotometry. Soil samples were analysed for DTPA-extractable micronutrient cations as suggested by Lindsay and Norvell (1978). Correlation studies of soil and plant micronutrient cations were worked out.

The means, ranges and standard deviations of micronutrient cations in soils and rice plants are given in Table 1.

Micronutrient Cations in Soils

The DTPA-extractable Zn in rice growing soils of Haryana ranged from 0.10 to 2.25 ppm, the mean value being 0.52 ppm. In recent alluvial soils of Bihar, Singh *et al.* (1985) also reported that DTPA-extractable Zn varied from 0.26 to 2.46 ppm (av. 0.77 ppm). Judging by the critical level of 0.71 ppm established by Singh *et al.* (1985) for DTPA-Zn, the soils under study may be regarded as potential defi-

TABLE 1

Means, ranges and standard deviations of Zn, Fe, Cu and Mn in soils and rice plants of Haryana

Element	Soil			Plant		
	Mean (ppm)	Range	σ	Mean (ppm)	Range	σ
Zn	0.52	0.1-2.25	0.54	17.1	11.2-28.0	3.86
Fe	17.3	3.3-31.2	7.88	294	146-843	149.98
Cu	3.3	0.7-10.5	2.05	15.6	8.5-27.2	3.84
Mn*	—	—	—	329	145-521	104.65

σ —Standard deviation.

*Mn content in soil not detected.

cient in Zn as 81% soils were found to be deficient. The mean content of DTPA-extractable Fe in all the samples was 17.3 ppm, the range being 3.3 to 31.2 ppm. In the light of critical value of 4.5 ppm proposed by Lindsay and Norvell (1978), all the soils, except two were quite high in available Fe content.

The mean available Cu content was 3.3 ppm (range 0.7 to 10.5 ppm) and in view of the suggested critical limit of 0.20 ppm (Lindsay and Norvell, 1978) all the soils could be rated as adequate to high in Cu status.

Micronutrient Cations in Plants

In the present study, the Zn values varied from 11.2 to 28.0 ppm, with a mean value of 17.1 ppm (Table 1). These values were lower than those reported for 3rd leaf of rice (av. 21.1 ppm) by Singh *et al.* (1985). About 89% of the total sites were deficient with respect to Zn if 21.5 ppm is taken as the critical limit of Zn in rice plant as suggested by Singh *et al.* (1985). In general, there is

a good correspondence between the extent of Zn deficiency as indicated by plant tissue Zn and DTPA extractable Zn.

Tanaka and Yoshida (1970) considered that 70 ppm Fe is the lower critical level in rice plants and above 300 ppm it is toxic. In the present investigation, Fe values ranged from 146 to 843 ppm with a mean value of 294 ppm (Table 1). About 32% of the total sites were in toxic range with respect to Fe at mid-tillering stage.

Tissue concentration of copper in rice plants ranged from 8.5 to 27.2 ppm with an average of 15.6 ppm. Karim and Vlamis (1962) reported that 6 ppm of Cu is the critical value for Cu deficiency in rice plants. On the basis of this, all the sites could be rated as adequate in available Cu content.

Tanaka and Yoshida (1970) considered that 20 ppm Mn in rice leaves was sufficient for normal growth of rice plants. However, in the present study, Mn values varied from 145 to 521 ppm with a mean

MICRONUTRIENTS IN SOILS AND RICE PLANTS

TABLE 2

Means (ppm) and standard deviations of Zn, Fe, Cu and Mn in soils and rice plants of different districts of Haryana

		Karnal		Kurukshetra		Sonapat		Hisar	
		Soil	Plant	Soil	Plant	Soil	Plant	Soil	Plant
Zn	σ	0.40	4.09	0.17	2.38	0.25	4.42	0.06	1.75
	$\bar{X}$	0.63	16.80	0.38	17.27	0.48	17.11	0.23	19.13
Fe	σ	2.54	170.99	3.98	41.44	5.22	116.80	2.50	154.20
	$\bar{X}$	4.26	299.20	24.20	192.10	12.43	343.00	9.10	323.87
Cu	σ	2.44	4.05	0.23	4.32	1.26	3.23	0.47	0.80
	$\bar{X}$	3.82	16.09	2.33	15.58	2.91	15.48	2.77	13.03
Mn*	σ	—	102.49	—	96.00	—	87.48	—	2.69
	$\bar{X}$	—	296.01	—	321.20	—	376.08	—	445.48
No. of samples		19	19	6	6	9	9	3	3

*Mn content in soil not detected; σ —standard deviation; $\bar{X}$ —mean.

value of 329 ppm. None of the sites was deficient with respect to Mn on this basis.

The soils and associated plants were further classified on the basis of different districts and their means and standard deviations are given in Table 2. In general, soils from Karnal have more Zn and Cu and less Fe than soils of the other three districts, but this is reversed in case of Zn and Mn concentrations in rice plants. Furthermore, plant Fe and Cu concentrations are lowest in Kurukshetra and Hisar districts, respectively.

Correlations between DTPA-extractable Zn and Cu in wetland soils and in associated rice plants were found to be significant ($r=0.451^{**}$ and 0.474^{**}). However, no such relationship existed between DTPA-extractable Fe in soils and its content in plants ($r=0.215$). The poor correlation between DTPA-extractable Fe and plant Fe concentration suggests that rice roots are not capable to extract the Fe from such pools under present soil conditions, which are extracted by this extractant.

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RESEARCH NOTE

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SALT TOLERANCE IN CARROT SEED CROP

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Carrot root crop has been classified as medium salt tolerant crop (Anonymous, 1954). However, information available in the literature regarding salt tolerance behaviour of carrot seed crop is meagre. Therefore, an experiment was conducted at the Research Farm of Haryana Agricultural University, Hisar, during 1985-86 and 1986-87 to assess the salt tolerance of carrot seed crop. The soil was light in texture (loamy sand), low in organic carbon (0.30%), having pH 8.25 (1 : 2) and 1.10 dS/m EC_e. Sodium chloride, sodium sulphate, magnesium chloride and magnesium sulphate in 1 : 1 : 1 : 1 ratio were used to develop soil salinity levels of 2, 4, 6, 8 and 10 dS/m.

The artificially salinised soil was filled in polyethylene-lined cemented pots (45 cm × 45 cm × 45 cm) @ 50 kg per pot. Each treatment was replicated four times and the experiment was conducted in a completely randomized design. Three seedlings of carrot (upper 6-8 cm part of mature root) variety Hisar-Selection were planted in each pot under different salinity levels in the first week of December during both the years. The plants were nourished four times at two week interval with equal amount (150 ml/pot) of nutrient solution (Arnon and Hoagland, 1940). The pots were irrigated by canal water having 0.25 dS/m EC_e (Table 1). The harvesting of seed

TABLE 1

Electrical conductivity of soil saturation extract from various salinity treatments

Desired EC _e (dS/m)	Measured EC _e (dS/m)			
	At planting		At the end of the experiment	
	1985-86	1986-87	1985-86	1986-87
1.10 (Control)	1.10	1.15	1.25	1.30
2.0	1.85	2.05	2.10	2.25
4.0	3.80	3.90	3.95	4.10
6.0	6.10	5.95	6.30	6.15
8.0	7.70	8.00	7.95	8.20
10.0	10.10	9.80	10.30	10.05

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TABLE 2
Effect of soil salinity on various growth and yield attributes of carrot seed crop*

Soil ECe (dS/m)	Seedling establishment (%)	Time taken for sprouting (days)	Plant height (cm)	Number of leaves/plant at 35 days	Flowering time (days)	Seed yield per plant (g)	1000-seed weight (g)
1.10 (Control)	93.8	7.3	87.3	7.5	66.5	15.8	5.87
2.0	100.0	7.5	78.3	8.5	63.0	15.2	5.59
4.0	93.8	8.5	77.0	6.3	60.3	14.3	5.15
6.0	75.0	13.8	59.0	6.3	59.3	9.0	4.97
8.0	37.5	19.0	48.0	5.0	53.8	7.5	4.50
10.0	12.5	22.0	44.5	6.0	26.3	7.2	4.14
C D. at 5%	22.5	2.73	10.9	NS	23.3	2.98	0.73

*Average of two years data.

TABLE 3

Soil tolerance behaviour of carrot seed crop*

Expected average yield/ plant under normal conditions (g)	Tolerance limit ¹ (dS/m)	Threshold value ² (dS/m)	Coefficient of regression ³	r ⁴
17.10	7.50	1.08	-7.0	-0.96

*Average of two years data.

¹Soil salinity at which 50% yield decreases.²Soil salinity at which initial yield decline begins.³Per cent yield change per unit salinity rise.⁴Correlation coefficient between salinity and seed yield.

was started from second week of April onwards as and when umbels matured. Observations were recorded on per cent establishment, plant height, sprouting, number of leaves/plant, flowering time and seed yield.

Per cent steckling establishment decreased significantly at 8.0 dS/m EC_e (Table 2). At highest soil salinity (10.0 dS/m), only 12.5% stecklings established. Number of days taken to sprout was significantly higher beyond 4.0 dS/m. Plant height decreased significantly beyond 4.0 dS/m. However, soil salinity had no adverse effect on number of leaves per plant. Reduction in steckling establishment, sprouting and plant height may be because of ion toxicity and increased osmotic pressure in the root zone (Prisco and O' Leary, 1970). Present results confirm the findings of Mangal *et al.* (1987) in seed crop of leafy vegetables and Mangal *et al.* (1986) in coriander and fennel seed crops. Flowering was 40 days earlier in highest salinity treatment (10.0 dS/m) as compared to control (1.10 dS/m). However, there was no significant decline in

flowering time upto 8.0 dS/m. Carrot seed yield decreased significantly at 6.0 dS/m. However, seed yields at 6.0, 8.0 and 10.0 dS/m levels of soil EC_e were statistically at par. Carrot seed yield decreased linearly with increasing soil salinity. Seed yield decreased at a rate of 7% per unit increase in soil salinity over a threshold EC_e value of 1.08 dS/m (Table 3). Mangal *et al.* (1987) reported a similar behaviour in *Foenum graecum* and palak seed crops under saline conditions. The 50% reduction in yield which may be taken as salt tolerance limit for carrot seed crop, was found to be 7.5 dS/m, thus, confirming the earlier report of its being moderately salt tolerant (Anonymous, 1954).

Seed vigour (1000-seed weight) remained unchanged upto 4.0 dS/m soil EC_e beyond which significant reduction was noticed. Seed vigour at 6.0, 8.0 and 10.0 dS/m was at par.

Carrot seed production was adversely affected as the soil salinity increased beyond 4.0 dS/m.

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DETERMINATION OF MATURITY STANDARDS OF BER (*ZIZYPHUS MAURITIANA* LAMK) FRUITS

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Ber is one of the ancient fruits of subtropical and tropical India. It is very rich in minerals, carbohydrates and vitamins. The characteristic taste and flavour of fruit are achieved only when the fruit is harvested at right stage of ripening. The various maturity standards serve as important parameters to determine the optimum ripening stage (Biswas and Roy, 1985; Rathore, 1986; Yamdagni *et al.*, 1987). Ber fruits are generally harvested at greenish yellow (colour turning) or yellow colour stage of ripening. The changes in quality parameters of ber fruit with ripening have been reported by several workers (Bal and Singh, 1978; Bal *et al.*, 1978; Kader *et al.*, 1982). The present study was undertaken to determine the associated physiological parameters with ripening as maturity standards of Umrán, Gola and Kaithli cultivars of ber.

The mature fruits of commercially grown cultivars of ber, viz. Umrán, Gola and Kaithli, growing at Horticultural Farm Area of Haryana Agricultural University, Hisar, were harvested at green mature, greenish yellow and yellowish colour stages of ripening. The average weight and per cent moisture per fruit were recorded. The specific gravity of fruit

was determined by water displacement method and fruit pressure by fruit hardness tester OSK-2712, using its cylindrical shaped resistance head of $5\phi \times 10$ mm dimension. The ethylene evolution rate was determined by incubating the fruits in 250 ml jars and then measuring the ethylene evolved by Nucon's gas liquid chromatograph having Porapak column. The rate of respiration was determined by using the differential mode of Infra-red Gas Analyser (IRGA).

It was observed that fruit weight decreased with ripening. The maximum fruit weight was obtained for Umrán followed by Gola and Kaithli. The moisture percentage in the fruit was not affected from green mature to greenish yellow stage but decreased at yellow stage of ripening in all the cultivars. However, no significant difference was observed between various cultivars in the mean moisture content. The specific gravity of the fruits decreased with ripening in Umrán, increased in Gola and was not affected in Kaithli cultivar. The mean specific gravity of the fruits was not different for cvs. Kaithli and Gola but fruits of Umrán showed little lower specific gravity. The fruit wall pressure decreased with ripening. The

MATURITY STANDARDS OF BER

mean fruit wall pressure was not significantly different for different cultivars. Bal and Singh (1978) reported that in Umran cultivar of ber, specific gravity decreased and fruit weight remained unaffected with ripening. The moisture content of the ber fruits of cvs. Bambaw, Zaytoni and Mallesey has also been reported to get decreased with ripening (Abbas *et al.*, 1988).

There was no ethylene evolution at green mature stage and it increased with ripening in all the cultivars (Table 1). The maximum ethylene evolution was observed in the fruits of Umran followed by Kaithli. The respiration rate of fruits increased with ripening in all the cultivars. The mean respiration rate per fruit was maximum in Umran fruits. These differences in the respiration rate were perhaps due to varietal characteristics and differences in the weight of fruits. Similar

changes in ethylene evolution and respiration rate with ripening have also been reported by Kader *et al.* (1982) for Chinese jujube fruits.

The above observations suggest that characters of ber fruits, particularly fruit weight, specific gravity, fruit pressure, ethylene evolution and respiration rate are closely associated with stages of ripening. At different stages, marked differences in the ethylene evolution and respiration rate were observed in different cultivars but for other parameters, the differences were not so marked.

Thus, if the fruits are to be transported, fruits of Kaithli cultivar may be harvested upto greenish yellow stage of maturity, because of retention of high fruit wall pressure. However, if the fruits are to be stored, the fruits of Gola cultivar can be harvested at any stage because of low ethylene evolution rate.

TABLE 1
Physiological changes in ber fruits at various stages of ripening

Cultivar	Stage	Weight per fruit (g)	Per cent moisture	Specific gravity	Fruit pressure (kg)	Ethylene (μ l/h/kg fruit)	Respiration (ml CO ₂ /h/kg fruit)
Umran	G	14.0	84.6	0.88	3.07	Nil	1.68
	GY	13.5	84.8	0.83	2.75	48.6	1.72
	Y	13.6	83.7	0.81	2.80	316.2	1.94
	Mean	13.7	84.3	0.84	2.87	182.3	1.78
Gola	G	9.8	83.6	0.82	3.21	Nil	0.91
	GY	9.2	83.0	0.85	2.93	15.6	1.06
	Y	9.3	80.6	0.93	2.53	21.2	1.26
	Mean	9.4	82.4	0.86	2.88	18.4	1.07
Kaithli	G	7.7	84.6	0.87	3.14	Nil	0.64
	GY	7.8	85.0	0.86	3.33	13.0	0.85
	Y	7.0	82.8	0.85	2.07	175.0	1.23
	Mean	7.5	84.1	0.86	2.84	94.0	0.90
C.D. at 5% Cultivar	Stage	0.128	1.01	0.042	0.286	11.62	0.130
	Cultivar	0.466	1.93	0.059	0.431	19.78	0.152

G—Green, GY—Greenish Yellow, Y—Yellow.

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PANEER PREPARATION FROM CASEINATE ENRICHED MILK

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ABSTRACT

Paneer preparation by the addition of skim milk (treatment T_1), calcium caseinate (treatment T_2) and sodium caseinate (treatment T_3) was compared in cow milk by standardizing the milk to C/F ratios 0.6, 0.7, 0.8, 0.9, 1.0 and 1.1 for yield, composition and recovery of milk constituents. The yield of paneer in treatments T_1 , T_2 and T_3 varied from 720.90 ± 0.43 to 604.00 ± 5.73 g, 794.67 ± 3.03 to 713.33 ± 5.44 g and 806.67 ± 15.5 to 726.67 ± 10.89 g, respectively. Analysis of variance for the effect of different treatments and level of C/F ratio on yield of paneer showed that the treatments differed significantly ($P < 0.05$). Levels of C/F ratio for recovery of fat, protein and total solids also differed significantly ($P < 0.05$). Acceptability on 9-point Hedonic scale ranged from 7.37 to 5.83.

Paneer is a popular indigenous milk product primarily prepared by acid coagulation of milk. It is used as an ingredient for cooking vegetable dishes. In cheese industry, casein/fat (C/F) ratio is used for standardization of the milk but little work has been reported for preparation of paneer based on this type of standardization of milk. Therefore, an attempt was made to prepare paneer from cow milk using skim milk, sodium caseinate and calcium caseinate as a source of casein for adjusting C/F ratio of milk.

MATERIAL AND METHODS

Preparation of Casein and Caseinate

Casein was precipitated from fresh skim milk at pH 4.5 and temperature 40°C using 10% hydrochloric acid (AR). The curd was washed four times with

water at 40°C to remove the traces of acid. Ten per cent solutions of sodium caseinate and calcium caseinate were prepared from freshly prepared wet casein (Hall and Hedrick, 1966) using 10 % sodium hydroxide (AR) and calcium hydroxide (AR), respectively. Casein was dispersed with the help of a Waring blender (Yelco Make) by maintaining pH at about 7.

Preparation of Paneer

Cow milk obtained from Animal Farm, Haryana Agricultural University, Hisar, was standardized to 4% fat level. Using caseinates as source of casein, the milk was further adjusted to C/F ratio of 0.6 (L_1), 0.7 (L_2), 0.8 (L_3), 0.9 (L_4), 1.0 (L_5) and 1.1 (L_6). Paneer was prepared on laboratory scale from 5 kg of standardized milk by using skim milk (T_1), calcium caseinate (T_2) and sodium case-

inate (T_3), in three replications for each C/F ratio, using the method as reported by Arora (1972).

The milk was analysed for fat (ISI, 1977), protein (AOAC, 1980), casein (Pyne, 1933), total solids and ash contents (ISI, 1972). Paneer was analysed for fat (ISI, 1964), protein (AOAC, 1980), total solids and ash contents (ISI, 1972). Paneer was subjected to sensory evaluation in terms of appearance, handfeel, body and texture, flavour and taste using a 9-point Hedonic scale.

RESULTS AND DISCUSSION

Composition of Milk

The average composition of milk standardized to different levels of C/F ratio under three treatments is presented in Table 1. As the C/F ratio increased, per cent fat and T. S. decreased, whereas per cent protein increased. The variations in treatment T_1 were more as compared to treatments T_2 and T_3 . It is because of the fact that for the adjustment of casein level, volume of milk used was almost four times more as compared to caseinates. The ash content in treatment T_1 showed increasing trend but it was the reverse in treatments T_2 and T_3 which may be due to the use of concentrated form of casein as caseinates.

Yield of Paneer

Average yield of paneer obtained from 5 kg of standardized milk under different treatments is presented in Table 2. Treatment T_1 differed significantly ($P < 0.05$) from treatments T_2

and T_3 , whereas levels of C/F ratio showed no significant difference. Comparison revealed that the yield was significantly low in treatment T_1 as compared to treatments T_2 and T_3 while difference was non-significant between treatments T_2 and T_3 . Low yield observed in T_1 was due to the fact that comparatively large volume of skim milk was used to adjust the C/F ratio, which resulted in decreased level of fat, T. S. and protein. Higher yields in treatments T_2 and T_3 were because the milk in these treatments had more fat, protein and T. S. as compared to treatment T_1 (Table 1). Slightly higher level of protein in T_2 and T_3 may also help in increased water holding capacity of paneer. However, level of C/F under treatments T_1 , T_2 and T_3 had no significant effect on yield of paneer.

Composition of Paneer

The average composition of paneer is presented in Table 3. The fat content was in a decreasing trend in all the treatments from level L_1 to L_6 . In all the three treatments at C/F ratio 0.6 (level L_1), fat content in paneer was in agreement with the observations of De *et al.* (1971) for paneer prepared from high acid milk containing on an average 4.06 % fat. However, if the fat content is compared with PFA-standards, C/F ratio of 0.6 (level L_1) was just meeting the legal standards. On the basis of present study, it may be worthwhile to recommend an amendment in PFA standard to a level of 40 % fat (on dry matter basis) for paneer prepared from cow's milk.

Values of protein percentage were in close agreement with the observations

PANEER PREPARATION

TABLE 1

Per cent composition of standardized milk

C/F ratio	Fat			Protein			T. S.			Ash		
	T ₁	T ₂	T ₃	T ₁	T ₂	T ₃	T ₁	T ₂	T ₃	T ₁	T ₂	T ₃
0.6	4.07	4.00	4.00	3.20	3.28	3.25	12.72	12.71	12.30	0.71	0.69	0.67
0.7	3.47	3.87	3.83	3.20	3.36	3.33	11.31	12.60	12.04	0.76	0.62	0.62
0.8	3.10	3.67	3.63	3.27	3.63	3.49	10.65	12.29	11.66	0.77	0.58	0.62
0.9	2.73	3.50	3.47	3.32	3.75	3.70	10.16	11.81	11.41	0.74	0.51	0.63
1.0	2.50	3.30	3.30	3.34	3.94	3.96	9.99	11.54	11.33	0.75	0.48	0.64
1.1	2.23	3.20	3.17	3.38	4.06	4.02	9.71	10.57	11.20	0.76	0.45	0.66

Values are means of three trials.

TABLE 2

Yield of paneer from 5 kg milk

C/F ratio	Yield (g)			Pooled average
	T ₁	T ₂	T ₃	
0.6	720.00	713.33	726.67	720.00
0.7	686.67	730.67	765.00	727.44
0.8	663.33	756.67	806.67	742.22
0.9	636.67	773.67	781.67	730.67
1.0	620.00	794.67	781.67	732.11
1.1	604.00	778.33	761.67	714.67
Pooled average	655.11 ^a	757.89 ^b	770.56 ^b	

Values are means of three trials.

Means having different superscripts differ significantly ($P < 0.05$).

TABLE 3

Per cent composition of paneer

C/F ratio	Fat			Protein			T. S.			Ash		
	T ₁	T ₂	T ₃	T ₁	T ₂	T ₃	T ₁	T ₂	T ₃	T ₁	T ₂	T ₃
0.6	21.19	21.07	20.16	18.37	18.80	18.31	42.29	42.13	40.10	1.23	1.23	1.23
0.7	20.39	19.88	19.30	19.61	19.48	19.17	46.43	42.78	40.06	1.27	1.20	1.35
0.8	18.72	18.82	18.53	19.52	19.14	19.64	42.08	41.16	39.55	1.37	1.34	1.39
0.9	18.59	18.53	18.15	20.01	19.65	18.78	43.01	41.66	39.06	1.41	1.43	1.47
1.0	16.63	18.02	18.00	19.78	19.95	18.05	41.57	41.23	39.19	1.38	1.56	1.63
1.1	15.54	17.00	18.14	20.16	20.41	17.52	40.85	41.00	39.88	1.39	1.64	1.89

Values are means of three trials.

of Bhattacharya *et al.* (1971) who observed that the paneer prepared from buffalo milk and standardized to C/F ratio 0.54, 0.64 and 0.94 contained 17.86, 18.57 and 19.03 per cent protein, respectively. In the use of sodium caseinate at C/F ratio 0.9 to 1.1, clear whey separation could not be achieved resulting into loss of protein in whey as is evident from the results (Table 3).

T. S. of the product showed little variation between the treatments and the levels of C/F ratio. However, values of T. S. were comparatively less than observed by Bhattacharya *et al.* (1971) which were because of the fact that these workers used buffalo milk for paneer making, while in the present study cow milk was used.

Ash content in paneer showed a reverse trend when compared to the milk composition (Table 1). Increasing trend of ash percentage in T_2 and T_3 as compared to T_1 was because of the use of caseinates in which calcium and sodium salts used might have formed a complex with the protein and thereby resulting in increased level of ash content.

Recovery of Fat, Protein and Total Solids in Paneer

In the recovery of fat, protein and T. S. (Table 4) the analysis of variance showed non-significant differences ($P < 0.05$) amongst treatments, whereas levels of C/F ratio were found to differ significantly ($P < 0.05$). In the recovery of fat, it was observed that with the increase in C/F ratio, fat recovery in all the treatments increased while the per

cent fat in milk taken had decreased (Table 1). It can be concluded that the fat-holding capacity of coagulum improves as the C/F ratio increases. Bhattacharya *et al.* (1971) and Anonymous (1974) observed higher levels of fat recovery as compared to the present study. They used buffalo milk while in present study cow milk was used. Fat holding capacity of coagulum in buffalo milk may also be better than cow's milk.

With the increase in C/F ratio, the protein recovery showed a reverse trend as compared to fat. Protein recovery was significantly higher in T_2 as compared to T_1 , however, the differences between T_2 and T_3 were found to be non-significant. The recovery of T. S. was found to be almost similar in all the treatments. It was found to be significantly lower at C/F ratio 0.6 as compared to other levels. Higher T. S. recoveries were reported by Bhattacharya *et al.* (1971) and Anonymous (1974) when buffalo milk was used in paneer preparation.

Sensory Evaluation of Paneer

Sensory evaluation score based on 9-point Hedonic scale is presented in Table 5. The average score was found to be within the acceptable range for all the samples, which further indicated that use of caseinates for adjusting level of C/F ratio of milk did not affect the acceptability of paneer. Paneer prepared by the use of calcium caseinate was comparatively better in appearance, body and texture. Beyond C/F ratio 0.7, it scored higher than the paneer prepared by the use of sodium caseinate.

PANNEER PREPARATION

TABLE 4
Per cent recovery of fat, protein and total solids in paneer

C/F ratio	Fat recovery			Protein recovery			Total solids recovery		
	T ₁	T ₂	Pooled average	T ₁	T ₂	Pooled average	T ₁	T ₂	Pooled average
0.6	75.06	75.00	73.27	82.60	81.96	81.94	47.89	47.28	47.52 ^a
0.7	80.77	75.13	76.96	84.06	84.70	88.14	56.38	49.61	52.31 ^b
0.8	80.16	77.67	82.27	79.28	79.89	80.85	52.41	50.68	52.63 ^b
0.9	86.67	81.92	81.84	76.66	81.09	79.50	53.90	54.60	54.03 ^b
1.0	82.51	86.76	83.27	73.43	80.83	71.26	51.59	56.76	54.16 ^b
1.1	85.67	82.70	87.27	72.05	78.32	66.41	50.94	60.41	55.18 ^b
Pooled average	81.81 ^a	79.86 ^b	80.81 ^{ab}	78.01 ^a	81.10 ^b	79.68 ^{ab}	52.17	53.22	52.52

Values are means of three trials.

Means having different superscripts differ significantly ($P < 0.05$).

TABLE 5

Acceptability score of paneer on 9-point Hedonic scale

	0.6	0.7	0.8	0.9	1.0	1.1
T ₁	6.87	6.72	6.32	6.77	6.78	6.93
T ₂	7.13	6.55	6.98	6.67	6.37	6.86
T ₃	7.37	7.15	6.00	6.25	6.21	5.83

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EFFECT OF VETROLIV SYRUP ON EGG PRODUCTION OF SYNTHETIC EGG LINE PULLETS

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ABSTRACT

Synthetic egg line (White Leghorn-Babcock-Dekalb-Hisex) pullets were administered from 21 to 40 weeks of age, Vetroliv syrup* in water at the dose of 0, 15, 30 or 45 ml per 100 pullets per day. Administering 15 ml Vetroliv syrup per 100 pullets per day has been found to yield an extra 700 eggs during the period. Increasing the dose of Vetroliv syrup beyond 15 ml resulted in reduced egg production.

Incorporation of liver tonics like Liv 52 powder in broiler diets at the dose of 1 g per kg (Shrivastava, 1982), 2 g per kg (Prasad and Singh, 1982) and 3 g per kg (Gabriel Raj *et al.*, 1982) was not found to improve broiler body weight and feed conversion efficiency. However, Subramanian *et al.* (1982) reported that Liv 52 powder at 1 g per kg in broiler feed improved weight gain significantly. A study with Livogen syrup (Liver tonic) on broiler by Sundararasu *et al.* (1985) had indicated that administering Livogen syrup in water at the dose of 10 ml per 100 broilers per day had improved weight and profit margin. Present study was conducted with synthetic egg line pullets by administering different levels of Vetroliv syrup.

MATERIAL AND METHODS

Study was carried out on 400 synthetic egg line (White Leghorn-Babcock-Dekalb-Hisex) pullets housed in individual cages. One hundred pullets were allotted to each of four treatments, viz. 0, 15, 30 or 45 ml of Vetroliv syrup per treatment per day. The experiment lasted from 21 to 40 weeks. Egg production, feed consumption, mortality, and body weight and egg weight at different ages were recorded. Age at sexual maturity of pullets was also noted. Feed and water were provided *ad lib*. The layer mash contained 18% crude protein and 2750 Kcal ME/kg. Data were analysed by employing student t test for testing the statistical significance between

*Herbal liver tonic manufactured by FARMCURE INDIA LTD.

treatments for various production parameters as per Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

Data on egg production, egg weight and body weight at different ages, mortality, feed consumption and feed efficiency after administering Vetroliv syrup at various doses are presented in Table 1. Hen day production of 107.73 was recor-

ded in 15 ml Vetroliv group which was significantly superior than other treatments. First egg weight was improved by Vetroliv administration. After 40 weeks, pullets under 15 ml Vetroliv syrup gained significantly higher body weight than all other treatments. Pullets treated with Vetroliv consumed significantly more feed than control. However, among the Vetroliv syrup administered treatments, there was no significant difference in feed consumption. Feed efficiency

TABLE 1
Production performance of synthetic egg line pullets

Parameter	Vetroliv syrup per 100 pullets per day (ml)			
	Control (0)	15	30	45
Hen day production**	100.66 ^b	107.73 ^a	103.67 ^b	101.91 ^b
Per cent hen day production	70.16	74.68	72.37	70.58
Egg weight (g)				
First egg	38.95	39.55	40.07	40.36
30th week	53.30	53.25	53.07	53.27
40th week	54.46	54.08	54.21	53.56
Body weight (g)				
20th week	1293.60	1305.00	1260.80	1324.60
At sexual maturity	1375.00	1434.80	1377.30	1403.33
40th week**	1513.33 ^b	1582.23 ^a	1537.60 ^b	1511.68 ^b
Age at sexual maturity (days)	152.7	151.3	152.7	153.5
Feed				
Consumption/pullet/day (g)*	100.16 ^a	103.62 ^b	104.03 ^b	103.89 ^b
Efficiency				
per dozen egg ^{NS}	1.596	1.609	1.612	1.599
per kg egg mass ^{NS}	2.518	2.537	2.539	2.523
Per cent mortality	3	5	4	5
Return over feed and Vetroliv cost (Rs.)	15.21	16.65	13.27	11.11

*Significant at $P < 0.05$

**Significant at $P < 0.01$

NS=Not significant

Figures with same superscripts within same column do not differ significantly.

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showed no significant difference between different treatments per dozen eggs and per kg egg mass.

Mortality recorded in this study for different treatments ranged from 3 to 5 per cent and was not found to be influenced by Vetroliv syrup.

Economics of this study was calculated by deleting fixed cost. Return over cost including Vetroliv syrup cost with receipts through sale of eggs indicated that 15 ml

Vetroliv syrup group earned a profit of Rs. 16.65 per pullet which is Rs. 1.44 higher than control. Thirty and 45 ml Vetroliv syrup groups earned Rs. 13.27 and 11.11, respectively. The results suggest that Vetroliv syrup can be administered at the dose not exceeding 15 ml daily for 100 pullets to earn a maximum profit. Profit of using liver-tonics in birds is comparable to those of Subramanian *et al.* (1982) and Sundararasu *et al.* (1985).

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EFFECT OF TWO STOCKING DENSITIES AND CAGE LEVEL ON EGG QUALITY AND PLASMA ALKALINE PHOSPHATASE LEVEL OF WHITE LEGHORN PULLETS

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ABSTRACT

The effect of floor space under three tier cage system of housing, on egg quality and plasma alkaline phosphatase content of birds during summer was studied. Barring a few exceptions, the effect of cage space (450 and 900 cm² per bird) or cage level (Upper, Middle and Lower) on egg quality traits like Haugh Unit, shell thickness and yolk index was non-significant. The plasma alkaline phosphatase level remained unaffected by cage space and cage level except at 40 weeks of age.

The system of rearing birds in cages is gaining popularity because of economy in space. Multi-deck cage system is used to further reduce the cost of housing. Even after long use of cages by farmers there is uncertainty about the proper shape, density and deck system and their effect on various production parameters. The present investigation was carried out to study the effect of cage space and deck height on egg quality and plasma alkaline phosphatase level of blood of birds. Wilson *et al.* (1967), Mareks *et al.* (1970) and Wolford and Tanaka (1970) did not observe any significant difference for Haugh Unit or shell quality due to cage space or deck height. Christmas *et al.* (1973) reported that birds provided with lesser space in cage produced eggs with significantly better shell quality.

MATERIAL AND METHODS

One hundred eight pullets were randomly picked up at 20 weeks age from a

flock of 350 WLH. These were distributed in 4-three tier batteries each having 18 individual compartments of 30×30 cm, permitting six birds in each deck when the space provided was 900 cm²/bird and 12 birds in each deck when the space provided was 450 cm²/bird. Two batteries were used for each density condition. *Ad lib.* feeding was practised and the birds were given a ration containing 16% protein and 2820 Kcal of metabolizable energy per kg. Haugh Unit, shell thickness and yolk index of eggs laid during the last three consecutive days of the different periods (20–24, 24–28, 28–32, 32–36, 36–40, 40–44, 44–48 and 48–52 weeks) were recorded. The plasma alkaline phosphatase was measured quantitatively by Ames Blood Analyser using Reagent kit. The data were analysed using standard statistical methods.

RESULTS AND DISCUSSION

The analysis of variance of data of Haugh Unit for the two housing condi-

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tions did not reveal any significant difference (Table 1). This indicates that the birds getting lesser cage space (450 cm²) laid eggs which were in no way inferior in Haugh Units/albumen quality to those laid by birds getting 900 cm² cage space. The results agreed with those of Wilson *et al.* (1967) and Mareks *et al.* (1970). The eggs laid by birds kept in three different decks also did not reveal any significant difference.

The differences in shell thickness due to cage space were significant only at 32 and 40 weeks of age (Table 2). Christmas *et al.* (1973) observed that a decrease in birds density resulted in better shell quality. Wilson *et al.* (1967) reported that the difference in shell quality due

to different densities was small and showed no definite trend. Present findings agreed with these observations. The averages for shell thickness of eggs laid by the birds kept in three decks did not differ significantly.

The means for yolk index of eggs laid by birds given 900 and 450 cm² floor area are presented in Table 3. In the beginning (24 weeks) and at the last phase of the experiment (48 and 52 weeks of age) the trend was towards larger yolk indices for the birds kept on 450 cm² floor area per bird. At 32, 36, 40 and 44 weeks of age, the birds provided with 900 cm² floor area showed greater yolk index than the birds with 450 cm² floor area per bird. This difference in the

TABLE 1

Haugh Units of eggs laid by birds given different floor spaces and kept in different decks of batteries

Treatment	Age (weeks)							
	24	28	32	36	40	44	48	52
Floor space (cm²/bird)								
900	83±5 (54)	84±8 (29)	83±6 (28)	81±8 (17)	80±4 (11)	80±4 (8)	80±2 (13)	78±1 (11)
450	84±6 (59)	83±7 (61)	82±5 (39)	81±6 (23)	79±4 (17)	78±4 (12)	80±5 (34)	76±2 (24)
Deck								
Upper	83±6 (38)	83±8 (27)	83±6 (23)	81±7 (11)	79±4 (10)	81±5 (6)	80±5 (18)	77±2 (7)
Middle	83±5 (42)	82±8 (29)	81±4 (21)	79±6 (14)	81±4 (9)	79±4 (8)	79±3 (17)	77±2 (14)
Lower	83±5 (33)	85±6 (34)	82±4 (23)	82±8 (15)	79±4 (9)	77±4 (6)	79±6 (12)	77±1 (14)

Figures in parentheses are number of observations.

Differences between the two floor spaces and three decks were non-significant at $P \geq 0.05$.

TABLE 2
Shell thickness (mm) of eggs laid by birds given different floor spaces and kept in different decks of batteries

Treatment	Age (weeks)							
	24	28	32	36	40	44	48	52
Floor space (cm ² /bird)								
900	0.28±.03	0.28±.02	0.26 ^a ±.02	0.27±.02	0.30 ^a ±.02	0.29±.02	0.30±.02	0.31±.02
450	0.26±.04	0.28±.03	0.25 ^b ±.02	0.26±.02	0.28 ^b ±.03	0.28±.02	0.29±.02	0.20±.02
Deck								
Upper	0.26±.05	0.28±.04	0.25±.02	0.26±.02	0.29±.29	0.29±.01	0.30±.03	0.30±.02
Middle	0.26±.03	0.28±.03	0.25±.02	0.26±.03	0.29±.29	0.30±.02	0.30±.03	0.30±.02
Lower	0.27±.04	0.27±.02	0.25±.02	0.26±.02	0.29±.29	0.28±.03	0.30±.03	0.30±.02

Number of observations are same as in Table 1.

Figures having different superscripts in a column differ significantly at $P \leq 0.05$.

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TABLE 3

Yolk index of eggs laid by birds given different floor spaces and kept in different decks of batteries

Treatment	Age (weeks)							
	24	28	32	36	40	44	48	52
Flood space (cm²/bird)								
900	44 ^a ±3	57±4	46±3	43±3	44 ^a ±7	45±3	44±4	43±3
450	46 ^b ±3	47±5	45±5	43±3	41 ^b ±3	43±3	45±3	43±2
Deck								
Upper	55±3	47±3	45±5	43±3	43 ^a ±3	44±2	45±3	44±3
Middle	45±3	47±2	45±4	43±4	43 ^b ±2	45±2	45±3	42±2
Lower	45±4	48±1	46±3	42±2	42 ^a ±3	42±5	43±4	43.5±14

Number of observations are same as in Table 1.

Figures having different superscripts in a column do not differ significantly.

TABLE 4

Plasma alkaline phosphatase level (I. U./100 ml) of birds given different floor spaces and kept in different decks of batteries

Treatment	Age (weeks)								
	20	24	28	32	36	40	44	48	52
Flood space (cm²/bird)									
900 (n=6)	36±5	37±4	38±6	45±6	61±6	76 ^a ±6	87±6	97±6	92±6
450 (n=12)	84±4	36±4	41±4	50±7	68±9	82 ^b ±5 ^a	90±10	105±10	97±11
Deck									
Upper (n=6)	36±5	37±5	40±4	50±7	68±8	82 ^a ±5 ^a	89±12	105±11	100±12
Middle (n=6)	34±5	36±5	39±3	45±8	59±7	75 ^b ±4	87±8	100±5	94±9
Lower (n=6)	35±2	37±3	41±9	49±8	69±7	82 ^a ±7	92±6	101±7	93±7

Figures having different superscripts in a column differ significantly at $P \leq 0.05$.

trend of yolk index values in the beginning and at the last phase of the experiment seemed to be related with the high environmental temperature rather than cage floor area. During 32 to 44 weeks of age the birds getting lesser floor area might have felt the heat stress greater than their counterparts resulting in reduced synthesis of yolk material in the liver. No significant difference was observed between values of yolk index of eggs laid by birds of different decks except at 40 weeks age.

The birds provided with 900 cm² floor area showed higher levels of plasma alkaline phosphatase than their counterparts with 450 cm² floor area at the age of 20 and 24 weeks (Table 4). After 24 weeks the trend was reversed and the difference in PAP levels between the two housing conditions continued upto the end of the experiment. No significant difference in PAP levels of birds kept in different decks was observed except at 40 weeks age.

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IMPACT OF GRAIN WEIGHT ALLELES ON ASSOCIATION OF GRAIN YIELD AND ITS COMPONENTS IN WHEAT HYBRIDS

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ABSTRACT

The impact of grain weight alleles on associations among grain yield and its components was studied in hybrid progenies of six diverse lines differing in grain weight. Grain weight alleles strengthened the correlation between 1000-grain weight and plant height, 1000-grain weight and ear length, and plant height and ear-length. These have also caused changes in the associations of grain yield with days to heading, tiller number and number of grains per ear. Plant height, number of grains per ear and 1000-grain weight had positive direct contribution towards grain yield. 1000-grain weight had high amount of indirect contribution through plant height and days to heading. Selection strategies for future selection programmes by taking the advantage of desirable associations have been discussed.

Grain yield is a complex entity, a product resulting from the interplay of a number of component characters contributing to it. Grafius (1964) strongly advocated component breeding approach in cereals. However, the components of grain yield as selection criteria suffer the disability that they tend to mutually compensate. In wheat, grain yield is dependent on three major components, viz., tiller number, 1000-grain weight and number of grains per ear. Changes in any of these components through selection are likely to change the association among different components themselves as well as with grain yield. However, information on the impact of genes for a particular character on subsequent progenies is not known. Rana *et al.* (1983) reported strengthening of certain correlations, while others were

weakened in populations where selection for seed weight was practised. In the present study, impact of grain weight alleles on the association of some morphological and component traits as well as the extent and nature of direct and indirect effects of these characters on yield have been studied.

MATERIAL AND METHODS

The segregating populations of three crosses, viz. UP 368 × WC 457, UP 368 × Shailza and WH 157 × Bulk 1858 were handled through mechanical mass selection for grain size using size six sieve. After three cycles of selection, out of several lines isolated, five lines of high, medium and low grain weight of approximately 60, 50 and 40 g per 1000-grain respectively, were developed. These five

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lines alongwith Sonalika were crossed in all possible combinations (excluding the reciprocals) to produce 15 hybrids. Twentyone genotypes (6 parents+15 F_1 's) were grown in randomized block design with three replications. The single row plots of 3 m with rows and plants spaced at 30 cm and 10 cm, respectively, were raised. Observations on days to heading, plant height, tiller number, ear length, spikelet number, number of grains per ear, 1000-grain weight and grain yield per plant were recorded on 10 randomly selected plants in each genotype in all the replications. Correlation coefficients were calculated using the formulae suggested by Miller *et al.* (1958). Direct and indirect effects were worked out using the genotypic correlation coefficients as suggested by Dewey and Lu (1959).

RESULTS AND DISCUSSION

The estimates of genotypic correlations were higher than the corresponding phe-

notypic correlations for almost all the characters (Table 1). The highest phenotypic (0.66) and genotypic (-0.79) correlations were obtained for 1000-grain weight and ear length, and tiller number and ear length, respectively. The genotypic and phenotypic correlations for number of grains per ear and plant height, number of grains per ear and spikelet number, number of grains per ear and grain yield, and 1000-grain weight and grain yield were of similar magnitude. This indicated that grain weight alleles have brought about changes in genetic background which minimized the role of environment to a greater extent for grain number. The correlation of grain yield with different morphological and component characters was non-significant. In earlier studies (Gandhi *et al.*, 1964; Sharma and Singh, 1983; Balyan and Singh, 1986; Singh *et al.*, 1987) usually grain weight and number of grains exhibited significant positive correlations with grain yield. Such variations in the association of grain yield and its components

TABLE 1

Genotypic (above diagonal) and phenotypic (below diagonal) correlation coefficients between yield and its components in F_1 generation of wheat crosses

Character	Days to heading	Plant height	Tiller number	Ear length	Spikelet number	Number of grains/ear	1000-grain weight	Grain yield/plant
Days to heading		-0.29	0.49	-0.63	-0.07	0.34	-0.54	-0.37
Plant height	-0.26		-0.49	0.71	0.62	-0.08	0.64	0.24
Tiller number	0.44	-0.42		-0.79	-0.77	-0.09	-0.46	0.31
Ear length	-0.31	0.59*	-0.41		0.36	-0.26	0.77	-0.14
Spikelet number	0.01	0.46	-0.47	0.45		0.25	0.38	-0.07
Number of grains/ear	0.29	-0.08	-0.06	-0.19	0.25		-0.44	0.20
1000-grain weight	-0.48	0.62*	-0.37	0.66**	0.35	-0.42		0.13
Grain yield/plant	-0.33	0.22	0.36	-0.07	-0.03	0.19	0.13	

*, **Significant at 5 and 1 per cent, respectively.

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are expected because all the changes in the components need not be expressed in the changes in grain yield. There had been mutually compensatory changes in the component. 1000-grain weight had positive strong association with plant height and ear length. Plant height was also having significant positive correlation with ear length. Rest of the correlations were non-significant. Thus, it appeared that 1000-grain weight alleles brought about maximum changes in plant height and ear length. It is a general observation that high grain weight lines have more plant height and are earlier in heading (Rana *et al.*, 1983).

Grain yield per plant is of prime importance and is considered as the dependent variable and other component traits as the causal variables. Path coefficient analysis is useful in further dissecting the associations of grain yield with its component traits for their direct and indirect influences. The direct contribution to-

wards grain yield was maximum through plant height followed by 1000-grain weight and number of grains per ear (Table 2). Other characters had negative direct contributions. This indicated that two of the yield components, *i. e.* number of grains per ear and 1000-grain weight, though did not show significant correlations with yield, but these components had considerably high direct influence on grain yield. Now it is well known that the group of genes responsible for 1000-grain weight, grain number, spikelet number and plant height are on distinct chromosome (group 2 and group 7) and their channelizing effects are very pronounced towards grain yield. It is interesting to note that ear length had the maximum direct negative contribution but its influence has been nullified by its indirect contribution through days to heading, plant height, tiller number and 1000-grain weight. The genes for bigger spike are reported to be situated on group 2 chromosomes but it is the fertility of the florets in the spikelet which is res-

TABLE 2

Path coefficients of grain yield vs other characters in F_1 generation of wheat crosses

Character	Days to heading	Plant height	Tiller number	Ear length	Spikelet number	Number of grains/ear	1000-grain weight	Correlation with grain yield
Days to heading	-0.82	-0.26	-0.12	0.80	0.05	0.20	-0.43	-0.37
Plant height	0.18	0.90	0.12	-1.07	-0.35	-0.05	0.51	0.24
Tiller number	-0.31	-0.44	-0.24	1.19	0.52	-0.05	-0.37	0.31
Ear length	0.33	0.64	0.19	-1.50	-0.24	-0.16	0.61	-0.14
Spikelet number	0.05	0.46	0.18	-0.54	-0.68	0.15	0.30	-0.07
Number of grains/ear	-0.21	-0.07	0.02	0.40	-0.17	0.59	-0.35	0.20
1000-grain weight	0.33	0.57	0.11	-1.16	-0.26	-0.26	0.80	0.13

possible for number of grains per ear (Millet, 1986). Consequently, the overall correlation of ear length becomes negative. Similar is the case with days to heading.

The grain weight is determined later in the plant development than other yield components. So any genetical modification designed to increase grain yield through increase in grain weight is less likely to offset by compensatory changes in other component traits. But in the present material, the selection for grain weight has resulted in the development of lines in which undesirable influences of other components have also been offsetted. Consequently, there have been alterations in the correlation pattern

among yield components and direct and indirect influences of different components towards yield. The increase in plant height probably may cause lines vulnerable to lodging. But it is possible to exploit the positive influences of minor genes for plant height on grain yield through development of tall dwarf's as advocated by Gale and Law (1976). In present material, positive effect of plant height alleles has been exploited along with grain weight alleles. In future selection programmes, there is need to concentrate on other important yield component, *i.e.* grain number per ear which may be manipulated through tiller number whose genetic mechanism appeared independent of grain weight alleles.

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STORAGE STUDIES ON F₁ CROSSES OF MUTANT *RIN* AND NORMAL VARIETIES OF TOMATO (*LYCOPERSICON ESCULENTUM* MILL)

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ABSTRACT

The fruits of parents and F₁-hybrids of three cultivated varieties (HS-101, HS-102 and SI-12) and a mutant *rin* were stored at room temperature for six days. Minimum physiological loss in weight amongst the parents was recorded in mutant *rin* and amongst the hybrids in SI-12 × *rin*. The decay loss and ethylene evolution were less in hybrids. The hybrids exhibited lower acidity and higher ascorbic acid than their respective cultivated varieties and this trend was maintained throughout the storage period.

The mutant ripening inhibitor (*rin*) reported by Robinson and Tomes (1968) has been extensively documented by Tigchelaar *et al.* (1973). It develops only a fraction of lycopene even upto 180 days after anthesis and its surface remains very hard (Sink *et al.*, 1974). Increased shelf-life is the main utility of the ripening mutant. The *rin* hybrids have considerable improvement over the normal varieties for shelf-life (Buescher *et al.*, 1976; Ng, 1976).

MATERIAL AND METHODS

The studies were conducted on mutant *rin* and its F₁ hybrids with three commercial varieties of tomato, *i.e.* HS-101, HS-102 and SI-12, grown in Vegetable Research Farm of Haryana

Agricultural University, Hisar. The fruits were harvested in the month of July, at colour turning stage of maturity, packed in perforated wooden crates and stored at room temperature ($39^{\circ} \pm 2^{\circ}\text{C}$) for six days. The observations were recorded at an interval of two days for physiological loss in weight (PLW) and per cent decay loss according to the formula suggested by Srivastava and Tandon (1968), ethylene evolution using Gas Liquid Chromatography and quality parameters, *viz.* total soluble solids by hand refractometer, acidity and ascorbic acid content of the fruit juice by titration methods as described by AOAC (1980). Two factorial randomised block design was used for determining the critical difference (C. D.) at five per cent level of significance.

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TABLE 1
Physiological loss in weight, decay loss and ethylene evolution of the fruits of some F_1 -hybrids and their parents during storage

Genotype	Physiological loss in weight (%)				Decay loss (%)				Ethylene evolution (μ l/kg/h)			
	Days in storage				Days in storage				Days in storage			
	2	4	6		2	4	6		0	2	4	6
HS-101	8.7	2.4	56.6		12.3	30.1	47.4		1.98	5.49	6.62	6.96
HS-101 $\times$ rin	3.7	6.2	18.2		3.1	9.4	24.1		1.74	2.04	5.11	5.73
SI-12	5.4	7.0	37.3		1.2	23.0	43.6		5.91	8.11	9.71	9.28
SI-12 $\times$ rin	5.5	6.9	15.8		1.0	6.3	19.5		1.96	3.54	7.68	8.06
HS-102	6.4	13.4	33.1		4.5	19.9	37.2		1.58	7.26	8.61	9.11
HS-102 $\times$ rin	5.4	8.5	22.9		0.5	12.3	24.8		1.25	3.18	7.09	7.85
rin	2.4	3.0	5.2		0.0	0.01	0.5		0.00	1.43	1.85	1.90
C. D. at 5%												
Genotype		0.43				0.41				0.13		
Storage		0.58				0.89				0.66		

TABLE 2
Total soluble solids, acidity and ascorbic acid contents of the fruits of some F_1 -hybrids and their parents during storage

Genotype	Total soluble solids (%)				Acidity (mg/100 ml juice)				Ascorbic acid (mg/100 ml juice)			
	Days in storage				Days in storage				Days in storage			
	0	2	4	6	0	2	4	6	0	2	4	6
HS-101	7.8	6.2	6.1	5.9	704	704	800	844	34.6	31.8	28.7	25.2
HS-101 $\times$ <i>rin</i>	7.2	6.8	6.2	6.0	576	544	608	692	35.8	27.5	27.3	25.1
SI-12	6.9	6.7	6.3	6.0	608	640	672	711	47.4	27.3	27.5	25.1
SI-12 $\times$ <i>rin</i>	7.0	7.0	6.8	6.4	512	544	576	610	51.2	32.7	24.6	21.3
HS-102	6.5	6.6	6.4	6.2	668	640	704	730	41.5	30.4	26.0	21.3
HS-102 $\times$ <i>rin</i>	6.8	6.6	6.2	6.0	640	672	704	730	17.4	26.0	26.0	23.2
<i>rin</i>	6.8	6.9	6.6	6.4	680	672	678	790	50.0	31.8	27.3	28.7
C. D. at 5%												
Genotype	0.32							7.66				2.38
Storage	0.33							10.45				3.26

RESULTS AND DISCUSSION

The physiological loss in weight was lowest in *rin* and highest in HS-101, followed by HS-102 (Table 1). This trend was maintained throughout the storage period. All the F_1 hybrids showed lower PLW as compared to their respective cultivated varieties of parents, however, it was still higher than parent *rin*. The decreased PLW in *rin* and its hybrids may be due to the low membrane permeability (Poovaiah *et al.*, 1975) and delayed softening of the fruit surface (Buescher *et al.*, 1976).

There was no decay loss in *rin* on second day of storage and this value remained low throughout the storage period (Table 1). The highest decay loss was observed in HS-101 and SI-12, however, F_1 hybrids with *rin* showed lower decay loss. The decreased decay loss in *rin* and its hybrids may be due to hard surface of fruit and reduced activity of wall softening enzymes (Buescher and Tigchelaar, 1975; Mattoo and Vickery, 1977).

The ethylene evolution by the fruits at the time of harvest was highest in SI-12 and there was no ethylene evolution in *rin* (Table 1). All the F_1 hybrids showed lower ethylene evolution. The same trend was observed throughout the storage period. Mizrahi *et al.* (1975) also reported very low level of ethylene evolution in old fruits of *rin*. Ng and Tigchelaar (1977) showed that in the F_1 hybrid of *rin* and *nor*, the ripening got delayed due to less ethylene evolution.

The total soluble solids (TSS) and ascorbic acid content decreased and acidity increased in the fruit juice with increase in the period of storage (Table 2). At the time of harvest, maximum T.S.S. was observed in HS-101 and minimum in HS-102; acidity was maximum in HS-101 and minimum in SI-12; and ascorbic acid was maximum in *rin* and lowest in HS-101. All the F_1 hybrids have lower acidity and higher ascorbic acid as compared to their respective cultivated variety's parents.

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RELATIVE CONTRIBUTION OF COMPONENT TRAITS TO GRAIN YIELD IN WHEAT UNDER TWO DIFFERENT ENVIRONMENTS

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ABSTRACT

The relative contribution made by three component traits, viz., tillers per plant, grains per spike and 1000-grain weight towards grain yield under two different environments, i. e. normal sown and late sown, was studied through path analysis in 52 homozygous lines and varieties of bread wheat. The yield was positively associated with all three component traits in both the environments. Tillers per plant had largest direct effect followed by grain number and 1000-grain weight.

The grain yield in wheat is mainly dependent on three major components, viz. tillers per plant, grains per spike and grain weight. The knowledge of inter-relationship between yield and its components and path analysis is essential to know the effectiveness of selection for simultaneous improvement in these traits. The present study was undertaken to know the relative importance of component traits in terms of contribution made towards grain yield in bread wheat under two different environments.

MATERIAL AND METHODS

Fiftytwo diverse homozygous lines and varieties, of different phyto-geographical origin, of bread wheat (*Triticum aestivum* L.) were selected from wheat germplasm maintained at Wheat Breeding Section of Haryana Agricultural University, Hisar. These homozygous lines were raised in single row plots of 3 m length having row to row distance of 23 cm and

plant to plant distance of 10 cm in randomized block design with three replications under two different environmental conditions (timely sown on 15 November and late sown on 15 December) during rabi 1986-87. The observations were recorded on ten randomly selected competitive plants per plot for grain yield per plant, tiller number per plant, grain number per spike and 1000-grain weight. Plot means were used for calculating correlations and direct and indirect effects of three component traits of grain yield. The path coefficient analysis was carried out as demonstrated by Dewey and Lu (1959).

RESULTS AND DISCUSSION

Data in Table 1 reveal that the genotypic correlation coefficients were higher in magnitude than the phenotypic correlation coefficients for all traits under both the environments, indicating that these traits were genetically inherited. The

YIELD COMPONENTS IN WHEAT

TABLE 1

Phenotypic (P) and genotypic (G) correlation coefficients for yield and its component traits in some homozygous lines and varieties of wheat under timely sown (E₁) and late sown (E₂) environments

Trait	Environment	Correlation	Grains/ spike	1000-grain weight	Yield/plant
Tillers/plant	E ₁	P	0.376**	-0.233	0.623**
		G	0.391	-0.267	0.676
	E ₂	P	0.318*	-0.183	0.598**
		G	0.364	-0.216	0.634
Grains/spike	E ₁	P		-0.313*	0.496**
		G		-0.365	0.525
	E ₂	P		-0.284*	0.513**
		G		-0.337	0.567
1000-grain weight	E ₁	P			0.399**
		G			0.410
	E ₂	P			0.363**
		G			0.384

* $P < 0.05$

** $P < 0.01$.

grain yield per plant showed a positive correlation with all the three component traits studied. The tillers per plant showed positive correlation with grains per spike but had a negative correlation with 1000-grain weight under both timely and late sown conditions. However, the grains per spike exhibited negative correlation with 1000-grain weight under both the environments.

The direct effects of these three component traits on grain yield under two environmental conditions indicated that tillers per plant had largest contribution followed by grain number and 1000-grain weight (Table 2). Fonseca and Patterson (1968), Jaimini *et al.* (1974) and Quick (1978) also found tillers per plant and grains per spike having high direct effect

on grain yield. The highly significant and positive correlation of tillers per plant with grain yield seemed to be due to the substantial direct influence of this character on grain yield. Indirect effect of tillers per plant via grains per spike was also positive as compared to that via 1000-grain weight, where it was negative in both environments. Grains per spike also had high positive direct effect on grain yield. Its negative contribution via 1000-grain weight was almost compensated by indirect effect through tillers per plant in timely sown condition, while under late sown condition, its negative contribution via 1000-grain weight was somewhat larger as compared to its indirect effect through tillers. The 1000-grain weight though had high positive direct influence on grain yield under both

TABLE 2

Direct and indirect effects of component traits on grain yield in some homozygous lines and varieties of wheat under timely sown (E_1) and late sown (E_2) environments

Trait	Environment	Effect via			Genotypic correlation coefficient with grain yield
		Tillers/ plant	Grains/ spike	1000-grain weight	
Tillers/plant	E_1	0.713	0.112	-0.149	0.676
	E_2	0.685	0.133	-0.164	0.634
Grains/spike	E_1	0.154	0.532	-0.101	0.525
	E_2	0.129	0.586	-0.148	0.567
1000-grain weight	E_1	-0.092	-0.119	0.621	0.410
	E_2	-0.084	-0.114	0.582	0.384

Residual effect=0.374 (E_1), 0.418 (E_2)

Figures in bold are direct effects.

the environmental conditions but their effects were negative through tillers per plant and grains per spike, that is why their correlation coefficients were comparatively low.

Since the effective tillers per plant had highest direct effect on grain yield

followed by grains per spike and 1000-grain weight under both the environmental conditions in the present study, selection with greater emphasis on number of effective tillers per plant could be effective in bringing the maximum genetic improvement for grain yield in wheat.

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EVALUATION OF SOME NEW POTATO HYBRIDS

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ABSTRACT

Tuber yields at 75 as well as 90 days were higher in PH/F-1545 than the highest yielding standard variety Kufri Badshah and the difference at 90 days was significant. EM/I-965 and PJ-376 also showed better bulking than Kufri Badshah at 75 days. Leaf weight in PH/F-1545 was comparable with Kufri Badshah at 75 as well as 90 days. Linear regression of tuber yield on leaf, stem and foliage weight was significant ($P=0.01$) during both the years. Stem number and tuber number also had significant relation with tuber yield but during one year only. Leaf weight accounted more variance in tuber yield as compared to other growth parameters.

Proper testing of genotypes is very important to get higher yield and ultimately good return. The information on the association of physiologically important characters such as leaf and stem weight with tuber yield is useful in the selection of genotypes. Present investigation was, therefore, aimed at to compare the performance of some promising hybrids at pre-release stage with three standard potato varieties and to study the association of yield with growth parameters such as leaf weight, stem weight and total foliage weight.

MATERIAL AND METHODS

Thirty genotypes in 1985-86 and 17 in 1986-87 were planted in the first week of October in plots measuring 3.0×3.6 m at the Vegetable Research Farm of Haryana Agricultural University, Hisar. Well sprouted tubers were planted at a spacing of 20 cm in 60 cm apart rows. Treatments were replicated five

times and arranged in randomized block design. Two replications were harvested at 75 days and three at 90 days. In 1985-86, 17 genotypes were harvested at 75 and 90 days after planting and remaining 13 were harvested only after 90 days of planting. In 1986-87 all the genotypes were harvested at 75 as well as 90 days after planting. Twelve genotypes were common during both the years. Correlations between leaf, stem and total foliage weight with tuber yield were worked out. The correlations of yield at 90 days were also estimated with growth parameters at 75 days. For working out correlation and regression, data for all the genotypes grown were used.

RESULTS AND DISCUSSION

At 75 days after planting PH/F-1545 recorded highest yield of 198.0 q/ha, followed by PJ-376 and EM/I-965. All these three genotypes yielded higher than

the standard varieties, Kufri Badshah, Kufri Bahar and Kufri Chandramukhi and Kufri Badshah did not differ significantly from these highest yielding genotypes (Table 1). Tuber yield in Kufri Bahar and Kufri Chandramukhi was low in this trial because of poor emergence. At 90 days also PH/F-1545 recorded highest tuber yield and was significantly better than the highest yielding standard variety, Kufri Badshah. Tuber yields of MS/78-56 and QB/A 9-73 were significantly lower than Kufri Badshah at 75 as well as 90 days after planting. Better performance of Kufri Badshah has also been reported earlier as compared to Kufri Chandra-

mukhi and Kufri Bahar (Pandita and, Sidhu, 1979; Anonymous, 1986). Data for proportion of various tuber sizes are presented in Table 1. Proportion of large size tubers at 75 as well as 90 days was highest in MS/78-46 followed by MS/78-56. EM/I-965, PS/E-787 and JN-1752 recorded lower proportion of large size tubers as compared to other genotypes at 75 as well as 90 days. Proportion of medium size tubers was highest in JN-1752 followed by QB/A 9-73 and EM/I-965 at 75 days. At 90 days it was highest in PS/E-787 followed by EM/I-965 and JN-1752. Proportion of small size tubers was low in MS/78-46

TABLE 1

Tuber yield, tuber number and per cent of various tuber sizes in different potato genotypes (average of two years)

Genotype	Tuber yield		Percent of			Per cent of			Tuber number per hill
	(q/ha)		different tuber sizes			different tuber sizes			
	75 days	90 days	at 75 days			at 90 days			
			Large (> 60 g)	Medium (40- 60 g)	Small (< 40 g)	Large (> 60 g)	Medium (40- 60 g)	Small (< 40 g)	
EM/I-965	175.7	206.5	31.6	42.1	26.3	45.9	39.2	14.9	7.33
PS/E-787	168.0	210.8	35.8	41.9	22.3	43.1	41.2	15.7	6.16
MS/78-46	158.0	214.3	61.6	25.6	12.8	80.1	15.0	4.9	4.77
JN-1752	158.9	229.7	35.7	47.3	17.0	50.7	34.2	15.1	8.87
QB/A 9-73	90.0	147.4	44.1	43.0	12.9	65.3	25.4	9.3	8.63
QB/A 1-20	160.5	210.1	48.7	37.3	14.0	67.9	23.4	8.7	7.13
PJ-376	187.1	248.4	42.7	36.5	20.8	53.1	32.6	14.3	6.16
MS/78-56	108.3	159.3	57.4	29.8	12.8	79.1	15.9	5.0	4.08
PH/F-1545	198.0	280.5	51.0	36.1	12.9	71.6	21.3	7.1	5.18
Kufri Bahar	90.4	139.9	51.4	32.3	16.3	59.8	31.3	8.9	4.27
Kufri Badshah	169.4	236.5	43.2	36.4	20.4	69.3	22.7	8.0	6.15
Kufri Chandramukhi	97.8	131.4	45.3	28.3	26.4	54.4	32.7	12.9	4.68
C. D. at 5%	46.8	42.6							1.32

EVALUATION OF SOME POTATO HYBRIDS

and MS/78-56 at 75 as well as 90 days as compared to remaining genotypes. Tuber number was highest in JN-1752 followed by QB/A 9-73 and these two genotypes were significantly better than all the remaining genotypes and varieties tested except EM/I-965.

Leaf weight at 75 days in PH/F-1545, PJ-376, EM/I-965 and PS/E-787 was at par with Kufri Badshah, while at 90 days PH/F-1545 and QB/A 9-73 were at par with Kufri Badshah for this character. Kufri Chandramukhi and Kufri Bahar recorded lower leaf weight at 75 as well as 90 days as compared to Kufri Badshah (Table 2). Stem weight at 75 as well as 90 days was significantly higher in Kufri Badshah as compared to all the genotypes and varieties tested. Stems/hill were highest in EM/I-965 followed

by PS/E-787, PJ-376, PH/F-1545 and JN-1752 and these genotypes were significantly superior to all the three standard varieties tested (Table 2). Plant height was recorded at 55 and 90 days. Plants were tallest in Kufri Badshah which were at par with PS/E-787 and QB/A 1-20 at 55 days and QB/A 1-20 at 90 days.

Association of leaf and stem weight with tuber yield was worked out (Table 3). Tuber yields have been related to leaf area duration by various workers (Bremner and Taha, 1966; Gunasena and Harris, 1968). In the present investigation leaf weight at 75 days accounted 90 and 63 per cent of the variance in tuber yield at 75 days in 1985-86 and 1986-87, respectively. Stem weight alone accounted 55 and 50 per

TABLE 2

Growth characters of potato genotypes (average of two years)

Genotype	Leaf weight (q/ha)		Stem weight (q/ha)		Stems per hill	Plant height (cm)	
	75 days	90 days	75 days	90 days		55 days	90 days
EM/I-965	69.7	52.7	43.2	37.9	4.75	26.0	28.5
PS/E-787	65.9	36.6	53.5	35.4	4.34	37.3	38.5
MS/78-46	50.7	58.5	29.0	36.9	2.36	29.2	33.7
JN-1752	59.9	53.7	43.6	42.2	3.85	31.5	36.7
QB/A 9-73	50.2	71.4	42.6	49.9	3.13	35.7	38.5
QB/A 1-20	47.8	48.9	45.9	44.1	3.24	39.6	41.9
PJ-376	75.7	56.0	55.8	40.2	3.99	36.1	39.2
MS/79-56	29.3	47.8	18.0	33.4	2.27	29.6	36.6
PH/F-1545	74.2	80.0	52.8	54.6	3.90	35.0	37.5
Kufri Bahar	38.9	35.1	28.7	24.0	2.69	32.5	35.3
Kufri Badshah	77.4	78.1	76.7	71.5	3.27	40.9	46.3
Kufri Chandramukhi	34.3	25.8	26.4	16.3	2.54	23.5	26.6
C. D. at 5%	12.5	17.6	12.5	14.1	0.47	4.3	5.2

TABLE 3

Regression equations for tuber yield on various growth parameters

1985-86		1986-87	
Regression equation	Correlation coefficient	Regression equation	Correlation coefficient
TY 75=28.8+1.787 LW 75	0.96**	TY 75=2.6+2.668 LW 75	0.79**
TY 75=65.1+1.475 SW 75	0.74**	TY 75=66.9+2.102 SW 75	0.71**
TY 75=40.7+0.871 FW 75	0.88**	TY 75=29.3+1.283 FW 75	0.78**
TY 90=125.8+1.281 LW 90	0.77**	TY 90=44.6+2.547 LW 90	0.54**
TY 90=100.6+2.132 SW 90	0.70**	TY 90=93.2+2.537 SW 90	0.72**
TY 90=109.9+0.868 FW 90	0.76**	TY 90=59.6+1.370 FW 90	0.64**
TY 90=94.5+1.740 LW 75	0.96**	TY 90=25.7+3.149 LW 75	0.61**
TY 90=110.1+1.772 SW 75	0.77**	TY 90=99.1+2.551 SW 75	0.67**
TY 90=93.6+0.946 FW 75	0.89**	TY 90=55.5+1.533 FW 75	0.66**

TY 75 and TY 90=Tuber yield in q/ha at 75 and 90 days, respectively.

LW 75 and LW 90=Leaf weight in q/ha at 75 and 90 days, respectively.

SW 75 and SW 90=Stem weight in q/ha at 75 and 90 days, respectively.

FW 75 and FW 90=Foliage weight (leaf+stem) in q/ha at 75 and 90 days, respectively.

**=Significant at 1% level.

cent of the variance in tuber yield in 1985-86 and 1986-87, respectively. Foliage (leaf+stem) weight accounted more variance as compared to stem weight. It accounted 77 and 60 per cent of the variance in tuber yield in 1985-86 and 1986-87, respectively.

Regression of tuber yield at 90 days or leaf weight at 90 days accounted much lower variance as compared to respective figures for 75 days. It may be due to the reason that senescence of leaves in different varieties followed different pattern depending upon their maturity period. However, regression of tuber yield at 90 days on stem and foliage weight separately accounted 48.2 and 58.1 per cent in 1985-86 and 51.7 and 41.2 per cent of the variance in 1986-87, respectively. These are comparable with the figures at 75 days.

Relationship of leaf, stem and foliage weight at 75 days with tuber yield at 90 days was also significant at 1% level of significance. Tuber number had positive relationship with tuber yield but was significant only during 1985-86. Stem number also had positive relationship with tuber yield and tuber number but was significant during 1985-86. From the foregoing discussion and the regression equations presented in Table 3, it may be stated that tuber yield at 75 or 90 days can be estimated better from the leaf weight at 75 days as compared to stem and foliage weight at 75 or 90 days and leaf weight at 90 days. Therefore, leaf weight attained by a genotype at early stages of growth upto 75 days should be given due consideration while selecting a hybrid for higher tuber yield.

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EFFECT OF PRE-HARVEST APPLICATION OF CYCOCEL, CALCIUM NITRATE AND ZINC SULPHATE ON THE STORAGE BEHAVIOUR OF DELIGHT GRAPES

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ABSTRACT

Pre-harvest application of various chemicals, *viz.* cycocel, calcium nitrate and calcium nitrate in combination with zinc sulphate reduced the loss in weight, berry drop and berry rot in Delight grapes. The highest reduction in total spoilage was observed with CCC (1000 ppm) followed by calcium nitrate (1%) + zinc sulphate (0.2%). The total spoilage also increased during prolonged storage. Firmness of the fruit decreased with the increase in storage period, but the decrease was much slower in grapes treated with chemicals. The best effective treatments were 1000 ppm cycocel and 1% calcium nitrate.

The grape is one of the important commercial fruit crops of Haryana. It is highly perishable in nature, therefore, it can neither be stored for a longer period nor transported to a longer distance. The storage life of grapes can be prolonged by growth retardants (Dhillon *et al.*, 1975). Calcium is associated with pectic substances in the middle lamella which may prevent disorders (Bangerth *et al.*, 1972). Zinc sulphate and combination with calcium have been found to increase uptake of calcium and thereby further prolong the shelf-life of apple fruits (Tessoni and Pizzocaro, 1981). Keeping this in view, the present studies were undertaken to find out the effect of pre-harvest application of cycocel, calcium nitrate, and zinc sulphate alone and in combination with nitrate calcium on the shelf-life of Delight grapes.

MATERIAL AND METHODS

The study was carried out at the Experimental Vineyard and post-harvest laboratory during the year 1985. Twelve-year old uniformly growing vines spaced at 3×3 metres and trained on bower system were selected for the studies. The vines were kept under uniform conditions of orchard management. The fruits were sprayed 10 days before harvest with cycocel (250, 500 and 1000 ppm), calcium nitrate (1%), zinc sulphate (0.2%) and calcium nitrate plus zinc sulphate using Teepol as surfactant in the water solution. One treatment was kept as control. The grapes were harvested at ripe firm stage. After removing the damaged, diseased and other undesirable berries, two bunches were packed in perforated polythene bags. One bag was kept extra

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in each treatment for quality analysis. The bags were kept at room temperature ($34^{\circ}\pm 4^{\circ}\text{C}$ with 40-50% R. H.) and cold storage ($0^{\circ}\pm 1^{\circ}\text{C}$ and 80-85% R. H.).

Observations on loss in weight, berry rot and total spoilage were recorded at 6 days interval and calculated in terms of percentage on initial weight of the fruit. Firmness of the berries was determined with thumb pressure technique.

RESULTS AND DISCUSSION

Loss in Weight

Data on loss in weight during storage reveal that there was an increase in weight loss with the increased period of storage (Table 1). The rate of increase

in weight loss was reduced with the application of growth retardant, calcium nitrate and zinc sulphate. The highest reduction was obtained with cycocel at 1000 ppm at room as well as at low temperature (9.21 and 7.52 per cent) followed by cycocel at 500 ppm and maximum in control (12 and 10.74 per cent). The increase in weight loss with the increased period of storage is obvious as during storage evapotranspiration of moisture takes place which might have caused the reduction in weight. The reduction in weight loss rate with application of cycocel can be attributed to increase in affinity for berry water which can retain more water against the force of evaporation resulting in lesser weight loss during storage by altering

TABLE 1

Effect of pre-harvest treatments on per cent loss in weight in Delight cultivar of grapes during storage

Treatment	Room temperature				Low temperature				
	Days in storage				Days in storage				
	2	4	6	Mean	6	12	18	24	Mean
Control	3.47	10.65	21.90	12.00	2.79	6.79	12.96	20.41	10.74
CCC 250 ppm	2.94	9.58	13.13	10.22	2.20	4.55	10.74	17.49	8.74
CCC 500 ppm	2.49	8.56	17.41	9.40	2.09	4.53	10.04	17.02	8.42
CCC 1000 ppm	2.37	8.08	17.19	9.21	1.45	3.78	9.36	15.49	7.52
Ca(NO ₃) ₂ (1%)	2.56	9.07	17.80	9.81	1.76	4.05	9.78	16.11	7.92
ZnSO ₄ (0.2%)	2.84	9.82	18.80	10.38	2.24	5.72	9.91	17.80	8.92
Ca(NO ₃) ₂ (1%) + ZnSO ₄ (0.2%)	2.77	9.21	18.30	10.09	2.13	4.50	9.11	16.26	8.00
Mean	2.27	9.28	13.50		2.09	4.85	10.27	17.23	

C. D. at 5%

Treatments = 0.54
Days = 0.17
Treatments $\times$ Days = 0.94

Treatments = 0.25
Days = 0.19
Treatments $\times$ Days = 0.51

some of the proteinaceous constituents of the cell (Mitchell, 1949). Similar results were reported by Dhillon *et al.* (1975) in grapes during storage. Decreased loss in weight in grapes from calcium spray might be due to the fact that calcium is reported to retard the rate of respiration, decay or prevent cellular disintegration by maintaining the protein and nucleic acid synthesis, thus, delaying senescence. The reduction in loss in weight is also reported by Gupta *et al.* (1980) in grapes and by Singh *et al.* (1981) in guava. Zinc showed synergistic effect on penetration, mobilization and accumulation of calcium in fruit tissues. This is in agreement with the findings of Testoni and Pizzocaro (1981) in apple.

Berry Drop

Berry drop was reduced significantly by the pre-harvest application of various

chemicals in comparison with control (Table 2). The lowest drop was observed with CCC at 1000 ppm (6.03 and 6.01 per cent) and highest in control (9.33 and 9.05 per cent). The reduction in berry drop with growth retardant could be due to the maintenance or increase in the firmness of attachment of the berries. The calcium, probably, effectively reduced the berry drop by reducing the decay infection at the point of pedicel attachment of the berries. Similar type of observations were also recorded by Drake *et al.* (1966) in apple. The reduction in berry drop by zinc compound was probably due to increase in calcium content in the tissue. However, with the increase in storage period, the berry drop increased irrespective of treatments. This was probably because of increased rotting with time particularly at the point of pedicel attachment of berries.

TABLE 2

Effect of pre-harvest treatments on per cent berry drop in Delight cultivar of grapes during storage

Treatment	Room temperature				Low temperature				
	Days in storage				Days in storage				
	2	4	6	Mean	6	12	18	24	Mean
Control	1.97	7.49	15.55	9.33	1.96	4.84	12.70	13.53	9.05
CCC 250 ppm	1.23	5.67	12.99	6.63	1.15	3.50	7.57	13.81	6.51
CCC 500 ppm	0.94	5.51	12.70	6.38	1.06	3.42	6.26	14.60	6.33
CCC 1000 ppm	0.66	5.24	12.21	6.03	0.00	3.08	6.90	12.90	5.72
Ca (NO ₃) ₂ (1%)	0.84	6.10	13.23	6.72	0.87	3.23	6.98	12.96	6.01
ZnSO ₄ (0.2%)	1.39	6.51	13.89	7.26	1.23	3.56	7.73	13.95	6.61
Ca (NO ₃) ₂ (1%) + ZnSO ₄ (0.2%)	1.35	6.43	13.80	7.09	0.95	3.28	7.19	13.24	6.16
Mean	1.19	6.13	13.44		0.99	3.44	7.82	13.85	
C. D. at 5%									
	Treatments		=	0.38	Treatments		=	0.27	
	Days		=	0.25	Days		=	0.20	
	Treatments × Days		=	0.65	Treatments × Days		=	0.54	

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TABLE 3

Effect of pre-harvest treatments on per cent berry rot in Delight cultivar of grapes during storage

Treatment	Room temperature				Low temperature				
	Days in storage				Days in storage				
	2	4	6	Mean	6	12	18	24	Mean
Control	3.29	10.13	16.67	10.03	2.35	5.80	12.95	19.90	10.00
CCC 250 ppm	2.53	8.01	12.36	7.63	1.92	4.95	9.19	15.84	7.97
CCC 500 ppm	2.47	7.76	11.82	7.35	1.54	4.28	8.93	15.21	7.49
CCC 1000 ppm	1.98	7.02	11.14	6.71	1.30	3.95	8.47	14.42	7.03
Ca (NO ₃) ₂ (1%)	2.20	6.45	12.36	7.00	1.72	4.66	9.09	15.56	7.70
ZnSO ₄ (0.2%)	2.63	8.31	12.77	7.90	1.99	5.22	9.82	16.18	8.30
Ca(NO ₃) ₂ (1%) + ZnSO ₄ (0.2%)	2.29	7.62	11.60	7.17	1.37	4.11	8.60	14.70	7.19
Mean	5.48	7.90	12.67		1.73	4.71	8.24	15.98	

C. D. at 5%

Treatments = 0.46
Days = 0.30
Treatments × Days = 0.79

Treatments = 0.41
Days = 0.31
Treatments × Days = NS

Berry Rot

Lowest rot was observed with CCC at 1000 ppm (6.03 and 7.03 per cent) when compared to control (9.33 and 10 per cent) at room temperature and cold storage, respectively (Table 3). The reduction in berry rot with the growth retardant could possibly be due to the fact that this might have reduced or checked the bio-chemical changes in the berries. This in turn might have imparted some resistance against the penetration or growth of the pathogens in the berries. This is in conformity with the findings of Narasimham *et al.* (1967) and Beerh *et al.* (1976). Possible reduction in berry rot with calcium nitrate application may be due to its effect on the firmness of cells which might have minimized the disease

incidence. Gupta *et al.* (1980) reported almost similar results with Perlette grapes. Similarly in apple, the incidence of fruit rot was considerably reduced with the application of calcium (Scott and Wills, 1975). The zinc sulphate with calcium nitrate enhances the calcium compound in the tissues thus delaying senescence and resulting in lesser berry rot.

Total Spoilage

The lowest spoilage was observed in the grapes treated with cycocel at 1000 ppm (40.54 and 42.81 per cent) followed by cycocel (500 ppm), calcium nitrate (1%), and the highest in control (54.12 and 58.84 per cent) at room and low temperatures, respectively (Figs. 1 and 2).

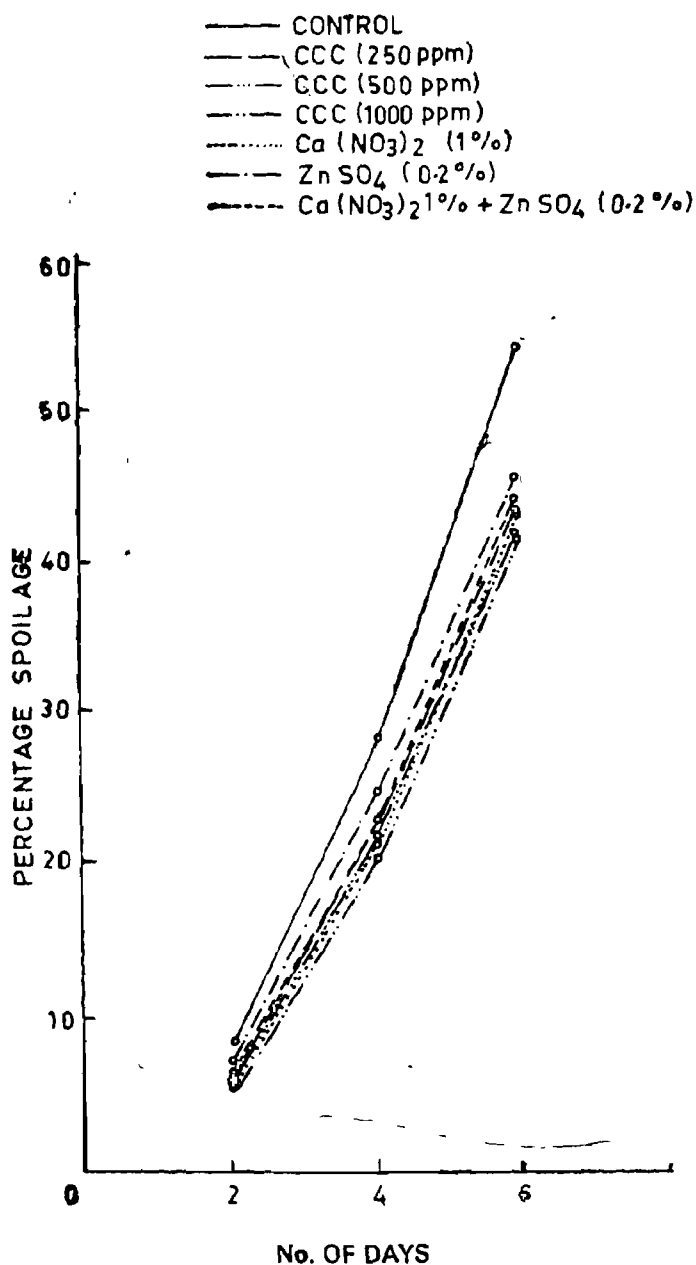


Fig. 1. Percentage spoilage in Delight cultivar of grapes stored at room temperature.

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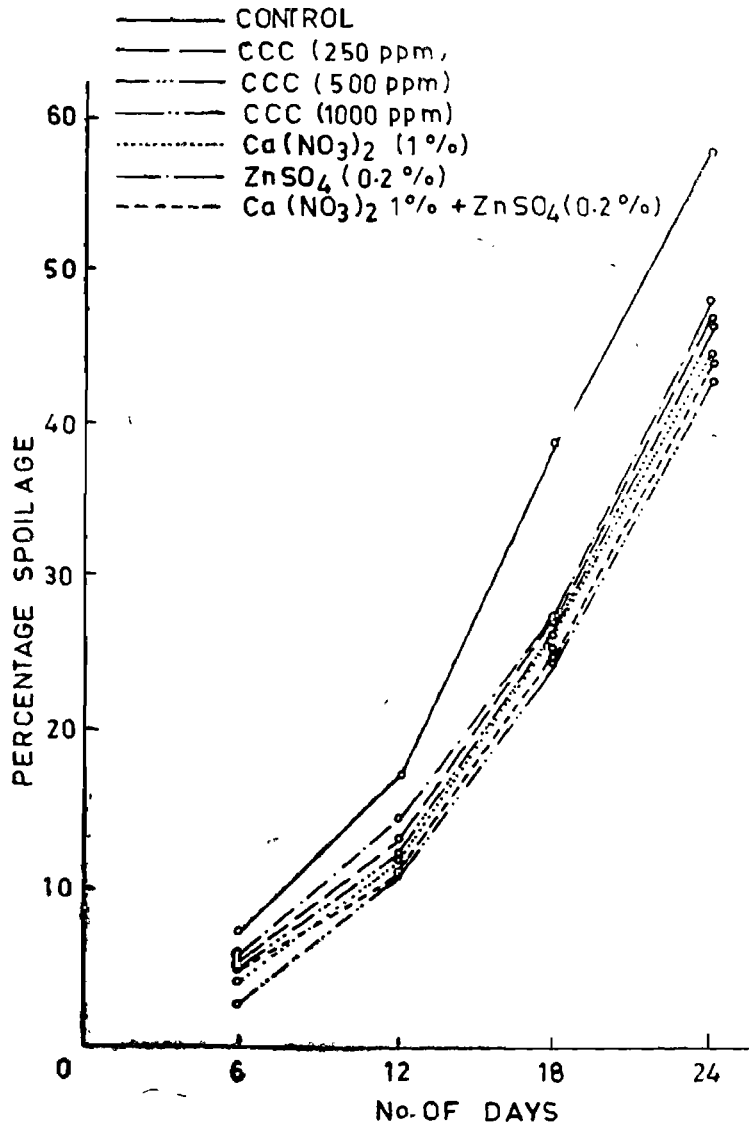


Fig. 2. Percentage spoilage in Delight cultivar of grapes stored at low temperature.

TABLE 4

Effect of pre-harvest treatments on firmness in Delight cultivar of grapes during storage

Treatment	Room temperature			Low temperature			
	Days in storage			Days in storage			
	2	4	6	6	12	18	24
Control	Firm	Medium	Soft	Firm	Medium	Medium	Soft
CCC 250 ppm	Firm	Medium	Soft	Firm	Medium	Medium	Soft
CCC 500 ppm	Firm	Firm	Medium	Firm	Medium	Medium	Medium
CCC 1000 ppm	Firm	Firm	Medium	Firm	Firm	Firm	Medium
Ca (NO ₃) ₂ (1%)	Firm	Firm	Medium	Firm	Firm	Firm	Medium
ZnSO ₄ (0.2%)	Firm	Medium	Medium	Firm	Firm	Medium	Soft
Ca (NO ₃) ₂ (1%) + ZnSO ₄ (0.2%)	Firm	Firm	Medium	Firm	Firm	Firm	Medium

There was an abrupt increase in spoilage with the increase in storage period in all the treatments. The effect of various chemicals used on trial basis also followed the same pattern as reported under individual characters. This confirms the effectiveness of pre-harvest application for increasing the shelf-life of grapes.

Berry Firmness

A perusal of the data given in Table 4 reveals that the berries of Delight grapes treated with CCC (1000 and 500

ppm) and calcium nitrate (1%) alone and in combination with zinc sulphate (0.2%) remained firm upto 4 and 18 days as compared to 2 and 6 days in control at room temperature and in cold storage. This might be due to firmness by growth retardant and increase in the resistance of middle lamella by calcium. Similar observations have also been reported by Brian (1970) in pear and Chopra *et al.* (1981) in apricot. Gupta *et al.* (1980) also reported an increase in firmness in Perlette grapes with the application of calcium nitrate.

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MICROCLIMATIC STUDIES IN DIFFERENT INTERCROPPING SYSTEMS OF PEARL MILLET AND MUNGBEAN CROPS

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ABSTRACT

Nine different intercropping systems of pearl millet and mungbean were planted during *kharif* season of 1986, to study the microclimatic variations, *viz.* temperature, relative humidity and photosynthetically active radiation (PAR) profiles under various intercropping systems. A change of -6 to $+10$ per cent in relative humidity was observed in various treatments in evening hours (1600 h) as compared to pure pearl millet. The relative humidity deviations were higher in the upper foliage layers when compared to lower layers in both morning and evening hours. The temperature profiles were almost reverse to the humidity profiles. In morning (0800 h), the temperature variations in intercrop treatments were in the range of -0.3° to $+0.5^{\circ}\text{C}$ when compared to sole pearl millet crop, whereas this variation ranged from -1.2° to $+1.5^{\circ}\text{C}$ at noon hours (1200 h). Transmission of photosynthetically active radiation (PAR) was more (22.0%) in the intercrop of pearl millet and mungbean (1 : 3), whereas the absorption was maximum (78.0 %) in pure mungbean treatment. The PAR reflection (albedo) was maximum (20.0%) in pure pearl millet plots.

In an intercropping system, planting of two or more crops on the same piece of land is done simultaneously to achieve better interception of the incoming solar energy, effective utilization of water and nutrients, risk coverage and a higher exploration of the growth contributing factors related to the environment (Norman, 1972; Osiru and Willey, 1976). Intercropping is particularly beneficial when it involves two component crops which are of very different growth cycles because this allows the greatest scope for making better temporal use of resources (Willey and Lakhani, 1976). A number of research workers have observed that crop combinations having

shade tolerant legumes of non-climbing habit such as groundnut, mungbean, cowpea and soybean with millet, maize, sorghum, cotton or castorbean have given greater overall yield when compared to sole cropping (Evans, 1960; Evans and Sreedharan, 1962; Bodade, 1964; Schilling, 1965; Enyi, 1973; Osiru, 1974). These yield advantages have been attributed to differences in component crops, *viz.* height, rooting pattern and maturity period, which enable better spatial and/or temporal utilization of light, soil moisture and nutrients.

Research on intercropping is primarily focussed on the effect of agronomic

manipulations such as spacing and date of seeding and on the effect of combinations of different species on productivity (Ramos, 1976). Systematic research involving the micrometeorology of intercropping has begun only recently and principles involved in it are only just beginning to be subjected to scientific study and elucidation. The present study was carried out to understand the micrometeorology of various intercropping systems in pearl millet and mungbean (green gram) at Hisar.

MATERIAL AND METHODS

The study was conducted during the kharif season of 1986 at the Research Farm of Department of Agricultural Meteorology, Haryana Agricultural University, Hisar (Lat. 29°10'N, Long. 75°46' E, Alt. 215.2 m msl.). Pearl millet and mungbean (pure and their intercrops) were seeded on 4 July, 1986 in the field adjoining the Agromet Observatory. The crop was sown in rows 45 cm apart and all package of practices for crop husbandry were followed. The experiment consisted of nine planting systems of pearl millet (hybrid HHB-45) and mungbean (K-851) as per details given below :

T₁—Pearl millet pure

T₂—Mungbean pure

T₃—1 pearl millet+1 mungbean (mixed cropping on seed weight basis)

T₄—2 pearl millet + 1 mungbean (mixed cropping on seed weight basis)

T₅—1 row pearl millet : 1 row mungbean

T₆—2 rows pearl millet : 1 row mungbean

T₇—3 rows pearl millet : 1 row mungbean

T₈—1 row pearl millet : 2 rows mungbean

T₉—1 row pearl millet : 3 rows mungbean

The experiment was laid out in a thrice replicated randomized block design with plot size of 11.7 m × 6.5 m.

PAR (Photosynthetically Active Radiation) interception was measured with the help of Lux Meter (300-S) at two stages of crop growth : Stage I—Ear emergence in pearl millet and flower initiation in mungbean (17 August, 1986) and Stage II—Physiological maturity (17 September, 1986). The PAR interception was measured at different heights from the ground surface, *viz.* just above the ground surface, 30 cm, 80 cm, 120 cm, and 200 cm above the ground surface at stage I and in addition at 250 cm above the ground surface at stage II. Optical characteristics (transmission, reflection and absorption) were obtained with the help of PAR data for these stages. At physiological maturity, the temperature and relative humidity profiles were recorded with Assman Psychrometer, manually.

RESULTS AND DISCUSSION

Temperature and Relative Humidity Profiles

Temperature profiles obtained at different times of the day, *i.e.* 0800, 1200 and 1600 h under various intercropping treatments have been depicted in Figs. 1-3, respectively. At morning hours, the air temperature values at various heights were highest in pure pearl millet (T₁) among all the treatments with the exception of pure mungbean cropped (T₂) plot

(Fig. 1). The morning temperature deviations in various treatments from T_1 varied in the range of ± 0.3 to -2.0°C . The maximum deviation was observed in case of T_8 and $\frac{1}{2}T_9$ treatments; further these deviations were more pronounced upto the height of 120 cm from the ground surface and, thereafter, the deviations decreased with increase in height from the ground surface. At noon, the temperature profile pattern was most irregular (Fig. 2). The temperature deviations in various treatments from pure pearl millet ranged from $+1.5$ to -1.2°C . The temperatures in pure mungbean were lower than the pure pearl millet at all heights upto 120 cm from ground surface. At evening hours (1600 h), the temperature values in various treatments

when compared to pure pearl millet deviated in the range of $+3.4$ to -1.8°C . The profiles in the pure mungbean crop were coolest. In general, an interesting observation regarding temperature profiles in various treatments was that the lapse rate (change in temperature with height) was more upto a height of 120 cm (height of the mungbean crop on the date of observation) and, thereafter, the lapse rate narrowed down. A substantive increase in air temperature was observed in T_8 and T_9 treatments (both with mungbean component dominating) upto a height of 120 cm during morning hours. This may be due to absorption of longwave radiation by the mungbean canopy which effectively covered the ground surface, whereas the

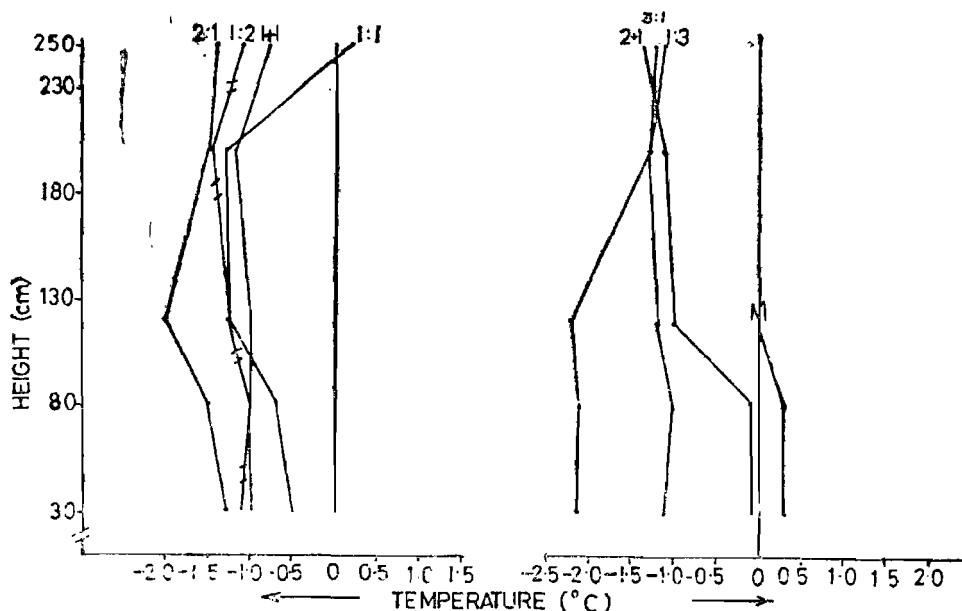


Fig. 1. Temperature deviations from pure pearl millet under various treatments at 0800 h on 17 September, 1986.

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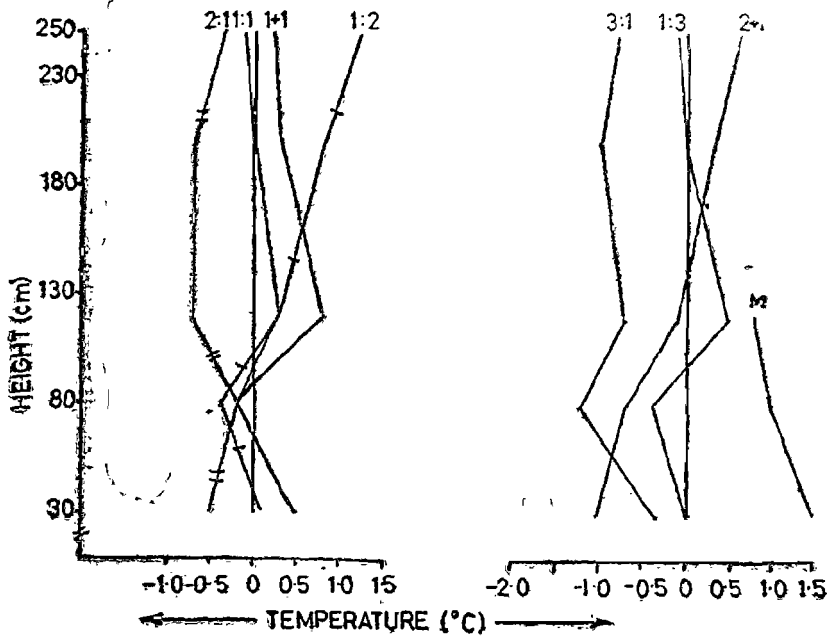


Fig. 2. Temperature deviations from pure pearl millet under various treatments at 1200 h on 17 September, 1986.

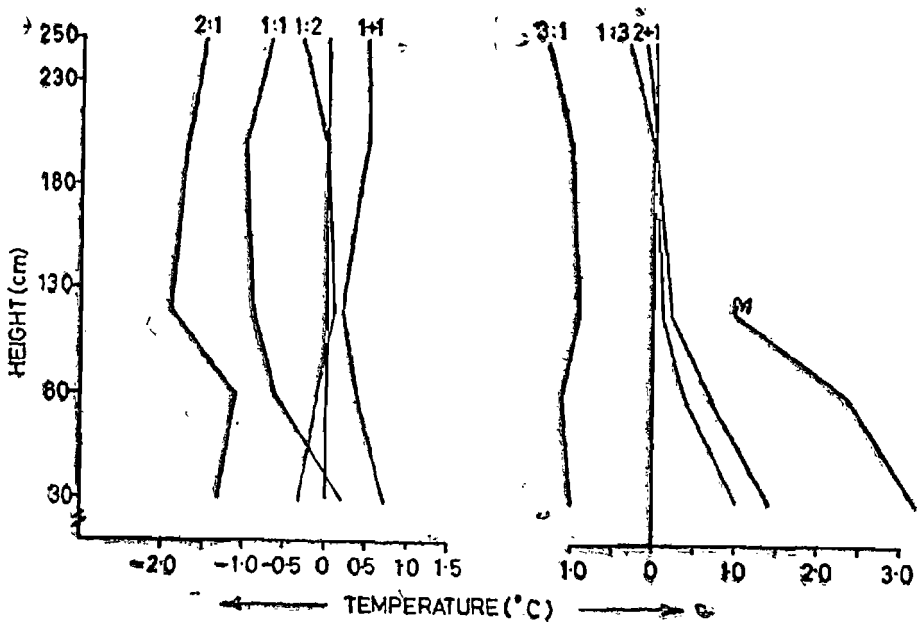


Fig. 3. Temperature deviations from pure pearl millet under various treatments at 1600 h on 17 September, 1986.

reverse was true during evening hours, i.e. the temperatures were low in T_8 and T_9 upto 120 cm. The possible explanation is the large transpiring area exposed (mungbean leaves) in this region of the crop canopy.

The data presented in Figs. 4-6 depict the relative humidity (RH) profiles at morning, noon and evening hours. In general, the humidity profile pattern was almost reverse of temperature pattern. At 0800 h, the deviations of the RH from pure pearl millet varied in the range of +3 to -11 per cent. This variation was +5 to -11% during noon hours and +10 to -6% during evening hours. The differences in the RH values in various profiles upto 120 cm above the ground surface were markable in all the treatments at

morning and evening hours when compared to pure pearl millet but at upper heights this difference was less, which may be due to the existing mungbean in these treatments.

PAR Interception

The optical characteristics of PAR at noon hours at stages I and II in various treatments have been presented in Table 1. Transmission of PAR was more in T_9 (12 and 22 per cent) at both the stages. The per cent reflection of PAR was more in T_1 (20.2 and 20.0 per cent) over all other treatments at both the stages. The absorption was more in T_8 (78.7%) and T_3 (78.0%) at stages I and II, respectively. This might be due to higher radiation interception and higher

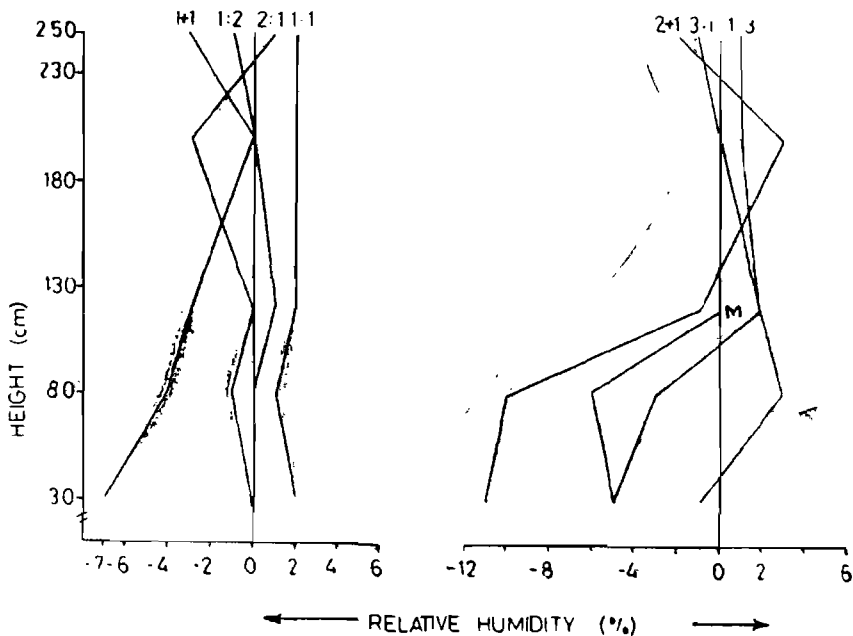


Fig. 4. Relative humidity deviations from pure pearl millet under various treatments at 0800 h on 17 September, 1986.

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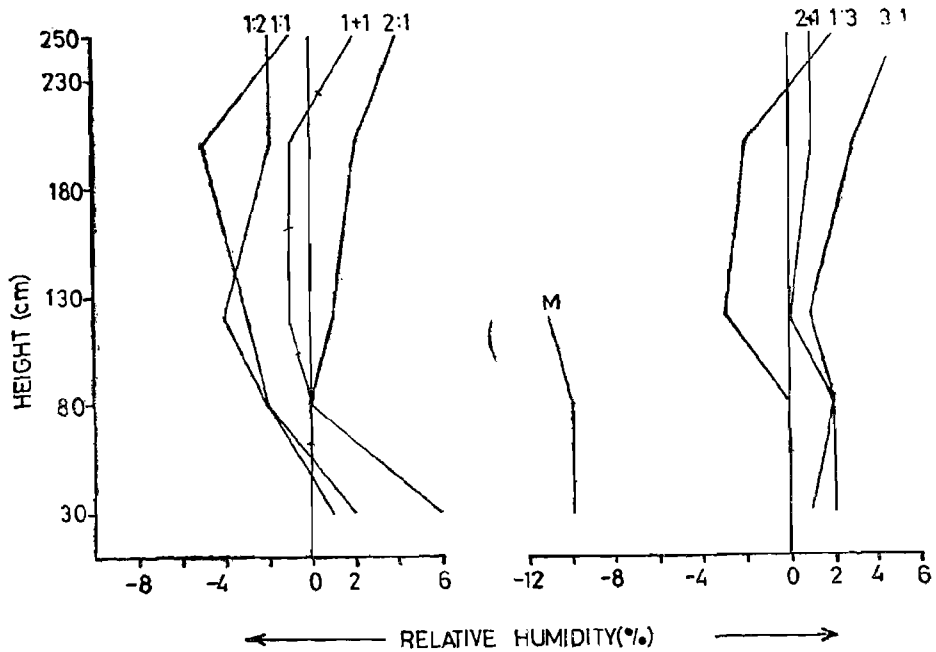


Fig. 5. Relative humidity deviations from pure pearl millet under various treatments at 1200 h on 17 September, 1986.

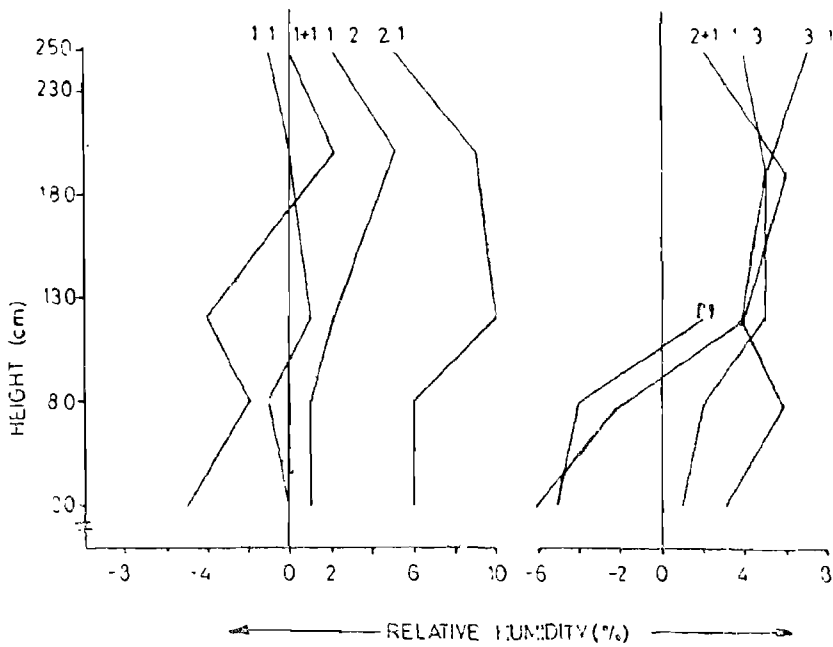


Fig. 6. Relative humidity deviations from pure pearl millet under various treatments at 1600 h on 17 September, 1986.

leaf area index in these treatments. The PAR interception is also influenced by the canopy morphology. The relationship of intercepted radiation and leaf area index of the crop at stages I and II are presented in Figs. 7-8. Light penetrating a plant stand is diminished through interception and absorption by the leaves and other parts of the shoot system. The potential shares of the

light that will be gained by components of an intercrop are determined by the relative height of their canopies and by the efficiency with which they intercept and absorb light. The light interception was more upto 120 cm from the ground surface in all the treatments except T_2 (mungbean pure) where a significant interception took place upto 40 cm (stage I) and 50 cm (stage II).

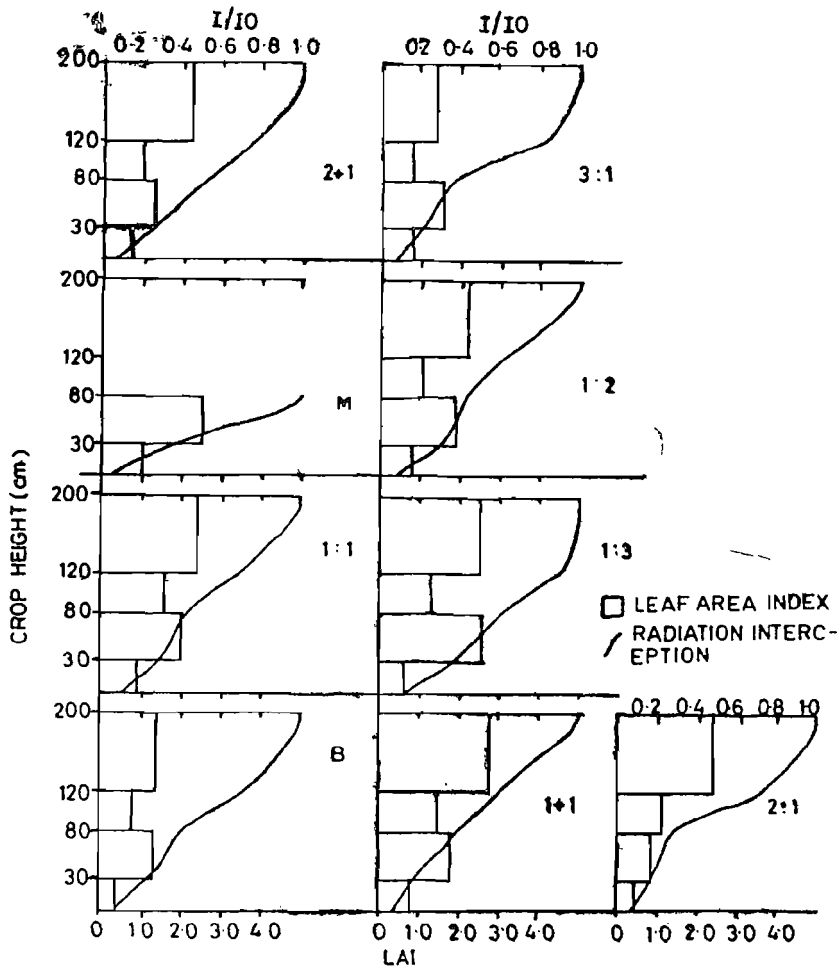


Fig. 7. PAR absorption at 1200 h on 17 August, 1986 in pearl millet and mungbean intercropping.

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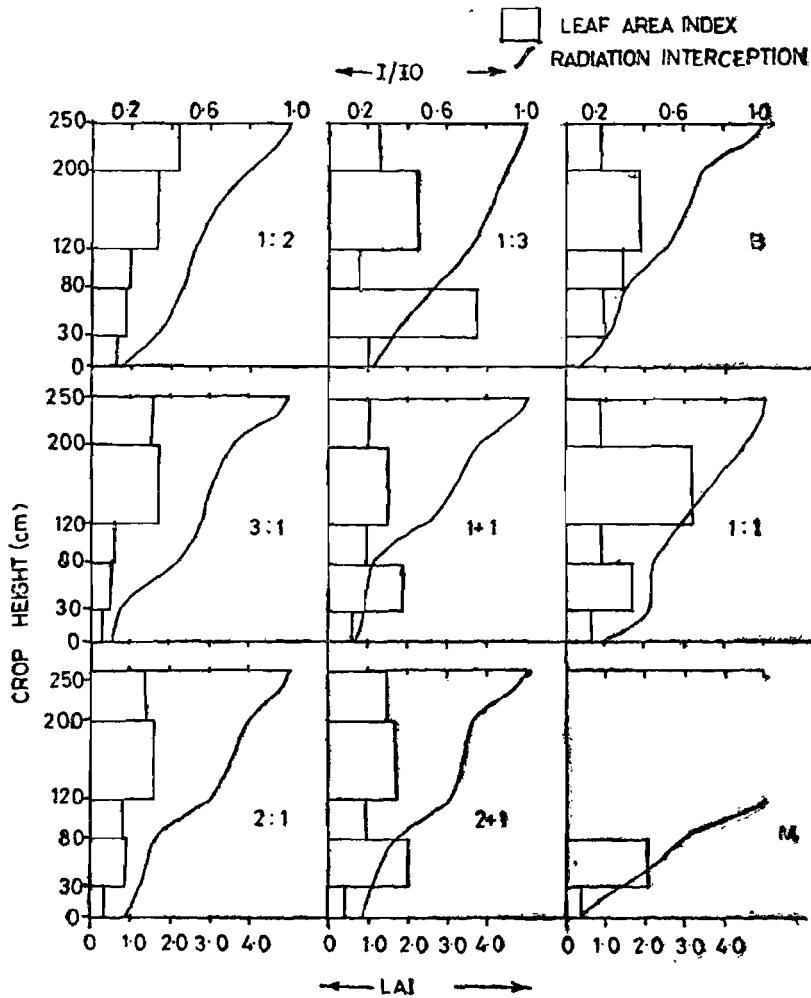


Fig. 8. PAR absorption at 1200 h on 17 September, 1986 in pearl millet and mungbean intercropping.

TABLE 1

Absorbed (A), reflected (R) and transmitted (T) photosynthetically active radiation (PAR) in different intercropping systems of pearl millet and mungbean

Treatment	Optical characteristics (%)			Optical characteristics (%)		
	A	R	T	A	R	T
	Stage-I (17.8.86 at 1200 noon)			Stage-II (17.9.86 at 1200 noon)		
T ₁	73.8	20.2	6.0	74.0	20.0	6.0
T ₂	77.0	17.0	6.0	78.0	16.0	6.0
T ₃	74.1	18.9	7.0	69.2	17.8	13.0
T ₄	76.4	17.6	6.0	66.2	17.8	16.0
T ₅	70.0	19.0	11.0	63.8	18.2	18.0
T ₆	76.8	16.2	7.0	65.7	16.3	18.0
T ₇	77.9	15.1	7.0	71.2	17.8	11.0
T ₈	78.7	15.3	6.0	71.0	15.0	14.0
T ₉	73.0	15.0	12.0	62.6	15.4	22.0

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EFFECT OF PLANT GROWTH SUBSTANCES ON EARLINESS AND YIELD OF SUMMER SQUASH (*CUCURBITA PEPO* L.)

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ABSTRACT

Experiments were conducted to study the effect of plant growth substances on earliness in fruiting and total fruit yield in summer squash cv. Hisar Selection-1 during winter season of 1986. Among the various sex modifying chemicals, Ethrel at 250 ppm improved early fruiting in terms of number and weight of fruits. Total yield of fruits was the maximum with Ethrel at 250 ppm followed by Ethrel at 100 ppm and MH at 50 ppm. Cost : benefit ratios were 4.84 and 2.32 with Ethrel 250 ppm in respect of early and total yield, respectively.

Summer squash is one of the earliest cucurbitaceous vegetables generally produced in the months of February and March in North India. It is a monoecious cucurbit where male flowers are normally produced in greater number than female flowers. As the female flowers contribute to total yield, any shift towards femaleness will certainly increase yield. Certain plant growth regulators have been reported to influence sex expression in various cucurbitaceous crops leading to suppression of male flowers or to increased number of female flowers (Saimbhi and Thakur, 1973; Pandita *et al.*, 1982; Shannon and Robinson, 1978) and thus alter sex ratio (Arora *et al.*, 1985). Recent studies have shown beneficial effects of Ethrel and MH in increasing the number of female flowers and improvement in yield of summer squash (Arora

et al., 1982). However, some commercial products like Cytozyme formulations (Crop⁺ and Seed treat⁺) which have come in the market during the last few years have claimed to improve growth and yield of several vegetable crops (Pandita *et al.*, 1986). Cytozyme is bacterially derived protein extract which augments nutritional support for plants. These formulations have a specific balance of bacterial enzyme growth regulating compounds, especially of the cytokinin group and amino acid chelated micro-nutrients, and are specific for application to seeds, crops and soil. Miraculan is marketed by National Organic Chemicals Industries Ltd., Bombay and is based on a naturally occurring long-chained aliphatic alcohol, commonly called triacontanol. However, there are not much reports regarding the effects of these chemicals

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in combination with sex modifying chemicals on earliness and yield of summer squash.

MATERIAL AND METHODS

Experiments were conducted at Vegetable Research Farm, Haryana Agricultural University, Hisar during winter of 1985-86 with two dates of sowing. Sowing of seeds was done on 2 December, 1985 (D₁) and 11 January, 1986 (D₂) maintaining plot sizes at 3.0 m × 1.8 m with 12 plants per plot. All the plots were covered with polythene sheet after sowing for 10-12 days to hasten germination. The treatments were replicated thrice adopting factorial RBD design. Following sex modifying and growth promoters were sprayed either alone or in combinations, thus making a total of 16 treatments, repeated in both dates of sowing.

A. Sex modifying chemicals

1. Ethrel 100 ppm
2. Ethrel 250 ppm
3. MH 50 ppm

B. Growth promoters

1. Cytozyme Crop⁺ 0.2 per cent
2. Miraculan 0.02 per cent
3. Cytozyme Crop⁺ 0.2 per cent + Miraculan 0.02 per cent

Sex modifying chemicals were sprayed at 2- and 4-true leaf stages of plants, while growth promoters were sprayed 30-35 days after Ethrel or MH spray. Control plants were sprayed with distilled water. Tween-20 was used as surfactant

@ 0.05 per cent. Recommended cultural practices were adopted uniformly for all the treatments. Total of the first nine pickings of fruits from 9 March, 1986 to 31 March, 1986 was made for D₁ and the total of first six pickings from 24 March, 1986 to 6 April, 1986 was made for D₂ for calculating early yield (kg/plant and q/ha). Total number and weight of fruits per plant were calculated on the basis of 19 and 14 pickings in D₁ and D₂, respectively.

RESULTS AND DISCUSSION

Significant differences in the number and weight of fruits from early yield were observed due to sex modifying and growth promoting chemicals in both the dates of sowing (Table 1). The maximum number of fruits from early yield was obtained in D₁. Early yield per plant and per hectare was also significantly higher in D₁ than D₂. Different growth promoters were statistically at par with each other in both the dates of sowing. Among sex modifying chemicals Ethrel at 250 ppm proved to be significantly superior in increasing the number of fruits per plant from early yield followed by Ethrel at 100 ppm. Control plants gave least number of fruits per plant. MH also significantly increased the number of fruits per plant from early yield. When growth promoters were used in combination with sex modifying chemicals, growth promoters showed inhibitory effect. However, Cytozyme crop⁺ at 0.2 per cent + Miraculan at 0.02 per cent when used in combination with sex modifying chemicals, the effects were marked and the number of fruits from early yield increased further. Least

TABLE 1

Effect of plant growth substances on early fruit yield in two dates of sowing (D_1 and D_2) in summer squash

Sex modifying chemical (SM) (ppm)	Growth promoting chemical (GP)														
	Control			Cytosylme (0.2%)			Miraculan (0.02%)			Cytosylme (0.2%) + Miraculan (0.02%)			Average		
	D ₁	D ₂	Av.	D ₁	D ₂	Av.	D ₁	D ₂	Av.	D ₁	D ₂	Av.	D ₁	D ₂	Av.
No. of fruits from early yield															
Control	5.0	4.0	4.5	7.1	4.2	5.7	6.9	4.5	5.7	7.5	6.6	7.1	6.6	4.3	5.5
Ethrel 100	15.0	8.0	11.5	13.2	7.5	10.4	12.8	7.0	9.9	12.9	13.5	13.2	13.5	7.4	10.5
Ethrel 250	20.2	10.5	15.4	18.1	8.5	13.8	18.6	9.0	12.8	17.8	18.2	18.0	18.2	9.4	13.8
MH 50	11.4	7.0	9.2	11.0	6.8	8.9	10.2	6.5	8.4	9.5	10.5	10.0	10.5	8.6	8.6
Average	12.9	7.4	10.2	12.3	7.0	9.7	11.6	6.8	9.2	11.9	12.2	12.1	12.2	8.9	8.9
C. D. at 5%	SM : D ₁ =1.6; D ₂ =0.6			GP : D ₁ =NS; D ₂ =NS			SM × GP : D ₁ =3.1; D ₂ =1.9								
Early yield (kg/plant)															
Control	0.30	0.24	0.27	0.53	0.32	0.43	0.53	0.31	0.42	0.59	0.36	0.48	0.49	0.31	0.40
Ethrel 100	0.90	0.48	0.69	0.92	0.49	0.71	0.91	0.49	0.70	0.91	0.54	0.73	0.91	0.50	0.71
Ethrel 250	1.11	0.58	0.85	1.12	0.59	0.86	1.08	0.59	0.84	1.06	0.60	0.83	1.09	0.59	0.84
MH 50	0.78	0.42	0.60	0.82	0.44	0.63	0.81	0.47	0.64	0.86	0.47	0.67	0.82	0.45	0.64
Average	0.78	0.43	0.61	0.85	0.46	0.66	0.83	0.47	0.65	0.86	0.49	0.68	0.83	0.46	0.65
C. D. at 5%	SM : D ₁ =0.10; D ₂ =0.08			GP : D ₁ =0.05; D ₂ =0.01			SM × GP : D ₁ =0.13; D ₂ =0.08								
Early yield (q/ha)															
Control	60.5	48.0	54.3	106.5	63.0	84.8	106.3	62.4	84.4	117.0	71.8	94.4	97.6	61.3	79.5
Ethrel 100	180.0	96.0	138.0	184.0	97.5	140.8	182.1	98.0	140.1	181.1	107.1	144.1	181.8	99.7	140.8
Ethrel 250	222.2	115.5	168.9	224.3	114.0	169.2	217.1	117.0	167.1	212.1	119.0	165.6	218.9	116.4	167.7
MH 50	156.1	84.0	120.1	164.0	88.4	126.2	162.3	93.6	128.0	172.1	93.0	132.6	163.6	89.8	126.7
Average	154.7	85.9	120.3	169.7	90.7	130.2	166.9	92.8	129.9	170.6	97.7	134.2	165.5	91.8	128.7
C. D. at 5%	SM : D ₁ =17.9; D ₂ =5.6			GP : D ₁ =10.4; D ₂ =5.6			SM × GP : D ₁ =54.7; D ₂ =17.6								

TABLE 2
Effect of plant growth substances on total fruit yield in two dates of sowing (D_1 and D_2) in summer squash

Sex modifying chemical (SM)	Growth promoting chemical (GP)											
	Control			Cytoszyme (0.2%)			Miraculan (0.02%)			Cytoszyme (0.2%)+ Miraculan (0.02%)		
	D ₁	D ₂	Av.	D ₁	D ₂	Av.	D ₁	D ₂	Av.	D ₁	D ₂	Av.
(ppm)												
No. of fruits from total yield												
Control	14.5	9.0	11.8	15.7	8.0	11.9	14.5	8.5	11.5	15.9	8.6	12.4
Ethrel 100	25.2	14.0	19.6	23.3	13.8	18.6	21.6	12.7	17.2	22.7	12.5	17.7
Ethrel 250	33.3	17.5	25.4	32.6	16.5	24.6	30.1	16.0	23.1	31.1	15.5	23.3
MH 50	19.5	13.1	16.3	20.4	11.2	15.8	19.3	12.5	32.0	18.2	11.5	14.9
Average	23.1	13.4	18.3	23.0	12.4	17.7	21.4	12.4	16.9	22.0	12.0	17.0
C. D. at 5%	SM : D ₁ =1.4; D ₂ =0.8			GP : D ₁ =NS; D ₂ =NS			SM X GP : D ₁ =7.5; D ₂ =2.4					
Total fruit yield (kg/plant)												
Control	0.87	0.54	0.71	1.11	0.64	0.88	1.03	0.60	0.82	1.12	0.68	0.90
Ethrel 100	1.52	0.85	1.19	1.64	0.90	1.27	1.60	0.89	1.25	1.71	0.94	1.33
Ethrel 250	1.84	0.97	1.41	1.96	0.99	1.48	1.93	0.98	1.46	2.04	1.01	1.53
MH 50	1.37	0.79	1.08	1.48	0.84	1.16	1.46	0.83	1.15	1.54	0.90	1.22
Average	1.40	0.79	1.10	1.55	0.84	1.20	1.50	0.83	1.17	1.60	0.88	1.24
C. D. at 5%	SM : D ₁ =0.36; D ₂ =0.20			GP : D ₁ =NS; D ₂ =NS			SM X GP : D ₁ =0.33; D ₂ =0.18					
Total fruit yield (q/ha)												
Control	174.7	108.7	141.7	221.4	127.3	174.4	206.2	119.5	162.9	239.5	135.1	187.3
Ethrel 100	303.3	169.9	236.6	328.9	180.1	254.5	319.4	178.1	248.8	341.8	188.1	265.0
Ethrel 250	367.4	193.6	280.5	392.1	198.1	295.1	385.6	195.3	290.5	407.1	201.8	304.5
MH 50	274.9	158.7	216.8	296.2	167.2	231.7	291.5	165.4	228.5	307.8	179.3	243.6
Average	280.1	157.7	218.9	309.7	168.2	239.0	300.7	164.6	232.7	324.1	176.1	250.1
C. D. at 5%	SM : D ₁ =9.2; D ₂ =4.8			GP : D ₁ =9.2; D ₂ =4.8			SM X GP : D ₁ =65.4; D ₂ =36.7					

TABLE 3
Effect of Ethrel on net gain (Rs./ha) over the control* and cost : benefit ratio in summer squash

Character	Control	Ethrel 100 ppm	Ethrel 250 ppm
Yield characters			
Early yield (q/ha)	79.5	140.8	167.7
Total yield (q/ha)	166.6	251.3	292.7
Economics			
	Early yield		Total yield
	Control	Ethrel 100 ppm	Ethrel 250 ppm
Gross income (Rs.)*	3975.0	7040.0	8385.0
Approximate cost of cultivation (Rs./ha)	3000.0	3300.0	3500.0
Cost of Ethrel spraying operations (Rs./ha)**	—	48.0 + 50.0 = 98.0	120.0 + 50.0 = 170.0
Total net profit (Rs./ha)	975.0	3642.0	4715.0
Net gain (Rs./ha) over control	—	2667.0	3740.0
Cost : benefit ratio		3.74	4.84
		1.91	2.32

*Summer squash @ Rs. 50/q and Rs. 35/q for early and total yield respectively.

**Ethrel @ Rs. 24/10 ml.

fruit number was recorded from untreated control in both the dates of sowing. Increase in the number of fruits per plant due to Ethrel and MH were in confirmation with the findings of Arora *et al.* (1982) in summer squash, while effects of growth promoters were in consonance with the findings of Pandita *et al.* (1982) in muskmelon. Early yield also followed more or less similar trend. The maximum early yield (kg/plant and q/ha) was observed with Ethrel at 250 ppm followed by Ethrel at 100 ppm and MH at 50 ppm. However, growth promoters were statistically at par with each other. Control plants performed poorest in this regard.

Significant differences were evident in the total number of fruits and total weight of fruits due to sex modifying and growth promoting chemicals in both the dates of sowing (Table 2). The number of fruits per plant from total yield was the highest in D₁. Total yield per plant (and per hectare) was also highest in D₁. The maximum number of fruits per plant was recorded due to Ethrel at 250 ppm followed by Ethrel at

100 ppm and MH at 50 ppm. Control plants gave least number of fruits and fruit yield by weight per plant. Total yield (kg/plant and q/ha) also followed similar trend. Growth promoters were statistically at par with each other when used alone or in combination with various sex modifying chemicals when compared with untreated control. Effects of sex modifying chemicals were similar to those recorded by Singh *et al.* (1974) and Arora *et al.* (1982) in summer squash. However, non-significant results of growth promoters followed the findings of Arora *et al.* (1988).

Data in Table 3 reveal that spray of Ethrel 250 ppm gave a net profit of Rs. 4715.0/ha and Rs. 6574.5/ha from early and total yield, respectively. However, it was Rs. 975.0/ha and Rs. 2831.0/ha from control plants. The net gains from Ethrel 250 ppm were Rs. 3740.0/ha and Rs. 3743.5/ha from early and total yield, respectively. Cost : benefit ratio from Ethrel 250 ppm came out to be 4.84 and 2.32 for early and total yield, respectively.

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REACTION OF GERMPLASM AND STUDIES ON AVOIDABLE YIELD LOSSES IN CHICKPEA DUE TO ROOT-KNOT NEMATODE, *MELOIDOGYNE JAVANICA*

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ABSTRACT

A total of 220 available chickpea germplasm were screened for resistance to root-knot nematode, *Meloidogyne javanica*. None was found resistant to the nematode species. In a field trial, avoidable loss in chickpea was found to be 9.22% due to *M. javanica*.

Root-knot nematode, *Meloidogyne javanica* (Treub, 1885) Chitwood, 1949 is most predominant species infecting chickpea. It is known to damage this crop severely (Srivastava *et al.*, 1974; Dhargar and Gupta, 1983). Host plant resistance is an important component of integrated pest management to combat nematode problem in various crops. Attempts have been made previously to evaluate germplasm of chickpea for resistance (Hasan, 1983; Mani and Sethi, 1984; Handa *et al.*, 1985; Sharma and Mathur, 1985; Verma and Gupta, 1986) but a little success was obtained in identifying sources of resistance. Hence, further investigations were made to evaluate the available germplasm against *M. javanica* and to know the avoidable losses due to this nematode in a field trial.

MATERIAL AND METHODS

Three seeds of each germplasm were sown in earthen pots filled with 500 g

steam sterilized soil. Ten days after sowing, one plant per pot was retained and then each seedling was inoculated with 500 freshly hatched second stage juveniles of *M. javanica*. Each line was replicated thrice. Local cultivar 'Gaurav' was kept as control. Fortyfive days after inoculation each plant was removed by washing the soil and observations on gall index were recorded. The lines were categorised according to gall index of 1-5 (Anonymous, 1985).

To estimate yield losses, an experiment was laid out in paired plot design in the sick-plot of Department of Nematology, with the initial population of 310 ± 10 juveniles of *M. javanica*/250 ml soil. There were only two treatments, *i. e.* carbofuran (Furadan 3 G) @ 4 kg a. i./ha as soil application before sowing (cv. Gaurav) and untreated check. There were eight replications of each treatment and each plot measured 1×1.5 metre. The plants were harvested at maturity and

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grain yield per plot (converted to hectare basis) and root-knot index were calculated.

RESULTS AND DISCUSSION

Out of 220 germplasm evaluated against *M. javanica* none showed resis-

tance to the nematode but 42 showed moderately resistant reaction. Rest of the lines were either susceptible or highly susceptible Table 1).

The data in Table 2 reveal that yield was significantly more in case of treated

TABLE 1

Reaction of available chickpea germplasm to *Meloidogyne javanica*

Category	Germplasm/line						
Highly resistant	None						
Resistant	None						
Moderately resistant	IC-6411,	IC-10823,	IC-11315,	IC-11316,	IC-11317,	IC-11324,	IC-12233,
	IC-12238,	IC-12241,	IC-12247,	IC-12243,	IC-12244,	IC-12245,	IC-12248,
	IC-12249,	IC-12250,	IC-12251,	IC-12267,	IC-12267,	IC-12268,	IC-12272,
	IC-12274,	IC-12431,	IC-12432,	IC-12434,	IC-12437,	IC-12438,	IC-12439,
	IC-12440,	IC-12443,	IC-12444,	IC-12446,	IC-12448,	IC-12457,	IC-12459,
	IC-12460,	IC-12462,	IC-12466,	IC-12467,	IC-12469,	IC-12472,	IC-Pi-320.
Susceptible	IC-12463,	IC-12441,	IC-12436,	IC-12246,	IC-12273,	IC-12453,	IC-12256,
	IC-12251,	IC-12257,	IC-12258,	IC-12259,	IC-12445,	IC-12464,	IC-12252,
	IC-12254,	IC-12467,	IC-12429,	IC-12275,	IC-12242,	IC-12253,	IC-12458,
	IC-12236,	IC-12430,	IC-12234,	IC-11312,	IC-11322,	IC-11311,	IC-12235,
	IC-12461,	IC-12240,	IC-12247,	IC-11323,	IC-11314,	IC-11313,	IC-12470,
	IC-12471,	IC-12269,	IC-12270,	IC-12478,	IC-11319,	IC-12271,	IC-12230,
	IC-12451,	IC-12452,	IC-12454,	IC-11321,	IC-12455,	IC-11318,	IC-12442,
	IC-12449,	IC-12468,	IC-12450,	G-130,	H 75-35,	IC-1435,	IC-1441,
	IC-1870,	IC-2243,	IC-2484,	IC-2664,	IC-3328,	IC-3428,	IC-6440,
	IC-6474,	IC-6488,	IC-6800,	IC-6817,	IC-7489,	IC-8988,	IC-9025,
	IC-9032,	IC-9035,	IC-9112,	IC-10384,	IC-10511,	IC-10630,	IC-10802,
	IC-809,	IC-11311,	IC-11314,	IC-11318,	IC-11321,	IC-11323,	IC-11324,
	IC-11550,	IC-11552,	IC-12239,	IC-12249,	IC-12250,	IC-12254,	IC-12256,
	IC-12258,	IC-12259,	IC-12268,	IC-12272,	IC-12273,	IC-12431,	IC-12432,
	BA-1, Gaurav.						
Highly susceptible	IC-184,	IC-434,	IC-438,	IC-594,	IC-595,	IC-606,	IC-779,
	IC-871,	IC-925,	IC-1297,	IC-1314,	IC-1406,	IC-1434,	IC-1437,
	IC-2246,	IC-2450,	IC-2595,	IC-3354,	IC-2858,	IC-3075,	IC-3407,
	IC-3528,	IC-3768,	IC-4485,	IC-4850,	IC-5901,	IC-6384,	IC-6501,
	IC-6730,	IC-6815,	IC-7481,	IC-8166,	IC-8999,	IC-9023,	IC-9029,
	IC-9033,	IC-9055,	IC-11224,	IC-11312,	IC-11313,	IC-11315,	IC-11316,
	IC-11317,	IC-11319,	IC-11320,	IC-11322,	IC-11551,	IC-11554,	IC-12233,
	IC-12234,	IC-12235,	IC-12236,	IC-12237,	IC-12238,	IC-12240,	IC-12241,
	IC-12243,	IC-12244,	IC-12245,	IC-12246,	IC-12248,	IC-12252,	IC-12253,
	IC-12255,	IC-12257,	IC-12267,	IC-12269,	IC-12270,	IC-12271,	IC-12274,
	IC-12275,	IC-12428,	IC-12429,	IC-12430,	IC-12434,	IC-12436,	IC-12437,
	KW-4.						

TABLE 2
Avoidable loss in chickpea infected with
Meloidogyne javanica

Treatment	Mean yield/ ha (q)	Avoidable loss	Root- knot index
Carbofuran (Furadan 3 G) 4 kg a. i./ha	15.87	9.22	2.1
Untreated (control)	14.53	—	3.4
t at 5%	9.5		4.9

plots as compared to untreated ones. The per cent increase in yield in treated

plots over control was 9.22. However, Upadhyay and Dwivedi (1986) reported 38.7 to 46.8 per cent loss in yield due to *M. incognita* in chickpea. The differences in both the studies might be due to some variation in species of the nematode, cultivar and some other edaphic factors in the experimentation. However, root-knot index was decreased significantly in treated plots over untreated ones.

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INTERGENOTYPIC COMPETITION STUDIES IN KABULI GRAM (*CICER ARIETINUM* L.)

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ABSTRACT

Twentyeight mechanical mixtures of kabuli gram, produced by eight cultivars in 1 : 1 ratio, were evaluated both in rainfed and irrigated environments. General and specific competitive ability (GCA and SCA) variances were significant for all the characters except plant height and biological yield in rainfed conditions for SCA. GL 629 was best general competitor followed by GL 635. These cultivars were good competitor for most of the characters. According to SCA effects, the mixtures, BG 411 + GL 633, BG 410 + L 144, GL 635 + GL 886, BG 410 + GL 886, L 550 + GL 629, GL 635 + GL 629, GL 635 + GL 629 and BG 410 + GL 635 were best for earliness, dwarfness, more number of branches and pods per plant, 100-seed weight, harvest index, seed yield and biological yield, respectively. Though mixtures are not alternative to pure cultures, yet under specific situations they perform better for stable production.

The traditional breeding techniques for improvement of gram, a highly autogamous species, have not resulted in any spectacular achievement. The economic utilization of the available variability through pure line and pedigree methods of selection has exhausted the major limits for further improvement. So, a synthesis of acceptable heterogenous population is necessary where economic advantage as a result of utilizing both individual as well as population buffering can outweigh advantages obtainable from growing monocultures. Keeping this in view, the present investigation was undertaken to study the intergenotypic competition in the mechanical mixture of eight cultivars/components of kabuli gram.

MATERIAL AND METHODS

Eight cultivars of kabuli gram (*Cicer arietinum* L.), selected on the basis of genetic variability, were mixed in 1 : 1 ratio by counting to produce a mechanical diallel. These 28 mixtures alongwith eight parents/components were sown in a randomized block design with four replications in two environments—rainfed and irrigated. Each entry was planted in paired rows of 5 metres spaced 30 cm; and plants within rows were spaced 10 cm apart. Twenty competitive plants per entry per replication were recorded to compute competitive abilities. Mean data were subjected to combining ability analysis in the same fashion as combining ability of lines in hybrid combinations (Griffing, 1956).

RESULTS AND DISCUSSION

The analysis of variance of all the eight characters studied in two different environments showed that the mean squares due to treatments were highly significant (Table 1). This indicated the presence of significant differences among components and or their mixtures. Similarly, the mean squares due to general competitive ability (GCA) effects were significant for all characters studied. However, mean squares due to specific competitive ability (SCA) were non-significant for plant height and biological yield under rainfed conditions. It indicated that both the GCA and SCA effects were important under both the environments.

Hence, improvement of yield in this crop will depend on selection of genotypes/components on the basis of both GCA and SCA effects.

The inference derived from the estimates of GCA effects of parents for different characters in different environments indicated that L 144, GL 629, BG 411, BG 410, L 144, GL 886, BG 410 and GL 629 were best general competitors for earliness, tallness, branches, pods, seed size, biological yield, harvest index and seed yield, respectively (Table 2). However, GL 629 was the best general competitor as it contributed favourably to all characters except earliness and bolder seeds. Similarly, GL 635 was good

TABLE 1

Mean squares for intergenotypic competition studies in kabuli gram

Characters/D.F.	Environments	Treatments 35	General mixing ability 7	Specific mixing ability 28	Error 105
Days to maturity	E ₁	303.23*	76.83*	75.55*	4.67
	E ₂	384.12*	35.90*	111.06*	1.14
Plant height	E ₁	142.63*	115.92*	15.59	22.83
	E ₂	284.98*	72.66*	70.89*	1.80
Branches per plant	E ₁	1.17*	0.52*	0.24*	0.01
	E ₂	5.54*	0.89*	1.51*	0.11
Pods per plant	E ₁	244.11*	121.76*	45.85*	33.76
	E ₂	149.25*	49.27*	34.33*	26.69
100-seed weight	E ₁	38.96*	40.72*	2.00*	1.50
	E ₂	79.85*	54.59*	11.31*	1.69
Biological yield per plant	E ₁	220.48*	163.42*	28.11*	34.22
	E ₂	384.99*	72.37*	102.22*	51.09
Harvest index	E ₁	411.81*	58.25*	123.44*	23.94
	E ₂	164.67*	30.39*	43.86*	6.90
Seed yield per plant	E ₁	94.19*	12.31*	26.35*	0.12
	E ₂	98.52*	13.21*	27.49*	0.08

E₁=Rainfed; E₂=Irrigated

*Significant at 1%.

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TABLE 2

General competitive ability effects (ranks) in kabuli gram

Characters	Env	L 550	BG 410	GL 635	GL 629	GL 886	BG 411	GL 633	L 144
Days to maturity	E ₁	2*	7*	1*	5	3*	4	6*	8*
	E ₂	6*	7*	2*	3*	5*	4*	1*	8*
Plant height	E ₁	7*	8*	2	1*	5	6	4	3
	E ₂	5	4	8	2*	7	1*	6*	3*
Branches per plant	E ₁	7*	8*	2*	1*	5	3	6	4
	E ₂	6*	7*	3*	4*	8*	1*	5*	2*
Pods per plant	E ₁	7	1*	3	2*	6	5	4	8*
	E ₂	3	1*	4	2	7	8	6	5
100-seed weight	E ₁	5	6	8*	7*	2	3	4	1*
	E ₂	3	4	7*	6*	2*	5*	8*	1*
Biological yield per plant	E ₁	7*	8*	2*	1*	4	6	3*	5
	E ₂	2*	3	4	5	1	7	6	8*
Harvest index	E ₁	2*	1*	7*	4	3	5	8*	6
	E ₂	4	3	5	1*	7	6	8	2*
Seed yield per plant	E ₁	3*	8*	2*	1*	5	6*	7*	4
	E ₂	2*	8*	5	1*	4	6*	7*	3*

E₁=Rainfed; E₂=Irrigated

*Significant at 1%.

general competitor for yield and its major components. Contrarily, GL 633 was the poorest competitor as it failed to contribute favourably to any of the characters.

Maximum SCA effect for earliness was observed in the mixture BG 411+GL 633, whereas mixture GL 629+GL 633 was the latest to mature (Table 3). Similarly, dwarfest mixture was BG 410+L 144 and tallest mixture was GL 886+BG 411 followed by GL 635+GL 633. The mixture GL 635+L 144 had minimum number of branches, whereas mixture GL 635+GL 886 produced maximum number of branches. For pods per plant, mixture GL 629+BG 411 was best under rainfed, whereas BG 410+GL 886 was best under irrigated environment. Contrarily,

mixture L 550+BG 410 under rainfed and mixture GL 886+BG 411 under irrigated had lower pods. The mixture GL 633+L 144 had smallest seeds under both environments. The mixture GL 635+GL 629 was desirable for harvest index and seed yield per plant while mixture GL 629+GL 886 had minimum seed yield, biological yield and harvest index. However, highest biological yield was observed in the mixture BG 410+GL 629.

It is obvious that uniformity in many characters of the crop cultivars is desired by the farmers, traders and consumers. A mixture may be highest yielder but is useless if their characteristics are different. Therefore, whenever a mixture of two components/cultivars is to be grown then

TABLE

Specific competitive ability

Characters → Mixtures	Days to maturity		Plant height		Branches per plant	
	E ₁	E ₂	E ₁	E ₂	E ₁	E ₂
L 550 + BG 410	25*	22*	20	13	9	20*
L 550 + GL 635	6*	6*	22	22*	3*	9*
L 550 + GL 629	15	10*	14	23*	27	17*
L 550 + GL 886	22*	27*	12	5*	20	18*
L 550 + BG 411	9*	8*	27	20*	12	8*
L 550 + GL 633	24*	26*	21	17*	4*	6*
L 550 + L 144	20*	16	8	7*	24	25*
BG 410 + GL 635	5*	14*	17	28*	16	22*
BG 410 + GL 629	18	18	28	21*	8	11
BG 410 + GL 886	7*	7*	9	1*	13	19*
BG 410 + BG 411	13	4	19	24*	17	14*
BG 410 + GL 633	3*	15	11	11	10	7*
BG 410 + L 144	19	21*	23	26*	11	3*
GL 635 + GL 629	4*	12*	2	8*	26	26*
GL 635 + GL 886	14	1*	16	14	1*	4*
GL 635 + BG 411	17	17	10	12	5	5*
GL 635 + GL 633	12	3*	4	2*	19	21*
GL 635 + L 144	27*	23*	18	18*	28	28*
GL 629 + GL 886	26*	24*	24	15	18	16*
GL 629 + BG 411	10*	11*	15	27*	6	12
GL 629 + GL 633	2*	2*	26	19*	14	2*
GL 629 + L 144	23*	20*	3*	9	27	15*
GL 886 + BG 411	11*	13*	1	3*	25	24*
GL 886 + GL 633	1*	5*	25	16*	7	1*
GL 886 + L 144	16	19*	3	25*	15	23*
BG 411 + GL 633	28*	28*	5	10	23	13
BG 411 + L 144	8*	9*	7	6*	2*	10*
GL 633 + L 144	21*	25*	6	4*	23	27*

E₁ = Rainfed; E₂ = Irrigated

*Significant at 1%.

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effects (ranks) in kabuli gram

Pods per plant		100-seed weight		Biological yield per plant		Harvest index		Seed yield per plant	
E ₁	E ₂	E ₁	E ₂	E ₁	E ₂	E ₁	E ₂	E ₁	E ₂
28*	15	15	2*	20	23	18	18	19*	17*
16	17	6	15	18	17	12	14	16*	15*
17	24	2	3*	13	11	10	7	8*	10*
18	16	14	7*	5	3	4*	10	5*	8*
15	7	8	17	6	12	27*	28*	26*	27*
2*	8*	10	5*	12	13	14	11	12	11
23	19	3	8	10	10	16	16	10*	9*
4	14	17	25*	3	4	17	21*	17*	20*
7	12	4	9	11	1*	11	3*	9*	2*
3	1*	16	4*	16	20	8	9	14	13*
14	25	11	13	4	7	7	6*	3*	5*
19	3	7	16	8	5	2*	2*	2*	3*
13	23	27	22	15	27*	21	13	18*	23*
20	26	18	14	21	24	1*	1*	1*	1*
5	4	25	21	17	15	23*	17	21*	18*
11	9	19	24*	25	19	22	20	23*	22*
12	18	24	27*	19	26*	19	15	15*	12
22*	22	1	12	26	25	24*	24*	27*	26*
9	5	23	28*	23	28*	28*	25*	28*	28*
1*	10	5	1*	27	21	6	26*	25*	25*
26	6	9	6*	24	14	20	23*	24*	24*
10	11	12	10	2	6	25*	27*	22*	21*
27	28*	22	19	14	22	5*	8	4*	4*
21	20	21	23*	28	18	15	12	20*	16*
24	27	13	11	22	16	3*	4*	6*	6*
25	21	20	18	1	8	26*	22*	7*	19*
6	2	26	20	9	9	9*	5*	11*	7*
8	13	28	26*	7	2	13	19	13	14*

the cultivars should be almost with similar days to maturity, seed size and plant height. Characteristics of all the cultivars are given in Table 4. Many specific mixtures showed early maturity as well as reduced height but the mixture BG 411 + GL 633 was best for earliness. This mixture contained both the components with similar days to maturity. Similarly, mixtures BG 410 + GL 635 and BG 410 + L 144 had reduced height under irrigated conditions which is desirable because irrigated environment causes excessive growth resulting in poor seed yield as there is minimum pod setting. The earliness was due to competition because Luedders (1979) reported that competition hastens maturity. In the present investigation, the mixture L 550 + BG 410

showed earliness. However, days to maturity differed by 17 days in the two components, BG 410 being late in maturity. Thus, L 550 showed undercompensation type of competitive ability. Similarly, mixture BG 410 + GL 629 was good yielder. Interestingly, component BG 410 was poorest yielder and GL 629 was highest yielder among all the eight components included in this study. This may be the result of complementary competition in these two components, BG 410 showing overcompensation and GL 629 showing neutral compensation. Similarly, mixture BG 410 + BG 411 showed good yield, whereas BG 410 was poor yielder and BG 411 was high yielder. Banerjee *et al.* (1971) also reported that poor yielders increased seed

TABLE 4
Mean characteristics of cultivars in kabuli gram

Characters	Env.	L 550	BG 410	GL 635	GL 629	GL 886	BG 411	GL 633	L 144
Days to maturity	E ₁	149.25	131.50	145.65	159.25	138.75	150.50	136.00	146.75
	E ₂	155.50	140.30	147.25	150.00	157.00	147.75	163.75	161.25
Plant height	E ₁	42.10	41.15	53.30	62.50	56.20	42.10	56.40	57.45
	E ₂	73.00	85.20	67.25	79.38	66.75	78.10	58.90	76.90
Branches per plant	E ₁	4.68	4.86	5.80	6.53	5.01	5.50	4.78	5.90
	E ₂	4.83	4.10	6.78	5.03	4.38	6.45	4.23	6.13
Pods per plant	E ₁	58.15	72.70	63.35	66.35	52.15	50.55	55.70	45.50
	E ₂	67.75	67.63	70.10	57.50	66.83	81.73	57.60	70.23
100-seed weight	E ₁	19.47	20.95	17.06	18.13	23.71	20.89	21.84	33.13
	E ₂	20.68	17.48	24.80	19.16	30.46	21.23	21.35	31.71
Biological yield per plant	E ₁	39.40	39.45	60.30	53.15	51.75	44.45	57.68	46.00
	E ₂	80.63	68.43	90.75	77.43	85.83	66.73	70.88	70.38
Harvest index	E ₁	44.61	20.60	26.85	39.66	33.95	45.17	27.57	40.71
	E ₂	22.58	11.78	17.29	27.34	19.33	27.34	21.66	27.83
Seed yield per plant	E ₁	17.58	8.08	16.12	20.44	15.14	18.25	14.56	18.43
	E ₂	18.06	7.60	15.16	19.93	16.18	17.31	14.75	18.97

E₁ = Rainfed; E₂ = Irrigated

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yield, whereas good yielders decreased it in mixtures. Interestingly, BG 410+ GL 633 showed superiority though both were poor yielder indicating overcompensation.

differential response of genotypes to varying micro and macro environments can be utilized by producing a mixture of these provided the marketable produce is more or less homogeneous.

Since chickpea, like other pulses is highly unstable in its performance, the

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PERFORMANCE OF VARIOUS HYBRIDS OF BRINJAL (*SOLANUM MELONGENA* L.)

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ABSTRACT

One hundred and five hybrids along with four standard varieties of brinjal were evaluated for two years. The extent of heterosis over standard variety BR-112 was 239.81% for number of fruits and 164.56% for fruit yield per plant. The maximum heterosis over variety PH-4 was 80.76 and 157.68 per cent for number of fruits and yield, respectively. The range for fruit number and yield per plant was 4.42 to 28.00 and 445 to 3270 g, respectively. The maximum number of fruits (28.00) and highest yield (3270 g) per plant were produced by hybrid H-11 × H-7. The minimum borer infestation (7.34%) was found in hybrid R-34 × PH-4. The highest heterosis for yield in long fruited hybrids over variety PH-4 was found in hybrid H-11 × H-7 (157.68%). Among good fruit colour round fruited hybrids, the maximum heterosis over variety BR-112 for number of fruits and total yield was in PBR-91-2 × 202-9 (65.29 and 62.14 per cent, respectively). The hybrids H-11 × H-7, H-7 × R-34, R-34 × ARU-20 and H-17 × H-7 (long fruited); PBR-91-2 × 202-9, PBR-1205 × PBR-91-1, H-8 × BR-112 (round fruited) and BR-112 × H-7, H-7 × H-8, H-7 × ARU-20, PBR-91-2 × PBR-120-5 and H-11 × PBR-91-2 (oblong fruited) were superior for yield and fruit colour.

Exploitation of hybrid vigour by inter-varietal hybridization is one of the potential means for commercial increase in production. In brinjal it has been reported by many workers for yield and its contributing characters (Mishra, 1961; Thakur *et al.*, 1968; Singh *et al.*, 1974). Hybrid varieties are generally upto market standards as these are uniform in maturity, quality and yield. Though many studies have been conducted on the exploitation of heterosis in brinjal but the extent of availability of hybrids at commercial level is restricted, yet the crop has additional advantage of producing a large number of seeds per fruit.

The present investigation was undertaken to select high yielding with better quality hybrid variety suitable for commercial production.

MATERIAL AND METHODS

One hundred and five hybrids and four standard varieties, viz. BR-112 and H-8 (round); PH-4 and H-7 (long) were transplanted in the second week of August, during 1985-86 and 1986-87, in a randomized block design with three replications at the Vegetable Research Farm, Haryana Agricultural University, Hisar. The spacing between rows and

plants was kept 60×60 cm. All the recommended cultural practices were followed for raising the crop. To screen the hybrids for resistance/tolerance to shoot and fruit borer infestation, the crop was not sprayed. The observations were recorded on five randomly selected plants in each replication for number of fruits per plant, yield per plant (g), per cent shoot and fruit borer infestation, fruit shape and fruit colour. Heterosis for round and oblong fruit bearing hybrids was calculated over recommended variety BR-112, and for long ones over variety PH-4 for number of fruits and yield per plant. The data presented in Table 1 are pooled mean of both the years.

RESULTS AND DISCUSSION

The mean values among hybrids were found to be highly significant for all the characters (Table 1). The maximum number of fruits per plant (28.00) was harvested from hybrid H-11×H-7 followed by R-34×ARU-20 (26.06), H-17×H-7 (26.05) and R-34×PH-4 (25.19) as compared to long standard varieties PH-4 (15.49) and H-7 (19.22). The fruits of these hybrids were long with dark purple colour except R-34×PH-4. Significant differences were also found for shoot and fruit borer infestation. Hybrid R-34×PH-4 showed least infestation (7.34%) followed by H-8×202-14 (8.84%), PBR-91-2×P-8 (9.04%) and PBR-91-1×ARU-20 (9.15%) but these hybrids were poor yielder. Among check varieties BR-112 showed maximum infestation (31.39%) followed by H-8 (20.21%), PH-4 (16.09%) and H-7 (12.05%). Reciprocal crosses showed a significant difference

for borer infestation. When H-8 was used as male, *i.e.* 202-14×H-8, then there was more infestation (32.18%). Similarly when Aushey was used as male parent (BR-112×Aushey) the infestation was very high (45.13%) and when Aushey was used as female (Aushey×BR-112) the infestation was recorded 12.84 per cent. Similar cases were observed for other parents also (Table 1). This may be due to the maternal effect of the parents for shoot and fruit borer incidence. The oblong fruit bearing hybrid H-11×H-8 produced maximum infested fruits (47.22%).

Hybrid H-11×H-7 exhibited highest yield per plant (3270 g) with long dark purple fruits followed by PH-4×BR-112 (2666 g), BR-112×H-7 (2565 g), H-7×R-34 (2420 g), H-7×PBR-91-2 (2354 g), PBR-120-5×R-34 (2264 g), 202-9×PBR-91-1 (2048 g), PBR-91-2×202-9 (2004 g) and PBR-1205×PBR-91-1 (1833 g) (Table 1). But the colour of the fruits of hybrids PBR-120-5×R-34 and 202-9×PBR-91-1 was light purple. The standard varieties BR-112, H-8, PH-4 and H-7 yielded 1236, 1279, 1269 and 1374 g per plant, respectively.

Number of fruits and yield per plant ranged from 4.42 to 28.00 and 445 to 3270 g, respectively (Table 2). The shoot and fruit borer infestation ranged from 7.34 to 47.22 per cent. The hybrids exhibited heterosis of -46.36 to 239.81 per cent over recommended variety BR-112 for number of fruits per plant. The range of heterosis over the variety BR-112 for number of fruits is more because the data include some long hybrids also which produced more

TABLE 1
Performance of different hybrids of brinjal

S. No.	Hybrid	No. of fruits/ plant	Borer infestation (%)	Total yield/ plant (g)	Fruit shape	Fruit colour
1	2	3	4	5	6	7
1.	Aushey × BR-112	7.16	12.84	1130	Round	Good purple
2.	Aushey × H-7	9.57	37.31	1064	Oblong	Dark purple
3.	Aushey × PBR-91-1	11.40	16.87	1202	Oblong	Purple
4.	Aushey × PBR-91-2	10.34	12.00	1332	Oblong	Good purple
5.	Aushey × PH-4	8.73	9.55	1181	Long	Purple
6.	Aushey × R-34	10.41	25.00	1350	Oblong	Light purple
7.	ARU-1 × PBR-91-1	13.00	29.23	2100	Oblong	Purple
8.	ARU-20 × H-7	21.16	25.45	1627	Long	Bright dark purple
9.	ARU-20 × H-8	12.50	31.25	1450	Oblong	Dark purple
10.	ARU-20 × PH-4	14.37	21.12	1666	Long	Purple
11.	BR-112 × H-7	14.80	24.32	2565	Oblong	Good purple
12.	BR-112 × H-8	6.30	28.94	1007	Round	Good purple
13.	BR-112 × Aushey	5.63	45.13	912	Round	Purple
14.	BR-112 × PBR-91-1	9.51	35.05	1158	Round	Purple
15.	BR-112 × PBR-91-2	7.50	23.93	862	Round	Purple
16.	BR-112 × R-34	15.98	21.05	1615	Oblong	Purple
17.	Chespo Bloom × PBR-91-1	14.96	27.03	1709	Oblong	Purple
18.	H-7 × H-8	15.55	31.77	1840	Oblong	Dark purple
19.	H-7 × ARU-20	15.16	25.84	1702	Oblong	Good purple
20.	H-7 × BR-112	15.49	30.31	2141	Oblong	Purple
21.	H-7 × PH-4	13.41	26.63	1471	Long	Good purple
22.	H-7 × PBR-91-1	17.57	24.67	1710	Oblong	Dark purple
23.	H-7 × PBR-91-2	19.91	27.60	2354	Oblong	Purple
24.	H-7 × R-34	24.00	17.36	2420	Long	Bright dark purple
25.	H-8 × BR-112	11.24	14.96	1524	Round	Good dark purple
26.	H-8 × PH-4	15.37	22.72	1936	Oblong	Light purple
27.	H-8 × PBR-91-1	7.99	22.73	990	Round	Purple
28.	H-8 × PBR-91-2	8.07	18.90	1144	Round	Dark bright purple
29.	H-8 × PBR-120-5	8.00	15.14	1349	Round	Good purple
30.	H-8 × PBR-1206	9.23	12.63	1358	Oblong	Dark purple
31.	H-8 × H-7	7.71	18.52	771	Oblong	Purple
32.	H-8 × 202-9	8.00	33.33	1060	Oblong	Bright dark purple
33.	H-8 × 202-14	9.23	8.84	1457	Round	Light purple
34.	H-10 × H-7	10.25	27.02	1017	Oblong	Bright dark purple
35.	H-10 × H-8	5.78	33.15	835	Round	Dark purple
36.	H-10 × H-17	10.90	22.24	1271	Oblong	Bright dark purple

Contd.

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1	2	3	4	5	6	7
37.	H-10×BR-112	9.21	27.00	1418	Round oblong	Good purple
38.	H-10×PBR-91-1	6.28	27.77	837	Round oblong	Good purple
39.	H-10×PBR-91-2	13.43	29.81	1327	Oblong	Good purple
40.	H-11×H-7	28.00	29.76	3270	Long	Dark purple
41.	H-11×H-8	12.00	47.22	1625	Oblong	Good purple
42.	H-11×H-10	13.38	18.76	1437	Oblong	Bright dark purple
43.	H-11×PBR-91-1	15.76	31.96	1327	Oblong	Dark bright purple
44.	H-11×PBR-91-2	18.00	16.66	1721	Oblong	Dark purple
45.	H-11×BR-112	15.28	25.93	1258	Oblong	Purple
46.	H-12×BR-112	4.42	19.35	507	Round	Light purple
47.	H-12×H-7	9.60	25.79	1059	Oblong	Purple
48.	H-12×H-8	8.05	41.82	1170	Round	Purple
49.	H-12×H-11	14.20	27.31	1480	Oblong	Dark purple
50.	H-12×PBR-91-1	8.05	41.82	1346	Oblong	Purple
51.	H-12×PBR-91-2	7.14	15.22	839	Oblong	Purple
52.	H-13×H-7	13.88	27.03	1301	Oblong	Good purple
53.	H-13×H-16	13.85	35.47	1595	Oblong	Bright dark reddish purple
54.	H-16×H-7	5.16	35.48	445	Oblong	Good purple
55.	H-16×H-8	9.85	21.74	1271	Round oblong	Bright dark purple
56.	H-17×BR-112	8.26	22.48	833	Oblong	Purple
57.	H-17×H-7	26.05	35.58	1686	Long	Bright dark purple
58.	H-17×H-8	9.58	26.20	1314	Oblong	Light purple
59.	H-17×H-18	8.16	22.45	633	Oblong	Light purple
60.	H-17×PBR-91-1	6.00	41.67	637	Oblong	Light purple
61.	H-17×PBR-91-2	9.91	21.41	989	Oblong	Dull dark purple
62.	H-18×BR-112	13.20	21.34	1608	Oblong	Purple
63.	H-18×H-7	15.80	16.64	1316	Long	Good purple
64.	H-18×H-8	10.30	24.15	1399	Oblong	Purple
65.	H-18×H-11	11.70	26.55	964	Oblong	Purple
66.	H-18×PBR-91-1	10.71	36.74	1374	Oblong	Light purple
67.	H-18×PBR-91-2	11.53	27.74	1870	Oblong	Purple
68.	H-19×BR-112	9.65	34.62	1098	Oblong	Light purple
69.	H-19×H-7	15.00	23.26	1318	Long	Bright dark purple
70.	H-19×H-8	7.05	36.04	1038	Round oblong	Purple
71.	H-19×H-12	11.26	26.74	1002	Oblong	Dark purple
72.	H-19×PBR-91-1	16.12	32.09	1761	Oblong	Light purple
73.	H-19×PBR-91-2	7.38	38.70	1148	Oblong	Good purple

Contd.

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1	2	3	4	5	6	7
74.	Hisar Durgapur × PBR-91-1	6.55	27.77	1322	Oblong	Light purple
75.	KT-2 × PBR-91-1	11.60	28.00	1588	Oblong	Purple
76.	PBR-91-1 × Aushey	6.35	27.39	783	Round	Dark purple
77.	PBR-91-1 × ARU-20	12.50	9.15	1257	Oblong	Good purple
78.	PBR-91-1 × PH-4	12.09	23.96	1272	Oblong	Purple
79.	PBR-91-1 × R-34	10.52	21.91	1239	Oblong	Purple
80.	PBR-91-2 × BR-112	9.31	24.59	1168	Round	Light purple
81.	PBR-91-2 × PH-4	11.46	21.71	1555	Oblong	Poor light purple
82.	PBR-91-2 × ARU-20	22.97	12.30	2212	Oblong	Light purple
83.	PBR-91-2 × P-8	8.33	8.04	1024	Round oblong	Purple
84.	PBR-91-2 × PBR-91-1	11.39	11.97	1355	Round oblong	Purple
85.	PBR-91-2 × PBR-120-5	11.82	14.87	1751	Oblong	Good dark purple
86.	PBR-91-2 × R-34	8.26	12.21	1715	Oblong	Dark purple
87.	PBR-91-2 × 202-9	13.62	9.38	2004	Round oblong	Good purple
88.	PBR-91-2 × 202-14	15.78	12.36	1329	Oblong	Light purple
89.	PBR-1205 × ARU-20	12.39	13.51	1466	Oblong	Light purple
90.	PBR-1205 × PBR-91-1	11.85	35.68	1833	Round	Good purple
91.	PBR-120-5 × ARU-20	13.53	18.14	1846	Oblong	Purple
92.	PBR-120-5 × BR-112	15.47	14.97	2086	Oblong	Light purple
93.	PBR-120-5 × PH-4	9.29	13.24	1301	Oblong	Light purple
94.	PBR-120-5 × R-34	21.00	12.63	2264	Oblong	Light purple
95.	PH-4 × BR-112	23.16	12.41	2666	Oblong	Purple
96.	R-34 × PH-4	25.19	7.34	1697	Long	Light purple
97.	R-34 × ARU-20	26.06	11.45	1858	Long	Good purple
98.	RHR-58 × PBR-91-1	11.95	36.58	1339	Oblong	Purple
99.	Sel-1 × PBR-91-1	13.82	23.12	1077	Oblong	Purple
100.	Sel-2 × PBR-91-1	11.61	35.54	1505	Round	Purple
101.	White fruited × PBR-91-1	8.46	37.09	764	Oblong	Good purple
102.	202-9 × PBR-91-1	12.74	24.42	2048	Round	Light purple
103.	202-14 × H-7	13.59	32.12	1847	Oblong	Poor light purple
104.	202-14 × H-8	7.83	32.18	1385	Round	Purple
105.	202-14 × PH-4	8.29	24.85	1834	Oblong	Light purple
General mean		12.18	24.49	1428		
Checks						
1.	BR-112	8.24	31.39	1236	Round	Light purple
2.	H-8	8.81	20.21	1279	Round	Bright purple blackish
3.	PH-4	15.49	16.09	1269	Long	Light purple
4.	H-7	19.22	12.05	1374	Long	Bright purple blackish
General mean		12.94	19.94	1290		
C. D. at 5%		0.89	1.58	51		

PERFORMANCE OF BRINJAL HYBRIDS

TABLE 2

Mean values and range of hybrids, checks and heterosis for various characters in brinjal

Character	Hybrids		Checks		Heterosis over		Heterosis over	
	Mean	Range	Mean	Range	BR-112 (%)		PH-4 (%)	
					Mean	Range	Mean	Range
Number of fruits/plant	12.18	4.42 to 28.00	12.94	8.24 to 19.22	47.73	-46.36 to 239.81	-21.41	-71.47 to 80.76
Total yield per plant (g)	1428	445 to 3270	1290	1236 to 1374	15.53	-64.00 to 164.56	12.50	-64.93 to 157.68
Borer infestation (%)	24.49	7.34 to 47.22	19.94	12.05 to 31.39	—	—	—	—

number of fruits per plant as compared to round ones. Heterosis for yield per plant ranged from -64.00 to 164.56 per cent and -64.93 to 157.68 per cent over recommended varieties BR-112 and PH-4, respectively (Table 2). The wide range showed a great possibility of selecting suitable hybrids for these traits.

The perusal of data in Table 3 revealed that among long hybrids the highest heterosis for total yield per plant over recommended long variety PH-4 was found to be in hybrid H-11×H-7 (157.68%) followed by H-7×R-34 (90.70%) and R-34×ARU-20 (46.41%). Heterosis for number of fruits per plant over variety PH-4 was also highest in hybrid H-11×H-7 (80.76%) followed by R-34×ARU-20 (68.24%), H-17×H-7 (68.17%) and R-34×PH-4 (62.22%). Hybrid 202-9×PBR-91-1 showed highest heterosis over variety BR-112 for yield per plant (65.70%) among round hybrids followed by PBR-91-2×202-9 (62.14%) and PBR-1205×PBR-91-1 (48.30%) while for number of

fruits the same was highest in hybrid PBR-91-2×202-9 (65.29%) followed by 202-9×PBR-91-1 (54.61%), PBR-1205×PBR-91-1 (43.81%) and Sel-2×PBR-91-1 (40.90%). Among oblong hybrids the highest heterosis for yield over recommended variety BR-112 was exhibited by hybrid PH-4×BR-112 (115.70%) followed by BR-112×H-7 (107.52%) and H-7×PBR-91-2 (90.45%). The expression of heterosis for the character has also been reported by Mishra (1961), Thakur *et al.* (1968), Singh *et al.* (1974, 1978a, b) and Dahiya *et al.* (1984). The variation in the order of sequence for heterosis between number of fruits and yield per plant may be due to variation in their fruit size. A few high yielding hybrids presented in Table 3 bear light purple colour fruits, and thus may not be commercially viable.

Data on some of the long, oblong and round hybrids having high yield with good fruit colour are presented in Table 4. The highest heterosis for yield in long hybrids over recommended variety

TABLE 3

Heterosis for number of fruits and yield per plant over standard varieties of some high yielding hybrids of brinjal

S. No.	Hybrid	Fruit shape	Fruit colour	No. of fruits/plant		Total yield/plant	
				Per cent heterosis over		Per cent heterosis over	
				BR-112	PH-4	BR-112	PH-4
1.	H-11×H-7	Long	Dark purple	—	80.76	—	157.68
2.	H-7×R-34	Long	Bright dark purple	—	54.94	—	90.70
3.	R-34×ARU-20	Long	Good purple	—	68.24	—	46.41
4.	R-34×PH-4	Long	Light purple	—	62.62	—	33.73
5.	H-17×H-7	Long	Bright dark purple	—	68.17	—	32.86
6.	202-9×PBR-91-1	Round	Light purple	54.61	—	65.70	—
7.	PBR-91-2×202-9	Round oblong	Good purple	65.29	—	62.14	—
8.	PBR-1205×PBR-91-1	Round	Good purple	43.81	—	48.30	—
9.	H-8×BR-112	Round	Good dark purple	36.41	—	23.30	—
10.	Sel-2×PBR-91-1	Round	Purple	40.90	—	21.76	—
11.	PH-4×BR-112	Oblong	Purple	181.07	—	115.70	—
12.	BR-112×H-7	Oblong	Good purple	79.61	—	107.52	—
13.	H-7×PBR-91-2	Oblong	Purple	141.63	—	90.45	—
14.	PBR-120-5×R-34	Oblong	Light purple	154.85	—	83.17	—
15.	PBR-91-2×ARU-20	Oblong	Light purple	178.76	—	78.96	—

PH-4 was found in hybrid H-11×H-7 (157.68%) followed by H-7×R-34 (90.70%), R-34×ARU-20 (46.41%) and H-17×H-7 (32.86%). All these hybrids produced dark and bright dark purple colour fruits. Among good fruit colour round fruited hybrids, the maximum heterosis over variety BR-112 for number of fruits and total yield per plant was found in hybrid PBR-91-2×202-9 (65.29 and 62.14 per cent, respectively) followed by PBR-1205×PBR-91-1 (43.81 and 48.30 per cent), H-8×BR-112 (36.41 and 23.30 per cent) and H-10×BR-112 (11.77 and 14.72 per cent). The highest heterosis for total yield per plant among good fruit colour oblong fruited hybrids

over variety BR-112 was found in hybrid BR-112×H-7 (107.52%) followed by H-7×H-8 (73.22%), H-7×ARU-20 (48.87%), PBR-91-2×PBR-120-5 (41.66%) and H-11×PBR-91-2 (39.24%).

It is concluded that out of 105 hybrids under study H-11×H-7, H-7×R-34, R-34×ARU-20 and H-17×H-7 (long fruited); PBR-91-2×202-9, PBR-1205×PBR-91-1, H-8×BR-112 (round fruited); and BR-112×H-7, H-7×H-8, H-7×ARU-20, PBR-91-2×PBR-120-5 and H-11×PBR-91-2 (oblong fruited) hybrids were found to be superior in respect of yield with dark purple fruit colour.

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TABLE 4

Heterosis for number of fruits and yield per plant over standard varieties of some high yielding with good fruit colour hybrids of brinjal

S. No.	Hybrid	Fruit shape	Fruit colour	No. of fruits/plant		Total yield/plant	
				Per cent heterosis over		Per cent heterosis over	
				BR-112	PH-4	BR-112	PH-4
1.	H-11×H-7	Long	Dark purple	—	80.76	—	157.68
2.	H-7×R-34	Long	Bright dark purple	—	54.94	—	90.70
3.	R-34×ARU-20	Long	Good purple	—	68.24	—	46.41
4.	H-17×H-7	Long	Bright dark purple	—	68.17	—	32.86
5.	ARU-20×H-7	Long	Bright dark purple	—	36.60	—	28.21
6.	PBR-91-2×202-9	Round oblong	Good purple	65.29	—	62.14	—
7.	PBR-1205×PBR-91-1	Round	Good purple	43.81	—	48.30	—
8.	H-8×BR-112	Round	Good dark purple	36.41	—	23.30	—
9.	H-10×BR-112	Round oblong	Good purple	11.77	—	14.72	—
10.	BR-112×H-7	Oblong	Good purple	79.61	—	107.52	—
11.	H-7×H-8	Oblong	Dark purple	88.71	—	73.22	—
12.	H-7×ARU-20	Oblong	Good purple	83.98	—	48.87	—
13.	PBR-91-2×PBR-120-5	Oblong	Good dark purple	43.45	—	41.66	—
14.	H-11×PBR-91-2	Oblong	Dark purple	118.46	—	39.24	—

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FIELD EVALUATION OF SOME INSECTICIDES AGAINST ONION THRIPS, *THRIPS TABACI* LINDEMAN (THYSANOPTERA : THIRIPIDAE)

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ABSTRACT

In field trials, ten insecticidal foliar sprays during 1986 and seven during 1987 were evaluated for their efficacy against onion thrips, *Thrips tabaci* Lind. Deltamethrin 0.002% and cypermethrin 0.006% proved most effective and were followed by endosulfan, fenitrothion, dichlorvos, malathion, each at 0.05% and fenvalerate 0.006%. Oxydemeton methyl 0.025%, dimethoate 0.03% and monocrotophos 0.04% were inferior to all other insecticides, except malathion and fenvalerate. Maximum bulb yield was recorded in plots treated with cypermethrin and minimum in case of dichlorvos treated plots.

Onion (*Allium cepa* L.) is an important vegetable cash crop. Of the various factors responsible for the reduction in onion yield, damage caused by onion thrips, *Thrips tabaci* Lind. is considerable. Early damage by the pest is characterized by the appearance of silvery patches on the leaves. However, in case of severe infestation, the leaves later on wither, turn brown and dry up. The crop gives a blighted appearance and remains stunted. In Haryana, only malathion is recommended for the control of this pest (Anonymous, 1986), though elsewhere a number of insecticides have been found effective against it (Mote, 1976; Reddy and Jagdish, 1980; Sinha *et al.*, 1983; Gupta *et al.*, 1984; Mayer *et al.*, 1987). Therefore, it was considered worthwhile to test the efficacy of some newer insecticides for the effective control of this

pest under the agro-climatic conditions of Haryana.

MATERIAL AND METHODS

The experiments were conducted at the Research farm of Haryana Agricultural University, Hisar, during 1986 and 1987 and at Farmer's field during 1986. A total of 12 treatments including the control during 1986 and 8 during 1987 were compared in a randomized block design with three replications keeping plot size of 3×3 m. In all the experiments, seedlings of onion variety Pusa Red were transplanted with a spacing of 15×10 cm in the month of January and harvesting was done in June.

The insecticides and their concentrations (in canal water) used were :

INSECTICIDES AGAINST ONION THRIPS

endosulfan (Thiodan 35 EC), malathion (Malathion 50 EC), fenitrothion (Folthion 50 EC) and dichlorvos (Vapona 76 EC) each at 0.05%; 0.04% monocrotophos (Monocil 36 WSC); 0.03% dimethoate (Rogor 30 EC); 0.025% oxydemeton methyl (Metasystox 25 EC); 0.006% fenvalerate (Fenval 20 EC) and cypermethrin (Ripcord 10 EC); and 0.002% deltamethrin (Decis 2.5 EC). Since, during the 1986 trials systemic insecticides, viz. oxydemeton methyl, dimethoate and monocrotophos were found to be the poorest in controlling thrips, these were excluded from the 1987 trial. During both the years, the crop was sprayed only once with the help of knapsack sprayer fitted with tripple action nozzle using 300 litres spray material per acre in the last week of March when the crop height was about 40 cm.

Population counts of both nymph and adult thrips were made from the central leaves of ten random plants with the help of a hand lens before 9 a.m. While recording the population the insects were kept undisturbed to the extent possible. The data were recorded one day before and 3, 7 and 11 days after spraying. The data from each trial and pooled data for the two years were subjected to analysis of variance.

RESULTS AND DISCUSSION

During 1986, all the insecticidal treatments except oxydemeton methyl, and at all the testing intervals (3, 7 and 11 days after spraying) proved better than the control (Table 1). However, during 1987, endosulfan, dichlorvos, cypermethrin and deltamethrin proved

better than the control at all the testing intervals (Table 2). There were no differences in the insect counts in the plots sprayed with water or kept unsprayed (Table 1).

Amongst the contact insecticides, deltamethrin, cypermethrin, endosulfan, fenitrothion and dichlorvos proved most promising and equi-effective in checking thrips population both 3 and 7 days after spraying (Tables 1, 2 and 3). When these five insecticides were compared 11 days after spraying, deltamethrin and cypermethrin treated plots proved better than the others. Similar findings were reported by Sinha *et al.* (1983) wherein these two pyrethroids provided protection from thrips for longer periods than the other insecticides, except fenitrothion. In the present studies, fenvalerate proved to be the least toxic amongst the synthetic pyrethroids. Thus, considering all the testing intervals, deltamethrin and cypermethrin proved as the most effective insecticides and the next group of effective insecticides comprised endosulfan, fenitrothion, dichlorvos, malathion and fenvalerate.

All the treated plots recorded higher bulb yield than the control (Table 2). Maximum increase (71.0%) in yield over control was recorded in plots treated with cypermethrin and the minimum increase (49.1%) in case of dichlorvos treated plots. Bhushan (1986) also observed 36 to 55 per cent increase in bulb yield over the control as a result of spraying the crop with different insecticides for thrips control. On the contrary, Sinha *et al.* (1983) did not find significant increase in yield over control in the

TABLE

Efficacy of various insecticides against

Treatment (per cent spray)	Mean number of nymph and			
	At Research farm			
	24 h before spraying	Days after spraying		
		3	7	11
Endosulfan (0.05)	398.7(19.64) ^{*ab}	29.3(5.28) ^{ab}	57.0(7.41) ^b	122.3(10.55) ^b
Dichlorvos (0.05)	632.7(24.71) ^b	13.3(3.70) ^{ab}	36.7(5.98) ^{ab}	272.3(15.60) ^c
Fenitrothion (0.05)	368.0(18.75) ^a	5.3(1.83) ^a	35.7(5.76) ^{ab}	112.7(10.15) ^b
Malathion (0.05)	1018.0(31.87) ^c	36.7(6.10) ^b	153.3(12.12) ^c	394.7(19.45) ^c
Cypermethrin (0.006)	1877.3(43.21) ^d	42.3(5.98) ^b	12.3(3.59) ^a	3.3(1.74) ^a
Deltamethrin (0.002)	1700.0(41.24) ^d	39.3(5.47) ^{ab}	18.3(4.24) ^a	15.3(3.93) ^{ab}
Fenvalerate (0.006)	1542.7(39.28) ^d	120.3(10.86) ^c	96.7(9.72) ^{bc}	74.7(8.36) ^b
Monocrotophos (0.04)	730.0(26.58) ^b	131.3(11.33) ^c	92.7(9.65) ^{bc}	117.3(10.61) ^{bc}
Dimethoate (0.03)	394.3(19.81) ^{ab}	116.3(10.66) ^c	145.3(11.94) ^c	359.0(18.73) ^c
Oxydemeton methyl (0.025)	1249.7(35.22) ^{cd}	471.7(21.69) ^d	428.0(20.65) ^d	649.7(25.36) ^d
Water spray	1036.0(32.19) ^c	892.0(29.88) ^e	806.7(28.41) ^e	724.7(26.94) ^d
Control (no spray)	1079.3(32.85) ^c	828.3(28.79) ^e	700.0(26.47) ^e	791.3(28.14) ^d
C.D. at 5%	(5.21)	(3.64)	(2.83)	(5.00)

*Square root transformation.

Pre-treatment population of thrips in different treatments varied significantly.

INSECTICIDES AGAINST ONION THRIPS

1

Thrips tabaci attacking onion (1986)

adult thrips/10 plants			
24 h before spraying	At Farmer's field		
	Days after spraying		
	3	7	11
* ^a 826.3(28.71)	^{bc} 177.0(13.29)	^b 274.3(16.44)	^{bc} 1112.7(33.25)
^a 868.0(29.41)	^b 230.7(15.12)	^b 310.7(17.64)	^b 1230.7(35.08)
^a 862.0(29.37)	^{ab} 106.7(10.33)	^b 185.3(13.58)	^b 1107.3(33.10)
^{ab} 1066.0(32.53)	^b 163.3(12.63)	^c 456.3(21.36)	^c 1414.3(37.59)
^b 1239.0(36.16)	^b 205.7(14.35)	^b 199.0(13.54)	^a 966.7(31.08)
^b 1381.0(37.15)	^a 88.0(9.11)	^a 72.0(8.35)	^a 743.7(27.24)
^b 1328.3(36.37)	^d 507.0(22.53)	^d 785.0(27.81)	^c 1675.7(40.95)
^{ab} 920.7(30.16)	^d 422.7(20.57)	^c 413.0(20.27)	^c 1643.0(40.40)
^b 1184.3(34.38)	^c 249.3(15.77)	^c 436.0(20.88)	^b 1217.0(34.89)
^b 1161.3(34.07)	^c 267.7(16.36)	^c 441.0(20.96)	^b 1416.0(37.54)
^b 1388.3(37.25)	^e 3730.0(61.08)	^e 2613.7(51.13)	^d 2810.7(52.99)
^b 1416.7(32.62)	^e 3750.0(61.25)	^e 2638.0(51.35)	^d 2728.3(52.24)
(4.43)	(2.61)	(4.20)	(4.46)

TABLE 2
Efficacy of various insecticides against *Thrips tabaci* attacking onion (1987)

Treatment (per cent spray)		Mean number of nymph and adult thrips/10 plants				Average bulb yield (kg/plot)	Per cent in- crease over control
		24 h before spraying	Days after spraying				
			3	7	11		
Endosulfan	(0.05)	696.7(25.59)*	126.3(11.20) ^b	102.0(10.05) ^a	51.7(7.17) ^a	12.07 ^a	64.67
Dichlorvos	(0.05)	619.7(24.78)	287.7(16.84) ^c	153.3(11.85) ^{a,b}	83.3(8.84) ^a	10.93 ^a	49.12
Fenitrothion	(0.05)	730.3(26.66)	184.0(13.32) ^{b,c}	248.7(15.14) ^b	80.3(8.95) ^a	11.50 ^a	56.89
Malathion	(0.05)	672.3(25.86)	153.3(12.17) ^b	242.0(15.26) ^b	106.7(10.02) ^a	11.70 ^a	59.62
Cypermethrin	(0.006)	579.0(23.39)	55.0(7.41) ^a	114.3(10.66) ^{ab}	76.0(8.71) ^a	12.53 ^a	70.95
Deltamethrin	(0.002)	439.3(20.80)	44.3(6.52) ^a	150.0(12.14) ^{ab}	50.0(7.06) ^a	11.37 ^a	55.12
Fenvalerate	(0.006)	691.3(25.77)	286.0(16.89) ^c	290.0(17.00) ^{b,c}	329.7(17.51) ^b	11.93 ^a	62.76
Control (no spray)		696.3(26.28)	468.7(21.43) ^d	329.3(17.91) ^{b,c}	303.0(17.25) ^b	7.33 ^b	—
C. D. at 5%		(NS)	(3.73)	(5.04)	(5.35)	1.93	

*Square root transformation.

INSECTICIDES AGAINST ONION THRIPS

TABLE 3
Pooled data on efficacy of various insecticides against *Thrips tabaci* attacking onion*

Treatment (per cent spray)	Mean number of nymph and adult thrips/10 plants			
	24 h before spraying	3	7	11
Endosulfan (0.05)	639.8(24.64)**a	110.9(9.92) ^a	144.4(11.30) ^a	428.9(16.38) ^b
Dichlorvos (0.05)	706.8(26.30) ^{ab}	177.2(11.88) ^{ab}	172.9(11.99) ^{ab}	532.0(19.84) ^b
Fenitrothion (0.05)	653.4(24.93) ^{ab}	98.7(8.49) ^a	156.6(11.49) ^{ab}	433.4(17.40) ^b
Malathion (0.05)	918.8(30.08) ^b	117.8(10.29) ^{ab}	283.9(16.25) ^b	777.2(22.35) ^c
Cypermethrin (0.006)	1231.8(33.92) ^b	101.0(9.24) ^a	108.6(9.26) ^a	348.7(13.84) ^{ab}
Deltamethrin (0.002)	1173.4(33.06) ^b	57.2(7.03) ^a	82.9(8.24) ^a	269.7(12.74) ^a
Fenvalerate (0.006)	1187.4(33.80) ^b	304.4(16.69) ^b	390.6(18.17) ^b	873.6(22.27) ^c
Control (no spray)	961.9(30.28) ^b	1642.1(36.08) ^c	1284.3(33.42) ^c	1786.1(34.83) ^d
C. D. at 5%	(5.32)	(6.58)	(4.86)	(3.64)

*Two trials conducted during 1986 and one during 1987.

**Square root transformation.

insecticide treated plots. However, this may be due to the fact that the thrips population was low in their trials compared to a very high population in the present studies.

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RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XIX, No. 4, pp. 343—348 (December 1989)

REACTION OF SOME COTTON GENOTYPES AND HISTOPATHOLOGICAL CHANGES IN *GOSSYPIMUM HIRSUTUM* DUE TO *MELOIDOGYNE INCOGNITA*

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Cotton—a major fibre crop, is attacked for the first time by Luthra and Vasudeva by a number of pests and diseases including plant-parasitic nematodes. In India, *Meloidogyne incognita* and *M. acrita* on cotton root-knot disease of cotton was reported at New Delhi. Infestation of cotton

TABLE 1

Reaction of Desi cotton (*Gossypium arboreum*) genotypes for resistance against *Meloidogyne incognita**

S. No.	Genotype	Number of galls	Number of egg masses	Reaction
1.	HD-79	520.0 (22.6)**	73.5 (8.5)	Highly susceptible
2.	HD-65	262.0 (15.4)	49.0 (7.0)	"
3.	HD-72	215.7 (14.6)	43.5 (6.4)	"
4.	HD-73	203.2 (14.2)	30.7 (5.5)	"
5.	HD-87	200.2 (14.1)	63.2 (8.0)	"
6.	HD-82	194.7 (13.9)	48.2 (7.0)	"
7.	HD-75	194.0 (13.9)	32.0 (5.6)	"
8.	HD-62	191.5 (13.7)	50.0 (7.0)	"
9.	HD-64	186.5 (13.6)	42.5 (6.5)	"
10.	HD-37	176.0 (13.3)	29.7 (5.4)	"
11.	HD-74	172.2 (13.0)	68.0 (8.2)	"
12.	HD-40	172.0 (13.7)	41.2 (6.4)	"
13.	HD-58	167.2 (12.7)	47.7 (6.7)	"
14.	HD-43	165.5 (13.5)	32.2 (5.6)	"
15.	HD-69	164.2 (12.8)	44.5 (6.6)	"
16.	HD-71	163.5 (12.8)	28.7 (5.3)	"
17.	HD-85	162.7 (12.7)	36.7 (6.2)	"
18.	HD-81	160.0 (12.6)	46.7 (6.7)	"
19.	G-27	147.0 (12.1)	44.0 (6.6)	"
20.	HD-44	147.0 (11.9)	38.7 (6.2)	"
21.	HD-70	142.0 (11.9)	28.7 (5.4)	"
C. D. at 5%		(3.3)	(1.3)	

*Mean of four replications.

**Figures in parentheses are $\sqrt{n}$ transformed values.

plants in Haryana and Punjab has also been reported by Bajaj *et al.* (1986) and Sakhuja *et al.* (1986), respectively. Because of the advantages in managing root-knot nematodes through use of resistant varieties, several studies have been done on these aspects in cotton. In present study, a few genotypes of cotton were screened to locate sources of resistance against *M. incognita*. In addition, some preliminary studies were also carried out to investigate the histopathological changes brought about due to *M. incognita* infection in *Gossypium hirsutum* (var. H 777).

Twentyone genotypes in each American and Desi cotton were sown in 15 cm size earthen pots containing one kg steam sterilized soil. Each plant was inoculated with 1000 freshly hatched second-stage juveniles of *M. incognita*, one week after germination. Sixty days after inoculation, observations were recorded on number of galls and egg masses per plant; and genotypes were categorised (Anonymous, 1985). For histopathological studies, roots of cotton (var. H 777) showing infection were taken 7 and 20 days after inoculation and fixed in F. A. A. for 24 h and processed for histological studies (Sass, 1964).

TABLE 2

Reaction of American cotton (*Gossypium hirsutum*) genotypes for resistance against *Meloidogyne incognita**

S. No.	Genotype	Number of galls	Number of egg masses	Reaction
1.	H-1034	320.0 (17.9)**	90.0 (9.4)	Highly susceptible
2.	H-685	300.7 (17.1)	136.0 (11.2)	"
3.	H-978	287.0 (16.9)	62.0 (7.9)	"
4.	H-1633	245.0 (15.3)	85.0 (9.3)	"
5.	H-1651	236.7 (15.3)	76.7 (8.7)	"
6.	H-926	228.4 (15.0)	73.0 (8.5)	"
7.	C-4	205.0 (14.5)	64.2 (8.8)	"
8.	C-6	190.7 (13.7)	70.5 (8.3)	"
9.	H-835	169.0 (13.0)	56.7 (7.5)	"
10.	H-999	166.2 (12.8)	50.2 (7.0)	"
11.	H-777	164.7 (12.7)	81.0 (9.0)	"
12.	H-888	162.2 (12.7)	59.4 (7.7)	"
13.	Red	158.2 (12.5)	46.0 (6.8)	"
14.	HS-45	148.0 (12.1)	65.2 (8.0)	"
15.	Fregobract	142.0 (12.0)	25.5 (5.0)	"
16.	H-976	140.2 (11.8)	62.3 (8.0)	"
17.	H-842	133.7 (11.4)	58.2 (7.6)	"
18.	H-854	127.7 (11.3)	47.7 (6.9)	"
19.	Nectrilless	123.0 (10.7)	61.0 (7.6)	"
20.	Glandless	116.0 (10.7)	34.0 (5.8)	"
21.	Okra	74.2 (8.6)	35.2 (5.9)	Susceptible
C. D. at 5%		(2.0)	(2.2)	

* Mean of four replications.

** Figures in parentheses are $\sqrt{n}$ transformed values.

Data in Table 1 reveal that in *G. arbo-
reum*, the maximum number of galls
(520.0) and egg masses (73.5) were
recorded in HD-79; while minimum galls
(142.0) were in HD-70 and egg masses
per plant (28.7) were in HD-70 and HD-
71. In *G. hirsutum* (Table 2) maximum
number of galls per plant (320.0) were
observed in H-1034, while it was mini-
mum (74.2) in cultivar 'okra'. But, the
maximum number of egg masses per plant
(136.0) were in H-685 and minimum
(15.5) in Fregobract. However,
all the genotypes, both in Desi and
American cotton groups exhibited susce-
ptible to highly susceptible response.

Histopathological changes in cotton
roots revealed that *M. incognita* larvae
after penetration moved towards the

steler region and oriented parallel to the
root axis, seven days after inoculation
(Fig. 1). Minton (1961) and Jatala and
Jensen (1976) also made similar obser-
vations. *M. incognita* infection led to the
formation of four to five multinucleate
giant cells with dense cytoplasm and
thickened cell wall (Fig. 2). Nematodes
fed on metaxylem and induced giant cells
in xylem tissues, which further enlarged
and ruptured the phloem tissue also
(Figs 3 and 4). Irregular shape of some
giant cells with diffused walls indicated
the dissolution of cell walls and formation
of multinucleate giant cells. However,
Huang and Maggenti (1969) and Jones
and Payne (1978) have shown that
multinucleate giant cells were formed
from repeated mitosis without cytokinesis.

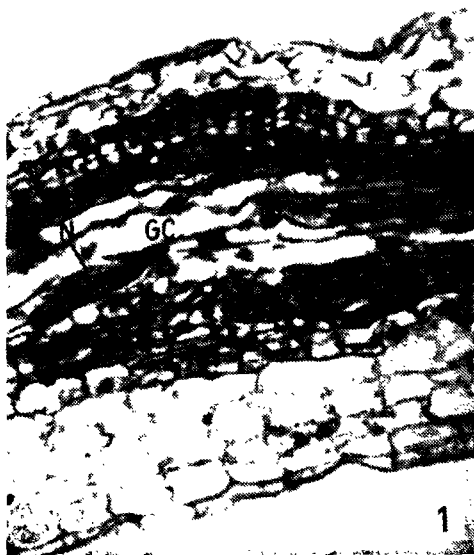


Fig. 1. L. S. of cotton root seven days after inoculation of *M. incognita*.

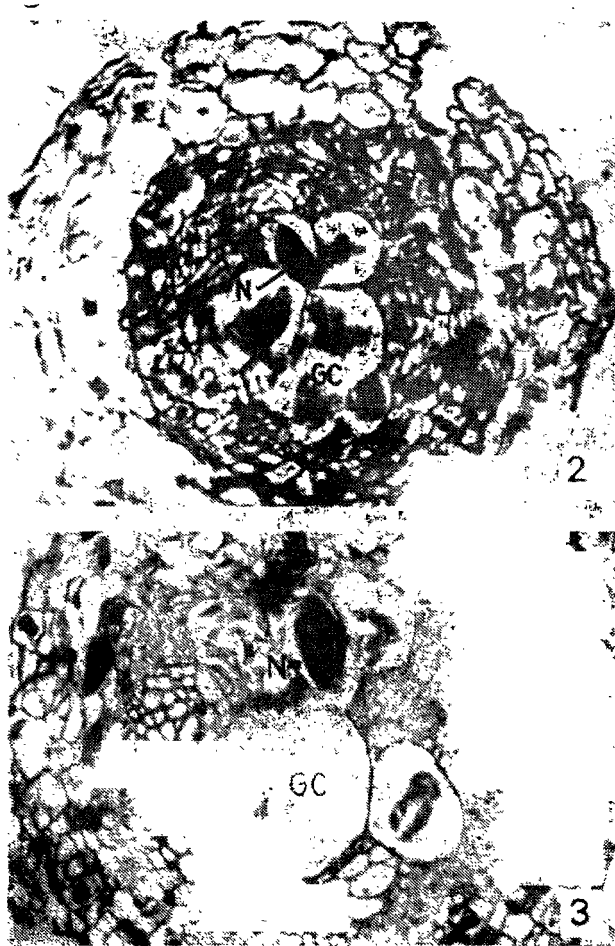


Fig. 2. T. S. of cotton root seven days after inoculation of *M. incognita*.

Fig. 3. Advance stage of giant cell alongwith *M. incognita* female.

ROOT-KNOT DISEASE OF COTTON

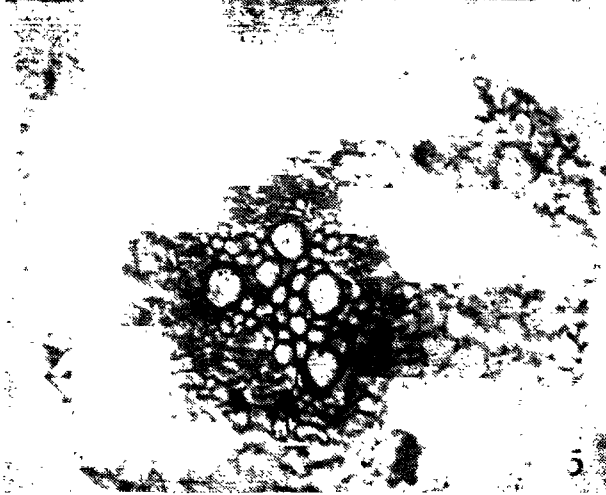
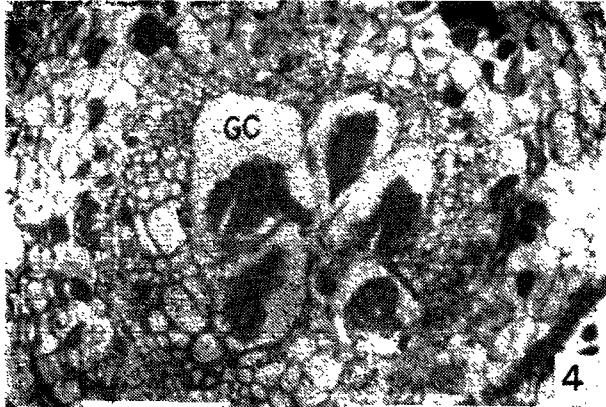


Fig. 4. Giant cells with dense cytoplasm and disintegrated cell walls.

Fig. 5. T. S. of healthy cotton root.

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STUDIES ON TEMPERATURE AND HUMIDITY PROFILES IN BRASSICA UNDER TWO LEVELS OF LIGHT STRESS

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Temperature and humidity play a significant role in crop growth by regulating transpiration and evaporation, development and mortality of insect-pests and diseases of crops. In a crop profile, temperature and relative humidity can be manipulated by cultural practices, sowing methods, genotypes, planting density and irrigation. Su *et al.* (1981) reported that daily range of air temperature at different heights in maize alone was lower than when intercropped with legumes. Mulching and presence of plant canopy decreased the minimum soil temperature (Suzuki *et al.*, 1982).

Studies on temperature and humidity were conducted in Brassica during winter season of 1983-84 on sandy loam soil at NARP Research Farm, Haryana Agricultural University, when the crop was 25 cm in height. Two treatments with varying levels of light stress, *i.e.* LS-1 (recommended plant density) and LS-2 (1.5 times the recommended plant density) were replicated twice. Temperature was measured at 1200 hours with the help of thermocouple psychrometer from soil surface to top of crop canopy at an interval of 5 cm and also above the crop canopy upto 100 cm in the environment/atmosphere. Soil temperature was

also measured at depths of 0, 5, 10, 15 and 30 cm. Simultaneously, the wet and dry bulbs readings were recorded in the crop canopy at 5, 10, 15, 20 and 25 cm height and 5, 10, 15, 20 and 75 cm above crop canopy. The mean readings of psychrometer were converted into temperature ($40 \mu V = 1^\circ C$). The temperature in $^\circ C$ was converted into saturated vapour pressure (svp) with the help of converting table. Absolute humidity (ρ_v) was calculated by the following formula

$$\rho_v = \frac{e}{R_v T}$$

Where e = Actual air pressure = $ew - \gamma (T_D - T_W)$

ew = svp at wet bulb (millibar)

γ = 0.648 millibar/ $^\circ K$ at $25^\circ C$

T_D = Dry bulb temperature ($^\circ C$)

T_W = Wet bulb temperature ($^\circ C$)

R_v = Specific gas constant of water vapour ($4610 \text{ millibar cm}^{-3} \text{ g}^{-1} \text{ }^\circ K^{-1}$)

T = Absolute temperature in $^\circ K$ ($^\circ K = -273^\circ C$).

The temperature profiles in the soils as affected by treatments (Fig. 1) indicate

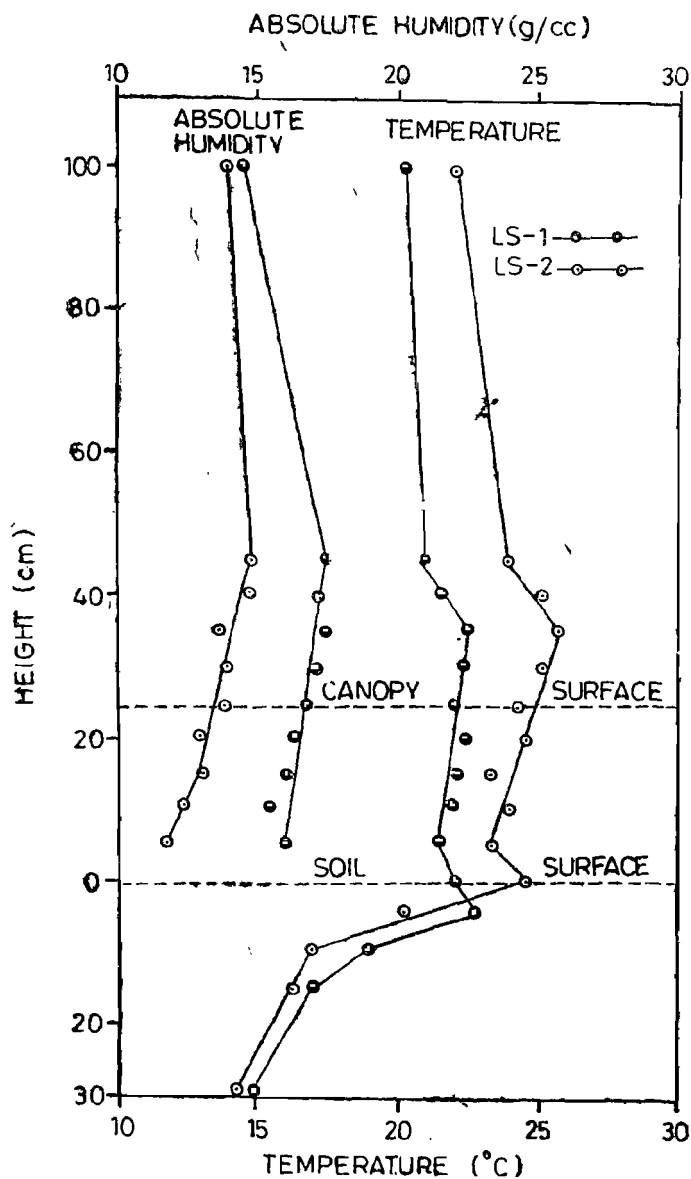


Fig. 1 Temperature and relative humidity profile of Brassica as influenced by light stress.

that there was lower soil temperature in LS-2 as compared to LS-1. The low soil temperature in LS-2 was due to shading of soil surface by higher plant population in this treatment. The dense crop canopy acted as a barrier for incoming solar radiation. Whereas, the incoming radiation was not interrupted when the crop was widespaced (LS-1) and, thus, resulted in higher soil temperature.

The temperature profile of the aerial parts showed that LS-2 recorded higher temperature as compared to LS-1 throughout the profile of canopy probably due to locking up of heat from incoming radiation by its profuse canopy. Su *et al.* (1981) also reported that the daily range of air temperature at different heights in intercropped maize was higher than in maize alone. The slight increase in temperature above crop canopy in both the treatments might be due to the reflection of heat of incoming solar radiation by the crop canopy. Thereafter, the

temperature started declining and followed a uniform pattern upto 100 cm height from surface.

The absolute humidity was lower in case of LS-2 where the plant population was more (Fig. 1). This may be because of low transpiration rate due to water stress caused by early depletion of soil water by densely populated crop. The high temperature in the treatment is also an indicative of this phenomenon. On the other hand, due to relatively sparse crop canopy in LS-1, soil profile contained more moisture available to crop resulting in relatively more leaf turgidity which led to more transpiration and higher absolute humidity. The pattern of variation of absolute humidity was similar under both the treatments along the height above 20 cm of the crop canopy. The difference in absolute humidity at 100 cm was lost due to displacement of water vapour by blowing wind.

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RESPONSE OF PLANTING METHODS, FERTILITY LEVELS AND SPACINGS ON SEED PRODUCTION OF KHARIF ONION

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To meet the increasing consumption of bulbs, the need has been felt to produce the onion in kharif season. Therefore, seed production of onion for kharif variety has also become a pressing issue. Looking on the paucity of genuine literature and importance and demand of kharif onion seed, the present study was conducted during kharif season of 1985-86. The soil was sandy loam, containing 0.5% organic carbon, 153 kg/ha available nitrogen, 36 kg/ha phosphorus, 613 kg/ha potash and pH 8.1. The treatments included two methods of planting (seed to seed and bulb to seed), three fertility levels (low—50 kg N+20 kg P+10 kg K/ha, medium—100 kg N+40 kg P+15 kg K/ha, and high—150 kg N+60 kg P+20 kg K/ha) and three plant spacings (45×15, 45×30 and 45×45 cm). The treatments were replicated three times in a randomized block design. Six weeks old seedlings of variety N-53 were transplanted for producing seed by seed to seed method as per spacing treatments and also transplanted for bulb production in the same field at a spacing of 45×45 cm. Phosphorus and potassium were applied as basal dose at transplanting. Nitrogen was splitted in four equal doses.

The first dose of nitrogen was applied at transplanting, second at 30 days and third at 60 days after transplanting. The fourth dose of nitrogen was applied on 18 December 1985 in both the methods as it was also the date of planting of bulbs in case of bulb to seed method.

The bulbs used for planting were uniform in size (80 to 100 g), shape and colour. All cultural and plant protection operations were followed as and when required as per package of practices (Anonymous, 1984). The observations were recorded on growth and yield of the seed crop as well as quality of seed. The number of leaves per plant (39.7), number of scapes per plant (6.07), and seed yield per plant (19.58 g) and per hectare (9.66 q) under bulb to seed method were recorded significantly higher than seed to seed method where these figures were 10.3, 1.86, 14.35 and 6.68, respectively (Table 1). Highest seed yield of 9.66 q/ha under bulb to seed method was due to better performance of individual plant showing more seed yield (19.58 g). These results are in agreement with the findings of Nehra (1979). Quality of seed in terms of boldness of

SEED PRODUCTION IN KHARIF ONION

TABLE 1

Response of method of planting, fertility level and plant spacing on vegetative growth, seed yield and quality characters in kharif onion

Treatment	Height of plant (cm)	Number of leaves	Number of scapes per plant	Seed yield per umbel (g)	Seed yield per plant (g)	Seed yield (q/ha)	1000-seed weight (g)	Germination (%)	E. C (mmhos/cm)
Method of planting									
Seed to seed	73.7	10.3	1.86	2.58	14.35	6.68	3.22	73.2	0.58
Bulb to seed	53.8	39.7	6.07	1.12	19.58	9.66	2.79	72.3	0.74
C. D. at 5%	1.4	2.0	0.58	0.07	0.71	0.70	0.32	0.3	0.01
Fertility level									
(N-P-K per hectare)									
50-20-10	62.4	23.0	3.23	1.51	11.29	4.91	2.86	75.8	0.67
100-40-15	65.5	25.4	4.26	1.99	19.20	9.33	3.25	76.2	0.66
150-60-20	63.3	26.6	4.41	2.04	20.39	10.27	2.91	76.8	0.65
C. D. at 5%	1.7	2.4	0.71	0.09	0.87	0.86	NS	0.3	NS
Plant spacing (cm)									
45×45	66.3	21.2	3.67	1.64	14.23	12.11	2.88	73.8	0.68
45×30	63.9	24.9	4.32	1.94	19.78	8.07	3.11	77.0	0.66
45×15	61.1	28.9	3.90	1.97	16.88	4.34	3.02	78.0	0.68
C. D. at 5%	1.7	2.4	NS	0.09	0.87	0.80	NS	0.3	NS

NS=Non significant.

seeds/thousand-seed weight, germination percentage and seed vigour (lower is the EC value more vigorous is the seed, Frity, 1965) under seed to seed method was significantly superior to bulb to seed method (Table 1).

High fertility comprising the application of 150 kg N, 60 kg P and 20 kg K per hectare gave the highest seed yield (10.27 q/ha), which was about twice the yield obtained from low fertility level (Table 1). This was because of better yield attributes like seed yield per umbel (2.04 g) and per plant (20.39 g) and number of scapes per plant (4.41) under high fertility level as compared to low fertility levels. Present findings are in

agreement with those Nandpuri *et al.* (1968) and Ahmed and Abdulla (1984). Seed quality was also improved with high fertility (Table 1) as the germination of seed was higher (76.8%) than medium or low fertility levels (76.2 or 75.8%).

Data in Table 1 reveal 12.1, 8.07 and 4.34 q/ha seed yield under closest, medium and widest plant spacings, respectively. Increasing the plant spacing from 15 cm to 45 cm significantly increased the number of leaves, and seed yield per umbel and per plant. Despite better growth and higher seed yield per plant under plant spacings 45×45 cm and 45×30 cm, the seed yield per hectare was higher under closest plant spacing (45×15

TABLE 2

Response of interaction of method of planting, fertility level and plant spacing on seed yield (q/ha) in kharif onion

Method of planting	Plant spacing (cm)	Fertility level (N-P-K kg/ha)		
		50-20-10	100-40-15	150-60-20
Seed to seed	15	6.30	10.21	13.55
	30	3.36	9.22	7.62
	45	1.21	2.47	3.98
Bulb to seed	15	10.46	15.06	15.73
	30	5.71	12.48	8.84
	45	1.77	3.72	6.21

C. D. at 5% = (Method of planting $\times$ plant spacing $\times$ fertility level) = 2.12

cm) because of higher plant population per unit area. But the germination of seed was highest (78.0%) with widest plant spacing (45 $\times$ 45 cm). Singh and Gill (1980) and Pandey *et al.* (1982) also reported highest seed yield under closest plant spacing.

The interaction of all the three factors (Table 2) showed the synergetic effects

and boosted the seed yield (15.73 q/ha) to about one and a half times more as compared to the individual effect, *i.e.* bulb to seed method (9.66 q/ha), high fertility level of N₁₅₀-P₆₀-K₂₀ kg/ha (10.27 q/ha) and closest plant spacing 45 $\times$ 15 cm (12.11 q/ha). The results are in close conformity to Pall and Padda (1972) and Madan and Saimbi (1984).

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IMPACT OF TECHNOLOGY ON SOCIAL LIFE OF RURAL WOMEN

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ABSTRACT

The study conducted on a sample of 200 women in village Mirzapur of Haryana reveals that respondents who visited cinema and craft centre had higher level of technology and vice-versa. The participation in recreational activities such as bhajans, saang and satsang was significantly associated with the level of technology. The respondents belonging to the higher level of technology group favoured abolition of purdah system, employment of girls, small family norms and immunization of children. The decisions in respect of farm and animal care were jointly taken by majority of the respondents, whereas household decisions were made by the respondents themselves in most of the cases.

The womenfolk constitutes the nerve centre of families, vital section of societies and backbone of the nations. About half of the world population and one-third of its work force comprise them. They play a significant role in domestic and social life of the society, therefore, national development is not possible without developing this important and substantial segment of our society. Women in Vedic society (2500 B.C.—500 B.C.) enjoyed greater freedom and equal status with men in every walk of life. But, their position declined during middle ages and it reached its lowest ebb in eighteenth century. However, advancement in scientific and technological sphere in the twentieth century resulted in radical transformation in the status of women. As a result of it many domestic chores are less dependent on traditional skills and less feminine in character. But, it is still not true in case of women living in rural areas. It has been reported that

modern technology has not reached the rural poor.

Vashist and Dhesi (1976) found in Ludhiana district that educational level of family members played a positive and significant role in adoption of labour saving devices within the kitchen. Sharma (1977) emphasized to facilitate the work of women with improved home technology specially related to cooking, water supply and grinding. Mary (1979) held that science and technology enabled women to take jobs by reducing the drudgery of household chores and lessening the risks of unwanted pregnancies. Dutt (1980) noted that efforts should be made for alleviating the daily burden of rural women. If rural women are freed from carrying water and wood from long distances, they will have time to learn about health care, nutrition and other basic knowledge which they lack. Planning Commission (1981) recognized that

mass media could play a useful role in spreading information relevant to home needs such as maintenance of household gadgets, electricity operated utensils, etc. Grover and Sharma (1981) held that existing technology has not made any significant impact on the lives of rural women so it is essential to analyse scientific technologies, their manner of application to foster the development of rural women and their families. Kaur (1982) emphasized that improved household technology has still not trickled down to majority of rural women. Knowledge about improved household technology was found to be very low especially among those who have low level of exposure to means of communication, illiterate and from low socio-economic strata. Kokate and Dubey (1983) emphasized that there is a need of flexible science education programme to bring the desirable changes in attitude and knowledge about improved practices among rural communities. This would result in the adoption of new techniques for rural development.

Thus, the technological benefits have not percolated to the rural women. All the more, no systematic and in-depth attempt has so far been made to understand the impact of technology on the social life of rural women particularly in this part of the country. Therefore, the present study was undertaken in a village community of Haryana.

METHODOLOGY

The present empirical study was conducted in Mirzapur village situated at a distance of 12 km from Hisar City in

Haryana State in the year 1986-87. This village was purposively selected because the authors were quite familiar with the dialect and culture of the people of Mirzapur. Secondly, this village is influenced by modern technologies related to household and agriculture because of its proximity to the district headquarter. Out of 400 households, half of them were selected through simple random sampling technique for gathering primary data. One woman from each of the selected household was interviewed for gathering information on different dimensions of impact of technology on rural women's social life. In order to assess the impact of technology, a comprehensive list of both household and agricultural technologies was prepared. In order to know extent, four categories, viz. nil (having no technology), low (technologies in the range of 1-4), medium (technologies in the range of 5-8) and high (technologies in the range of 9-12) were formulated. Chi-square test with Yate's correction was applied. Yate's correction was applied, because the expected frequencies in most cases were less than five.

$$\text{Formula : } \frac{(o_1 - e_1 - 0.5)^2}{e_1}$$

o_1 = observed frequencies,
 e_1 = expected frequencies.

$$\text{Expected frequencies} = \frac{R \times C}{N}$$

R = total of rows

C = total of columns,

N = grand total of rows and columns.

RESULTS AND DISCUSSION

Impact of technology was seen in relation to participation in social activi-

TABLE 1
Relationship between participation in different social activities and level of technology

Participation/visit	Response	Level of technology				Total	χ^2 value d.f.—3
		Nil	Low	Medium	High		
Ramliila show	Yes	18(94.8)	101(84.9)	43(83.0)	10(100.0)	172(86.0)	1.10 NS $P < 0.05$
	No	1(5.2)	18(15.1)	9(17.0)	0(0.0)	28(14.0)	
	Total	19(100.0)	119(100.0)	52(100.0)	10(100.0)	200(100.0)	
Bhajana	Yes	1(6.2)	9(7.5)	4(7.6)	5(50.0)	19(9.5)	38.25* $P < 0.05$
	No	18(94.8)	110(92.5)	48(92.4)	5(50.0)	181(90.5)	
	Total	19(100.0)	119(100.0)	52(100.0)	10(100.0)	200(100.0)	
Saang	Yes	16(84.2)	100(84.0)	37(71.1)	4(40.0)	157(78.5)	9.79* $P < 0.05$
	No	3(15.8)	19(16.0)	15(28.9)	6(60.0)	43(21.5)	
	Total	19(100.0)	119(100.0)	52(100.0)	10(100.0)	200(100.0)	
Formal organisation (craft centre)	Yes	2(10.5)	36(30.2)	20(38.6)	8(80.0)	66(33.0)	12.16* $P < 0.05$
	No	17(89.5)	83(69.8)	32(61.5)	2(20.0)	134(67.0)	
	Total	19(100.0)	119(100.0)	52(100.0)	10(100.0)	200(100.0)	
Circus	Yes	18(94.7)	113(94.9)	50(96.5)	10(100.0)	191(95.5)	0.22 NS $P < 0.05$
	No	1(5.3)	6(5.1)	2(3.5)	—	9(4.5)	
	Total	19(100.0)	119(100.0)	52(100.0)	10(100.0)	200(100.0)	
Cinema	Yes	3(15.7)	39(32.7)	28(53.8)	8(80.0)	78(39.0)	11.84* $P < 0.05$
	No	16(84.3)	80(67.3)	24(46.2)	2(20.0)	122(61.0)	
	Total	19(100.0)	119(100.0)	52(100.0)	10(100.0)	200(100.0)	

Figures in parentheses denote percentages.

*Significant.

NS=Non-significant.

ties, acceptance of family planning methods, choice of mate, purdah system, employment of girls, child care and decision making related to home, animal husbandry and the farm.

Participation in Social Activities

Relationship between level of technology and participation in social activities has been depicted in Table 1. Tho saang was found negatively associated with level of technology, *i. e.* as the level of technology increased, participation in saang decreased. Participation in bhajans was positively related to level of technology. But, participation/visit to ramlila and circus show was not related significantly to level of technology. However, respondents with nil and low level of technology were found interested in ramlila and circus show. It could be due to the fact that participation in ramlila and circus show did not require much investment.

Family Planning Methods

In the present study, only sterilisation (tubectomy) aspect of family planning

was related to the level of technology because the number of respondents who adopted this method was quite substantial.

It is evident from chi-square values in Table 2 that the adoption of family planning operation was not related to the level of technology. Respondents adopted tubectomy because incentives were given for this and such operations were performed without any charges. Mary (1979) also held that technology enabled women to lessen the risks of unwanted pregnancies and were capable of performing a substantial economic role.

Mate Selection

In the beginning of twentieth century, mate selection was done by the parents. Modern science and technology have contributed much in changing traditional mate selection procedures. An appraisal of data in Table 3 indicates that the choice of mate selection was not related to the level of technology. Women's say in the mate selection has gained weight over the years irrespective of

TABLE 2
Relationship between adoption of sterilisation and level of technology

Adoption of sterilisation	Level of technology				Total	X ² value d.f.=3
	Nil	Low	Medium	High		
Yes	10 (52.6)	60 (50.4)	25 (48.0)	4 (40.0)	99 (49.5)	0.096 NS
No	9 (47.4)	59 (49.6)	27 (52.0)	6 (60.0)	101 (50.5)	P < 0.05
Total	19 (100.0)	119 (100.0)	52 (100.0)	10 (100.0)	200 (100.0)	

Figures in parentheses are percentages.

NS=Non-significant.

TABLE 3

Relationship between respondents' say in mate selection and level of technology

Say in mate selection	Level of technology				Total	X ² value d.f.=3
	Nil	Low	Medium	High		
Yes	16 (84.2)	104 (87.3)	46 (88.4)	10 (100.0)	176 (88.0)	0.499 NS
No	3 (15.8)	15 (12.7)	6 (11.6)	—	24 (12.0)	P<0.05
Total	19 (100.0)	119 (100.0)	52 (100.0)	10 (100.0)	200 (100.0)	

Figures in parentheses are percentages.

NS=Non-significant

TABLE 4

Relationship between respondents' opinion about purdah system and level of technology

Opinion on purdah system	Level of technology				Total	X ² value d.f.=3
	Nil	Low	Medium	High		
Favoured	19 (100.0)	114 (95.8)	44 (84.6)	2 (20.0)	179 (89.5)	50.77*
Not favoured	—	5 (4.2)	8 (15.4)	8 (80.0)	21 (10.5)	P<0.05
Total	19 (100.0)	119 (100.0)	52 (100.0)	10 (100.0)	200 (100.0)	

*Significant

Figures in parentheses are percentages.

their technological level. Similar findings were also reported by Kaur (1982) and Sihag (1985) in their study on technology and changing status of rural women in Haryana.

Purdah System

The purdah system is custom of our traditional society but is still prevalent in the countryside. The observance of purdah among women of different families having different technological level was studied.

A perusal of Table 4 indicates that an overwhelming majority was observing purdah system (89%), because it is a traditional custom. However, the significant value of chi-square shows that the level of technology was associated with purdah system, and opinion was against purdah system as the level of technology increased. Kaur (1982) and Sihag (1985) also reported similar association.

TABLE 5

Relationship between immunization of children and level of technology

Immunization of children	Level of technology				Total	X ² value d.f.=3
	Nil	Low	Medium	High		
Yes	10 (52.6)	101 (84.9)	48 (92.3)	10 (100.0)	169 (84.5)	14.00*
No	9 (47.4)	18 (15.1)	4 (7.7)	—	31 (15.5)	P<0.05
Total	19 (100.0)	119 (100.0)	52 (100.0)	10 (100.0)	200 (100.0)	

*Significant

Figures in parentheses are percentages.

TABLE 6

Relationship between decision making by respondents and level of technology

Decision making	Level of technology				Total	X ² value d.f.=3
	Nil	Low	Medium	High		
Related to farm						
Along with others	16 (84.2)	92 (77.3)	38 (73.0)	6 (60.0)	152 (76.0)	4.23 NS
Self	3 (15.8)	27 (22.7)	14 (27.0)	4 (40.0)	48 (24.0)	P>0.05
Total	19 (100.0)	119 (100.0)	52 (100.0)	10 (100.0)	200 (100.0)	
Related to animal care						
Along with others	15 (78.9)	95 (79.8)	42 (80.7)	10 (100.0)	162 (81.0)	2.69 NS
Self	4 (21.1)	24 (20.2)	10 (19.3)	—	38 (19.0)	P>0.05
Total	19 (100.0)	119 (100.0)	52 (100.0)	10 (100.0)	200 (100.0)	
Related to household						
a) Along with others	12 (63.2)	53 (44.6)	22 (42.4)	2 (20.0)	89 (44.5)	4.57 NS
b) Self	7 (36.8)	66 (55.4)	30 (57.6)	8 (80.0)	111 (55.5)	P>0.05
Total	19 (100.0)	119 (100.0)	52 (100.0)	10 (100.0)	200 (100.0)	

Figures in parentheses are percentages.

NS=Non-significant.

Immunization of Children

Children's well-being is one of the most important functions of the family. Women are mostly responsible for caring and rearing the children. Immunization is one of the important dimensions of keeping them healthy.

An appraisal of Table 5 shows that more than four-fifth of the respondents got their children immunized. The chi-square values reveal significant association between immunization of children and the level of technology. The increase in the level of technology was accompanied by immunization of children by respondents. Dutt (1980) also observed that increase in technological level helped rural women to learn about health care and immunization programmes.

Decision Making

One's involvement in decision making determines her status within the family.

Analysis of data in Table 6 shows that most of the respondents were involved in joint decision making in relation to farm and animal care. Joint involvement in decision making in relation to farm and animal care, was due to lack of knowledge about these areas. Most of the decisions related to household activities were taken by respondents themselves. The chi-square values in respect of decision making related to farm, animal care and household were non-significant indicating lack of association between decision making and the level of technology. Dhillon (1980) also observed that women had great say in purchase of household articles, in purchase and sale of milch animals, expenditure on ceremonial give and take, education of children, etc. Similar results have also been observed by Hira Nand (1979).

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