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NUTRITION OF FORAGE OAT UNDER CUTTING MANAGEMENT

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(Received : July 1, 1974)

ABSTRACT

Investigations were carried out at the Haryana Agricultural University Farm, Hissar during 1969-70 and 1970-71, to find out the nitrogen and phosphorus requirements of oats under cutting management. Oat gave significantly higher yield when cut twice over that cut once. Forage productions were significantly improved with 60 kg N/ha; however, beyond this dose improvement was not significant. Phosphorus application had no effect. Oat when cut twice and fertilized with 60 kg N/ha gave the highest forage production.

The shortage of green fodder is becoming acute day by day due to increase in cattle population and following of crop rotations which allow little provision for growing of green forages. Thus, there is need to increase the yield of good quality forage. Oat (*Avena sativa* L.) is one of the most important *rabi* fodder crops in the irrigated tracts of northern India. It is a common observation that when oat is harvested in early stage, it regenerates and another good cutting is possible. However, the nitrogen and phosphorus requirements of oats crop may be different when it is raised with cutting management.

MATERIAL AND METHODS

The experiment was conducted in the winter season of 1969-70 and 1970-71 at the Haryana Agricultural University Farm, Hissar. The soil of the experimental fields was sandy loam in texture, deficient in nitrogen, moderate in phosphorus and rich in potash with pH 8.5. The experiment comprising two treatments of cutting management (one cut and two cuts), four levels of nitrogen (0, 30, 60 and 90 kg N/ha) and three levels of phosphorus (0, 30 and 60 kg P_2O_5/ha) with three replications, was laid out in split plot design keeping number of cuttings and nitrogen levels in main plots and phosphorus levels in sub plots. Oat variety weston-11 was sown in lines at a distance of 25 cm on 6th November, 1969 and 8th November, 1970, respectively. Nitrogen and phosphorus were applied through calciums, ammonium nitrate and single superphosphate, respectively. In two cutting treatment half of nitrogen was applied at sowing time and remaining half after first cutting and in one cutting treatment half of nitrogen was applied at sowing time and the remaining half 60 days after sowing. Full dose of P_2O_5 was drilled at the time of sowing. In case of two cutting treatment, first cutting was made 55 days after sowing and

*Deputy Director of Agriculture, Govt. of Haryana second cutting at earing stage, while in case of single cut or conventional method, the crop was harvested only at earing stage.

RESULTS AND DISCUSSION

Oat, when cut twice, yielded significantly higher green and dry matter over that of conventional practice during both the years as well as in the pooled analysis (Table 1). It may be pointed out that due to regeneration capacity of oat, an extra cutting was taken and hence higher yield was possible.

It is interesting to point out that green as well as dry matter yields per hectare improved significantly with 60 kg N/ha over no nitrogen and 30 kg N/ha during both the years and increase in forage yield beyond 60 kg N/ha was not significant. The improvement in yield with higher levels of nitrogen may be attributed to higher meristematic activity and thus better growth of plants and ultimately higher yields were possible. Tomer (1969) and Singh *et al.* (1972) obtained similar results.

Phosphorus application had no effect on green and dry matter yields in any year of the experimentation.

Table 2 indicates that when oat was cut twice and fertilized with either 60 kg N or 90 kg N, significantly higher green and dry matter productions were obtained over that cut once and fertilized with 0, 30, 60 or 90 kg N/ha and cut twice and fertilized with 0 or 30 kg N/ha. The increase in forage yield by taking two cuts and fertilizing the crop either with 60 kg N or with 90 kg N/ha over any other treatment combination was more than 130 quintals in case of green forage and 21 and 14 quintals in first year and second year, respectively, in case of dry fodder yield.

TABLE 1

Effect of cutting, nitrogen and phosphorus levels on green and dry matter production of oat (q/ha).

Treatments	Green			Dry		
	1969-70	1970-71	Pooled	1969-70	1970-71	Mean
One cut	180.6	165.0	172.8	40.9	38.8	39.9
Two cut	269.8	272.0	270.4	56.2	51.7	53.9
S. Em. ±	15.8	7.9	12.5	2.1	1.2	—
C. D. at 5%	47.9	24.1	37.9	6.3	3.6	—
0 kg N/ha	128.8	118.3	123.6	29.6	26.5	28.0
30 kg N/ha	196.5	182.3	189.4	43.1	38.9	41.0
60 kg N/ha	275.4	280.0	277.7	61.3	56.5	58.9
90 kg N/ha	298.6	297.9	298.7	60.5	59.1	59.8
S. Em. ±	22 5	11.3	17.8	2.8	1.7	—
C. D. at 5%	68.2	34.2	53.9	8.6	5.1	—
0 kg P_2O_5/ha	226.1	210.8	218.4	49.4	44.1	46.8
30 kg P_2O_5/ha	226.1	221.4	223.7	48.6	44.0	46.3
60 kg P_2O_5/ha	222.2	226.6	224.4	47.8	44.6	46.2
S. Em. ±	6.1	8.7	7.5	3.1	2.7	—
C. D. at 5%	N. S.	N. S.	N. S.	N. S.	N. S.	—

TABLE 2

Effect of cutting x Nitrogen levels on forage yield (q/ha).

Nitrogen levels (kg/ha)	Green matter 1970-71		Dry matter 1969-70		Dry matter 1970-71	
	One cut	Two cut	One cut	Two cut	One cut	Two cut
0	89.0	147.7	27.0	32.7	22.1	29.9
30	146.8	217.7	40.9	45.3	33.3	42.9
60	210.0	350.0	51.1	72.7	47.7	64.5
90	214.4	381.3	44.6	76.5	50.4	69.8
S. Em. ±	15.9		4.2		3.3	
C. D. at 5%	48.2		12.1		8.2	

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Haryana agric. Univ. J. Res., Vol. V, No. 1, pp. 4 -10 (March 1975)

STUDIES ON THE COMPARATIVE PERFORMANCE OF SORGHUM AND SUDAN TYPES UNDER VARYING CUTTING MANAGEMENTS

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(Received : July 30, 1974)

ABSTRACT

Experiments to study the performance of sorghum and sudan cultivars under different cutting managements were conducted during the *kharif* seasons of 1972 and 1973. Amongst the varieties, S. S. G. 59-3, a sweet sudan grass, outyielded all the varieties in green as well as dry matter production. This variety was also found better in its regeneration. Piper was found to be the second best for multicut programme.

First cutting taken 55 days after sowing gave significantly higher yield of green fodder, whereas for dry matter production 70 days harvesting was better. As regards subsequent cuttings, 40 days interval was invariably found to be the best as it gave the highest green as well as dry matter production.

In order to meet the fodder deficit, more emphasis on growing of good quality forage crops with maximum tonnage is a must. Further, the deficit becomes more acute during the summer season. Therefore, growing of suitable forage crops which can provide green fodder during the lean periods would be most advantageous. Sorghum *(Sorghum bicolor)* and Sudangrass *(Sorghum sudanense)* differ markedly in various morphological characters in spite of the fact that both belong to the sub-section *Eu-Sorghum*. Sorghum is the premier forage crop of *kharif* season, especially in north India. However, it is generally poor in its regeneration. On the other hand, sudan grass is capable of providing nutritious green fodder in three to four repeated cuttings. As such, the supply of green fodder is ensured during both the lean seasons of May–June and Oct.–Nov. Unfortunately, in literature no information is available regarding the best cutting management of multicut varieties of sudan grass. Accordingly, the present study was undertaken to study the cutting management of sudan grass cultivars against promising fodder varieties of jowar.

MATERIAL AND METHODS

An experiment to test the performance of Sudan and Sorghum varieties under different cutting managements was laid out at the Haryana Agricultural University Farm, Hissar, during *kharif* seasons of 1972 and 1973. The varieties of sudan types were S. S. G. 59-3 and Piper, whereas that of sorghum types were J.S. 20, M.P. Chari and I.S. 6090. Three first-cutting treatments (40, 55 and 70 days after sowing) and three subsequent cutting treatments (20, 30 and 40 days after first cut) were studied. Split-plot design *with varieties and first cutting treatments* in main plots and subsequent cutting treatments in sub-plots was adopted. The treatment combinations were replicated four times. Sowings were done on 20th May and 8th May during 1972 and 1973, respectively. The crop was fertilized with 100 kg N and 50 kg P_2O_5/ha as uniform dose. Whole of the superphosphate was applied before sowing, whereas, nitrogen was applied in three split doses of 60+20+20 kg/ha. The number of subsequent cuttings under different cutting *managements in both the years are given* below :-

Ist cut	Number of subsequent cuttings
C_1 (40 days)	Sc_1 (20 days) = 4
	Sc_2 (30 days) = 3
	Sc_3 (40 days) = 2
C_2 (55 days)	Sc_1 (20 days) = 3
	Sc_2 (30 days) = 2
	Sc_3 (40 days) = 2
C_3 (70 days)	Sc_1 (20 days) = 3
	Sc_2 (30 days) = 2
	Sc_3 (40 days) = 1

RESULTS AND DISCUSSION

(a) Performance of varieties

The data given in Tables 1 and 2 indicate that SSG 59-3, a sweet sudangrass variety, gave the highest yield of both green and dry matter when total yield of all cuttings as well as yield of subsequent cuttings were taken into account. Based on overall yield, IS 6090 was the second best variety in both the years (Table 1).

In *kharif*, 1972 the dry matter yield over all cuttings was at par among varieties SSG. 59-3, IS 6090 and M. P. Chari, whereas SSG. 59-3, significantly outyielded both piper and JS 20. In *kharif*, 1973, SSG. 59-3 out yielded all the varieties in both the green and dry matter yield. In subsequent cuttings, SSG. 59-3 and piper, which were at par gave significantly. higher green and dry matter production over other varieties in 1972. In 1973, only SSG. 59-3 excelled all the other varieties significantly. Similarly SSG. 59-3 gave the highest green and dry fodder yield in all the coordinated trials of forage sorghum (Anonymous, 1972).

(b) Impact of first cutting treatments

The data given in Table 1 (total yield of all cuts) indicate that first cutting taken after 55 days of sowing was the best during both the years as it gave significantly higher green fodder yield over 40 days treatment. The increase in green fodder yield obtained after 70 days of sowing was not significant. Keeping dry matter production into consideration, late *harvesting (70 days after sowing) gave* significantly higher yield over the remaining treatments. These results, however, did not tally with those of Malik (1957) who stated that sudangrass gave first cutting 15 days after sowing. Moreover, it was observed that the crop harvested in early stages of its growth contained

TABLE 1

Cumulative yield of all the cuts as influenced by different treatments

Treatments	Green fodder yield (q/ha)			Dry matter yield (q/ha)		
	1972	1973	Mean	1972	1973	Mean
V_1 (S.S.G. 59-3)	567.5	570.2	568.8	140.0	119.5	129.7
V_2 (J.S. 20)	503.5	408.2	453.3	124.0	85.7	104.8
V_3 (M.P. Chari)	512.0	418.8	465.4	130.5	88.8	109.6
V_4 (Piper)	468.0	423.0	445.5	120.0	92.5	106.2
V_5 (I.S. 6090)	555.5	430.0	492.7	131.0	90.8	110.9
SEM±	29.0	9.20	—	4.5	2.0	—
C. D. 5%	82.9	26.3	—	12.9	5.66	—
First cut.						
C_1 (40 days after sowing)	448.5	379.1	413.8	94.0	67.7	80.8
C_2 (55 days after sowing)	563.0	480.4	521.7	129 5	93.2	111.3
C_3 (70 days after sowing)	552.7	487.5	520.1	163.5	125.5	144.5
SEM±	22.4	7.10	—	3.5	1.56	—
CD 5%	64.0	20.3	—	10.0	4.43	—
Subsequent cuttings :						
Sc_1 (20 days interval)	479.0	415.7	447.3	113.5	80.3	96.9
Sc_2 (30 days interval)	518.8	433.3	476.0	127.5	92.9	110.2
Sc_3 (40 days interval)	566.2	497.8	532.0	146.0	113.2	129.6
SEM±	7.73	4.60	—	1.65	0.95	—
C. D. 5%	21.67	12.67	—	4.66	2.66	—

TABLE 2

Cumulative yield of subsequent cuts as affected by different treatments

Treatments	Green fodder yield (q/ha)			Dry matter yield (q/ha)		
	1972	1973	Mean	1972	1973	Mean
V_1 (S S.G. 59-3)	263.0	302.0	282.5	59.1	56.0	57.5
V_2 (J.S. 20)	167.5	139.5	163.5	41.9	26.0	33.9
V_3 (M.P. Chari)	182.8	137.3	160.0	41 6	24.0	32.8
V_4 (Piper)	225.0	205.2	215.6	55.8	39.5	47.6
V_5 (I.S. 6090)	152.2	100.0	126.1	32.8	18.0	25.4
SEM±	15.0	6.30	—	2.8	1.15	—
C. D. 5%	42.4	18.01	—	8.0	3.29	—
C_1 (40 days)	241.5	208.5	225.0	56.0	38.5	47.2
C_2 (55 days)	205.0	180.6	192.8	44.0	33.0	38.5
C_3 (70 days)	160.0	141.9	150.9	38.7	26.0	32.3
SEM±	11.3	4.9	—	2.2	0.90	—
C. D. 5%	32.2	14.01	—	6.3	2.57	—
Sc_1 (20 days)	158.0	144.1	151.0	30.7	17.5	24.1
Sc_2 (30 days)	204.0	162.0	183.0	46.2	30.0	38.1
Sc_3 (40 days)	244.5	224.9	234.9	61.6	52.5	37.0
SEM±	6.3	4.20	—	1 7	0.85	—
C.D. 5%	17.99	11.8	—	4.85	9.4	—

TABLE 3(a)

Effect of varieties x first cutting treatment on the green and dry fodder yield of sorghum varieties

(Total of all cuts)

Treatments	Green fodder yield (q/ha)						Dry matter yield (q/ha)					
	C1		C2		C3		C1		C2		C3	
	1972	1973	1972	1973	1972	1973	1972	1973	1972	1973	1972	1973
V_1 (S.S.G. 59-3)	522.5	546.0	589.5	609.5	591.0	555.0	111.0	101.0	134.5	117.0	174.5	140.5
V_2 (J.S. 20)	460.0	336.5	565.5	397.0	486.0	446.0	90.5	64.0	134.0	79.5	147.0	113.5
V_3 (M.P. Chari)	405.0	435.5	546.5	435.5	585.0	485.0	93.5	58.0	125.0	85.5	172.5	123.0
V_4 (Piper)	486.0	360.0	455.0	476.0	463.5	433.0	108.5	68.0	121.0	95.0	129.5	114.5
V_5 (I.S. 6090)	368.5	287.5	659.5	484.0	638.5	518.5	67.5	47.5	132.0	89 0	193.5	136.0
SEM±	50.1	16.0					7.9	3.5				
C.D. 5%	143.2	45.7					22.5	9.9				

TABLE 3(b)

Effect of varieties x first cutting treatment on the green and dry fodder yield of sorghum varieties

(subsequent cuttings)

V_1 (S.S G. 59-3)	307.5	374.0	255.0	306.0	226.5	226.0	65.3	70.5	54.1	56.0	57.7	41.0
V_2 (J.S. 20)	241.5	176.0	210.5	127.5	110.0	115.0	53.0	32.0	46.9	24.5	25.8	21.5
V_3 (M.P. Chari)	205.5	161 5	174.0	129.5	169.0	121.0	49.6	28.5	35.8	22.0	39.5	21.5
V_4 (Piper)	304.5	215.0	203.5	247.5	167.0	156.0	79.9	42.5	47.0	46.5	44.5	29.5
V_5 (I.S. 6090)	149.0	116.0	181.0	92.5	126.5	91.5	32.4	20.5	36.1	17.0	29.9	16.5
SEM±	26.0	13.0					4.8	2.0				
C.D. 5%	74.3	37.2					13.7	5.7				

TABLE 4(a)

Effect of varieties x subsequent cuttings on the green and dry fodder yield of sorghum varieties

(Total of all cuttings)

Treatments	Green fodder yield (q/ha)						Dry matter yield (q/ha)					
	Sc1		Sc2		Sc3		Sc1		Sc2		Sc3	
	1972	1973	1972	1973	1972	1973	1972	1973	1972	1973	1972	1973
V_1 (S.S.G. 59-3)	506.0	491.0	565.0	565.0	632.0	654.0	115.5	92.5	137.5	117.5	166.5	148.5
V_2 (J.S. 20)	487.5	376.5	503.5	384.5	520.5	448.5	113.5	73.5	121.5	82.0	136.5	101.5
V_3 (M.P. Chari)	466.5	399 5	507.5	397.5	562.5	459.0	113.0	78.5	128.0	84.5	150.5	103.5
V_4 (Piper)	433.5	427.0	467.5	392.0	494.0	449.5	107.0	79.0	124.0	91.0	128.5	107.5
V_5 (I S. 6090)	502.0	384.5	542.0	427.5	622.5	478.0	118.0	78.0	127.0	89.0	148.0	105.0
SEM±	24.5	10.3					3.7	2.1				
C.D. 5%	48.8	28.9					N. S.	5.9				

TABLE 4(b)

Effect of varieties x subsequent cuttings on the green and dry fodder yield of sorghum varieties

(subsequent cuttings)

V_1 (S S.G. 59-3)	210.0	221.0	264.0	301.5	315.0	383.5	38.7	28.5	57.9	54.0	80.6	85.0
V_2 (J.S. 20)	162.5	115.0	196.0	116.0	214.9	187.5	27.2	14.5	42.0	21.5	56.4	42.0
V_3 (M.P. Chari)	136.5	118.5	181.5	119.5	230.5	174.0	24.6	14.0	39.9	20.5	60.3	37.5
V_4 (Piper)	192.0	201.0	232.0	183.5	251.0	234.0	44.6	24.0	60.5	39.5	62.2	55.0
V_5 (I.S. 6090)	99.0	65.0	145.5	89.5	212.0	145.5	19.0	7.5	30.8	15.0	48.6	32.0
SEM±	14.0	9.2					21.0	1.9				
C.D. 5%	39.3	26.5					N. S.	5.3				

high contents of HCN. The trend was reverse when green and dry matter yields of the subsequent cuttings (Table 2) were taken into consideration. Highest green and dry fodder yields were obtained when first cutting was taken at 40 days after sowing and both decreased significantly by delaying the first cutting upto 55 and 70 days after sowing. This may probably be due to the maximum number of cuttings taken after earlier harvestings. Moreover, the regeneration was also found better if the crop was harvested in early stages of its growth.

(c) **Effect of subsequent cuttings**

Subsequent cuttings taken 40 days after the first cut were found to be the best as it gave significantly higher green and dry matter production over the short intervals of 20 and 30 days during both the years. Similar trend was observed in total yield of all cuttings as well as the yield in subsequent cuttings.

The interaction of varieties and first cutting treatment was found significant during both the years for green as well as dry matter production. It is evident from the data in Table 3a (total yield of all cuttings) that SSG. 59-3 gave maximum green fodder yield, when it was harvested after 70 and 55 days after sowing during the year 1972 and 1973, respectively. However, differences were significant only during the second year. First cutting after 70 days of sowing resulted in significantly higher yield during both the years in case of both JS 20 and M. P. Chari over harvesting after 55 and 40 days of sowing. However, during first year, JS 20 was at par in yield at both 55 and 70 days after sowing. For IS 6090 first cutting taken after 55 days of sowing gave significantly higher green fodder yield. Highest yields of green fodder with piper were obtained when it was harvested after 40 and 55 days of sowing during both the years, however, significant improvement was noted only during the second year of testing. It was, therefore, established that, on an average, first cutting taken after 55 days of sowing and the subsequent cuttings taken at an interval of 40 days, was the best. As regards dry matter production, all the varieties gave significantly higher yields when first cutting was taken 70 days after sowing.

While considering the effect of varieties × first cutting treatment on the yield of green and dry matter production in the subsequent cuttings, it became clear from the data in Table 3b that the yield of green as well as dry matter in case of sudan grass and piper decreased significantly when first cutting was delayed from 40 days to 70 days. Varieties JS 20 and M. P. Chari also showed similar trend though the differences in yield between 55 and 70 days were not-significant. In case of IS 6090, though the yield of green as well as dry fodder decreased with delay in harvesting the crop for first cutting yet the differences among the various treatments were non-significant.

The interaction of varieties × subsequent cuttings was also found significant in both the years in respect of total green and dry fodder yield as well as yield in the subsequent cuttings. The data given in Table 4a indicate that in case of SSG. 59-3 and IS 6090, the total green as well as dry fodder yield increased significantly with delaying subsequent cutting interval from 20 to 40 days after first-cut, while in case of JS 20 and M. P. Chari, 20 days and 30 days interval did not differ significantly although the yield in both treatments were significantly inferior to the yield at 40 days interval. In case of piper, 30 and 40 days interval were significantly superior to 20 days interval, during 1972. During 1973, 30 days interval gave significantly lower yield of green fodder. Taking yield in subsequent cuttings into consideration (Table 4b) all the varieties behaved in the similar fashion as in case of total yield. On the whole, 40 days interval was found to be the best, as it gave the highest green fodder yield especially the dry fodder yield was enchanced to a great extent by delaying the cutting intervals.

These results are in line with these of Malik (1953 and 1957) and Gill *et al.* (1967) who have reported that sudan grass can give three to four repeated cuttings.

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APHIDS OF HISSAR (HARYANA)

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(Received : August 7, 1974)

ABSTRACT

Occurrence of 14 species of aphids on 49 different host plants around Hissar has been reported. The number of host plants attacked by each aphid species varied from 1 to 20. Thirty-three host plants were attacked by one aphid species each, 13 by 2 species each, 2 by 3 species each and one plant (wheat) by 4 species. Six aphid species did not have heavy pest intensity on any of the hosts and the remaining species had this intensity on 17 plants, involving only one species in each case.

Aphids infesting 49 different host plants, representing 17 field and fodder crops, 12 vegetables, 5 fruit trees, 11 ornamental plants and 4 weeds at Hissar, were collected during the period December, 1972 to March, 1974. The intensity of the pest was considered heavy when the tender parts of the host plants were completely covered with aphid colonies and the adoption of control measures was felt very necessary. If small colonies of aphids were present on tender parts of the host plants, resulting in slight curling of such parts, the pest intensity was classified as medium. When aphids were present singly on the host plants and their colonies were not formed their intensity was considered mild.

RESULTS AND DISCUSSION

Information on the species of aphids found along with their host plants and intensity of attack is given in Table 1. There was a wide variation in the number of host plants attacked by the 14 species of aphids, it being 20 for *Aphis gossypii*, 18 for *Myzus persicae*, 10 for *Aphis craccivora*, 6 for *Lipaphis erysimi*, 3 for *Rhopalosiphum maidis*, 2 each for *Brachyunguis calotropicus*, *Dactynotus coposi-tae* and *Rhopalosiphum rufiabdominalis* and one each for *Aphis nerii*, *Aphis punicae*, *Aphis solanella*, *Hyadaphis coriandri*, *Macrosiphum miscanthi* and *Rhopalosiphum padi*. Distribution of aphid species on different host plants further revealed the occurrence of 4 species of aphids on wheat, 3 on potato and milkweed, 2 on lentil, fenugreek, barley, safflower, tomato, okra, radish, kale, Phalsa, pomegranate, evening primrose, aster and country mallow while the remaining 33 host plants harboured only one species each.

A. punicae, *B. calotropicus*, *M. miscanthi*, *R. maidis*, *R. padi* and

TABLE 1

Aphid species and their pest status infesting different host plants at Hissar

Aphid species 1	Host Plant 2	Date collected 3	Intensity of attack 4
Aphis craccivora Koch	Gram, *Cicer arietinum*	Feb., 1973	Mild
	Lentil, *Lens culinaris*	Jan., 1974	Mild
	Green gram, *Phaseolus aureus*	Dec., 1973	Heavy
	Lucerne, *Medicago sativa*	Jan., 1973	Mild
	Fenugreek*(Metha)*, *Trigonella foenum-graecum*	Feb., 1973	Mild
	Tomato, *Lycopersicon esculentum*	Jan., 1974	Mild
	Potato, *Solanum tuberosum*	Feb., 1974	Mild
	Mango, *Mangifera indica*	March, 1974	Mild
	Wild pea, *Lathyrus aphaca*	March, 1974	Mild
	Pigweed, *Chenopodium album*	Jan., 1974	Mild
Aphis gossypii Glover	Cotton, *Gossypium hirsutum*	Jan., 1973	Medium
	Lentil, *Lens culinaris*	Feb., 1973	Mild
	Castor, *Ricinus communis*	Feb., 1973	Mild
	Senji, *Melilotus indica*	Feb., 1973	Mild
	Fenugreek, *(Methi)*, *Trigonella foenum-graecum*	Feb., 1973	Mild
	Brinjal, *Solanum melongena*	Dec., 1972	Medium
	Chillies, *Capsicum frutescens*	Jan., 1974	Mild
	Potato, *Solanum tuberosum*	Feb., 1974	Mild
	Cucurbit, *Cucumis sativus*	May, 1973	Mild
	Okra, *Abelmoschus esculentus*	March, 1974	Mild
	Hyacinth bean, *Dolichos lablab*	Feb., 1973	Heavy
	Guava, *Psidium guajava*	Feb., 1973	Mild
	Citrus, *Citrus sinensis*	Feb., 1973	Mild
	Phalsa, *Grewia asiatica*	March, 1974	Mild
	Rose Petioles, *Rosa alba*	Feb., 1974	Mild
	Marigold, *Tagetes erecta*	March, 1974	Mild
	Evening primrose, *Oenothera biennis*	March, 1974	Mild
	Aster, *Aster amellus*	March, 1974	Mild
	Milkweed, *Calotropis gigantea*	Dec., 1973	Medium
	Country mallow, *Abutilon indicum*	Feb., 1973	Mild
Aphis nerii Boyer de Fonscolmbe	Milkweed, *Calotropis gigantea*	Dec., 1973	Mild
Aphis punicae Passerini	Pomegranate, *Punica granatum*	Dec., 1973	Mild
Aphis solanella Theobald	Night jessamine, *Cestrum nocturunum*	Feb., 1973	Heavy
Brachyunguis calotropicus Menon & Powar	Milkweed, *Calotropis gigantea*	Feb., 1973	Medium
	Country mallow, *Abutilon indicum*	Feb., 1973	Mild
Dactynotus compositae (Theobald)	Safflower, *Carthamus tinctorius*	Feb., 1973	Medium
	Sweet Sultan, *Cenataurea moschata*	March, 1974	Heavy
Hyadaphis coriandri (Das)	Coriander, *Coriandrum sativum*	March, 1973	Heavy

1	2	3	4
Lipaphis erysimi (Kalt.)	*Sarson, Brassica campestris* var. *sarson*	Jan., 1973	Heavy
	Cabbage, *Brassica oleracea* var. *capitata*	Jan., 1973	Heavy
	Radish, *Raphanus sativus* (For seed)	March, 1974	Heavy
	Turnip, *Brassica rapa*	Feb., 1973	Mild
	Kale, *Brassica oleracea* var. *acephala*	March, 1974	Heavy
	Stocks, *Mathiola incana*	March, 1974	Heavy
Macrosiphum (Sitobion) micanthi Takahashi	Wheat, *Triticum aestivum*	Feb., 1973	Mild
Myzus persicae (Sulzer)	Sugarbeet, *Beta vulgaris* var. *rapa*	Feb., 1973	Heavy
	Safflower, *Carthamus tinctorius*	Feb., 1973	Medium
	Tobacco, *Nicotiana tobacum*	Dec., 1973	Heavy
	Oat, *Avena sativa*	Feb., 1973	Mild
	Fenugreek *(Methi),Trigonella foenum-graecum*	Feb., 1973	Mild
	Potato, *Solanum tuberosum*	Jan., 1973	Mild
	Tomato, *Lycopersicon esculentum*	Jan., 1974	Mild
	Okra, *Abelmoschus esculentus*	March, 1974	Mild
	Radish, *Raphanus sativus*	March, 1974	Medium
	Kale, *Brassica oleracea* var. *acephala*	March, 1974	Medium
	Pomegranate, *Punica granatum*	Dec., 1973	Mild
	Phalsa, *Grewia asiatica*	March, 1974	Mild
	Petunia, *Petunia axillaris*	March, 1973	Heavy
	Evening primrose, *Oenothera biennis*	March, 1974	Medium
	Double Venidium, *Venidium asctotoives*	March, 1974	Medium
	Aster, *Aster amellus*	March, 1974	Mild
	Poppy, *Papayer somniferum*	March, 1974	Mild
	Wild morning glory, *Convolvulus arvensis*	Feb., 1973	Heavy
Rhopalosiphum maidis(Fitch)	Maize, *Zea mays*	Aug., 1974	Medium
	Wheat, *Triticum aestivum*	Feb., 1973	Mild
	Barley, *Hordeum vulgare*	Jan., 1973	Medium
Rhopalosiphum padi (L.)	Wheat, *Triticum aestivum*	Feb., 1973	Mild
Rhopalosiphum rufiabdominalis Sasaki	Wheat root, *Triticum aestivum*	Feb., 1973	Mild
	Barley root, *Hordeum vulgare*	Feb., 1973	Mild

Unless otherwise indicated, aphids were collected from leaves and tender shoots of the host plants.

R. rufiabdominalis did not infest heavily any of the host plants under study. *B. calotropicus* on milkweed and *R. maidis* on maize and barley, however, had medium pest intensity.

Perusal of the data indicates that of the 49 host plants only 17 were severely attacked by one or the other aphid species. These host plants along with their major aphid pests were : Green gram and wild pea -*A. craccivora;* hyacinth bean and marigold–*A. gossypii;* milkweed–*A. nerii;* night jessamine–*A. solanella;* sweet sultan–*B. compositae;* coriander–*H. coriandri; sarson,* cabbage, radish, kale and stocks-*L. erysimi;* sugarbeet, tobacco, petunia, and wild morning glory-*M. persicae.*

The earlier records on the occurrence of aphids on different host plants in Haryana pertain only to *A. craccivora* on potato (Chaudhary and Pandita, 1974); *A. gossypii* on cotton (Singh and Butani, 1963), marigold (Chaudhary and Garg, 1973) and Potato (Chaudhary and Pandita, 1974); *L. erysimi* on cabbage (Kaushak and Gupta, 1971) and mustard (Gupta, 1971).

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COMBINING ABILITY ANALYSIS IN *PENNISETUM TYPHOIDES* (BURM) S & H

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ABSTRACT

Twenty one inbreds were tested for their combining ability against five male-sterile lines. Non-additive type of gene action was found predominant as evidenced by higher magnitude of SCA than GCA variances. Mean performance of females and pollinators did not reflect their good combining ability. L-101A exhibited its superiority for grain yield and 500-grain weight. TF-23D$_2$A was best parent when all characters were considered collectively. A line having good general combining ability did not produce better hybrids. However, it differed with genetic back-ground.

The genetic improvement in yielding potential of pearl-millet has been one of the spectacular achievements in the field of plant breeding. This has largely been possible through the exploitation of male-sterility. In the last decade, a number of male-sterile lines have been evolved. However, extensive use of TF-23A has been made in all hybrid programmes in India. It has generally been realised that any hybrid programme should make use of wider genetic base and a variety of male-sterile lines should be used, particularly in order to have insurance against diseases to which most of the present hybrids have been found to be susceptible. Information on combining ability of the promising male-sterile lines as well as promising pollinators is scanty. Attempts were, therefore, made in the present investigation to study the combining ability using line x tester analysis in pearl-millet.

MATERIAL AND METHODS

Twenty one inbreds, derived from various crosses, were selfed up to S_6 generation. These lines were crossed with five male-sterile lines, viz., L-101A, L-103A, L-111A, TF-23A, TF-23D$_2$A. All the hybrids and parents along with H.B.1 as check were grown in a randomized block design with four replications. The distance between rows was 60 cm and plants were spaced 25 cm apart. Five plants were selected randomly from each progeny for recording the data. The characters studied were : days to ear emergence, number of ears per plant,

*Department of Genetics, Haryana Agricultural University, Hissar length of main ear per plant, diameter of main ear per plant, 500-grain weight in grams and grain yield per plant in grams. Combining ability analysis was done according to the procedure outlined by Kempthorne (1957) for line x tester analysis.

RESULTS

Analysis of variance for combining ability indicated significant differences among males as well as females for its components studied (Table 1). The magnitude of variance for females was invariably higher than that of the males except in case of grain yield. The interaction due to male x female variances was also significant indicating appreciable amount of differences among crosses. The characters were found to be predominantly governed by more of non-additive genes as evident from the GCA & SCA variances in Table 1. The GCA variance due to males was higher for grain yield and days to ear emergence, whereas, the GCA variances for females were higher for remaining characters.

The GCA effects of the males as well as of the females alongwith their respective mean performance are presented in Table 2. It is evident that among females L-101A was the best general combiner for most of the characters except for ears per plant and ear length. The second best combiner was TF-23D_2A followed by TF-23A. From among males, H-403, H-27 and H-111 were the best general combiners for grain yield per plant. Among these, H-27 appeared to be a good combiner for almost all the characters. However, for the selection of good females and pollinators based on their mean performance, it was observed that a parent with good general combining ability was not necessarily having high mean performance.

Specific combining ability effects and magnitude of heterosis for grain yield per plant for different hybrids are presented in Table 3. The hybrids L-101A x H-297, L-101 A x H-414, L-101A x H-224, TF-23D_2A x H-198 and TF-23D_2A x H-440 were the best combinations for grain yield. It was observed that high SCA effect was not always accompanied by high heterosis.

Parents and hybrids having best performance for different characters are presented in Table 4. H-403 had shown highest GCA for yield but its hybrids were not among the highest yielders. However, from among females, L-101A was the best combiner for yield per plant, 500-grain weight, ear diameter and days to ear emergence and was female parent for the best hybrids in respect of grain yield per plant and ear diameter. It is evident from these results that it was not necessary that a good general combiner will produce better hybrids. Out of 105 total cross combinations, 25 crosses excelled H. B. 1, the check, in their mean yields. The range of mean yield of these crosses was 119-183 gms. as against 116 gms. per plant in case of H.B.1. Most of these superior crosses were obtained by using 101A as the male sterile line followed by TF-23D_2A.

DISCUSSION

All the pearl-millet hybrids released so far in India involved TF-23A as the female parent. In spite of its superiority, it is now felt that susceptibility of released hybrids to various diseases and pests

TABLE 1

Analysis of variance for combining ability

Source of variation	d.f.	Grain yield (gms)	Ear number	500-grain weight (gms)	Ear length (cms)	Ear diameter (cms)	Days to ear emergence
		Mean sum of squares					
Replications	3	3512.00	44.67	0.11	4.88	0.18	12.15
Hybrids	104	3987.31**	8.43**	1.54**	127.24**	0.39**	52.06**
Females	4	3501.61**	22.02**	20.57**	1371.98**	600.34**	102.56**
Males	20	5166.95**	8.40**	1.42**	324.39**	88.84**	81.09**
Crosses (Female x Male)	80	5166.03**	10.96**	0.25	155.87**	43.28**	67.65**
Error	312	110.05	0.10	0.78	1.38	0.01	28.13
Estimates of component of variance :							
δ^2 SCA		922.76	2.29	—0.40	130.08	88.07	6.97
δ^2 GCA (Males)		0.04	−0.12	+0.05	8.32	2.27	0.67
δ^2 GCA (Females)		—19.81	0.13	0.25	14.47	6.63	0.41
δ^2 GCA (Pooled over males and females)		—15.99	0.08	0.21	13.71	5.79	0.80

**Significant at 1% level.

TABLE 2

Mean and general combining ability effects (in parenthsis)

Parents	Grain yield (gms)	Ear number	500-grain weight (gms)	Ear length (cms)	Ear diameter (cms)	Days to ear emergence
1	2	3	4	5	6	7
Females :						
L-101A	42.41 (+8.09)**	4.30 (—0.70)**	5.68 (+0.74)**	17.40 (—2.03)**	2.24 (+0.51)**	51.17 (—0.57)
L-103A	14.14 (—8.81)**	6.85 (+0.69)**	3.52 (—0.63)**	14.65 (—1.48)**	1.17 (—0.26)**	56.96 (—0.67)
L-111A	55.94 (—3.67)*	5.70 (—0.07)*	4.13 (—0.11)	34.75 (+7.23)**	1.52 (—0.06)**	63.33 (+1.33)**
TF-23A	34.02 (+1.61)	6.97 (+0.20)**	2.96 (+0.03)	20.30 (—2.03)**	1.71 (—0.10)**	60.55 (1.02)
TF-23D$_2$A	18.85 (+2.76)	5.05 (—0.12)**	3.38 (—0.01)	16.35 (—1.68)**	1.70 (—0.08)*	63.50 (—1.11)
S. E. ±	1.51	0.03	0.96	0.12	0.01	0.57
Males :						
H-9	41.84 (—11.25)**	6.45 (+0.48)**	3.27 (+0.07)*	18.10 (—2 48)**	1.51 (—0.11)**	46.45 (—2.75)*
H-27	81.96 (+18.68)**	4.47 (—0.01)	4.22 (+0.16)**	26.40 (+2.67)**	2.00 (+0.01)	47.33 (—1.44)
H-28	43.04 (—8.83)**	4.95 (+0.07)	3.57 (+0.38)**	25.61 (—2.42)**	1.73 (—0.02)	60.35 (—0.30)
H-35	113.60 (—4.47)	9.15 (+1.13)**	4.20 (+0.29)**	24.35 (—1.07)	1.64 (—0.15)**	54.35 (+3.01)*
H-48	34.56 (—17.33)**	5.65 (+0.73)**	3.61 (+0.03)	20.02 (+1.97)*	1.35 (-0.23)**	48.70 (—3.01)*
H-51	51.71 (—9.76)**	9.45 (—0.51)**	4.12 (+0.60)**	30.60 (+6.66)**	1.47 (—0.09)**	52.87 (—0.67)

H-52	39.27 (—16.57)**	6,10 (+0.14)*	2.86 (+0.01)	37.20 (—0.77)*	1,59 (—0.19)**	59.80 (—1,20)
H-53	29.32 (—10.68)**	5.05 (—0.89)**	2.86 (—0.12)**	34.45 (+6.95)**	1.80 (—0.14)**	49.37 (—1.15)
H-111	36.16 (+16.27)**	4.40 (—1.50)**	3.23 (+0.09)*	48.70 (+10.39)**	2.03 (+0.08)**	57.45 (+5.46)**
H-126	23.86 (+5.82)*	8.35 (+0.92)**	2.66 (—0.15)**	16.10 (—4.07)**	1.67 (—0.02)	56.50 (—0.11)
H-157	23.84 (+7.07)**	5.40 (—0.21)**	3.43 (+0.12)**	17.30 (+2.52)**	1.33 (—0.01)	54.70 (+0.38)
H-191	14.17 (—28.19)**	5.20 (+0.73)**	3.57 (+0.15)**	17.70 (—5.19)**	1.71 (—0.84)**	61.42 (+0.63)
H-198	24.89 (—5.04)*	3.80 (—0.11)	3.44 (—0.25)**	19.05 (—0.45)	1.74 (+0.08)**	58.00 (+0.84)
H-224	45.00 (+2.28)	3.90 (—0.41)**	5.38 (+0.09)*	24.70 (—3.05)**	2.95 (+0.09)**	52.05 (—1.20)
H-269	66.04 (—0.86)	5.85 (+0.35)**	3.05 (—0.39)**	21.60 (—1.18)	1.68 (—0,01)	48.20 (—0.57)
H-297	78.81 (—0.79)	9 65 (—0.20)**	3.86 (+0.09)*	21.20 (—1.67)*	1.53 (+0.07)**	59.09 (+3.22)**
H-366	40.76 (+10.56)**	5.12 (—0.94)**	1.49 (—0.11)**	17.21 (—0.70)	1.73 (+0.19)**	52.62 (—0.87)
H-403	32.20 (+49.95)**	4.30 (+0.41)**	2.60 (—0.23)**	14.32 (—2.61)**	2.01 (+0,15)**	50.42 (—1.28)
H-407	20.71 (+3.80)	5.05 (+0.21)**	3.09 (—0.59)**	13.93 (—3.25)**	1.81 (+0.12)**	46.92 (—1.37)
H-414	61.43 (—3.59)	6.05 (—0.14)*	3.13 (—0.21)**	18.90 (—1.91)*	2.06 (+0.19)**	41.25 (+0.80)
H-440	98.14 (+2.29)	4.75 (—0.27)**	4.07 (—0.06)	33.75 (+3.66)**	1.85 (+0.18)**	50,14 (+1.14)
S. E. ±	2.34	0.07	0.03	0.83	0.03	1.18

* Significant at 5% level.

** Significant at 1% level.

TABLE 3

Heterosis in percentage and estimates of specific combining ability effects (in parenthesis) for grain yield.

	1	2	3	4	5
Females/Males	L—101A	L—103A	L—111A	TF—23A	TF—23D₂A
H-9	+135.7 (+22.6)**	+105.8 (—8.2)	— 28.5 (—49.2)**	+145.8 (+19.0)**	+135.5 (+15.8)**
H-27	+ 73.4 (+34.8)**	+ 15.7 (—29.4)**	+ 70.7 (—20.8)**	+ 27.7 (—9.2)	+ 16.7 (—17.0)**
H-28	+103.0 (+7.6)	+ 82.4 (+18.2)**	+104.4 (—22.8)**	+ 70.5 (—12.9)*	+ 99.6 (+0.8)
H-35	— 0.3 (+29.2)	— 6.6 (+5.0)	— 27.1 (—13.0)*	—45.7 (—32.2)**	— 14.3 (+7.8)
H-48	+ 56.4 (—5.0)	+ 44.0 (—36.5)**	+ 51.5 (—1.7)	+137.3 (+4.2)	+230.4 (+37.6)**
H-51	+ 45.7 (—3.5)	+110.5 (+13.1)*	+ 13.7 (—27.1)**	+ 72.5 (+3.9)	+ 89.2 (+13.6)*
H-52	+133.9 (+27.1)**	+ 56.8 (—27.4)**	+ 21.5 (—16.0)**	+140.0 (+15.7)**	+ 98.6 (+0.6)
H-53	+184.1 (+42.5)**	+ 86.2 (—40.3)**	+ 32.1 (—20.8)**	+202.9 (+18.6)**	+183.8 (—0.1)
H-111	+ 72.5 (—31.7)**	+329.8 (+33.57)**	+ 43.2 (—36.6)**	+229.8 (+7.9)	+279.3 (+26.9)**
H-126	+332.5 (+88.8)**	+188.8 (—42.5)**	+ 36.4 (—30.0)**	+207.8 (—3.8)**	+176.2 (—20.1)**
H-157	+212.5 (+36.8)**	+268.2 (—24.8)**	+ 23.7 (—38.3)**	+187.5 (—4.4)	+356.6 (+30.7)**
H-191	+ 46.9 (+1.9)	+168.2 (—39.2)**	+ 57.1 (—15.6)**	+136.5 (+13.5)*	+156.3 (—8.2)

H-198	+102.2 (+2.1)	+120.2 (45.7)**	+105.7 (+19.7)**	+ 96.8 (23.2)**	+371.0 (+47.0)**
H-224	+200.3 (+44.2)**	+140.6 (+0.4)	+ 48.6 (−19.54)**	+138.9 (+10.1)	+ 35.6 (−35.2)**
H-269	+ 53.6 (+13.7)*	+ 12.0 (−30.7)**	+ 35.6 (−10.0)	+167.2 (+16.2)**	+ 57.5 (+10.9)
H-297	+125.5 (+89.9)**	− 14.9 (−37.7)**	+ 36.9 (8.3)	− 10.3 (−23.6)**	− 28.5 (−36.9)**
H-366	+ 6.6 (−54.0)**	+232.5 (−19.4)**	+ 82.8 (−8.7)	+183.2 (+9.8)	+238.6 (+33.5)**
H-403	+288.3 (+26.1)**	+384.4 (+0.5)	+131.2 (−21.1)**	+357.6 (+10.6)	+296.8 (−16.2)**
H-407	67.9 (−47.2)**	+372.4 (−11.5)**	+171.1 (+47.4)**	+294.7 (+35.3)**	+155.4 (−24.1)**
H-414	+131.1 (+57.0)**	+ 10.7 (−33.9)**	+ 97.3 (+24.4)**	− 5.9 (−33.7)**	− 24.9 (−13.7)*
H-440	− 50.3 (−42.7)**	− 3 70 (−13.9)*	− 19.9 (−24.7)**	+ 35.9 (+32.1)**	+ 45.7 (+46.4)**

S. E. (sij)± =5.85
*Significant at 5% level.
**Significant at 1% level.

TABLE 4

Best performing hybrids and parents

Particulars	Grain yield (g)	Ear number	500-grain weight (g)	Ear length (cm)	Ear diameter (cm)	Days to ear emergence
Best male parents	H-403 (+49.95)	H-35 (+1.13)	H-51 (+0.60)	H-111 (+10.39)	H-366 H—414 (+0.19) (+0.19)	H-48 (−3.00)
Best female parents	L-101A (+8.09)	L-103A (+0.69)	L-101A (+0.74)	L-111A (+7.23)	L-101A (+0.51)	L-101A (—0.57)
Best cross combination	L-101A×H-297 (+89.87)	L-103A×H-198 (+4.59)	TF23D:A×H-35 (+4.02)	L-111A×H-403 (+37.68)	L-101A · H-224 (+1.31)	L-111A×H-403 (—0.01)
GCA of parents of the cross combination	(+8.09) (—0.79)	(+0 69) (−0.11)	(—0.01) (+0.29)	(+7.23) (—2.61)	(+0.51) (+0.09)	(+1.33) (—1.23)
SCA of crosses	89.87	4.59	4.02	37.68	1.31	—0.10

is due to the weakness of TF-23A itself. This situation has alerted the breeder to search out some other male-sterile lines which may be used in place of TF-23A. Some male-sterile lines have been developed during the last decade which may be tested for their potentialities to yield better hybrids with newly developed pollinators. In the present study, it was observed that L-101A and TF-23D_2A had the potentiality to be used as female parent.

Male-sterile lines were found more variable than pollinators. The possibilities for such results could be the lower number of females than males or greater diversity of male-sterile lines (Gupta and Singh 1967). Also GCA variances were of larger magnitude in females than in males and, as such, females varied more than males. Moreover, it may be mentioned that pollinators were evolved from crosses involving T-55, S-350, Droa, B/L-1 and IP 139-75 and these inbreds are reported to have lower magnitude of GCA variance than females of identical genetical background that were used in the present study (Bains *et al.*, 1967).

The estimates of GCA & SCA variances had shown that non-additive gene action was predominent for all characters except 500-grain weight. Previous reports (Nanda and Gupta, 1967; Gupta and Nanda, 1967,1968; Ahluwalia, 1962; Ahluwalia *et al.*, 1962; Mahadevappa, 1968 a, b, c.) had also established that non-additive type of gene action was important for yield and yield components in pearl-millet. Moreover, the pollinators used in the present study were selected from crosses of inbreds having good GCA and such material is expected to have more non-additive gene action (Murty *et al.*, 1967; Pokhriyal *et al.*, 1967).

It is also noted that mean performance of females or pollinators does not necessarily reflect their combining ability potential. Therefore, individual performance can not be taken as criterion for selection of parents. However, some inbreds which had high GCA for yield as well as for its component like 500-grain yield weight, ear length and ear number per plant, produced better hybrids. On the contrary, inbreds like H-27, though good general combiner, could not produce better hybrids. Such type of discrepancies may be attributed to the genetic background of different inbreds (Ahluwalia and Patnaik, 1963) and type of gene action among all the inbreds seems to be non-additive and appreciable amount of heterosis is obtained for yield.

Among the pollinators, H-403, H-407, H-440, H-111, H-126, H-157, H-198 and H-224 had produced good hybrids. For example; TF-23D_2A x H-198, TF-23D_2A x H-403, TF-23D_2A x H-297, TF-23D_2A x H-414 and TF-23D_2A x H-440 gave 10 to 30 per cent higher yield than other hybrids in various coordinated and state level trials. It is felt that the genetic background of pollinators is still to be widened to make effective use of available male-sterile lines.

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OCCUPATIONAL AND JOB PREFERENCES OF SCHOOL STUDENTS

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ABSTRACT

Among agriculture, business and service, the one most liked by the students under study was service followed, in order, by business and agriculture. Agriculture was their last choice. The jobs of engineer, army officer and scientist were the three top-ranking ones. On the other extreme were the jobs of leader, actor and poet.

It is not just an academic exercise to be aware of the occupational and job preferences of school students. Such information can provide valuable guidelines to teachers and parents for future planning of students' career. The study reported here was undertaken with the students of Campus School, Hissar. There were 41 students in classes 7th, 8th and 9th and all were personally interviewed to collect data for this study. They were asked just two simple questions-one with regard to their liking for career in agriculture, business and service and the other in relation to their preferences for different jobs. The specific questions asked read as follows :

1. Given below is the list of three occupations. You have to rank them in order of your preference. Put 1 against the occupation you prefer most and 3 against that you prefer least. Put 2 against the occupation that lies in between.
2. Given below is the list of jobs. Indicate which jobs you like and which you do not like. If you like a job, put a tick mark in the corresponding column 'Like'. If you do not like a job, put a tick mark in the corresponding column 'Dislike'. In case you are not sure whether you like or dislike a job, put a tick mark in the corresponding column 'Undecided'.

Before administering these questions, the students were given a clear idea about different occupations and jobs. Both the questions were administered on a three-point rating scale. The three points on the continuum with their numerical values in paranthesis were as given below.

Like	(3)
Undecided	(2)
Dislike	(1)

The total score for each occupation and job was worked out by adding the individual scores. Based on these total scores, class-wise ranks were assigned to different occupations and jobs.

In order to see if there was any relationship between ranks of different jobs for different classes, rank-difference coefficient correlation (rho) was calculated.

Singh and Haque (1967) concluded that the boys belonging to different age groups, parental occupations and educational levels had more or less similar interest. Social service was ranked as the first interest by all the groups. Agriculture, new experiences, reading, music and playing were other interests indicated in order of preferences.

Sandhu and Sinha (1970) observed that research was the most preferred field of agricultural under-graduates. Their second overall choice went to extension job. Teaching came to be their third choice.

Singh and Ghosh (1973) found that the students under urban influence indicated greatest interest in technical activities. The next area of interest in order of their preference was outdoor life. The third interest area of their preference was sports. What they liked least of all the areas of interest was agriculture.

The three areas of greatest interest to the students under semi-urban influence were technical, medical and crafts. Their least interest was in fine arts.

The first three areas of interest in which the students under rural influence indicated greatest interest were literacy, household work and medicine. They had equal interest in fine arts, science and agriculture. What they were least interested in was sports.

RESULTS

The students were asked to indicate their liking for careers in agriculture, business and service by selecting any of the three alternative responses provided to each of the three. The rating scores were used to rank each occupation. The summary of rankings by students of different classes is given in *Table* 1.

TABLE 1

Class-wise students' ranking of different occupations

Occupation	7th class		8th class		9th class		Pooled	
	Rank order	Rank value	Rank order	Rank value	Rank order	Rank value	Rank order	Rank value
Agriculture	2	2.5	2	2.5	3	3	3	3
Business	2	2.5	1	1	2	2	2	2
Service	1	1	2	2.5	1	1	1	1

The data presented in Table 1 indicate that of the three occupations, the most liked one was service in case of seventh class and ninth class and business in respect of eighth class. Agriculture and business were equally preferred by the students of seventh class. Similarly, agriculture and service were at par in the preferential choices of eighth class students. Agriculture was the least preference of top class students, business occupying the neutral position. Surprisingly, agriculture was not given first preference by any of the three groups of students.

The summary of the data as to indirect rankings of different jobs by the students of the three different classes is given in Table 2.

TABLE 2

Class-wise students' ranking of different jobs

Jobs	7th class		8th class		9th class		Pooled	
	Rank order	Rank value	Rank order	Rank value	Rank order	Rank value	Rank order	Rank value
Doctor	4	5	3	3	3	4.5	5	5
Engineer	3	3.5	1	1	1	1.5	1	1
Professor	5	6	8	8.5	6	11	7	7
Advocate	9	10	8	8.5	5	8.5	9	10
Leader	12	13	11	12.5	8	13	12	13
Scientist	3	3.5	4	4	1	1.5	3	3
Pilot	2	2	5	5	2	3	4	4
Actor	11	12	10	11	5	8.5	11	12
Poet	10	11	11	12.5	5	8.5	10	11
Writer	8	9	9	10	4	6	8	8.5
Magistrate	7	8	7	7	7	12	8	8.5
Police Officer	6	7	6	6	5	8.5	6	6
Army Officer	1	1	2	2	3	4.5	2	2

TABLE 3

Rank correlation between the ranks assigned by students of different classes.

	X (7th class)	Y (8th class)	Z (9th class)
X	...	0.90**	0.22 N.S.
Y	...	...	0.74**

** Significant at 5 per cent level.

N.S. Non-significant.

As apparent from the data in Table 2, the three top ranking jobs in descending order of liking were those of army officer, pilot and engineer/scientist in case of seventh class, engineer, army officer and doctor in case of eighth class and engineer/scientist, pilot and army officer/doctor in case of ninth class students. The three lowest ranking jobs in ascending order of liking were those of leader, actor and poet in respect of seventh class, leader/poet, actor and writer in respect of eighth class and leader, magistrate and professor in respect of ninth class students. The students of all the three classes, taken together, engineer, army officer and scientist ranked as the top three jobs in descending order of importance and leader, actor and poet as the three lowest ranking jobs in ascending order of liking.

The result of rank-difference correlation analysis are given in Table 3.

Apparently, there appeared to be some differences in ranks assigned to different jobs by students of different classes. The rank-difference coefficient of correlation (rho), however, confirmed this difference only between seventh and eighth and eighth and ninth classes.

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SUSCEPTIBILITY OF *COCCINELLA SEPTEMPUNCTATA* LINN, (COCCINELLIDAE : COLEOPTERA) TO SOME INSECTICIDES*

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ABSTRACT

Relative susceptibility of nineteen insecticides to *Coccinella septempunctata* Linn. was determined. Out of these, seventeen insecticides, namely, monocrotphos, fenitrothion, methyl parathion, malathion, tetrachlorvinphos, methyl demeton, carbaryl, chlorfenvinphos, diazinon, formothion, phosphamidon, trichlorphon, dimethoate, ethyl parathion, endosulfan, endrin, and menazon were 1429.5, 1165.7, 285.6, 233.3, 144.2, 108.4, 83.3, 80.6, 71.7, 49.0, 47.6, 41.0, 37.4, 36.6, 3.8, 2.0 and 1.1 times more toxic than DDT. Aldrin was the only insecticide which was less toxic than DDT. As far as the safety limit is concerned, except tetrachlorvinphos, all the insecticides were comparatively safer to the predator than the host. In order of the series, menazon, endrin, aldrin, dimethoate, phosphamidon, DDT, ethyl parathion and endosulfan were the insecticides which were very much safe to the predator and quite toxic to the host. Use of monocrotophos and fenitrothion may also be avoided as the actual doses recommended for aphid control may prove to be lethal for the predator also.

Coccinella septempunctata is an important predator of mustard aphid (*Lipaphis erysimi* Kalt.). Use of wrongly chosen insecticides in aphid infested mustard fields, destroys a large number of predators, allowing the pest to multiply at a faster rate. Pradhan *et al.* (1959) studied the relative toxicity of sixteen insecticides to the grubs and adults of this predator and reported that organophorous insecticides, in general, were more toxic than chlorinated hydrocarbons. On the basis of LC_{50} values for mustard aphid and the adult predator, they reported that some of the organophorous insecticides, viz., malathion and parathion which were very toxic to the aphid were toxic to the adult predator also. However, all the insecticides of this group were not highly toxic to the predator. For instance, demeton, OMPA (Schradan), HETP and diazinon were quite toxic to the prey but safe to the predator. Sarup *et al.* (1965) determined the relative susceptibility of the adults of *C. septempunctata* to fourteen insecticides and reported that the predator was very susceptible to mevinphos, phorate, phosphamidon and dich-

*Based on the M.Sc. (Agri.) thesis of the junior author.

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TABLE 1

Relative toxicity of different insecticides to the adults of *C. septempunctata*

Sr. No. 1	Insecticide 2	Heterogeneity* 3	Regression Equation 4	LC_{50} 5	Fiducial limits 6	Relative toxicity 7
1.	Monocrotophos	$X^2(3)=0.732$	$Y=1.989x+2.570$	0.000190	0.0001409 0.0002575	1429.5
2.	Fenitrothion	$X^2(3)=2.059$	$Y=2.064x+2.178$	0.000232	0.0001774 0.0003055	1165.7
3.	Methyl parathion	$X^2(4)=3.520$	$Y=1.141x+2.743$	0.000951	0.0006270 0.001441	285.6
4.	Malathion	$X^2(3)=1.120$	$Y=1.628x+1.637$	0.001164	0.0008279 0.001634	233.3
5.	Tetrachlorvinphos	$X^2(4)=2.200$	$Y=1.728x+1.068$	0.001884	0.001333 0.001634	144.2
6.	Methyl demeton	$X^2(5)=3.193$	$Y=1.421x+1.590$	0.0025060	0.001774 0.003540	108.4
7.	Carbaryl	$X^2(4)=3.307$	$Y=1.949x+0.101$	0.0032580	0.002474 0.003291	83.3
8.	Chlorfenvinphos	$X^2(4)=1.886$	$Y=1.415x+1.420$	0.003368	0.002350 0.004887	80.6
9.	Diazinon	$X^2(3)=2.638$	$Y=2.483x-1.401$	0.003784	0.003055 0.004688	71.7
10.	Formothion	$X^2(4)=0.758$	$Y=1.702x+0.331$	0.005534	0.004048 0.007565	49.0

11.	Phosphamidon	$X^2(3)=4.698$	$Y=0.953x+2.373$	0.005702	0.003278 0.009915	47.6
12.	Trichlorphon	$X^2(3)=1.949$	$Y=1.674x+0.278$	0.006622	0.004842 0.009057	41.0
13.	Dimethoate	$X^2(4)=0.520$	$Y=0.919x+2.371$	0.007413	0.005117 0.01074	37.4
14.	Ethyl parathion	$X^2(3)=5.889$	$Y=1.377x+1.048$	0.007413	0.005117 0.01074	36.6
15.	Endosulfan	$X^2(4)=3.411$	$Y=1.836x-2.067$	0.070631	0.08659 0.09839	3.8
16.	Endrin	$X^2(3)=0.970$	$Y=1.905x-2.838$	0.130000	0.11590 0.14590	2.0
17.	Menazon	$X^2(3)=4.508$	$Y=1.589x-1.957$	0.238801	0.17100 0.33340	1.1
18.	DDT	$X^2(3)=0.724$	$Y=0.677x+1.958$	0.271601	0.15310 0.48190	1.0
19.	Aldrin	$X^2(3)=3.473$	$Y=2.519x-7.190$	0.690201	0.55980 0.85110	0.4

* In none of these cases the data were found to be significantly heterogenous at $P=0.05$

$x=$ Log (conc. x 10^5)

LC_{50}=Concentration calculated to give 50 per cent mortality.

Y=Probit kill.

X^2=Chi square

TABLE 2

Values of LC_{50} for the predator, *C. septempunctata* and the aphid, *L. erysimi* and the ratios between them

Sr. No.	Insecticide	Values of LC_{50} for		Ratios of LC_{50} values
		C. septempunctata	*L. erysimi*	
1.	Menazon	0.2388010	0.0004932	1 : 344.2
2.	Endrin	0.1300000	0.0004385	1 : 296.4
3.	Aldrin	0.6902010	0.0036641	1 : 188.3
4.	Dimethoate	0.0072610	0.0000452	1 : 160.6
5.	Phosphamidon	0.0057020	0.0000386	1 : 147.7
6.	DDT	0.2716010	0.0029650	1 : 91.6
7.	Ethyl parathion	0.0074130	0.0000830	1 : 89.3
8.	Endosulfan	0.0706310	0.0015450	1 : 45.7
9.	Methyl parathion	0.0009508	0.0000579	1 : 16.4
10.	Formothion	0.0055340	0.0004786	1 : 11.5
11.	Methyl demeton	0.0025060	0.0003412	1 : 7.3
12.	Diazinon	0.0037840	0.0007943	1 : 4.7
13.	Carbaryl	0.0032580	0.0007211	1 : 4.5
14.	Trichlorophon	0.0066220	0.0014720	1 : 4.5
15.	Chlorofenvinphos	0.0033680	0.0008831	1 : 3.8
16.	Malathion	0.0011640	0.0008110	1 : 1.0
17.	Monocrotophos	0.0001905	0.0001786	1 : 1.0
18.	Tetrachlorvinphos	0.0018840	0.0056492	1 : 0.3

lorvos. They also recorded that rotenone and endosulfan had very high safety margin for adults of the predator, being at the same time very effective against an aphid species *Dactynotus carthami*. Since the work of the above authors, several new insecticides have come to market and are being used against aphids without knowing their effects on natural enemies of the pest. It was, therefore, thought desirable to study these insecticides for their toxicity to the pest and safety to the predator. In this paper, the susceptibility of the adults of *C. septempunctata* to nineteen insecticides as contact poison, has been reported.

MATERIAL AND METHODS

Adults of *C. septempunctata*, which appeared in large numbers on mustard crop at the Haryana Agricultural University farm in February-March, 1972, were collected and used for these studies. The adults were pre-conditioned, in the laboratory, for two to three days and then starved for 24 hours before giving any treatment. Commercial formulations of nineteen insecticides were used after diluting them with desired quantity of tap water. Ten adult beetles, approximately of same size, were placed in 10.5 mm petri dishes, and sprayed with one ml. of the spray material directly under Potter's spraying tower at 24 cm mercury pressure. Each concentration was replicated three times. The sprayed insects were immediately transferred to clean petri dishes containing aphid infested twigs of mustard. The petri dishes were kept at room temperature which ranged from 15 to 25°C. Fresh food was supplied to beetles after every 24 hours. Mortality counts were taken 72 hours after treatment. The data were subjected to probit analysis (Finney, 1952). The values of relative toxicity of different insecticides were calculated by taking the LC_{50} value of DDT as unity.

To find the safety limit of the insecticides, the LC_{50} value for the predator was divided with the LC_{50} value for the host as suggested by Sarup *et al.* (1965). The LC_{50} for the host was also determined in the laboratory.

RESULTS

It is evident from the data given in Table 1 that the insecticides had a wide variation in their relative toxicity to the beetle. Monocrotophos, fenitrothion, methyl parathion, malathion, tetrachlorvinphos, methyl demeton, carbaryl, chlorfenvinphos, diazinon, formothion, phosphamidon, trichlorphon, dimethoate, ethylparathion, endosulfan, endrin and menazon were more toxic than DDT. Their relative toxicities were 1429.5, 1165.7, 285.6, 233.3, 144.2, 108.4, 83.3, 80.6, 71.7, 49.0, 47.6, 41.0, 37.4, 36.6, 3.8, 2.0 and 1.1 times that of DDT. Aldrin was the only insecticide which was less toxic than DDT, being only 0.4 times as toxic as DDT. Further, it is evident from the data in Table 2 that the adults of *C. septempunctata* were more tolerant to all the insecticides than *L. erysimi* except tetrachlorvinphos. The safety margin for menazon, endrin, aldrin, dimethoate, phosphamidon, DDT, ethyl parathion and endosulfan was very high. Other insecticides, viz., methyl parathion, formothion, methyl demeton, diazinon, carbaryl, trichlorphon, chlorfenvinphos, malathion and monocrotophos were also safer to the predator. Aldrin which was quite safe to the predator was not found effective against aphids in these studies. Tetrachlorvinphos was quite toxic to the adults of *C. septempunctata* and was least effective against *L. erysimi*. Thus, the insecticides which were not so toxic to predators, were safe to use.

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SOURCES OF INFORMATION FOR, AND FACTORS ENCOURAGING THE ADOPTION OF BANKING—A STUDY INTO RURAL BANKING

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ABSTRACT

The study revealed that family members, friends and relatives were the most important sources of information to farmers followed by Agricultural Inspectors, Village level workers, Patwaries and bank personnel.

Easy and timely availability of loan was one of the main factors in the adoption of banking followed by the low rate of interest and repayment suitability to the farmers. The study indicated that banking could be increasingly adopted if qualified local persons were appointed on the bank staff, amount of loan was sufficient, farmers were educated and trained in banking procedures and the stamp expenses and formalities were reduced.

It was observed that an increase in amount borrowed was associated with the increase in the openings of savings accounts. All those who had secured loans for tractors, tractor-cum-crops, levelling-cum-crops. and dairy farm had savings accounts in one or the other banking institutions.

The shortage of money and cumbersomeness of procedure were hindering the increase in deposits in the accounts of the respondents. They had opened accounts on the advice of bankers, friends and neighbours, getting aware of the banking activities, finding good behaviour of bank employees and having an increase in their income.

The study suggested better strategy of extension role of the banks for improved agricultural banking in rural areas.

Agriculture is still the pivot of Indian economy. After more than twenty years of planned development, the achievements at the food front are frustratingly gloomy: one of the reasons being the traditional character of agriculture bereft of modern technological inputs and spearheaded by the stark absence of capital investment. The farmer is still ignorant of utilizing the help of agencies supplying credit. He knows little about the banks as a source of agricultural finance. Unless details of banking assistance are adequately communicated to farmers, the subsequent stage of adoption will not occur.

Studies have been conducted to know the various sources of information and to determine their relative importance at different stages in the process of adoption. Obviously, all individuals do not adopt an innovation at the same time and same rate and that all agencies are not equally influential in the process of decision making for adoption. Those who are more influential are called opinion leaders, key-communicators and gate-keepers etc., as they leadingly influence the opinions and behaviour of others.

Chowdhary (1962) reported that farmers were bound to make head-way if the information about labour and capital requirement for various crop enterprises, that played a unique role in selecting right type of crop enterprises, was made available to them. Lionberger (1964) reported the following rank order of information sources in the adoption process-mass media, friends and neighbours; agricultural agencies; dealers and salesmen etc. Sharma (1970) found neighbours and sarpanches the most sought for sources of information by the farmers. Pachori *et al.* (1973) observed that neighbours, panchayat members, village level workers, agricultural official and scientists from agriculture colleges were important sources of information available to the farmers. Hendrix (1951) concluded that in the case of low income farmers, the rate of adoption of production-innovation would be enhanced in capital was readily available. Deshpande (1962) concluded that the differential response to the acceptance of cow dung gas plant might be attributed to differences in the socio-economic status, and needs of the individual farmers.

Sisodia (1971) found that larger size of landholdings was associated with increased loans obtained from banks by the farmers for farm mechanization. Pandhar (1971) found that higher socio-economic status and education helped the farmers in approaching and obtaining credit from various sources.

A review of literature, thus, indicates that, not many empirical investigations into this aspect have yet been carried out in India. The importance of the depth studies, although well recognized in banking policy, needs yet to be translated into action by the banks and policy makers to devise sound agricultural banking policy. The present study is sociologically focused on the important sources of banking information for farmers and rural people and the factors which were helpful in stimulating the adoption of banking. The following were the specific objectives of the study :

1. To know the sources of information and factors encouraging the adoption of banking.

2. To ascertain the nature of relationship between borrowings and savings.

3. To find out reasons for having/not having bank accounts.

MATERIAL AND METHODS

The present study was conducted in the four tehsils of the district Hissar in Haryana. The list of agricultural borrowers, alongwith the amount borrowed, was obtained from different branches of nationalized banks operating in the area. Fifty per cent of the total respondents were randomly selected for study. This yielded a sample of sixty two borrowers out of whom, only sixty could be interviewed for reasons of refusals and non-availability. The data was collected by personally administering a pretested schedule.

Simple tabular analysis aided by averages and percentages was the statistical technique for data analysis.

RESULTS AND DISCUSSION

The objective was to know the rank order of different sources of information in the adoption of banking. Table 1 details the sources of information for the respondents regarding banking and allied matters.

TABLE 1

Sources of information

S. No.	Sources	Frequency	Percentage
1.	Family members, friends and relatives	60	43.48
2.	Agri. Inspector, V.L.W.'s and Patwaries etc.	46	33.33
3.	Bank Officers.	23	16.67
4.	Lawyers.	5	3.62
5.	Politicians.	2	1.45
6.	Sarpanches.	2	1.45
	Total	138	100.00

Their main sources of information still were, the family members, friends, and relatives. Government personnel (like A.I., V.L.W.'s etc.), field officers of banks were next in importance. Lawyers and politicians, as sources of bank information, unheard earlier, were now more important sources than even the sarpanches. This is symbolic of the new developmental emphasis and field-spread of the elites.

Much work has been done to know about the factors in the adoption of new technology. However, the factors influencing adoption of banking by farmers have hardly been studied except by a few (Pandhar, 1971; Sisodia, 1971). The respondents were hence asked to give such factors which encourage adoption of banking among farmers.

TABLE 2

Factors influencing adoption of banking

S. No.	Factors	Frequency	%age
1.	Easy and timely availability of loan.	57	24.23
2.	Low rate of interest.	54	23.08
3.	Repayment suitability to farmers.	53	22.66
4.	Qualified local persons as bank staff.	52	22.22
5.	Sufficiency of loan.	14	5.98
6.	Educating farmers about banking facilities.	2	0.85
7.	Reduction in stamps fee etc.	2	0.85
	Total	234	100.00

They told that easy and timely availability of loan, low rate of interest; suitability of repayment; and appointment of local qualified persons to bank positions, were almost equally, the more important factors helping the adoption of banking. Education of farmers in banking and reduction in stamp expenses etc. were other allied factors Thus increase in adoption of banking has to be struck at a point of terms which are suiting not only to the banks but the clients also.

In order to ascertain the nature of relationship between borrowing and saving, the answers of the respondents were tabulated as given below.

TABLE 3

Borrowing and saving accounts

S. No.	Borrowings (in Rs.)	No. of borrower	Percentage	Presence of saving account	Percentage
1.	Upto-10,000	39	66.10	16	41.25
2.	10,001-20,000	12	20.34	12	100.00
3.	20,001-30,000	4	6.78	4	100 00
4.	30,001 and above	4	6.78	4	100.00
	Total	59*	100.00	36	

*Only 98.33 per cent furnished the informations regarding their saving accounts in different institutions.

Thus 41.25 per cent of those who had borrowed upto Rs. 10,000/– had saving accounts, while all those who had borrowed more than this had saving accounts. It showed that increased borrowings and opening saving accounts were related probably because those who borrowed more had greater repaying capacity as they had high level of income. They also felt it more secure and profitable to deposit their savings in the bank, as it gave them a reasonable amount of interest too.

The following table classified the responses regarding purposes of their borrowings and existence of saving accounts.

TABLE 4

Purpose of borrowing and existence of saving accounts

S. No.	Purpose of borrowings	Frequency of borrowings	Saving accounts Frequency	Saving accounts percentage
1.	Crops	28	11	39.28
2.	Tractors	18	18	100.00
3.	Tubewells	10	4	40.00
4.	Tractor-cum-crops	1	1	100.00
5.	Levelling-cum-crops	1	1	100.00
6.	Dairy farms	1	1	100.00
	Total	59*	36	

* Refer to the foot note of Table 3.

All those who had obtained loans for tractors, tractor-cum-crops levelling-cum-crops, and dairy farm, had saving accounts in one or the other institution. Only 40 per cent and 39.28 per cent of those who had borrowed for tubewells and crops, respectively, had savings accounts.

Another important aspect of study was the knowledge about the problems in not opening saving accounts with banks. The answers of the respondents are given in Table 5.

The main difficulties in opening saving accounts were : (i) absence of savings for deposit, and (ii) long and cumersome procedure. About seventeen per cent already had a bank account. Some of them felt insecurity in depositing money with banks. Distance of banking institutions, ignorance of the procedure and comparatively low rate of interest were

TABLE 5

Problems in opening saving accounts

S. No.	Problems	Frequency	Percentage
1.	No saving for deposit.	55	25.82
2.	Long and cumbersome procedure.	52	24.41
3.	Already having account.	36	16.20
4.	Fear of loss of money.	17	7.98
5.	Distance of banking institutions.	15	7.04
6.	Ignorance of the procedure.	14	6.57
7.	Low rate of interest.	12	5.64
8.	Preference given to educated clients.	4	1.88
9.	Unfair behaviour of the bank employees.	3	1.41
10.	Loss of confidentiality.	2	0.94
11.	Wastage of time.	2	0.94
12.	Money not easily available at the hours of need.	1	0.47
	Total	213	(100.00)

other important inhibitions for the development of banking habits in rural clients.

Publicity by bankers, advice of friends and neighbours etc. and awareness of the banking activities; good behaviour of bank employees and increased income were the important drives for those who had opened new accounts after taking the present loan.

The respondents were invited to suggest measures acceptable to them to increase borrowings from, and open accounts with, the banks. The responses are given in Table 6.

TABLE 6

Respondents' suggestions to bankers

S. No.	Suggestions	Frequency	Percentage
1.	Local qualified persons of the concerned area should be appointed in the banks.	55	22.82
2.	Educating the farmers about banking business.	55	22.82
3.	Bankers should be more courteous than at present to farmers.	51	21.17
4.	Useless and excessive formalities should be removed.	47	19.50
5.	Crop loan be provided as lumpsum loan.	19	7.88
6.	Providing loans quantum as demanded.	11	4.57
7.	Loan advancing procedure of these banks should be on the pattern of the Land Mortgage Banks.	3	1.24
	Total	241	(100.00)

The important suggestions were that bankers should appoint local qualified persons in the bank's rural branches and educate the farmers about details of banking business. Courteous behaviour with the farmers and removal of useless and excessive formalities were next in importance. Provision of lumpsum crop loan in sufficient quantity and its pattern being that of land Mortgage Bank's, were other suggestions of the respondents for improvement in rural banking business.

This indicated the general relevance of important factors in the adoption process like procedural simplification, adequacy, compatibility to local situations, hollistic and not piece-meal provision of the inputs and the human considerations.

The main findings of this study receive support for the earlier findings of Chowdhary (1962), Lionberger (1964), Sharma (1970), Pachori *et al.* (1973), Hendrix (1951), and Deshpande (1962) as far as factors implying adoption of innovation are concerned. The findings of Pandhar (1971), and Sisodia (1971) lend support to results of this study regarding the factors responsible for the adoption of banking by farmers.

· Thus, the banks have to lay more stress on their extension role, consisting of more information to rural clients and studying the client expectancy and the factors hindering the full utilization of banking facilities by them. This will require carrying out depth-studies to build a viable system of agricultural banking directed at maximising their role achievements.

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GREEN REVOLUTION AND FARM WAGES IN HARYANA

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ABSTRACT

The real wages of both skilled and unskilled agricultural labourers have been increasing steadily in Haryana but their growth became more pronounced after the initiation of green revolution in the mid sixties. The growth rates in the earnings of an industrial worker and in the wages of agricultural labour were at par during pre-green revolution period (1956-64); but wages of agricultural labour increased considerably after 1964. Though there was varying impact of green revolution on per capita gross value of agricultural output and on wage structure in different districts, its benefits were shared by all sections of rural population of the State.

Landless agricultural labourers form an important segment of the total rural population of Haryana State. Their percentage in total working force has increased from 6.90 per cent in 1961 to 16.23 per cent in 1971. Traditionally, landless agricultural labour have been occupying the lowest rung of the ladder in the rural society. With the initiation of the green revolution in Haryana in the mid sixties, it was expected that the standard of living of this depressed section of the rural population would improve through increase in real wages and employment level. In this article an attempt has been made to study the increase in money wages of casual male agricultural labourers in relation to consumer price index for agricultural labour, per capita earnings of industrial workers and gross value of agricultural output. More specifically the objectives of the present study were :

(i) to make a comparative study of trends in money wages of agricultural labour, consumer price indices for agricultural labour, earnings of industrial worker and per capita gross value of agricultural output in Haryana, and

(ii) to estimate the average wage rate and the growth rates in wages for various farm operations in different districts of Haryana State.

MATERIAL AND METHODS

Time series data relating to money wages paid to a casual male skilled labourer and an agricultural labourer for various farm operations, per capita gross value of agricultural output in different districts and annual earnings per industrial worker and consumer price indices for agricultural labour in Haryana State were collected from statistical abstracts of Punjab and Haryana. The data pertained to the years 1956 to 1973. However the latest figures available on earnings of the industrial workers and per capita gross value of agricultural output were for years 1971 and 1971-72, respectively. In order to know the impact of green revolution, the time series data were divided into two time horizons (i) period before 1965 representing pre-green revolution period and (ii) 1965 and onwards representing the era of the green revolution. The data on different variables were transformed into indices taking the average of 1956-58 as base 100. To find out the growth rates in the indices of money wages, consumer prices for agricultural labour, earnings of industrial workers, per capita gross value of agricultural output, linear trend equation of the following form was fitted for period I (pre-green revolution 1956 to 1964) and period II green revolution period after 1965).

$$Y=a+bT$$

where Y=indices of concerned variable, a=constant, b=annual growth rate (in percentage)/regression coefficient, and T=time in years.

RESULTS AND DISCUSSION

Linear trend equations for money wage rates, earnings per industrial worker, consumer price indices and per capita gross value of agricultural output in Haryana in different periods are shown in Table 1

The positive values of regression coefficients in all the equations during both the time periods showed upward trend in all the factors, namely, money wages, earnings of industrial workers, per capita gross value of agricultural output and consumer price indices for agricultural labour. However, the increase in wage rates for harvesting and other agricultural operations and in the consumer prices indices for agricultural labour was not significant during period I. On the other hand, the growth rates in all the variables in period II were highly significant and much higher than the corresponding regression coefficients in period I. The daily money wages of casual male labourer increased annually over the base period (1956-58) by 3.78, 6.45, 5.60, 2.40, 12.60 and 1.23 per cent during the pre-green revolution period against 22.18, 23.85, 19.90, 22.10, 17.37 and 12.80 per cent during green revolution period for ploughing, sowing, weeding, harvesting, cotton picking and other agricultural operations, respectively. The consumer price indices of food items and all commodities increased by 2.87 and 2.57 per cent during period I and 12.40 and 11.07 per cent in period II. Thus the real wage rates for all farm operations including harvesting and other agricultural operations which showed declining tendency during period I increased in period II. The money wage rates for major farm operations increased about one-and-a-half times faster than the rise in consumer price indices for agricultural labourers. Thus the real wages of both skilled and unskilled agricultural labourers in Haryana increased steadily which became more pronounced during the green revolution period.

The real earnings of industrial workers increased in both the periods. The difference between the growth rate in wages of agricultural labourers and earnings of industrial workers were not

TABLE 1

Trends in indices of wages, per capita industrial earnings, value of agricultural output and consumer prices in Haryana

Particulars	Period I (Pre-green revolution)	Period II (Green revolution)
Money wages for		
(a) Ploughing	Y=93.31+3.78T* (1.52)	Y=118.86+11.18T** (3.53)
(b) Sowing	Y=87.31+6.45T* (1.83)	Y=128.31+23.85T** (3.67)
(c) Weeding	Y=86.11+6.60T* (1.61)	Y=124.06+19.90T** (3.69)
(d) Harvesting	Y=90.78+2.40T (1.47)	Y=101.50+22.10T** (3.51)
(e) Cotton picking	Y=70.89+12.60T* (2.91)	Y=181.71+17.37T** (3.25)
(f) *Other agricultural* operations	Y=93.07+1.23T (0.99)	Y=129.67+12.80T** (2.65)
(g) Blacksmith	Y=86.01+4.82T* (1.61)	Y=120.53+19.05T** (3.60)
(h) Carpenter	Y=91.89+5.07T* (1.70)	Y=119.78+20.00T** (3.58)
Consumer price indices		
(a) Food	Y=92.09+2.87T (1.39)	Y=152.44+12.40T** (2.57)
(b) General	Y=93.94+2.57T (1.27)	Y=141.33+11.07T** (2.49)
4. Per capita gross value of agricultural output	—	Y=135.12+23.68T** (3.85)

* Significant at 5% level. ** Significant at 1% level.

apparent in time period I. Nevertheless, the wages for agricultural labourers increased faster than the earnings of industrial workers during green revolution period. Per capita gross value of agricultural output increased by 23.68 per cent annually during the green revolution period which was almost equal to the increase in wages for major farm operations of ploughing (22.18 per cent), sowing (23.85 per cent) and harvesting (22.10 per cent). Thus green revolution benefitted all segments of the rural population.

TABLE 2

Average daily wages of casual male labourer at two time periods in different districts of Haryana (Rs.)

Particulars	Average wages at two time periods in															
	Hissar		Rohtak		Gurgaon		Karnal		Ambala		Jind		Mahendergarh		Haryana	
	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II
Ploughing	3.05	5.82	3.54	5.50	2.38	5.12	2.17	5.01	2.77	4.64	3.33	6.18	2.91	4.49	2.62	5.24
Sowing	3.22	5.67	3.33	5.13	2.40	4.29	1.84	4.75	2.66	4.47	3.41	6.12	2.74	4.19	2.39	4.95
Weeding	2.87	4.97	2.42	4.08	2.02	3.81	1.46	3.70	2.58	4.52	2.87	5.17	1.95	3.77	2.40	4.32
Harvesting	3.16	5.68	3.59	5.72	2.31	4.09	2.03	5.83	2.88	4.66	3.37	6.18	3.39	4.06	2.82	5.26
Cotton picking	1.97	3.88	1.77	4.06	1.26	3.69	1.40	3.71	2.23	3.33	1.94	3.22	1.39	3.28	1.87	3.74
Other agril. operations	3.11	5.13	2.76	3.95	2.29	4.24	2.12	4.40	2.40	4.45	2.75	5.20	2.49	4 40	2.50	4.52
Blacksmith	4.82	8.31	3.27	7.35	4.30	9.04	4.55	8.33	4.13	8.91	4.78	7.42	3.73	6.34	4.04	7.94
Carpenter	5.00	8.32	3.49	7.40	4.72	9.07	4.75	8.36	4.25	8.91	4.94	7.36	3.76	6.65	4.17	7.98

Note : I=Pre-green revolution period (1956-64)

II=Green revolution period (1965-73)

Average wages

Table 2 shows the impact of green revolution on the wage structure of agricultural labourers in different districts of Haryana State. The average wage rates varied from operation to operation, district to district and time to time. Among the agricultural operations, wages were generally highest for harvesting followed by ploughing, sowing, other agricultural operations, weeding and cotton picking (Table 2). The wages for skilled labourers were roughly one and a half times higher than the wages of agricultural labourers. The wages of blacksmith and carpenter did not vary much. Their wages were more or less uniform. The average wage rate during green revolution were almost doubled from the pre-green revolution period.

During the pre-green revolution period, the wages for all farm operations were more than State average in Hissar and Jind, except for cotton picking in Rohtak and other agricultural operations in Ambala. The wages for ploughing, sowing and harvesting were more than State average wages in Mahendergarh district while the wages for all the farm operations were the lowest in Karnal followed by Gurgaon district. However, in the determination of wages both the demand and supply of labour should be taken into account. The percentage of male agricultural labour to total working force in 1961 were 10.34 per cent in Karnal, 4.58 per cent in Gurgaon and 2.17 per cent in Mahendergarh. This explains the prevailing wages structure in the agriculturally advanced district of Karnal, less advanced district of Gurgaon and backward district of Mahendergarh.

The wage structure during the green revolution period changed further due to varying impact of green revolution in different districts of Haryana. The wages were more than the State average wages for all farm operations in Hissar, for ploughing, sowing and harvesting operations in Rohtak for all operations, except weeding, in Jind, for weeding alone in Ambala and for harvesting alone in Karnal. The lower wages for all operations in Karnal district seemed anamolous because the impact of green revolution was more apparent in this district in comparison with other districts. The portion of male agricultural labour to total male working population was also the highest in Karnal district. With relatively more demand and highest supply of labour in this district the wage rates did not increase. The wages for all operations remained less than state average in Mahendergarh and Gurgaon where the green revolution has not shown much of its impact. Skilled labour received wages more than the State average in Hissar, Gurgaon, Karnal and Ambala, during both the periods. Skilled labour was paid the lowest wages in the most backward district of Mahendergarh followed by Rohtak.

Growth rates in different districts

Average wage rates do not provide the true picture regarding annual changes in the wage structure overtime. Therefore, annual growth rates obtained from the regression coefficients of linear trend equations for different types of labour were examined (Table 3).

The money wages and consumer price indices remained almost stagnant during pre-green revolution period, except for significant rise in wages for weeding, TABLE

Annual growth rates in money wages and per capita gross

Particulars	Linear growth rates in					
	Hissar		Rohtak		Gurgaon	
	I	II	I	II	I	II
Ploughing	9.13*	15.05**	— 1.40	15.58**	1.35	22.87**
	(2.92)	(3.19)	(0.85)	(3.15)	(0.83)	(3.86)
Sowing	9.28**	19.75**	— 1.30	15.75**	—1.47	12.37**
	(2.05)	(3.09)	(1.01)	(2.97)	(1.06)	(2.73)
Weeding	10.52**	21.70**	11.70**	13.10**	3.53*	13.55**
	(2.21)	(3.85)	(2.01)	(2.91)	(1.30)	(2.95)
Harvesting	11.80**	23.02**	— 0.92	13.93**	1.52	14.13**
	(2.55)	(3.39)	(1.12)	(2.57)	(1.21)	(2.65)
Cotton picking	8.32**	24.76**	5.67*	14.32**	11.28**	41.37**
	(1.97)	(3.98)	(1.82)	(2.87)	(2.75)	(4.65)
Other Agril. operations	7.86*	22.88**	4.78	9.12**	4.00	11.58**
	(2.50)	(3.61)	(1.92)	(2.45)	(1.85)	(2.72)
Blacksmith	6.97*	18.38**	16.05**	27.47**	5.83	20.73**
	(1.99)	(3.58)	(3.02)	(3.86)	(1.79)	(3.73)
Carpenter	7.08*	18.98**	17.63**	28.70**	3.57*	18.23**
	(1.84)	(3.48)	(3.25)	(3.95)	(1.41)	(3.39)
Per capita gross value		20.81**		15.91**		17.21**
of agril. output		(3.52)		(2.98)		(3.21)

The figures in the paranthesis are standard errors.
* Significant at 5% level.
**Significant at 1% level.

cotton picking and skilled labour in Rohtak and Gurgaon, for cotton picking alone in Karnal, skilled labour in Jind, skilled labour and harvesting in Ambala. In Hissar money wages for all types of labour increased significantly while in Mahendergarh wages improved significantly for all operations except for the cotton picking and skilled labour during pre-green revolution period. The growth rates showed a notable improvement in the wages of all types of labourers in all the districts in green-revolution period. However, the green revolution exhibited varying impact in different districts. The percentage increase in per capita gross value of agricultural output as well as in money wages for different farm operations was the highest in Karnal. The money wages per annum increased by 36.05 per cent for ploughing, 39.23 per cent for sowing, 34.60 per cent for weeding, 61.50 per cent for harvesting, 24.32 per cent for cotton picking and

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value of agricultural output in different districts of Haryana

different time periods in									
Karnal		Ambala		Jind		Mahendergarh		Haryana	
I	II	I	II	I	II	I	II	I	II
4.68	36.06**	−0.22	16.95**	−0.58	17.77**	16.57**	17.93**	3.78	22.18**
(2.09)	(4.00)	(1.01)	(3.25)	(0.97)	(3.29)	(2.81)	(3.30)	(1.52)	(3.53)
1.92	39.23**	1.58	19.08**	2.08	18.12**	13.33**	12.27**	6.45	23.35**
(1.11)	(4.16)	(0.99)	(3.12)	(1.15)	(3.17)	(2.59)	(2.80)	(1.83)	(3.67)
− 1.58	34.60**	2.58	16.45**	6.53**	14.15**	6.02**	21.33**	6.60	19.90**
(1.13)	(4.07)	(1.22)	(3.16)	(1.76)	(3.08)	(1.63)	(3.72)	(1.61)	(3.49)
− 2.18	61.50**	3.77*	15.50**	0.63	12.92**	13.72**	12.78**	2.40	22.10**
(1.28)	(4.91)	(1.39)	(3.70)	(0.97)	(2.43)	(3.01)	(2.62)	(1.47)	(3.61)
11.83**	24.32**	3.78	10.10**	3.10	10.88**	− 6.27	16.55**	12.60**	17.37**
(2.83)	(3.83)	(1.61)	(2.63)	(1.55)	(2.65)	(2.53)	(3.33)	(2.91)	(3.26)
3.02	30.58**	0.73	16.67**	4.42	16.38**	4.93*	7.73**	1.23	12.80**
(1.51)	(3.93)	(1.10)	(2.87)	(2.02)	(2.89)	(1.82)	(2.05)	(0.99)	(2.65)
4.07	21.08**	5.78*	27.95**	5.65*	6.17*	0.37	10.30**	4.82*	19.05**
(1.47)	(3.78)	(1.75)	(3.92)	(1.68)	(1.96)	(1.03)	(2.11)	(1.61)	(3.60)
2.68	18.55**	5.72*	27.30**	5.78*	6.40**	0.17	9.88**	5.07*	20.00**
(1.38)	(3.43)	(2.01)	(3.96)	(2.07)	(1.55)	(0.93)	(1.86)	(1.70)	(3.58)
	37.96**		28.50**		20.56**		16.23**		23.68**
	(4.18)		(3.57)		(3.26)		(3.90)		(3.85)

30.58 per cent for other farm operations, while the per capita gross value of agricultural output increased by 37.96 per cent annually. However, the growth rate in the wages of skilled labour did not keep pace with the increase in the wages of agricultural labour in Karnal district. The wages of blacksmith increased by 21.8 per cent and that of carpenter by 18.55 per cent against the rise in consumer price indices by 12.40 per cent in food and 11.07 per cent in all commodities.

The growth rate in money wages of all types of labour were almost equal to the growth rate in per capita gross value of agricultural output in Hissar, Rohtak, Gurgaon and Karnal districts. The growth rate in wages of agricultural labourer in Ambala, all types of labourers in Jind and skilled labour in Mahendergarh did not keep pace with the growth rate in per capita gross value of agricultural output in these districts.

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EFFECT OF SEED SIZE ON SEEDLING GROWTH AND MATURE PLANT CHARACTERS IN BARLEY *(HORDEUM VULGARE* L.)

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ABSTRACT

The effect of seed size on seedling growth and some mature plant characters has been reported. Bold grains produced healthier seedlings. Also, these lines were early in ear emergence, produced more tillers and higher grain yield than the lines produced by small grains. Grain weight was positively correlated with grain yield and the seedling dry weight with tiller number and grain yield.

Grain yield in cereals is a very complex character and is influenced by a number of factors. Plant breeder is interested in such factors so that a greater knowledge of them may be utilized in improved selection techniques. Indirect selection for a trait is often made either because of its suitability or because, sometimes, direct selection is not feasible. If indirect selection for a trait is exercised on a trait measurable earlier, this can greatly reduce the labour, time and cost. Seed size has been employed in screening F_3 lines for early vigour by Boyd *et al.* (1971). Relationship of the seed size with early development and grain yield of barley has been investigated by several workers (Kaufmann and McFadden, 1963; Kaufmann and Guitard, 1967; Dasgupta and Austenson, 1973). It has been shown that plants grown from large seed were superior to those grown from small seed in the rate of seedling growth and size of the first two leaves. Also, the plants derived from the larger seeds produced more tillers and gave higher grain yield.

The present study was planned to examine the influence of seed size on some seedling and mature plant characters in segregating generations of barley and to assess the possibility of indirect selection for grain yield and related characters.

MATERIAL AND METHODS

The material for the present investigation consisted of a 6x6 diallel cross. Largest and smallest seeds were selected by hand in each cross. Their weight was recorded before sowing. one lot of 30 populations was sown in the field, following a randomized block design with three replications. A second lot was used in the laboratory for recording seedling growth, and dry matter of the two weeks old seedlings. In the field experiment, observations were recorded on all the available plants (10 to 15 per replication) for days to ear emergence, plant height, tiller number, ear length and grain yield. Analysis of variance was followed to test the significance of the difference between large and small seed progeny means. Simple correlation coefficients between seed size and mature plant characters were also computed.

RESULTS AND DISCUSSION

The data on average performance of large seeded and small seeded progenies of different crosses are presented in Table 1. In all cases, the bold grained lines were having higher seedling vigour and seedling dry matter in comparision to small grained lines. In most of the crosses, lines of the large grains were found to be earlier in ear emergence than those grown from the small grains. However, there were some exceptions to this. For example, in the crosses IB226 x NP21, EB533 x Promisa and BR32 x NP21, small grain progenies flowered earlier than the bold grain progenies. Similar situation was observed in case of tiller number and grain yield per plant. Boyd *et al.* (1971) reported marked differences in seedling vigour and seedling dry matter in F_3 lines raised from large and small grains of barley.

Analysis of variance (see CD in Table 1) indicated highly significant differences among the treatments. These differences could partly be due to cross effect and partly because of grain size. The differences between the progeny of large and small seeds were tested. Table 1 (asterisks) indicated marked influence of seed size in ear emergence and to certain extent on ear length also. Progeny of bold seeds significantly outyielded the small seed progeny in two crosses, i. e., EB533 x IB226 and BR32 x NP21. It was observed by Kaufmann and McFadden (1963) that large seeds produced more tillers and greater yields than small medium or bulk seed. Demirlicakmak *et al.* (1963) and Dasgupta *et al.* (1973) also reported that yield variations among seed lots were primarily related to seed size.

In order to examine the possibility of indirect selection for grain yield and its components on the basis of some early measurable characters, simple correlations between seed size and mature plant characters were computed (Table 2). Seed weight was positively correlated with grain yield while seedling dry weight was correlated with tiller number and grain yield. Dasgupta and Austenson (1973) also reported significant positive correlation between initial seed weight and grain yield. Considering the findings of the present study as well as those reported earlier, indirect selection for tiller number and grain yield appears to be feasible on the basis of seed size.

TABLE 1

Average performance of large and small seed progenies of barley

Crosses	100 seed weight (g)		Seedling height (cm)		Seedling dry weight (mg)		Days to flowering		Plant height (cm)		Tiller number		Ear length (cm)		Grain yield (g)	
	L	S	L	S	L	S	L	S	L	S	L	S	L	S	L	S
Promisa×Toluca-1	4.0	3.1	10.2	9.8	989	824	109.0*	117.8*	105.5	98.2	34.4	30.9	8.0	8.2	40.2	34.9
NP-21×Toluca-1	5.0	2.9	11.7	10.0	1087	783	109.6*	117.1*	101.5	103.3	42.8	37.8	7.6	7.9	57.6	55.7
NP-21×Promisa	4.5	2.8	7.2	6.8	709	612	113.3*	123.2*	85.7	84.4	33.7	25.5	7.6	7.5	54.8	38.0
I. B. 226×NP-21	4.6	3.2	7.4	7.0	780	670	119.0*	109.3*	99.5	98.1	37.1	40.4	8.4	8.5	57.8	59.6
I. B. 226×Toluca-1	4.9	3.1	8.9	7.8	1011	700	110.4	112.3	101.9	105.4	35.1	33.0	8.6	9.1	60.9	61.6
I. B. 226×Promisa	4.8	2.2	8.0	6.8	909	484	111.6	113.8	87.7	92.9	27.5	31.7	8.8	8.9	51.0	51.0
E. B. 533×I. B. 226	5.4	3.7	8.9	8.0	959	728	112.2*	119.6*	91.6	91.3	31.8	26.9	8.2	8.1	63.9*	38.3*
E. B. 533×NP-21	4.9	3.1	8.1	7.7	969	698	112.0	115.5	92.2	94.2	42.5	32.5	7.3	7.5	70.4	55.6
E. B. 533×Toluca-1	3.7	1.8	6.6	5.8	631	440	106.4*	114.1*	102.8	106.7	37.8	27.9	8.3*	7.8*	73.1	52.7
E. B. 533×Promisa	4.5	2.7	7.5	6.5	780	584	119.0*	112.5*	86.8*	95.8*	32.5	35.8	7.2*	7.9*	51.5	53.6
BR-32×I. B. 226	5.4	2.8	5.8	3.3	824	419	105.3	106.0	96.3	95.5	36.2	39.0	8.3*	8.8*	68.1	53.6
BR-32×E. B. 533	4.5	2.6	5.7	4.9	705	600	106.5	109.1	86.1	84.2	25.8	22.4	7.6	7.7	62.4	39.9
BR-32×NP-21	4.9	2.5	6.9	6.1	846	539	107.6*	102.1*	90.1	90.6	37.7	35.3	7.9	7.7	73.6*	47.2*
BR-32×Toluca-1	5.4	3.2	5.3	4.6	827	524	103.7*	110.1*	100.9*	109.3*	34.4	30.5	8.1	7.9	42.8	37.0
BR-32×Promisa	4.7	2.7	6.8	6.6	959	573	117.8	118.9	97.8	95.2	37.4	22.1	8.3*	8.7*	57.8	41.4
C. D. at 5%	—		—		—		9.3		14.8		11.8		0.9		25.4	
C. V.	10.3	18.1	21.1	26.3	14.4	19.7	3.4		4.5		10.8		4.3		17.5	

*Significant at 5%

TABLE 2

Correlation coefficients of some early measurable characters with mature plant characters in barley

Early characters	Maturity characters				
	Flowering time	Plant height	Ear length	Tiller number	Grain yield
Seed weight	—0.207	—0.098	—0.053	0.316	0.444*
Seedling height	0.349	0.189	—0.073	0.223	0.052
Seedling dry weight	0.174	0.011	0.059	0.378*	0.379*

*Significant at 5%

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SCREENING OF MICROORGANISMS FOR MILK CLOTTING ENZYME PRODUCTION

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ABSTRACT

Twenty five isolates of bacteria, 23 isolates of fungi and 7 isolates of actinomycetes, obtained from different sources, were screened for production of milk clotting enzymes in skim milk medium and wheat bran semi-solid medium. The ratio of milk clotting activity to proteolytic activity (MCU/PU) was taken as an index for the selection of a potential culture. Wheat bran semi-solid medium under surface culture conditions was found to be superior for production of milk clotting enzymes for all the three groups of microorganisms. Among the cultures screened, *Mucor miehei* NRRL 3169 showed a maximum ratio of 75.0 in wheat bran semi-solid medium under surface culture condition.

In modern commercial cheese making, the enzyme rennet which is extracted from the stomach of the calf is commonly used. Attempts have been made from time to time by various workers to find a suitable substitute for animal rennet. Some of the factors that have prompted the investigations on the production of microbial rennet are : (i) non-acceptability of the rennet from animal origin by the vegetarian population, (ii) the acute shortage of animal rennet, and (iii) non-availability of animal rennet at competitive prices. Various microorganisms have been reported to produce milk clotting enzymes. Among bacteria *Bacillus* spp. are more potent (Emanuilov, 1959; Srinivasan *et al.*, 1964; Puhan, 1966). The potent fungi include *Entomophthorales* (Oringer, 1960), *Aspergillus* (Veselov *et al.*, 1965), *Mucor* (Arima and Iwasaki, 1962), *Rhizopus* (Fukumoto *et al.*, 1967; Arima *et al.*, 1967) and *Endothia parasitica* (Sardinas, 1966). This paper reports the results of screening of various microorganisms isolated from different sources for production of milk clotting enzymes.

MATERIAL AND METHODS

Bacterial cultures. Bacterial isolates tested for milk clotting activity were isolated from raw milk, boiled milk, curd, cream, butter and soil on tryptone milk medium (tryptone, 0.5%; yeast extract, 0.25%; glucose, 0.1%; agar, 2% and skim milk, 10 ml).

Actinomycetes cultures. These organisms were isolated from soils on tryptone milk medium and were tested for milk clottting activity.

Fungal cultures. Fungal cultures were isolated from soil, butter, cream and curd on potato dextrose milk medium (potato extract of 20 g peeled potato; dextrose, 1%; agar, 2% and skim milk 10 ml) and rose bengal milk medium (peptone, 0.5%; glucose, 1%; KH_2PO_4, 0.1%; $MgSO_4 \cdot 7H_2O$, 0.05%; agar, 2%; streptomycin, 3 mg; skim milk, 10 ml and rose bengal 1:30000), and were tested for milk clotting activity. Four other cultures, i.e., *Mucor pusillus* NRRL 3469, *Mucor miehei* NRRL 3169 and NRRL 3420 and *Endothia parasitica* NRRL 3212 were obtained from Northern Regional Research Laboratory, Peoria, Illinois, U.S.A. and were also tested for the milk clotting activity.

Stock cultures. Stock cultures of bacteria and actinomycetes were maintained on tryptone milk medium and fungal cultures on potato dextrose milk medium. The cultures after sufficient growth were stored at 5°C until used.

Methods of screening. In the primary screening, the organisms were grown on plates of casein agar medium (Lawrence and Sanderson, 1969). A clear zone surrounding the colony corresponding to proteolytic activity and a turbid zone at the periphery corresponding to milk clotting activity were observed. After 72 hr growth at 30°C, cultures showing wider zone of milk clotting activity and narrower zone of proteolytic activity were selected for secondary screening.

For secondary screening, the bacteria and actinomycetes were grown in skim milk medium under submerged culture and in wheat bran semi-solid medium under surface culture, whereas the fungal cultures were grown only in wheat bran semi-solid medium under surface culture. 50 ml of skim milk obtained from the Department of Livestock Production and Management, Haryana Agricultural University, Hissar, without any substitution was dispensed in 250 ml Erlenmeyer flasks, sterilized at 15 lb for 15 min and used. The wheat bran semi-solid medium containing 10.0 g of wheat bran, 10 ml of skim milk and 10 ml of distilled water was dispensed in 250 ml Erlenmeyer flasks, sterilized at 15 lb for 15 min and used. Freshly inoculated slants of bacteria, fungi and actinomycetes were incubated at 30°C for sufficient growth. Growth harvested from one slant (3 days growth in case of bacteria and 7 days growth in case of actinomycetes and fungi) was inoculated per flask.

After 72 hr growth at 30°C on rotary shaker, the skim milk broth was centrifuged at 10,000 rpm for 10 min at 10°C on refrigerated centrifuge (IEC, Model B-20), made to original volume and assayed for milk clotting and proteolytic activities. Similarly, after 72 hr growth at 30°C, the enzymes from wheat bran semi-solid medium was extracted in distilled water, centrifuged and the supernatant, after adjusting to 50 ml volume, was assayed for milk clotting and proteolytic activities.

Assay of milk clotting activity. The procedure used was same as described by Arima *et al.* (1970) except that the spray dried skim milk powder (Vita, Haryana Dairy Development Corporation, Chandigarh) was used as test milk.

Milk clotting units. One milk clotting unit is defined as the amount of enzyme present in 1 ml of extract which will clot 10 ml of substrate in 40 min at 37°C, i.e.,

$$\text{Milk clotting units/ml} = \frac{40 \times 60 \times DF}{t}$$

Where t = Clotting time in sec.
DF = Dilution factor.

Assay of proteolytic activity. The proteolytic activity was assayed by the method described by Arima *et al.* (1970).

RESULTS AND DISCUSSION

In this investigation the ratio of milk clotting units/ml to proteolytic units/ml was taken as an index to compare the performance of various isolates. Table 1 summarizes the results of screening of bacterial isolates for production of milk clotting enzyme in skim milk medium under submerged culture and wheat bran semi-solid medium under surface culture after 72 hr incubation at 30°C. In skim milk medium only three isolates, i.e., BI, M-16 and Cu-3 gave higher ratios of

TABLE 1

Results of screening tests for the production of milk clotting enzyme in skim milk medium (submerged culture) and in wheat bran semi-solid medium (surface culture) by bacterial isolates.

Bacillus	Skim milk medium			Bacillus	Wheat bran semi-solid medium		
Isolates	MCU/ml	PU/ml	MCU/PU	Isolates	MCU/ml	PU/ml	MCU/PU
BI	15.00	4.20	3.57	E_1-8	149.76	3.60	41.60
M-16	26.60	7.80	3.40	E_2-8	143.28	3.50	38.08
Cu-3	13.33	4.20	3.17	F-1	150.00	4.00	37.50
F-2	12.00	4.80	2.50	C-3	116.17	4.50	26.66
M-12	10.00	4.50	2.22	Cu-3	84.50	3.45	24.49
S-1	20.00	9.00	2.22	B-1	66.66	3.00	22.22
M-20	6.60	3.00	2.20	BI	42.00	2.40	17.50
E_1-8	16.00	8.40	1.90	F-2	33.00	2.10	15.71
M-5	7.28	4.20	1.73	M-10	38.40	2.78	13.85
E_2-8	13.34	7.80	1.70	1-P	20.00	1.50	13.33
M-6-B-P	10.00	6.90	1.45	M-16	15.00	1.28	11.71
F-1	10.00	6.90	1.45	NBI	16.00	1.50	10.66
NBI	4.76	3.40	1.40	M-14	32.00	3.00	10.66
M-10	4.00	3.00	1.33	S-1	36.00	3.50	10.28
M-11	8.00	6.00	1.33	M-8	36.00	4.00	9.00
B-1	5.32	4.20	1.27	M-12	16.00	2.40	6.66
M-8	9.60	7.80	1.23	M-1	13.20	2.00	6.60
M-5-P	2.30	3.00	0.79	M-20	9.40	1.60	5.87
1-P	2.90	6.40	0.45	M-6	6.53	1.50	4.35
M-14	1.70	5.00	0.34	M-2	6.00	1.50	4.00
M-3	1.94	6.90	0.28	M-5	18.00	4.50	4.00
M-2	1.24	7.80	0.16	M-11	13.34	3.40	3.92
M-6	0.66	3.96	0.16	M-5-P	13.34	3.40	3.92
C-3	0.80	5.00	0.16	M-6-B-P	3.20	0.84	3.81
M-1	0.66	4.80	0.14	M-3	12.24	4.00	3.06

MCU = milk clotting unit
PU = proteolytic unit

3.57, 3.40 and 3.17 and others gave lower ratios. However, in wheat bran semi-solid medium three isolates, i.e., E_1-8, E_2-8 and F-1 gave higher ratios of 41.60, 38.08 and 37.50, respectively. The observed increase in the ratios was due to higher milk clotting activity in wheat bran semi-solid medium as compared to proteolytic activity. Thus wheat bran semi-solid medium appeared to be a better medium for milk clotting enzyme production because most of the isolates produced higher amounts of this enzyme as compared to proteolytic enzyme.

Screening results of fungal isolates grown on wheat bran semi-solid medium after 72 hr incubation at 30°C are shown in Table 2. Among the isolates tested, *Mucor miehei* NRRL 3169 showed a highest ratio of 75.0 followed by *Mucor miehei* NRRL 3420 and *Aspergillus* isolates F-4 and N-11.

TABLE 2

Results of screening tests for the production of milk clotting enzyme in wheat *bran semi-solid medium (surface culture) by fungal isolates.*

Fungal Isolates	Isolate No.	MCU/ml	PU/ml	MCU/PU
1. *Aspergillus* sp.	F-4	83.47	0.60	52.17
2. ,,	N-11	70.42	1.40	50.30
3. ,,	N-10	75.96	1.80	42.20
4. ,,	N-3	12.22	1.00	12.22
5. ,,	N-8	4.66	0.60	7.76
6. ,,	N-5	5.70	0.80	7.11
7. ,,	N-2	5.30	0.80	6.87
8. *Penicillium* sp.	F-16	11.42	0.80	14.27
9. ,,	F-14	5.00	1.60	3.12
10. ,,	F-11	6.16	2.20	2.80
11. ,,	F-12	3.20	1.64	1.95
12. *Fusarium* sp.	F-3	9.24	4.92	1.87
13. ,,	F-2	0.67	2.00	0.33
14. *Rhizopus* sp.	F-6	21.60	0.80	27.80
15. ,,	F-7	1.77	1.54	1.14
16. ,,	F-5	1.14	4.00	0.28
17. *Mucor miehei*	NRRL 3169	120.00	1.60	75.00
18. ,,	NRRL 3420	64.00	1.08	59.17
19. *Mucor pusillus*	NRRL 3469	60.00	1.92	31.24
20. *Mucor* sp.	F-10	26.66	1.10	24.18
21. ,,	F-8	14.00	0.70	20.08
22. ,,	F-9	5.72	0.70	8.14
23. *Endothia parasitica*	NRRL 3212	72.42	1.70	42.60

MCU=milk clotting unit
PU =proteolytic unit

TABLE 3

Results of screening tests for the production of milk clotting enzyme in skim milk medium (submerged culture) and in wheat bran semi-solid medium (surface culture) by actinomycetes isolates.

Actinomycetes	Isolate	Skim milk medium			Actinomycetes	Isolate	Wheat bran semi-solid medium		
Isolates	No.	MCU/ml	PU/ml	MCU/PU	Isolates	No.	MCU/ml	PU/ml	MCU/PU
Actinomyces sp	A-1	40.00	11.20	3.57	*Actinomyces* sp	A-2	137.14	4.00	34.28
-do-	A-3	8.00	2.60	3.07	-do-	A-5	5.72	1.24	4.61
-do-	A-2	35.00	14.00	2.50	-do-	A-3	16.58	3.40	4.58
-do-	A-5	7.50	3.75	2.00	-do-	A-4	8.50	3.60	2.36
-do-	A-4	5.00	3.20	1.56	-do-	A-1	1.34	0.99	1.35
Streptomyces sp	M-13	11.42	4.70	2.85	*Streptomyces* sp	M-18	2.36	0.62	3.80
-do-	M-18	12.87	5.52	2.31	-do-	M-13	4.00	1.77	2.26

MCU—milk clotting unit.
PU =proteolytic unit.

Table 3 shows the results of screening of actinomycetes in skim milk medium under submerged culture and in wheat bran semi-solid medium under surface culture after 72 hr incubation at 30°C. Only one isolate A-2 of *Actinomyces* sp. showed highest ratio of 34.28 in wheat bran semi-solid medium. Again the skim milk medium was inferior to wheat bran semi-solid medium for milk clotting enzyme production with this group of microorganisms.

Thus, the wheat bran semi-solid medium was found to be better for the production of milk clotting enzyme with these three groups of microorganisms. This probably explains the extensive use of wheat bran for enzyme production (Babbar *et al.*, 1961; Orosin *et al.*, 1970). Skim milk medium was shown to be a poor medium for milk clotting enzyme production. Similar observation was made by Srinivasan *et al.* (1964). This study suggests that the type of medium used and medium components play a significant role in influencing the synthesis of the milk clotting enzymes. Therefore, in the screening programme, various media should be tested so that a potential culture may not be eliminated.

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COMPARATIVE EFFICACY OF PHENOTHIAZINE[1] AND PIPERAZINE ADIPATE MIXTURE, METHYRIDINE[2], TETRAMISOLE[3], AND THIABENDAZOLE[4] AGAINST NATURAL INFECTION WITH GASTROINTESTINAL NEMATODES AND *DICTYOCAULUS FILARIA* IN SHEEP

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ABSTRACT

Anthelmintic efficacy of phenothiazine and piperazine adipate mixture, methyridine, tetramisole and thiabendazole against naturally acquired infections of gastrointestinal nematodes and *Dictyocaulus filaria* was compared in 45 sheep, maintained under normal conditions of management along with the rest of the flock at the University Farm, Hissar.

Phenothiazine-piperazine adipate mixture and methyridine showed little effect against gastrointestinal bursate nematodes as the egg counts of both the groups post-treatment as well as untreated controls, were of the same order. Thiabendazole and tetramisole showed a high degree of efficacy, ranging from 92.02 to 99.28 and 92.9 to 100 per cent, respectively.

The efficacy of phenothiazine-piperazine adipate mixture, methyridine and thiabendazole against *D. filaria* infection was rather inconsistent. Tetramisole, however, showed a consistently high efficacy, ranging from 94.17 to 100 per cent, against *D. filaria*, also.

The purpose of the present investigation was to evaluate the efficacy of some common anthelminitics, viz., phenothiazine-piperazine adipate mixture, methyridine, tetramisole and thiabendazole against the nematode parasites of local sheep, irrespective of the species involved. The results may, therefore, be considered as non-specific against any particular species of nematode parasites, because speciation was not undertaken. They are, however, conclusive against the

1. Phenothiazine (Phenovis—Imperial chemical industries, India, Pvt., Ltd.)
2. Methyridine (Promintic—Imperial chemical industries, India, Pvt., Ltd.)
3. Tetramisole (Nilverm—Imperial chemical industries, India, Pvt., Ltd.)
4. Thiabendazole (Thibendole—Merck, Sharp & Dohme of India. Ltd.)

commonly encountered gastrointestinal nematodes of sheep in the area and are of practical utility to the farmers and field veterinarians for routine drenching operations.

It is evident from the literature that upto late 1950s, phenothiazine was reputed for its anthelmintic efficacy against *Haemonchus, Ostertagia, Trichostrongylus, Nematodirus, Chabertia* and *Oesophagostomum* species (Gordon, 1958). However, it is no more a drug of choice for reasons best described by Bennet and Todd (1964). Walley (1961) and Gibbs and Pullin (1962) demonstrated good efficacy of methyridine against intestinal nematodes but its efficacy against abomasal worms was not dependable. Thiabendazole is considered to be one of the best drugs against nematode parasites (Brown *et al.*, 1961). Extensive reviews and articles about its efficacy are available. It is particularly active against mature parasites but its activity against immature worms is variable (Gibbs and Pullin, 1963). The drug is said to be effective against *D. filaria* as well (Robinson, 1966). Recently, a few parasites have been reported by different workers to have exhibited resistance to thiabendazole (Smeal, 1968). Tetramisole is one of the most effective anthelmintics. It appears to have high efficacy against *D. filaria* as well (Thienpont *et al.*, 1966 and Walley, 1966).

MATERIAL AND METHODS

Haryana Agricultural University, Hissar maintains a flock of about 1000 sheep for breeding programmes. History of the flock, clinical signs and postmortem examination of sheep revealed that parasitic infections, although at subclinical level, were present in the flock, in spite of regular drenching schedule with phenothiazine and piperazine adipate mixture thrice a year. The parasites, generally encountered on postmortem belonged to the genera *Haemonchus, Oesophagostomum, Trichostrongylus* and *Dictyocaulus*.

Sixty ewes were selected at random for the trial from this flock on the basis of uniformity in size and weight. They were of Lohi or Nali breeds, 1-2 years of age and weighed 25-35 kg, with an average weight of 31 kg. Each animal bore a tattooing ear mark with number.

An average of six pre-treatment faecal egg/larval counts, carried out twice a week by modified McMaster technique (Gordon and Whitlock, 1939) for gastrointestinal nematode eggs per gram of faeces (epg) and for *Dictyocaulus filaria* larvae per gram of faeces (lpg), was calculated for individual sheep. Forty-five sheep out of 60, with an average faecal egg count of 1000 epg or more, were finally selected for this trial.

The animals were divided into five groups of nine each on the basis of fairly comparable group averages of epg/lpg. Four anthelmintics, namely, phenothiazine (600 mg/kg body weight) + piperazine adipate (150 mg/kg body weight) mixture, methyridine (200 mg/kg body weight), thiabendazole (66 mg/kg body weight) and tetramisole (15 mg/kg body weight) were tried in four different groups; the fifth group served as unmedicated controls. The dosages were calculated for individual sheep on the basis of their body weight and administered orally, except methyridine which was given subcutaneously.

The effectiveness of a treatment was assessed by comparing the pre-and post-treatment group averages of faecal egg/larval counts. Five post-treatment faecal egg/larval counts were determined for each sheep, the first after one week, the second after two weeks, the third after four weeks, the fourth after eight weeks and the fifth after twelve weeks of medication. The group averages were then calculated for final evaluation.

The experimental animals were housed and grazed together with rest of the flock as usual, so as to maintain them under normal conditions of farm management. The trials were conducted during winter season, from December, 1972 to Mid-March, 1973 when the chances of fresh pick-up of natural infection from fields, pastures and sheds should be minimal.

RESULTS

Faecal egg count

The data presented in Table 1 indicated that the pre-treatment averages of faecal egg count were not different for different groups. It worked out to be 1664$\pm$116 for the control group; 1635$\pm$163 for phenothiazine-piperazine adipate treated group; 1655$\pm$151 for methyridine treated group, 1529$\pm$180 for thiabendazole treated group and 1563$\pm$212 for tetramisole treated group of sheep.

The post-treatment faecal egg count averages were of particular interest. These declined gradually in the control group, due to natural factors without any treatment, to a maximum of 71.94 per cent reduction by the 4th observation after treatment of other group. However, a slight decline in per cent reduction to 67.67 was observed at the last (5th) observation. The per cent reduction of 49.72, 48.38, 71.44, 73.52 and 41.47 in faecal egg count during Ist, 2nd, 3rd, 4th and 5th observations, respectively, after treatment with phenothiazine-piperazine adipate mixture did not differ markedly from the corresponding values of 58.37, 59.03, 69.79, 59.46 and 33.53 in the case of methyridine treated group. Except for the first observation post-treatment, these values, for the corresponding observations, were of the same order as those of the control group, viz., 21.88, 41.89, 64.60, 71.94 and 67.67. However, the values of these three groups were markedly lower than the corresponding values of 94.89, 99.28, 97.84, 94.18 and 92.02 for thiabendazole treated group and 98.59, 100.00, 97.89, 100.00 and 92.90 for the tetramisole treated group.

The data were statistically analysed and the critical difference between any two treatments at 5 per cent probability level was found to be 212, while at 1 per cent probability level it was 278. Treatment with thiabendazole and tetramisole proved to be better than others because the average faecal egg count for these treatments at different observations differed significantly from those under treatment with phenothiazine-piperazine adipate mixture and methyridine, and the controls ($P<.01$). The faecal egg count of control sheep differed significantly from those under treatment with phenothiazine-piperazine adipate mixture and methyridine after one week of treatment. Subsequently, after 2, 4 and 8 weeks there was no difference in the faecal egg count of sheep in these three groups. After 12 weeks of treatment, there was an increase in the egg count and sheep under treatment with phenothiazine-piperazine adipate mixture and methyridine showed a larger egg count than the control sheep. There was not much difference among themselves in the faecal egg count of sheep under treatments with thiabendazole and tetramisole.

Faecal larval count

It will be seen from Table 2 that the control group showed an irregular pattern of per cent reduction of 40.63, 67.19, 25.00, 31.25 and 85.94 in the faecal larval count (1pg) of *D. filaria* during 1st, 2nd, 3rd, 4th and 5th observations, respectively, after treatment of the other groups. A similar trend of per cent reductions in the larval counts, for the corresponding observations, of three of the four treated groups of sheep was evident after their treatment, viz. 64.94, 55.84, 84.42, 88.31 and 72.73 for phenothiazine-piperazine adipate treated group; 92.50, 67.50, 66.25, 95.00 and 88.75 for methyridine treated group; 93.49, 67.44, 50.00, 71.63 and 87.09 for thiabendazole treated group of sheep. The tetramisole treated group, however, showed a consistently high per cent reduction of 100.00, 100.00, 94.17, 100.00 and 98.68 in their faecal larval count for the corresponding observations after treatment.

The statistical analysis revealed a critical difference of 1.27 at 5 per cent probability level and 1.67 at 1 per cent probability level. The data show no regular trend for the first four groups. However, the per cent reduction in faecal larval count of sheep treated with tetramisole was significantly higher than all the other groups for all the observations after treatment. It indicated that tetramisole was superior to other drugs in the treatment of *D. filaria*.

DISCUSSION

The comparative efficacy of different anthelmintics used in these trials against gastrointestinal parasites and *D. filaria* has been determined on the basis of reduction in faecal egg/larval counts after treatment. Although faecal egg/larval count is not an accurate index of the worm burden of the host (Bennett, 1968), yet six biweekly pre-treatment faecal examinations were carried out to arrive at as close an approximation of the worm burden as possible. It was seen that the pre-treatment faecal egg count values fluctuated considerably during different observations indicating that the egg count was not constant and, perhaps, factors other than the worm burden, also, influenced it.

It is evident from Table 1 and 2 that the faecal egg/larval counts of the control group declined gradually throughout the experiment except for the last observation. It may be due to reduced chances of fresh intake of infection from fields and pastures because of the prevailing unfavourable climatic conditions and partly due to elimination of adult worms by the host. An upward tendency in the faecal egg count of all the groups was noticed at the last observation, which was carried out on 16th March. The increase may have been due to a fresh pick-up of the infection from the ground because of improved weather conditions over the past month or so.

In the group treated with phenothiazine–piperazine adipate mixture, the decline in faecal egg and larval counts did not differ significantly from that of the control group. Phenothiazine has been claimed to be highly effective against *Haemochus, Ostertagia, Trichostrongylus, Nematodirus, Chabertia,* and *Oesophagostomum* spp. (Arundel, 1963; Bennett, 1968). However, normal doses of phenothiazine have been observed to fail several times against the above mentioned parasites. This has been ascribed to differences in the particle size of phenothiazine (Arundel, 1963; Bennett and Todd, 1964) or the development of resistant strains of parasites (Bennett, 1968). The low efficacy of phenothiazine-piperazine adipate mixture against gastro-intestinal nematodes, as observed in the present experiment (Table 1), may be due to any one or both of these possibilities. This mixture showed an irregular effect on the larval count for *D. filaria* (Table 2).

Reduction in faecal egg count after methyridine treatment was of the same order as that of the phenothiazine-piperazine adipate mixture treated group (Table 1). It has been shown by walley (1961) and Hotson (1963) that methyridine at 200 mg/kg, given orally or

TABLE 1

Pre-and Post-treatment faecal egg counts (epg)* of treated and control groups of sheep with per cent reductions at each observation

Group	No. of animals	Pre-treatment faecal egg count averages of six observations of G.I. parasites epg	Post-treatment faecal egg count averages of G.I.** parasites: 1st observation epg	2nd observation epg	3rd observation epg	4th observation epg	5th observation epg
Controls	9	1664±116	1300	967	589	467	538
per cent reduction			21.88	41.89	64.60	71.94	67.67
Phenothiazine and Piperazine adipate	9	1635±163	822	844	467	433	957
per cent reduction			49.72	48.38	71.44	73.52	41.47
Methyridine	9	1655±151	689	678	500	671	1100
per cent reduction			58.37	59.03	69.79	59.46	33.53
Thiabendazole	9	1529±180	78	11	33	89	122
per cent reduction			94.89	99.28	97.84	94.18	92.02
Tetramisole	9	1563±212	22	00	33	00	111
per cent reduction			98.59	100.00	97.89	100.00	92.90

* epg=eggs per gram of faeces

**G.I.=Gastro-intestinal

First observation	After one week of treatment	Critical difference ($P<.05$)=212
Second observation	After two weeks of treatment	,, ,, ($P<.01$)=278
Third observation	After four weeks of treatment	
Fourth observation	After eight weeks of treatment	
Fifth observation	After twelve weeks of treatment	

TABLE 2

Pre-treatment and Post-treatment faecal larval counts (lpg)* of treated and control groups of sheep with per cent reduction at each observation

Group	No. of ani-mals lpg	Pre-treatment faecal larval count averages (six observations)	Post-treatment faecal larval count averages of *D. filaria*				
			Ist obser-vation lpg	2nd obser-vation lpg	3rd obser-vation lpg	4th obser-vation lpg	5th obser-vation lpg
Controls	9	6.4±1.0	3.80	2.10	4.80	4.40	0.90
per cent reduction			40.63	67.19	25.00	31.25	85.94
Phenothiazine and Piperazine adipate	9	7.7±2.2	2.70	3.40	1.20	0.90	2.10
per cent reduction			64.94	55.84	84.42	88.31	72.73
Methyridine	9	8.0±1.3	0.60	2.60	2.70	0.40	0.90
per cent reduction			92.50	67.50	66.25	95.00	88.75
Thiabendazole	9	8.6±1.6	0.56	2.80	4.30	2.44	1.11
per cent reduction			93.49	67.44	50.00	71.63	87.09
Tetramisole	9	7.55±1.3	0.00	0.00	0.44	0.00	0.10
per cent reduction			100.00	100.00	94.17	100.00	98.68

* lpg = Larvae per gram of faeces

First observation	After one week of treatment	Critical difference (P<.05) = 1.27
Second observation	After two weeks of treatment	,, ,, (P<.01) = 1.67
Third observation	After four weeks of treatment	
Fourth observation	After eight weeks of treatment	
Fifth observation	After twelve weeks of treatment	

subcutaneously, was highly active against gastrointestinal nematodes but its efficacy against abomasal worms was variable. The low efficacy of the drug, as recorded in this trial, could be due to the fact that a majority of the worms, encountered at post-mortem examinations, was of *Haemonchus*, *Ostertagia*, *Trichostrongylus* (abomasal worms) and *Oesophagostomum* spp. The effect of methyridine treatment against *D. filaria* was, however, good with a reduction in larval count ranging from 66.25 to 95.00 per cent at different observations, but it was all the same inconsistent (Table 2). Walley (1962) found that methyridine at 200 mg/kg was able to eliminate 82 to 95 per cent of the mature *D. filaria*.

Treatment with thiabendazole at 66 mg/kg effectively reduced faecal egg count of gastro-intestinal nematodes by 92.02 to 99.28 per cent (Table-I), indicating a high degree of efficiency. The efficacy of thiabendazole at 44-66 mg/kg against gastrointestinal worms has been reported earlier also (Brown *et al.*, 1961; Keith, 1963; and Ames and Robinson, 1965). However, its efficacy against immature stages of gastrointestinal worms is controversial (Ciordia *et al.*, 1972). The slight rise noticed at the last observation may have been due to the maturation of immature worms. But, the possibility of a fresh pick-up of the infection from the ground, because of improved weather conditions, cannot be ruled out, as a similar trend was noticed in all the other groups.

The per cent reduction in faecal larval count of *D. filaria* worms, after treatment with thiabendazole was inconsistent and irregular. Hence, no definite conclusion regarding the efficacy of the drug against *D. filaria* can be drawn from these results. The efficacy of thiabendazole against *D. filaria* has been reported to be low at 44 mg/kg body weight (Robinson, 1966). The irregular results obtained in this trial may be due to the low dose of the drug, viz., 66 mg/kg employed for treatment.

The faecal egg/larval counts of animals in the tetramisole treated group showed a consistently marked reduction, except for the last observation, ranging from 92.9 to 100.00 per cent in case of gastrointestinal nematodes and 94.17 to 100 per cent in *D. filaria* infection (Tables 1 and 2). The present results agree in principle with the findings of Forsyth (1966), Arundel (1967), Hart and Curr (1968), Hiregoudar (1970) and Katiyar (1970). The persistently low worm egg/larval counts after treatment with tetramisole may be due to the destruction of immature stages, also. It has been claimed by the above mentioned workers that tetramisole at a dose rate of 15 mg/kg body weight and above effectively removes the immature worms, which stands substantiated by the present findings as well.

The present study indicates that of the four anthelmintics tried tetramisole at 15 mg/kg body weight orally has the highest efficacy against gastrointestinal strongylid nematode worms and *D. filaria*. It is followed closely by thiabendazole at 66 mg/kg body weight orally, as far as, gastrointestinal worms are concerned. Thiabendazole at 66 mg/kg body weight gave inconsistent results against *D. filaria*. The efficiency of methyridine at 200 mg/kg body weight subcutaneously and that of a mixture of phenothiazine at 600 mg/kg body weight with piperazine adipate at 150 mg/kg body weight orally proved ineffective against gastrointestinal nematodes and *D. filaria*. The reduction in faecal egg/larval counts in their case was of about the same order as that of the unmedicated controls, perhaps, due to the seasonal effects, etc.

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DISTRIBUTION OF ELASTIC, RETICULAR AND COLLAGEN FIBERS IN UTERI OF SHEEP AND GOATS UNDER NORMAL AND SOME PATHOLOGICAL CONDITIONS

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ABSTRACT

Some significant differences in the distribution and density of elastic, reticular and collagen fibers were observed in some gynaecological conditions of sheep and goats.

Craig and Denziger (1963) studied the distribution of collagen, reticular and elastic fibers, and their significance in different pathological conditions affecting the reproductive organs of women. However, in the available literature, there is negligible information on the distribution of elastic, reticular and collagen fibers in the uteri of animals except one report by Weber *et al.* (1948) in cases of cows affected with metrorrhagia and a brief mention about the connective tissue components in the normal uteri of sheep by Trautmann and Fiebiger (1957).

MATERIAL AND METHODS

Reproductive organs of sheep and goats were examined at the different slaughter houses in Haryana State (Hissar, Karnal and Ambala) and at Army Supply Corps abattoir, Delhi. The tissues were collected from the following conditions, fixed in 10% formalin and studied histologically with particular reference to the distribution of elastic, reticular and collagen fibers.

Normal nonpregnant uterus (2 sheep and 2 goats), acute endometritis (4 sheep), chronic atrophic endometritis (4 sheep), chronic proliferative endometritis (4 sheep and 1 goat) and cystic endometrium (2 sheep and 3 goats).

While selecting these cases, care was taken to collect the material from a more or less uniform age group of 3-4 years, both in case of normal (controls) and the affected animals. The following staining methods were employed for this purpose: Gomori's aldehyde fuchsin method for elastic fibers, van Gieson's method for collagen fibers and Gomori's method for reticulum.

RESULTS

Normal non-pregnant uterus

Elastic fibers. Only a few fine fibers were observed in the deeper endometrial stroma, whereas around the endometrial glands and in the adventitia of blood vessels there was marked condensation of the fibers. A few fibers were observed in the connective tissue septae of myometrium and were fairly abundant in the serosa (Table 1).

Reticular fibers. A heavy condensation was observed just around the basement membrane of the glands, in the deeper parts of the mucosa and in tunica adventitia of blood vessels. A fine network was observed in the endometrial stroma, between the glands and around the individual muscle fibers of myometrium. More abundant fibers were seen in the connective tissue septae of myometrium. Serosa revealed a few reticular fibers.

Collagen fibers. In general, far less collagen fibers were present in all the tunica, as compared to reticular fibers and to some extent elastic fibers. There was complete absence of fibers in the endometerial stroma, around and in between the superficial portions of the glands. Moderate density of fibers was observed around the deeper portions of the glands, in the adventitia of blood vessels, connective tissue septae of myometrium and serosa (Table 1).

Acute endometritis

Elastic fibers. In all cases, there was almost complete absence of fibers between the glands or some remnants of disintegrating, light purple fibers remained. The fibers were scanty in the endometrial stroma and around the glands unlike in control animals. They were almost absent around the glands filled with purulent exudate. In an early case, however, the elastic fibers were present but in lesser density than in controls.

Reticular fibers. In all cases, the reticular fibers were either absent or very scanty and undergoing disintegration, both in the stroma and in between the glands. There was marked condensation around the glands filled with purulent exudate (Fig. 1).

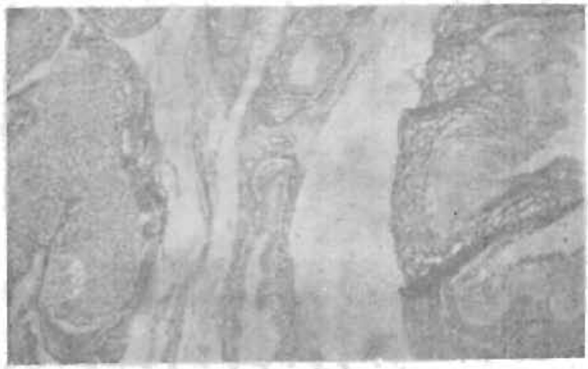

Fig. 1. Marked condensation of reticular fibers around the glands containing purulent exudate; normal glands are not showing this change.

Collagen fibers. The only difference from the control was complete absence of collagen fibers between and around the glands, and only a few fibers in the stroma.

Chronic atrophic endometritis

Elastic fibers. Very few fibers were observed in the stroma, around and between the glands. In one case (goat), the fibers around the blood vessels were fragmented and disintegrated. In the other four cases (sheep), the elastic fibers were fairly abundant in the tunica adventitia and partly in the tunica elastica of blood vessels. However, the fibers in the tunica elastica were apparently undergoing disintegration. Myometrium and serosa also revealed fewer fibers.

Roticular fibers. In all but one sheep very few fibers were seen in the interglandular uterine stroma which were undergoing disintegration (Fig. 2).

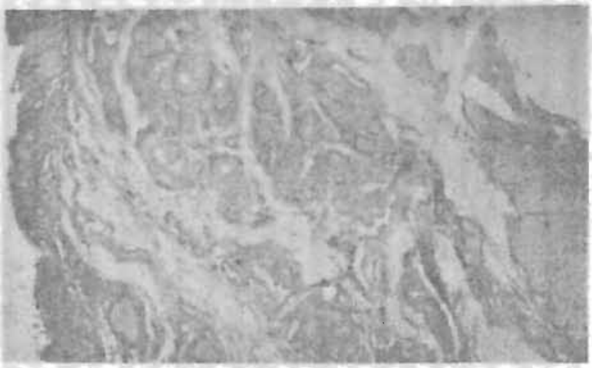

Fig. 2. Uterus from chronic atrophic endometritis, showing disintegration of reticular fibers in interglandular stroma.

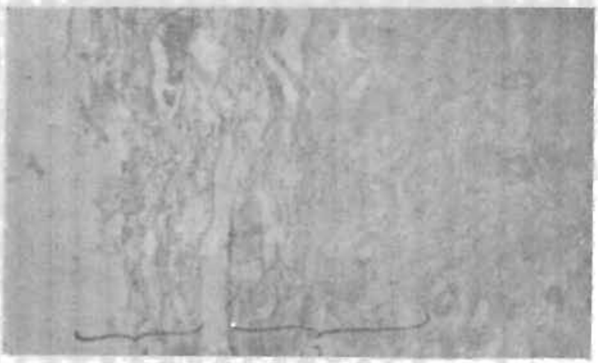

Fig. 3. Collagen fibers seen in the stroma (1) and deeper part of the uterine mucosa (2).

Collagen fibers. The fibers were distributed in the stroma and deeper part of mucosa, extending up to myometrium (Fig. 3). In one case (sheep), location of the fibers corresponded to normal controls.

Chronic proliferative endometritis

Elastic fibers. The fibers corresponded with normal controls in density and location except that they were absent in the stroma of papilliform projections formed due to proliferative endometritis.

Reticular fibers. The location and density of the fibers matched with the normal controls. The fibers were also present in the stroma of papilliform projections.

Collagen fibers. The location and density matched with the normal controls except that moderate amounts of fibers were also present in the stroma and papilliform projections unlike the normal controls.

Cystic endometrium

Elastic fibers. The fibers were heavily and conspicuously condensed just around the cystically dilated glands and in the deeper mucosa but absent in the superficial stroma. Noncystic glands were surrounded by normal density of fibers.

Reticular fibers. Lesser density of fibers was observed around the noncystic glands and were slightly more, around the cystic ones. The fibers between the glands were either disintegrated or absent. Slightly less than normal density was observed in the myometrium and serosa.

Collagen fibers. There was marked condensation of collagen around the cystic glands and at the base of caruncles. Moderate density was observed in between the glands, in the stroma and overlying large cysts. Rest of the endometrial stroma was devoid of collagen. In connective tissue septae of myometrium and in the serosa, there was comparatively more collagen (Table 1).

DISCUSSION

The distribution of reticular fibers noted in normal caprine and ovine uteri

TABLE 1

Comparative density of distribution of elastic, reticular and collagen fibers in uterus

Type of fibers	Condition	Location of the connective tissue fibers: Around endometrial gland	Location of the connective tissue fibers: Between the endometrial glands
Elastic fibers	Normal nonpregnant uterus	++	+
	Acute endometritis	±	–:(D)
	Chronic atrophic endometritis	±	±
	Chronic proliferative endometritis	++$	±
	Cystic endometrium	—	++
Reticular fibers	Normal nonpregnant uterus	+++	+++
	Acute endometritis	–(D)	–(xx)
	Chronic atrophic endometritis	+++	+(D)
	Chronic proliferative endometritis	+++	+++
	Cystic endometrium	+++	±(D)
Collagen fibers	Normal nonpregnant uterus	—	+
	Acute endometritis	+	—
	Chronic atrophic endometritis	+(A)	+
	Chronic proliferative endometritis	+	+
	Cystic endometrium	++	++(o)

Signs :

D	Disintegration
xx	Condensed around the glands distended with pus
A	Absent in one case
:	Around the glands scanty fibers
$	Absent in papilliform projections
o	More condensation around the glands
—	Absent
±	Scanty or absent
+	Deficient
++	Moderate
+++	Excess

was comparable to that described by Craig and Denziger (loc. cit.) in cases of women.

In the available literature there appeared to be no report regarding the density of distribution of connective tissue fibers in the uterus of animals. In case of turkeys, Simpson *et al.* (1962) reported fragmentation of elastic fibers due to the toxic factors of *Lathyrus odoratus*. In the present investigation, the disintegration of fibers noted in cases of acute endometritis could possibly be due to bacterial toxins. In acute endometritis, the reticular fibers were either few or absent in contrast to normal. This observation was comparable to that of Craig and Denziger (1963) who demonstrated the disintegration of much of reticulum or complete absence due to sloughing of endometrium during menstruation, as sloughing also occurs in acute endometritis. In chronic atrophic endometritis, the reticular fibers were less in number as compared to normal controls except in stromal tissue. In chronic proliferative endometritis, the distribution of reticulin in all layers matched with the normal controls. Craig and Denziger (1963) also observed no significant alteration in the pattern or density of reticular fibers, in cases of chronic endometritis in women. In cases of cystic endometrium, there was less density of reticular fibers in all the layers except for condensation around the cystic glands. Craig and Denziger (1963) also recorded increased density of these fibers around and inbetween the glands in cystic endometrium in women.

In the present investigation, the normal uteri revealed much less density of collagen in all the layers and complete absence in the stromal tissue as compared to the reticular and elastic tissue. In cases of acute endometritis, chronic atrophic and chronic proliferative endometritis there was increase of collagen fibers in the stroma which could have possibly been due to the conversion of reticular fibers to collagen fibers as explained by Pearse (1968). Craig and Denziger (loc. cit.) reported that in cases of chronic endometritis in women, collagen fibers were not always observed, except in rare cases. In cystic endometrium, there was increase in collagen fibers in the stromal tissue and around the cystic glands and was in accordance with the findings of Craig and Denziger (1963) and Sedlis and Kim (1971). Sedlis and Kim (1971) also noticed a high correlation between the endometrial collagen and cystic hyperplasia of uterus in women. They suggested that collagen is produced by the stromal cells, which in the absence of progesterone are able to mature into fibroblasts which produce collagen. However, Agrawal and Fox (1972) found that collagen is of no diagnostic significance in any pathological condition of human endometrium.

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SEX-LIBIDO IN NALI RAMS

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ABSTRACT

Fourteen Nali rams maintained in the Department of Animal Breeding were used for studies on measures of sex-libido. The time taken up to fourth service and number of services in 30 minutes were recorded and their averages are presented. The average number of services in 30 minutes ranged from 2.10 ± 0.17 to 4.15 ± 0.34. Significant differences among rams were observed in the time elapsing between first and second service, time elapsing between second and third services and number of services in thirty minutes. The season of testing significantly affected the number of services in thirty minutes only.

The sex libido, the desire of ram to perform coitus, is an important component of male fertility under natural service or when semen is collected in artificial vagina under artificial breeding. Studies of Parker and Bell (1966) suggested the low additive genetic variance for fertility. It, therefore, seems that heritability of this trait is low which may possibly be due to negative pleiotropic relations among different components of fertility. Therefore, for improving the male fertility, investigations on sex libido and different semen characteristics and their relationship with fertility need to be undertaken. The present study was attempted to study the sex-libido in Nali rams as affected by the season.

MATERIAL AND METHODS

Fourteen Nali rams of the same age group maintained in the Department of Animal Breeding, HAU, Hissar, were used in the year 1973-74 to carry out the present investigation. The animals were maintained on grazing throughout the year. About 500g of concentrate was given to them during the breeding seasons. The two breeding seasons followed were (i) middle of April to middle of June, and (ii) middle of September to middle of November. The rams were selected on the basis of their six monthly body weight. No attention was paid to either semen quality or the fertility of rams at the time of selection. Libido was measured as the time required to produce the successive ejaculate and the number of services per 30 minutes (Wiggins *et al.*, 1953; Dhillon, 1970). The time for each service was recorded by stop-watch. Five measures of sex libido, i.e., the number of services in 30 minutes, time taken for first service, time elapsing between first and second service, time elapsing between second and third service and time elapsing between third and fourth service were considered. The analysis of the data was done as described by Snedecor and Cochran (1968).

RESULTS AND DISCUSSION

The averages alongwith their standard errors of the different measures used for estimating sex libido, ram wise are presented in Table 1. The time taken for the

TABLE 1

Averages alongwith Standard Errors of various measures of Sex libido.

	Time taken for 1st ejaculate *in minutes*	Time elapsing between 1st & 2nd ejaculate in minutes	Time elapsing between 2nd & 3rd ejaculate in minutes	Time elapsing between 3rd & 4th ejaculate in minutes	No. of services in 30 minutes
Ram 898	0.31±0.06 (16)	3.79±0.58 (10)	12.50±1.21 (7)	—	2.59±0.20 (11)
101	9.33±0.06 (16)	6.73±1.23 (16)	7.17±0.41 (8)	—	2.56±0.24 (16)
126	0.27±0.04 (12)	8.10±1.50 (11)	—	—	2.10±0.17 (12)
112	0.30±0.02 (14)	5.06±0.80 (14)	10.40±1.00 (10)	—	2.71±0.10 (14)
131	0.38±0.01 (15)	4.64±1.65 (15)	7.43±1.45 (12)	10.64±0.00 (1)	3.46±0.25 (15)
144	0.25±0.06 (12)	2.51±0.41 (12)	6.83±1.66 (9)	8.15±1.38 (6)	3.00±0.30 (12)
157	0.46±0.17 (11)	5.66±1.11 (10)	11.77±0.61 (6)	8.00±0.00 (4)	2.54±0.24 (11)
195	0.25±0.05 (9)	4.77±1.13 (9)	7.00±0.59 (9)	10.91±0.64 (4)	3.33±0.33 (9)
204	0.37±0.01 (12)	5.15±0.83 (11)	7.53±1.60 (7)	13.00±0.54 (3)	2.91±0.36 (12)
215	0.20±0.03 (15)	3.65±0.90 (13)	8.38±0.88 (13)	9.16±1.52 (7)	3.46±0.24 (15)
231	0.40±0.09 (11)	5.11±0.21 (11)	9.20±0.88 (7)	11.83±0.31 (3)	2.90±0.24 (11)
232	0.31±0.06 (12)	7.45±0.60 (9)	8.25±0.70 (9)	—	2.30±0.26 (11)
259	0.18±0.04 (13)	2.85±0.28 (13)	7.36±1.06 (13)	11.29±1.66 (8)	3.80±0.79 (13)
156	0.37±0.12 (13)	3.05±0.77 (13)	4.20±1.60 (12)	6.99±1.54 (8)	4.15±0.34 (13)
Season I	0.28±0.03 (98)	5.02±0.39 (91)	7.95±0.60 (56)	10.23±1.80 (25)	2.86±0.10 (98)
II	0.36±0.05 (78)	4.68±0.42 (76)	8.23±0.52 (60)	9.30±3.03 (23)	3.20±0.10 (78)

TABLE 2

Analysis of variance of the effect of seasons and sires on sex libido

	Time taken for 1st service		Time elapsing between 1st and 2nd service		Time elapsing between 2nd and 3rd service		No. of services in 30 minutes	
Source	d.f.	M.S.	d.f.	M.S.	d.f.	M. S.	d.f.	M.S.
Between Seasons	1	905.77	1	16463.60	1	8430.93	1	4.95**
Among rams	13	284.31	13	888071.38**	13	153311.73**	13	13.63**
Error	161	523.40	152	49236.40	101	53873.04	161	0.02

**P∠0.01

first ejaculate ranged from 0.18 ± 0.14 to 0.46 ± 0.17 minutes. The second ejaculate was obtained after 2.51 ± 0.41 to 8.12 ± 1.50 minutes of the first ejaculate. The subsequent intervals between second and third and third and fourth ejaculates were relatively of larger duration, being 4.20 ± 1.60 to 12.50 ± 1.21 and 6.99 ± 1.54 to 13.00 ± 0.54 minutes, respectively. The present findings are in conformity with the report of Dhillon (1970). Analysis of variance (Table 2) for these traits revealed that there were no significant differences due to seasons. However, significant differences (P∠0.01) among rams were observed for the time elapsing between first and second service and second and third service. These results are indicative of the fact that the rams are quite consistent with their sex-libido as indicated by intervals between successive services and are little affected by the seasons. Shukla and Bhattacharya (1952) also reported the significant differences among rams in reaction time while the seasons were found to have no effect. The variation among rams is of important significance and may help in improving the male fertility if these measures are used as selection criteria as libido is to some extent related with semen quality.

The average number of services in 30 minutes was considered another measure for sex-libido and is presented ram-wise in Table 1. These ranged from 2.10 ± 0.17 to 4.15 ± 0.34. Dhillon (1970) reported on an average 3.76 services in 30 minutes. The differences between seasons and rams were highly significant (P∠0.01). The second breeding season was more favourable and the average number of services during this breeding season were 3.20 ± 0.10 as compared to 2.86 ± 0.10 in the first season. The rams in the breeding season from September to October after having a period of post-monsoon grazing, condition themselves properly and become sexually vigorous resulting in better sex-libido as reflected by number of services in 30 minutes in comparison with the performance in first breeding season. The winter stress does adversely affect the libido in the forthcoming breeding season. Since the quantity of semen produced depends on the number of ejaculations rather than interval among them, it may be preferable to use number of services in 30 minutes as a measure of libido.

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EVALUATION OF SOME COMMERCIAL BROILER CHICKENS

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ABSTRACT

Two hundred day-old chicks of four commercial broiler strains were observed for growth, mortality, efficiency of feed conversion, carcass yield and body conformation under floor and battery rearing systems. Differences among strains, between rearing systems and their interactions were significant. The highest body weight attained at 10 weeks of age was 1777 g and eviscerated percentage 73.3. The net profit per broiler ranged from Rs. 0.52 to Rs. 1.65.

A number of frenchise hatcheries in the country are selling broiler chickens which are mostly inbred line or strain crosses. Evaluation of relative performance of four commonly available commercial broiler strains under battery and floor rearing was done in the present study.

MATERIAL AND METHODS

During October, 1973, 200 day-old chicks were purchased from the 4 leading hatcheries*. One half of the chicks from each strain were reared on floor and the other half in the battery up to 10 weeks of age. Weighed amount of feed containing 22 per cent of protein and 3000 K. calories of energy was fed to the chicks. The chicks were protected against Ranikhet disease and Fowl Pox. Feed consumed during each week was recorded. Efficiency of feed conversion was worked out as the amount of feed consumed per kg gain in the body weight during every week as well as the amount of feed consumed per kg chicks delivered. Body weight at weekly interval was recorded up to 10 weeks of age. Production score (Teilen, 1970) was worked out as :

$$\frac{\text{Per cent survivors} \times \text{growth per chick per day}}{\text{Amount of feed consumed per kg chicks delivered}}$$

For working out the profit per chick, initial cost of the chick, incidental charges @ Rs. 1.00 per chick up to 10 weeks, Rs. 0.85 up to 9 weeks and Rs. 0.70 up to 8 weeks (labour charges, medicine, vaccination, electricity charges etc.) and cost of the feed consumed (@ Rs. 120 per quintal) were considered as expenditure. Income was worked out on the basis of Rs. 6.00 per kg live weight.

At 10 weeks of age, a random sample of 25 chicks reared on floor and 25 reared in battery were slaughtered from

*The particulars of hatcheries are being kept secret.

each strain for studying the meat yield. Pre-slaughter weight and measurements of shank length, shank diameter, and breast angle of each chick were taken. Eviscerated weight (after removing feather, shanks, head, viscera and other non-edible parts) was recorded and expressed as per cent of the pre-slaughter weight. Per cent mortality up to 10 weeks of age was also worked out. Analysis of variance was run to find out the difference among strains, between rearing systems and their interaction. The product moment correlations of shank length, shank diameter and breast angle with pre-slaughter weight and eviscerated weight were worked out for each strain separately and pooled according to Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

Growth

Growth was studied in terms of body weight at weekly interval up to the age of 10 weeks and the averages along with standard errors are presented in Table 1. The differences among the four strains were found to be significant (Table 2) at every stage of growth. In a similar study, Dev and Sharma (1972) recorded comparatively lower body weights for A, C and D strains (B-strain was not used by them). However, the trend corresponded to that in the present investigation. The mean body weight attained by the chicks of A-strain on floor was about 200 g more than that recommended by the supplier at this age.

Pho *et al.* (1971) reported the highest body weight attained by broiler breeds and their crosses as 1264 g at 12 weeks of age. Ramappa and Gowda (1973) reported the highest body weight of White Cornish as 1100 g at 10 weeks of age. Singh (1973) and Kaushal *et al.* (1973) reported maximum body weight of about 750 g at 10 weeks of age in broiler breeds and crosses. These results indicate that growth in commercial broilers is much faster than in the available broiler breeds.

Except at day-old and 2 weeks of age, the differences due to rearing systems were found to be significant at every stage of growth. The strain × rearing system interaction was also significant at all stages of growth. The chicks of A-strain and B-strain reared in battery were heavier up to 2 weeks of age as compared to these reared on floor. However, after this age in these two strains, and after day old-age in C-strain and D-strain, the chicks reared on floor were heavier. Contrarily Pho *et al.* (1971), Aggarwal *et al.* (1972) and Reece *et al.* (1971) have reported better growth of chickens in battery than on floor. Although the reasons of this discrepancy are not obvious, however, it may probably be due to the differences in season in which the experiment was conducted. Those experiments were conducted in winter whereas the present study was conducted in October. The effect of rearing system was not the same in all the four strains which is also evident by the significant interaction of strain × rearing system. These results agree well with those reported by Craig *et al.* (1969) who observed that breeds and strains behave differently in cages due to differences in social stress.

Carcass yield and body measurements

The averages for eviscerated weight,

TABLE 1

Average alongwith standard errors for weekly body weight (gms) up to 10 weeks of age in four commercial broiler chickens

Strains	System of rearing	Day old	1 week	2 weeks	3 weeks	4 weeks	5 weeks	6 weeks	7 weeks	8 weeks	9 weeks	10 weeks
	Floor	45.00	72.36	140.46	253.76	418.04	584.74	825 87	994.43	1272.88	1548.45	1777.50
A		±0.37	±1.06	±2.86	±5.69	±8.48	±10.61	±13.57	±14.12	±15.09	±29.52	±28.79
	Battery	44.97	79.98	148.70	251.14	395.83	574.73	765.70	925 59	1103.01	1323.10	1523.53
		±0.41	±1.08	±2.72	±4.71	±6.94	±16.84	±13.21	±24.07	±32.49	±36.93	±32.15
	Floor	41.63	62.88	123.20	213.58	355.75	503.93	685.73	914 64	1185.75	1462.95	1686.63
B		±0.29	±0.68	±2.34	±4.51	±5.98	±12.39	±12.07	±19.64	±20.03	±27.76	±27.41
	Battery	41.31	67.99	128.99	213.38	287.93	406.17	577.26	765.32	985.64	1207.68	1440.00
		±0 33	±0.56	±2.64	±3.77	±6.20	±9.54	±12.85	±16.24	±19.62	±25.21	±28.34
	Floor	41.56	70.44	131.09	251.35	389 35	571.60	794.80	1020.70	1237.70	1412 30	1693.80
C		±0.42	±0.63	±2.64	±5.06	±7 42	±10.47	±13.71	±16.29	±20.48	±23.01	±26 32
	Battery	41.37	64.08	123.03	218.75	320.62	402.13	480.66	628.80	822.44	1017.33	1215.56
		±0.38	±0.98	±2.77	±5.90	±7 21	±10.60	±12.73	±16.78	±20.43	±24.07	±27.97
	Floor	38.09	59.85	115.10	220.48	349.68	507.20	691.26	907.20	1135.97	1387.50	1525.43
D		±0.41	±0.90	±2 70	±5.20	±5.78	±12.06	±17.95	±20.15	±23.06	±28.09	±27.55
	Battery	38.27	59.29	106.93	197.90	308.22	450.65	588 31	750.87	937.93	1113.88	1300.00
		±0.41	±0.92	±2.62	±4.36	±6.84	±12.16	±16.54	±22.56	±25 69	±31.64	±33.34
Critical difference (P∠0.05)		1.03	2.43	7.36	13.72	19.20	29.73	39.10	52.64	63.75	79.08	80.24

TABLE 2

Analysis of variance for weekly body weight up to 10 weeks of age in four commercial broiler chickens

Source of Variation	D.F.	MEAN SQUARES Day old	One week	Two weeks	Three weeks	Four weeks	Five weeks	Six weeks	Seven weeks	Eight weeks	Nine weeks	Ten weeks
Among strains	3	1813**	10698**	38041**	77870**	287915**	584315**	1152156**	739207**	939170**	1644478**	2134761**
Between rearing systems	1	5	3155**	177	40881**	492340**	1445681**	3914529**	6849311**	11294814**	14709614**	17118678**
Strain X rearing system	3	22	594**	4328**	11737**	23474**	211775**	633918**	923363**	623786**	31556**	608499**
Residual		15	77	688	2356	4617	11049	19105	34279	49748	76556	78798
		(809)	(798)	(770)	(766)	(765)	(761)	(751)	(748)	(746)	(744)	(741)

**$P \angle 0.01$

Within parentheses are the residual degrees of freedom.

TABLE 3

Averages alongwith standard errors for eviscerated weight, eviscerated percentage, shank length and diameter, and breast angle in four commercial broiler chickens

Strains	System of rearing	Eviscerated weight(gm)	Evisc. percentage	Shank length (cm)	Shank diameter (cm)	Breast angle	Amount of feed consumed per kg gain in body weight (Kg)
	Floor	1334.40	73.31	7.87	1.43	67.32	2.92
A		±23.86	±0.66	±0.19	±0.01	±1.21	±0.23
	Battery	1288.00	74.14	7.83	1.46	66.48	3.05
		±33.88	±0.77	±0.19	±0.03	±1.14	±0.22
	Floor	1269.60	70.43	8.45	1.47	65.08	2.73
B		±34.27	±0.33	±0.09	±0.01	±1.06	±0.19
	Battery	1006.80	70.15	7.70	1.36	59.20	2.66
		±22.63	±0.36	±0.07	±0.01	±0.80	±0.21
	Floor	1253.60	68.80	8.26	1.38	68.72	2.76
C		±33.61	±0.39	±0.10	±0.01	±1.36	±0.23
	Battery	945.80	70.83	7.60	1.35	63.00	3.13
		±24.80	±0.30	±0.09	±0.02	±1.29	±0.31
	Floor	1071.20	70.08	8.28	1.33	61.04	3.20
D		±27.91	±0.19	±0.12	±0.02	±1.47	±0.50
	Battery	1046.40	71.39	8.03	1.35	63.60	2.94
		±33.05	±0.28	±0.10	±0.02	±0.02	±0.31
Critical difference (P∠0.05)		113.17	3.95	0.24	0.05	3.25	

TABLE 4

Analysis of variance for carcass yield, feed efficiency and body measurements in four commercial broiler chickens

Source of variance	D. F.	MEAN SQUARES					
		Evisc. weight	Evisc. percentage	Feed efficiency	Shank length	Shank diameter	Breast angle
Among strain	3	613960**	1559**	0.5307	0.93**	0.120**	296**
Between rearing systems	1	1327635**	48	0.0405	8.91**	0.020	305**
Strain x rearing system	3	273824**	11	0.4202	1.42	0.040**	209**
Residual		41676 (192)	51 (192)	0.8622 (72)	0.19 (192)	0.008 (192)	34 (192)

**P $\angle$ 0.01

Within parentheses are the residual degrees of freedom.

eviscerated percentage, shank length, shank diameter and breast angle are presented in Table 3 and their analysis of variance in Table 4. The eviscerated weight (1334 g) and eviscerated percentage (73.3) were found to be highest in A-strain. The effect of rearing system on eviscerated percentage was not evident; however, its effect on eviscerated weight was found to be significant since the latter is determined to a great extent by preslaughter weight. The eviscerated percentage of A-strain was also reported to be high (69.9%) in comparison to other strains by Dev and Sharma (1972). Chhabra *et al.* (1972) and Singh (1973) reported the eviscerated percentage in broiler breeds and their crosses as ranging from 65 to 70 per cent. These results indicated that there was little difference in the eviscerated percentage of broiler breeds and commercial broilers.

The differences in shank length, shank diameter and breast angle of the four strains were found to be significant. The effect of rearing system was significant for shank length and breast angle only. Strain x rearing system interaction was observed to be significant for all the three measurements. The correlation of shank length with preslaughter weight and eviscerated weight was found to be significantly different in all the four strains (Table 5). The correlation of preslaughter weight and eviscerated weight with shank diameter (pooled over strains) was estimated to be 0.60 and 0.56, respectively. The corresponding correlations with breast angle were 0.50 and 0.44. Chhabra *et al.* (1972) and Singh (1973) reported high possitive correlation between body weight and shank length. The latter worker also reported positive but low correlations of body weight and eviscerated weight with breast angle. There is no report in the available literature regarding the correlation of shank diameter with body weight and eviscerated weight. These results point toward

TABLE 5

The correlation of body measurements with body weight and eviscarated weight in four commercial broiler chickens

Traits	Body weights at 10 weeks				Eviscerated weight				Pooled	
	A	B	C	D	A	B	C	D	Body wt.	Evic. wt.
Shank length	$0.50 \pm .18$	$0.78 \pm .13$	$0.76 \pm .13$	$0.46 \pm .18$	$0.63 \pm .16$	$0.64 \pm .16$	$0.34 \pm .19$	$0.52 \pm .17$	—	—
Shank diameter	0.49	0.71	0.42	0.68	0.53	0.50	0.45	0.70	0.60 ± 0.06	0.56 ± 0.06
Breast angle	0.43	0.70	0.44	0.45	0.39	0.50	0.45	0.46	0.50 ± 0.06	0.44 ± 0.06

TABLE 6

Economics of 4 commercial broiler chickens.

Strain	System of rearing	Production score			Profit per chick (Rs.)			Amount of feed consumed per kg chicks delivered	Per cent mortality
		Eight weeks	Nine weeks	Ten weeks	Eight weeks	Nine weeks	Ten weeks		
A	Floor	605	710	757	1.03	1.41	1.46	3.07	5.8
	Battery	455	537	560	0.31	0.59	0.71	3.16	12.6
B	Floor	582	696	776	0.89	1.36	1.58	2.91	3.9
	Battery	466	560	638	0.37	0.72	0.94	2.92	6.8
C	Floor	610	670	801	1.00	1.12	1.65	2.88	1.9
	Battery	304	372	449	—0.37	—0.17	—0.03	3.20	13.7
D	Floor	514	618	591	0.65	1.04	0.52	3.24	9.9
	Battery	419	511	495	0.08	0.26	0.10	3.21	8.9

the possibility of predicting body weight and eviscerated weight on the basis of these body measurements.

Mortality and feed efficiency

The mortality during 0-10 weeks of age was less in the chicks reared on floor compared to the battery reared chicks (Table 6) and it was minimum in C-strain followed in ascending order by B-strain, A-strain and D-strain. Among the battery reared chicks highest mortality was recorded for C-strain (13.7%) and lowest in B-strain (6.8%). In C-strain most of the chicks in battery died due to non-specific enterities.

The efficiency of feed conversion (Table 3) was highest in battery reared chicks of B-strain and D-strain as compared to floor reared chicks. However, in A and C-strains it was higher in floor reared chicks. The most efficient value of 2.66 was recorded for B-strain chicks reared in battery and least efficient value of 3.13 for battery reared chicks of C-strain. But statistically non-significant differences were present among the four strains. Dev and Sharma (1972) reported the mortality in commercial broilers from 6 to 10 per cent and efficiency of feed conversion from 2.47 to 3.66 kg which are in close agreement with the present study. However, Pho *et al.* (1971) and Singh (1973) reported higher mortality and lower feed efficiency in broiler breeds and their crosses. Ramappa and Gowda (1973) reported the feed efficiency in 4 broilers breeds and their crosses ranged from 3.17 to 3.67 kg These results indicate that mortality was less while efficiency of feed conversion was higher in commercial chicks as compared to available broiler breeds.

Economic efficiency

The results pertaining to production score (Teilen, 1970) and the actual profit of raising broilers up to 8, 9 and 10 weeks of age are presented in Table 6. The net profit was higher in floor reared chicks as compared to battery reared chicks. This is because both growth and survivability were better in the former case. The net profit per broiler was highest (Rs. 1.65) for C-strain followed by B-strain (Rs. 1.58), A-strain (Rs. 1.46) and D-strain (Rs. 0.52) in the descending order. The profit was found to increase with the advancement of the age, but the trend of increase was not uniform in all the strains. Maximum increase however, was observed in the C-strain from 9 to 10 weeks of age. The results of the study are incomplete in the sense that actual age beyond which broilers become uneconomical could not be determined, because the study had to be discontinued after 10 weeks of age due to unavoidable circumstances.

The trend of production score was found to be closely associated with the net profit and this fact can certainly give an idea about the economics of broiler even without working out the actual profit. Dev and Sharma (1972) reported profit per 200 chicks of A, C and D strain as Rs. 144.81, Rs. 210.73 and Rs. 29.22, respectively, at 10 weeks of age. The C-strain was more economical in the present study also. Sharma (1974) worked out the profit for broiler breeds and their crosses from Rs. 0.14 to Rs. 1.80 per broiler. These results suggest that commercial broilers will be more economical than the broiler breeds or their crosses.

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EFFECT OF ADDITION OF AUREOMYCIN AND COPPER IN DIETS ON THE PERFORMANCE OF GROWING PIGS*

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ABSTRACT

An investigation was conducted to find the effect of aureomycin (0, 10 and 40 g/ton diet) and copper (0, 125 and 250 ppm) and their combinations in a factorial experiment on the average daily gain, efficiency of gain and protein efficiency ratio on 45 growing Middle White Yorkshire pigs. Addition of 10 and 40 g/ton aureomycin in the diet increased the rate of gain ($P \angle 0.05$) by 15 to 25 per cent. Aureomycin did not affect ($P \nearrow 0.05$) the efficiency of gain as measured by feed/gain and gain/feed. Addition of copper had no beneficial effect ($P \nearrow 0.05$) as evidenced by the average daily gain and feed efficiency on a basal diet containing 6 ppm copper. The best growth rate was observed on a diet supplemented with 40 g/ton aureomycin and 125 ppm copper. The pigs took three weeks less to reach the growing period weight of 54 kg with this diet which is important in any swine production programme. However, 250 ppm copper counteracted the beneficial effect of aureomycin on growth rate. The study indicated that copper supplementation deserves greater care in swine feeding than is generally given.

It has been reported by many workers (Glimp and Tillman, 1964; Miller, 1969) that addition of aureomycin in the diet of swine produces an increase in the average daily gain and feed efficiency as compared to the control diet. Gropp *et al.* (1972) and Novak *et al.* (1972), however, observed no improvement in the weight gain of pigs fed diets supplemented with antibiotics.

Barber *et al.* (1962), Gupta *et al.* (1964), Teague (1968) and Kline *et al.* (1972) found that 125-250 ppm copper produced a beneficial growth response under most conditions. NCR 42 committee on swine Nutrition (1970) has reported a positive growth response when 250 ppm copper was added to the diet of growing swine. Todd (1965) and Walker *et al.* (1971) did not obtain a beneficial growth response to supplemented copper (250 ppm).

Lucas *et al.* (1962) reported an additive effect of copper and aureomycin

*Data taken, in part, from the M.Sc. thesis submitted by the senior author to the Haryana Agricultural University, Hissar.

when added to the diet of pigs. Kosanovic et al. (1967) found no advantage in adding copper with antibiotics. The reasons for the variability in response to copper and antibiotics are not completely understood. Diet composition and managemental practices are apparently two factors.

The present study was undertaken to determine the effect of addition of copper and aureomycin alone and in combination in the diet on the growth rate and feed conversion efficiency in growing pigs.

MATERIAL AND METHODS

Forty-five Middle White Yorkshire Pigs, averaging 14.4 kg body weight, were used. The pigs were obtained from the Piggery Unit of Government Livestock Farm, Hissar. The pigs were vaccinated against swine pox, dewormed, treated for external parasites and allowed a 14–day adjustment period in the pens before being fed experimental diets. The animals were allotted from weight outcome groups to 9 treatments of five pigs each. The animals were allotted to the treatments at random. A factorial arrangement of treatments (Table 1) included three levels of added copper (0,125 and 250 ppm) and three levels of aureomycin (0, 10 and 40 g/ton). The basal diet (Table 2) formulated to contain 16 per cent protein and 6 ppm copper was fed throughout the experiment. The diet supplied all the essential nutrients needed by growing pigs.

The sources of experimental elements included in the diets which made up the various treatments were as follows: Copper as copper sulphate ($CuSo_4$, $5H_20$), aureomycin hydrochloride as Aurofac 20 feed supplement (Cynamid India Ltd.).

Pigs were housed in 2.70 · 2.55 m pens with cemented floors. Each pen provided 6.88 M^2 of floor space. All pigs were fed *ad libitum* in mangers. A watering trough was provided in each pen. All animals were weighed and feed con-

TABLE 1

Distribution of different groups to the experimental treatments

	Added Copper (ppm)*			Added aureomycin (g/ton)**		
Group	0	125	250	0	10	40
1.	x			x		
2.	x				x	
3.	x					x
4.		x		x		
5.			x	x		
6.		x			x	
7.		x				x
8.			x		x	
9.			x			x

*Copper sulphate ($CuSo_4$, $5H_20$) contained 25 per cent of copper.

**Aurofac 20 feed supplement (Cynamid India Ltd.) contained aureomycin hydrochloride 44/g/kg.

TABLE 2

Composition of the basal diet[a]

Ingredients	Per cent
Maize (9.5% C.P.)	66.85
Groundnut Cake (30.2% C.P.)	18.35
Wheat bran (14.4% C.P.)	5.00
Fish meal (42.5% C.P.)	8.00
Bone meal (Ca, 27.8% and P.14%)	0.70
Common salt	0.50
Mindiff (Boots[b])	0.50
Vitamin (mix[c])	0.10
	100.00

(a) Calculated to contain 16.0% C.P. By analysis the basal diet contained 6 ppm copper.

(b) Mindiff contributed the following per kg of diet: Sod. chloride 1.15 g, mangnese 100 mg, iron 175 mg, Copper 5 mg, cobalt 2.5 mg and iodine 9.5 mg.

(c) The vitamin mix contributed the following per kg of diet; Vitamin A 12000 i.u., Vitamin D_3 1500 i.u., Vitamin E 12 mg, Vitamin K 3 mg, Vitamin B_1 1.2 mg, Vitamin B_2 6 mg, Vitamin B_6 2.4 mg, niacine 18 mg, Cal. Pantotheate 12.0 mg and Vitamin B_{12} 16 mg.

sumption was determined at weekly intervals. The study was terminated after 81 days when the pigs averaged about 50 kg in body weight.

The data were analysed by variance method and statements regarding statistical significance pertain to a probability level of 5 per cent. One pig on treatment 8 died during the course of the trial and its data were excluded from the analysis.

RESULTS AND DISCUSSION

Summary of results and analysis of variance for the different traits studied are presented in Tables 3 and 4, respectively.

The analysis of variance revealed that the effect of diets was significantly different for the average daily gain ($P > .06$) only. When this effect was further partitioned into 'between aureomycin', 'between copper' and aureomycin × copper interaction, it was observed that only the effect of aureomycin was significant ($P < .05$).

The best results in terms of average daily gain were observed when 40 g/ton aureomycin and 125 ppm copper were added to the diet of growing pigs. The increase of 34 per cent in the above trait by pigs fed the above combination of the two feed additives over those fed the control diet was significant ($P < .05$). Although feed efficiency and protein efficiency ratios were not significantly affected by different dietary treatments, the feed efficiency increased by 4 per cent and protein efficiency ratio by 16 per cent on the above combination of the two feed additives. These results are in agreement with those reported by Buysse and Martin (1960) who reported best results with 125 ppm copper and 22 g/ton aureomycin.

TABLE 3

Effect of dietary aureomycin and copper on the performance of pigs

	Treatment identification									
Aureomycin added g/ton	0	10	40	0	0	10	40	10	40	
Copper added, ppm	0	0	0	125	250	125	125	250	250	S. E.
Average initial wt. (kg)	14.3	14.2	14.5	14.2	14.3	14.3	14.3	15.7	14.5	
Average final wt. (kg)	45.4	53.0	50.0	40.3	44.3	52.2	55.9	47.1	46.8	
Average daily gain (g)	383[a]	479[b]	440[b]	322[a]	391[a]	468[b]	514[b]	388[a]	398[a]	42
Average daily feed consumed (kg)	1.34	1.69	1.60	1.29	1.30	1.46	1.74	1.44	1.41	
Gain/feed	.285[a]	.283[a]	.275[a]	.249[b]	.267[a]	.320[b]	.295[b]	.269[a]	.282[a]	.033
Feed/gain	3.50[a]	3 53[a]	3.64[a]	4.00[b]	3.75[a]	3.12[b]	3.38[b]	3.71[a]	3.54[a]	0.48
Protein efficiency ratio	1.78[a]	1.78[a]	1.72[a]	1.56[b]	1.88[a]	2.09[b]	2.08[b]	1.69[a]	1.76[a]	

a, b means with the letters a and b are significantly different for average daily gain ($P \angle .05$), Gain/feed, Feed/gain and protein efficiency ratio ($P \angle .25$).

TABLE 4

Relative response of pigs fed various levels of aureomycin and copper

Feed additive	Index of growth	Index of G/F	Index of F/G
None	100	100	100
A_1	125	99	101
A_2	115	96	104
C_1	84	87	114
C_2	102	94	107
A_1C_1	122	112	89
A_2C_1	134	104	96
A_1C_2	101	94	106
A_2C_2	102	98	100

Note : A_1=10 g/ton aureomycin
A_2=40 g/ton aureomycin
C_1=125 ppm copper
C_2=250 ppm copper

The addition of 10 g/ton aureomycin, 40 g/ton aureomycin and 10 g/ton aureomycin+125 ppm copper increased the average daily gain of the pigs fed these diets by 25, 15 and 22 per cent, respectively, over those fed the basal diet. Aureomycin alone did not increase the feed efficiency but 10 g/ton aureomycin added with 125 ppm copper increased it by 12 per cent over the controls. These observations, though not significant at the normally accepted levels of probability, are important as they indicate a trend towards better performance of pigs fed diets supplemented with these additives and their economic impact in swine production is great. These results are substantiated by the reports of many workers. Brencis (1959) reported that pigs fed aureomycin alone finished 17 per cent heavier than those fed the control diet. Moulick *et al.* (1965) and Schellner (1967) reported an increase of 10 and 19 per cent, respectively. The finding of this study, however, do not agree with the report of Cropp *et al.* (1972).

The average daily gain of pigs fed diets containing 125 and 250 ppm copper was not different from those fed the control diet which confirms the reports of Moulick *et al.* (1965), Clyde and McDonald (1969) and Amer and Elliot (1973) who observed no beneficial effect of the addition of copper. However, other workers (Barber *et al.*, 1961; Zivkovic *et al.*, 1969; Krishna and Mahadevan, 1969; Hedges and Kornegay, 1973) obtained a positive response when 250 ppm copper was added in the diet.

Whereas the beneficial effect of aureomycin on the growth rate was sustained on a combination of aureomycin and 125 ppm copper, it was not so at 250 ppm copper. It appeared that the beneficial effect of aureomycin was counteracted by an excess of copper. Copper alone at 250 ppm did not depress growth but interfered with the beneficial action of aureomycin. The results indicate that the observations of NCR–42 Committee on Swine Nutrition (1970) on the beneficial effect of 250 ppm copper supplementation may not be applicable to antibiotic supplemented rations and may be harmful in as much as it might negate the advantage expected from the antibiotic supplementation. More exhaustive work is required to settle the point, particularly with a non-significant interaction of copper × aureomycin on growth rate etc. Copper supplementation deserves greater care in swine feeding than is generally given to it. Braude *et al.* (1962) and Moulick *et al.* (1965) also did not observe any advantage with copper and antibiotic combinations in swine rations.

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EFFECT OF DIFFERENT SPACINGS AND PHOSPHORUS LEVELS ON THE GROWTH, YIELD AND CHEMICAL COMPOSITION OF *MOONG (PHASEOLUS AUREUS* ROXB.) VARIETY *PUSA BAISAKHI* UNDER EARLY SUMMER CONDITIONS

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Pusa Baisakhi variety of *Moong (Phaseolus aureus* Roxb.) is quick growing, photo-insensitive and of short duration and can be grown during summer if assured irrigation is available. The work done earlier reveals that narrow spacing in *moong* gives more yield as compared to wider spacing (Sawhney and Moolani, 1967; Saxena *et al.*, 1972), while application of phosphorus increases grain yield (Singh and Virk 1965; Despande and Bathkal 1965; Mann 1968). There is, however, not much information available on the effect of spacing and phosphorus manuring of this crop grown during early summer.

A field experiment in all combinations of three row spacings (20, 30, 40 cm) and three plant spacings (10, 15, 20 cm) in main plots and four levels of phosphorus, viz., (0, 20, 40, 60 kg P_2O_5/ha), allocated in sub plots, was conducted at Hissar. The crop was sown on 25.3.1972 and harvesting was done on 10.6.1972 after picking of pods. The growth and yield data are given in Table 1.

Row and plant spacings did not differ significantly in terms of dry matter accumulation in the plants. Application of phosphorus at 40 and 60 kg P_2O_5/ha increased the dry matter per plant significantly over control. The difference in dry matter accumulation was also significant between 20 and 60 kg P_2O_5/ha (Table 1). There was no appreciable difference in number of pods per plant and number of grains per pod due to spacings. However, thousand grains weight increased with increase in row spacings. Application of 40 and 60 kg P_2O_5/ha which did not differ from each other, increased fruiting and test weight in *moong* significantly over lower doses, but number of grains per pod remained unaffected due to phosphorus levels (Table 1).

Though the grain yield per plant was increased with increasing row spacings, the grain yield per hectare decreased significantly with increasing row spacings. It might be due to less plant population at wider row spacings. Plant spacings did not affect grain yield significantly. Grain yield per plant and per hectare increased with increasing levels of phosphorus and

TABLE 1

Effect of spacings and phosphorus levels on growth, yield attributes, yield and quality of *moong*

Treatments	Dry matter g/plant (at harvest)	Dry matter yield (q/ha)	No. of pods/ plant	No. of grains/ pod.	Test weight (1000 grain weight (g)	Grain yield g/plant	Grain yield q/ha	Crude protein percentage in grain
Row spacings								
20 cm	11.91	31.87	15.9	8.49	40.84	5.62	6.76	18.87
30 cm	12.88	27.83	17.3	8.30	41.28	6.55	6.64	19.20
40 cm	13.35	23.97	17.7	8.45	42.04	7.13	6.04	18.99
S. Em.±	—	1.08	—	—	0.28	0.18	0.13	—
C.D. at 5%	—	3.15	—	—	0.82	0.52	0.40	—
Plant spacings								
10 cm	12.41	30.32	17.5	8.37	41.33	6.30	6.74	18.90
15 cm	13.39	28.11	16.9	8.32	41.53	6.29	6.40	18.99
20 cm	12.33	25.25	16.5	8.56	41.29	6.71	6.31	19.17
S. Em.±	—	1.08	—	—	0.28	0.18	0.13	—
C.D. at 5%	—	3.15	—	—	N.S.	N.S.	0.40	—
Phosphorus levels								
0 kg P_2O_5/ha	11.34	22.57	14.7	8.43	40.21	5.63	5.83	18.38
20 kg P_2O_5/ha	12.46	27.19	15.9	8.31	40.48	6.15	6.32	18.89
40 kg P_2O_5/ha	13.04	29.38	17.8	8.39	42.43	6.75	6.69	19.12
60 kg P_2O_5/ha	14.01	32.42	19.4	8.53	42.41	7.21	7.09	19.74
S.Em.±	0.40	0.97	0.63	—	0.36	0.23	0.15	0.18
C.D. at 5%	1.12	2.68	1.76	—	1.02	0.65	0.41	0.51

application of 40 and 60 kg P_2O_5/ha which did not differ from each other, produced significantly more grain over lower levels of phosphorus.

The plants of this variety remained green at the time of pod picking and could be used as fodder Therefore, the plants were harvested after picking and dry fodder yield was calculated. Narrow row and plant spacings produced significantly more dry fodder as compared to wider spacings (Table 1). Application of phosphorus increased the dry matter yield significantly. There was no significant difference in crude protein content in *moong* grain due to row and plant spacings. However, protein content increased significantly with increasing levels of phosphorus (Table 1).

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A METHOD OF GRADING FOR RESISTANCE TO MYROTHECIUM LEAF SPOT OF COTTON

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Myrothecium leaf spot of cotton caused by *Myrothecium roridum* Tode ex Fr. was first observed by Munjal (1951) in Delhi and later by Suryanarayana (1965) in Hissar. Srivastava and Singh (1973) reported a serious outbreak of this disease from Hissar while Srinivasan and Kanan (1974) from South India. Considering its wide prevalence in recent years in various cotton growing areas of the country it was thought desirable to evolve a method of grading for resistance to Myrothecium leaf spot.

While grading for resistance to Myrothecium leaf spot usually two types of spots are observed on the leaves. The one which appears mostly on resistant varieties as dark red spot with light coloured centre and does not exceed more than ½ cm in diameter and sporodochia are not formed; such spots will be referred to as 'undeveloped spots'. The other well defined spots characterized by sporodochia formation and shot-holes will be referred to as 'developed spots'.

The following grades may be adopted for scoring leaves for resistance to Myrothecium leaf spot.

Grade 0	Plants totally free
Grade 1	A few minute spots not exceeding more than quarter of a centimetre in diameter, and dark red in colour
Grade 2	A few undeveloped spots, not exceeding beyond ½ cm in diameter
Grade 3	A few undeveloped spots and one or two developed spots, not exceeding beyond one cm in diameter
Grade 4	A few undeveloped spots and four or five developed spots, tending to coalesce with each other
Grade 5	Spots covering more of leaf lamina, some of the developed spots beyond one cm in diameter, may coalesce to form bigger spots, irregular in shape and size, central portion of such spots may fall off

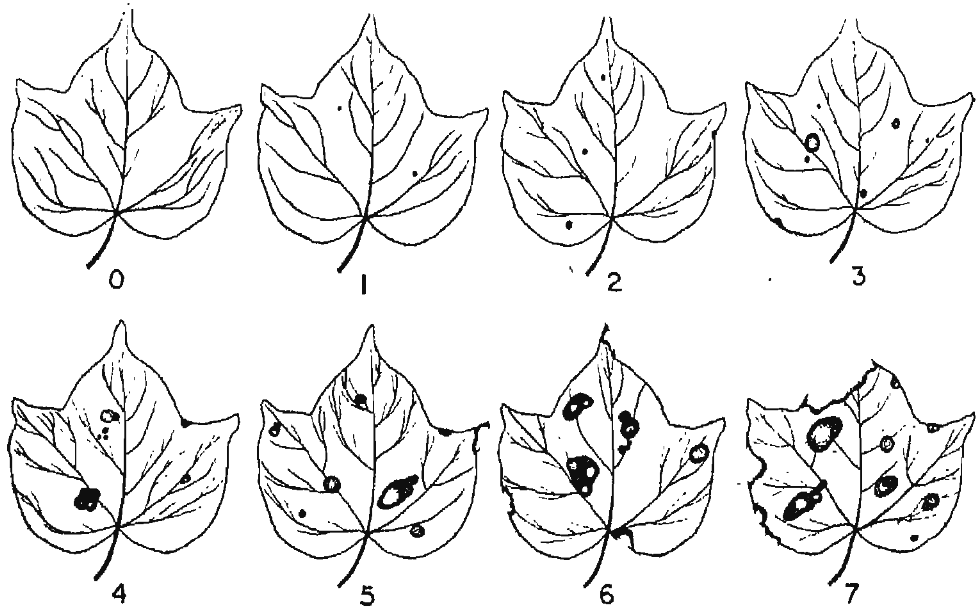

Fig. 1. Relative grades of Myrothecium leaf spot disease

(O—Immune; 1-2 Resistant; 3-4 Moderately susceptible; 5-7 Highly susceptible)

Grade 6	More of developed spots (5-10), still bigger in size. Falling off of infected leaf lamina from margin and other places very frequent
Grade 7	Infection quite heavy, often $\frac{1}{4}$th of the leaf lamina fall off, leaves dry up and become brittle

The grade O may be considered as immune, 1-2 as resistant, 3-4 moderately susceptible and 5-7 as highly susceptible (Fig. 1).

A representative number of plants of a strain or variety may be selected at random and scored. Since, all the leaves in a plant do not get infected, the maximum grade on any leaf may be taken as the grade index for that plant and the average grade of all the plants thus scored may be considered as grade index for the variety or strain.

However, for calculating disease index or intensity on a particular plant all the infected leaves will have to be scored and the intensity calculated by the following formula:-

$$\text{Infection index} = \frac{\text{Sum of all numerical ratings} \times 100}{\text{Total number of infected leaves} \times 7}$$

For creating artificial epiphytotic, the field can be flooded and plants can be sprayed with suspension of diseased leaves containing sporodochia in the evening. Spraying can also be done by a suspension prepared from ten-day old culture of the fungus.

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RAPID METHOD FOR DETERMINING LEAF AREA OF TRITICALE (*TRITICALE HEXAPLOIDE* LART.)

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Leaf area is closely related to grain production (Fagade *et al.*, 1971). Therefore, several methods have been tried to determine leaf surface area in plants in order to correlate it with the yield potentiality of a crop. However, most of the methods in vogue, are extremely laborious and cumbersome. Therefore, several workers have tried to find out less laborious but accurate methods of determining leaf area in different crops. Darrow (1932), first used length X width for leaf area of strawberry. In the cereals, Stickler (1961) and Singh (1970) derived simple formula for sorghum and dwarf wheat, respectively. Epstein *et al.* (1965) tried to correlate the leaf area with its length in potato.

The main objective of the present investigation, therefore, was to develop a rapid, non-destructive method for estimating leaf area of triticale in the field.

Ten randomly selected leaves were removed from ST 69-1 triticale plants grown at Research Farm of Meerut University, Meerut, during *rabi* 1973-74. After sampling, the outline of each leaf was immediately traced on heavy paper. The maximum length (L) was measured and the width (W) of the leaf was determined from its centre. The traced area on the paper was cut with the scissor and weighed. The known area on the same quality paper was weighed separately. From that figure the area of traced leaf was determined. The following formula was developed to find out the leaf area of triticale:

$$\text{Leaf area (cm}^2) = L \times W \times K$$

The value of K was determined by the following calculation:

$$K = \frac{\text{Area of the leaf in cm}^2 \text{ by weighing}}{L \times W}$$

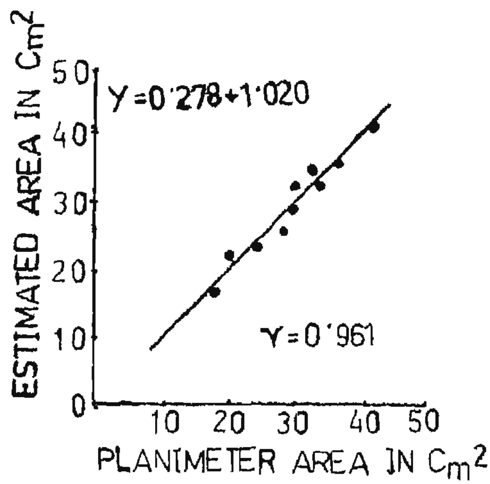
To determine the adoptability of this formula, 10 randomly selected leaves from five varieties of triticale, namely, ST 69-1, PC 151, PC 249, Armadillo-133 and Bronco-99 were taken. The area was measured with planimeter and was compared with the area determined by aforesaid formula. The data were put to x^2-test and correlation coefficient was also calculated.

The results in Table 1 show that there was no significant difference between leaf area determined by planimeter

TABLE 1

X^2-test for fitness of formula

Varieties	Observed	Expected	X^2 value
S.T. 69-1	32.84	32.64	0.001
P C 151	33.38	33.59	0.001
P C 249	23.86	23.52	0.005
Armadillo-133	34.38	36.13	0.015
Bronco-90	36.17	35.85	0.004
Total	160.63	160.65	0.001
Result			N S



and estimated by the above formula, while a high degree of correlation existed between the leaf area determined by two the methods as is evident from Fig. 1. Thus the formula developed can easily replace the planimeter method.

These results, therefore, suggest that maximum length X width (measured from the centre of the leaf) X 0.836 was a reliable and accurate method to determine leaf area for triticale in the field.

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BLOOD PICTURE OF BEETAL GOATS AT DIFFERENT AGES

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The present study was conducted to appreciate the haematological picture in Beetal goats from birth to 3-4 years of age. Female Beetal goats maintained at the University Animal Farm were used. Ten animals each from four age groups, i. e., 0-2 months, 2-6 months, 6-12 months and 3-4 years, were taken at random. Animals were reared under good feeding and management practices. Blood samples were collected in vials containing oxalates of ammonium and potassium, in the morning before the animals were fed and watered. All the blood samples were taken during the same season. The blood smears were prepared immediately after collection and stained with Leishman stain for differential leucocytic counts (DLC). The percentage for each was calculated by counting a total of 200 leucocytes. Haemoglobin (Hb) was determined by Hellige-Sahli method. Erythrocyte Sedimentation Rate (ESR) and Packed Cell Volume (PCV) were determined by using Wintrobe tubes. Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH) and Mean Corpuscular Haemoglobin Concentration (MCHC) were calculated by using the formulae given by Schalm (1965). The data obtained were subjected to statistical analysis by applying Student 't' test to determine the age differences of various blood parameters. The basophil values could not be tested statistically as most of values were zero.

1. Erythrocytic series

The mean values of erythrocytic series recorded at different ages are presented in Table 1. The RBC value of 15.76 millions per cmm at 0-2 months of age gradually decreased to 10.88 millions per cmm by 6-12 months of age. The age of the animal had highly significant effect on RBC values ($P \angle 0.01$). This decreasing trend is supported by the work of Holman and Dew (1964). The Hb value of 6.39 g per 100 ml of blood also exhibited a decreasing trend and a value of 5.44 g per 100 ml was obtained by 6-12 months of age. The Hb values were significantly affected by the age of the animal (P 0.05). Mukherjee and Bhattacharya (1952) reported Hb values in the range of 5.94 to 7.36 in goats which were in close agreement with the present study. The PCV values showed decreasing trend from a value of 31.30 per cent at 0-2 months of age to 28.95 per cent by 3-4 years of age, but these values were found to be statistically insignificant. The range of PCV values among all age groups was similar to that reported by Mukherjee and Bhattacharya

TABLE 1

Erythrocytic and Leucocytic series of blood in Beetal goats at different ages

Constituents	0-2 months	2-6 months	6-12 months	3-4 years	Average for all ages
A. Erythrocytic series					
RBC (millions/cmm.)**	15.76 ± 1.04^{a}	13.32 ± 2.48^{b}	10.88 ± 2.74^{c}	11.31 ± 1.72^{c}	12.81
HB (g/100 ml.)*	6.39 ± 0.23^{a}	6.0 ± 0.55^{b}	5.44 ± 0.68^{c}	5.72 ± 0.43^{c}	5.89
PCV (%)	31.30 ± 3.70	28.37 ± 2.95	29.20 ± 2.40	28.95 ± 2.58	29.45
MCV (cuu)**	17.40 ± 2.41^{a}	21.71 ± 3.17^{b}	29.56 ± 7.80^{c}	26.86 ± 5.85^{c}	23.88
MCH (uug)*	3.46 ± 1.10^{a}	4.67 ± 1.58^{b}	5.28 ± 2.20^{b}	$5.15 \pm 1\ 61^{b}$	4.64
MCHC (g/100 ml.)**	19.80 ± 3.63^{a}	21.32 ± 1.43^{b}	17.93 ± 1.84^{c}	19.26 ± 1.78^{a}	19.57
ESR (*mm*) at 2 h.	0.71 ± 0.21	0.80 ± 0.20	0.75 ± 0.26	0.80 ± 0.10	0.76
at 4 h.	1.50 ± 0.50	1.37 ± 0.31	1.25 ± 0.70	1.10 ± 0.10	1.30
at 6 h.	2.14 ± 0.88	1.95 ± 0.40	1.88 ± 0.60	1.47 ± 0.32	1.86
at 24 h**	7.36 ± 2.29^{a}	6.45 ± 1.55^{a}	4.75 ± 1.25^{b}	6.20 ± 0.77^{c}	6.19
B. *Leucocytic series*					
Leucocytes					
(thousands/cmm)*	14.60 ± 1.78^{a}	17.44 ± 2.42^{b}	14.55 ± 2.83^{c}	15.58 ± 1.13^{c}	15.54
(Neutrophils (%)	38.60 ± 6.65	40.50 ± 3.47	38.40 ± 6.04	40.8 ± 2.97	39.57
Lymphocytes (%)	56.40 ± 7.70	54.60 ± 2.68	55.00 ± 2.16	53.6 ± 3.43	54.87
Monocyt s (%)	3.00 ± 2.0	2.70 ± 2.0	$3\ 50 \pm 0.91$	2.70 ± 1.48	2.97
Eosinophils (%)	2.00 ± 2.3	1.70 ± 1.70	2.30 ± 1.59	2.40 ± 1.64	2.10
Basophils (%)	$0.20 \pm$	0.60	0.80	0.50	0.52

Statistical analysis: *Significant at 5% level of probability

**Significant at 1% level of probability. The mean values having different superscripts differ significantly($P \leq 0.05$)

(1952). The MCV and MCH values also showed an increasing trend up to the age of 6-12 months, thereafter values decreased slightly. These changes were found to be statistically significant ($P \angle 0.05$). The age of animals also had highly significant effect on MCHC values ($P \angle 0.01$). The overall average values of RBC and PCV were in close agreement with the values reported by Holman and Dew (1963). However, Hb values were lower in the present study. The RBC values obtained at 3-4 years of age in present study were similar to the findings of Gradwohl (1956) who recorded 9-10 millions per cmm for adult goats but were lower than that reported by Gautam (1965). These data clearly indicated that RBC, Hb and PCV decreased as the animals grew and reverse was the case with MCV and MCH. The ESR values at 2 hr were almost the same in all age groups. Although at 4 hr, 6 hr and 24 hr ESR values decreased with the advance of age but only 24 hr ESR values at various ages were found to be highly significant ($P \angle 0.01$).

2. Leucocytic series

The average values of total leucocytes and differential leucocytic counts (DLC) are shown in Table 1. The total leucocytes ranged between 14.55 to 17.44 thousands per cmm among all age groups. Animals of 2-6 months of age had maximum total leucocytes. The leucocytes were found to be significantly affected by the age of the animal ($P \angle 0.05$). DLC did not show a definite trend in different age groups studied. Neutrophils were observed to be highest in 3-4 years age group (40.80%) and lymphocytes in 0-2 months age group (56.40%). Neutrophil and lymphocyte values obtained at 3-4 years age group were similar to the values reported by Gautam (1965) for adult Beetal goats. Lymphocytes were observed to decline with advancing age. Eosinophils showed an increasing trend from 2-6 months of age onwards. The DLC values at various ages were found to be statistically insignificant. The overall mean for all age groups for neutrophils, lymphocytes, monocytes, eosinophils, basophils in the present study were 39.57, 54.87, 2.97, 2.10 and 0.52 per cent, respectively.

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COBALT STATUS OF HARYANA SOILS AND ITS RELATIONSHIP WITH SOME SOIL CHARACTERISTICS

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ABSTRACT

To determine the soil cobalt status and its inter-relationship with physico-chemical characteristics of the soils, surface soil samples were collected from eight representative locations situated in different soil and agroclimatic regions of Haryana State (India). Physico-chemical characteristics of the soil samples indicated a broad range of properties, i. e. pH from 6.8 to 9.35; E. C. from 0.042 to 1.800 mmhos/cm; O. C. from 0.12 to 1.00 per cent; $CaCo_3$ from 0.13 to 7.54 per cent; available P from 5 to 19 ppm, available cobalt from 0.05 to 0.88 ppm and texture from sandy to silty loam. On the basis of available cobalt content, surface soil samples were grouped into three categories; deficient, moderately deficient and sufficient range. About 25 per cent of soil samples were found to be containing available cobalt content in deficient range, 29 per cent samples were moderately deficient and the rest had sufficient cobalt. Positive significant correlation coefficient was observed between pH and available cobalt; highly significant positive correlations were found between electrical conductivity and available cobalt, silt+clay and available cobalt. Significantly negative correlations were found between organic carbon, available phosphorus and available cobalt. No correlation was observed between $CaCo_3$ and available cobalt.

Cobalt has been found to be essential for higher tillering in plants, increasing numbers of balls and decreasing fall of ovaries in cotton, increasing drought resistance and number of grains per ear in barley, etc. It has also been found to be a constituent of vitamis B_{12} (Saric and Saciragic, 1969; Bozhenkov, 1969).

Cobalt in soils exists in four forms, namely, water soluble, easily exchangeable or replaceable, dilute acid soluble and non-replaceable but the bulk of soil cobalt is in non-replaceable form. Mitchell (1955) argued that total content can be a reasonable indication of a trace element status of a soil. Still he believed that total content of trace elements threw no light on their availability to the plants, and the study was of interest only from geochemical aspect.

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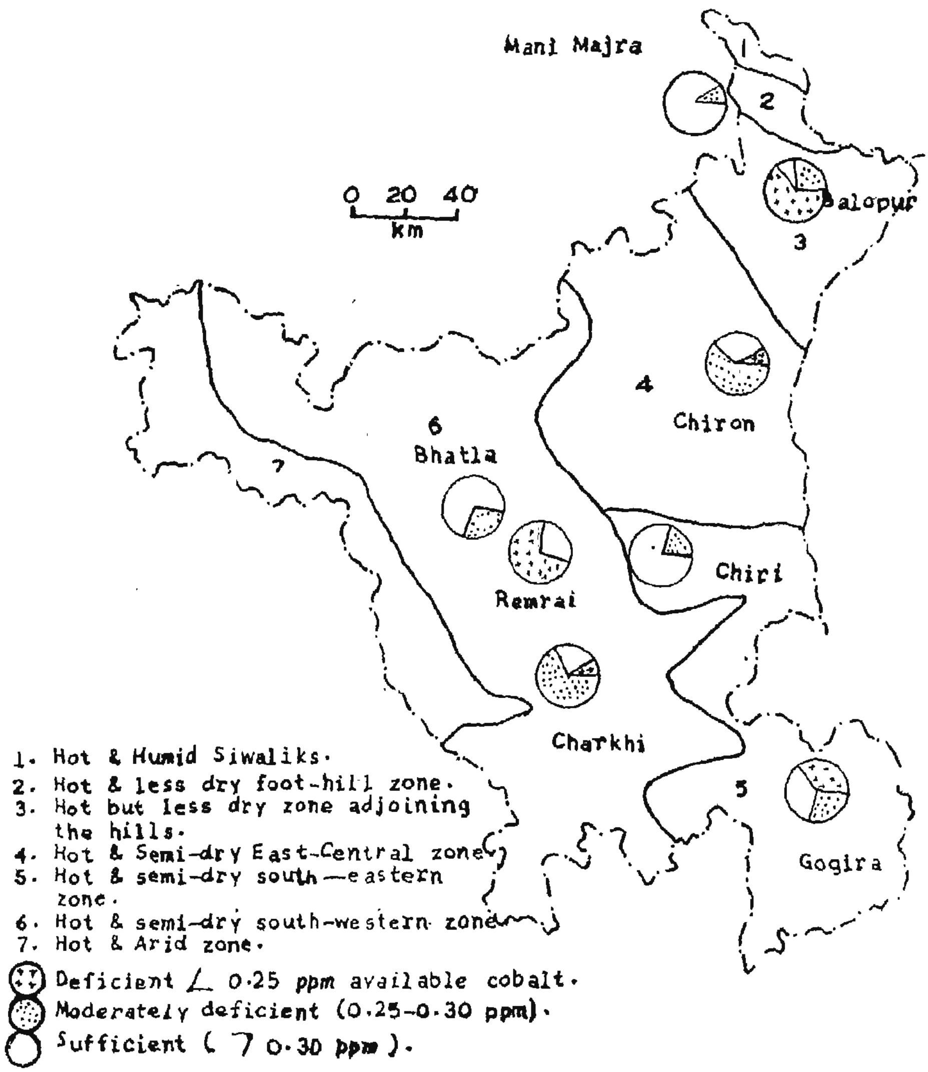
Cobalt is generally deficient in acid, highly leached, sandy, peaty, highly calcareous and granitic soils, and on such soils an application of cobalt has favoured the growth and yield of certain crops. Animals grazing on plants growing on cobalt deficient soils, suffer from pining, salt sickness, bush-sickness, coast disease and so many other diseases.

In spite of the excellent cattle wealth of Haryana, little attention seems to have been paid to study the distribution of cobalt in Haryana soils. To fill the gap in our knowledge of cobalt in Haryana soils, studies on the distribution of cobalt in different agroclimatic zones of Haryana and its relationship with various physico-chemical characteristics were undertaken.

Fig. 1. Map of Haryana, showing cobalt status.



MATERIAL AND METHODS

Surface soil samples were collected from eight locations of different soil and agroclimatic zones of Haryana State (Duggal, 1970) as shown in Fig. 1.

The soil samples thus collected were air dried, crushed in a wooden pestle with a mortar and sieved through a 2 mm stainless steel sieve. For chemical analysis, the samples were passed through 0.50 mm stainless steel sieve. Mechanical analysis was done by International pipette method. pH was determined in 1:2 soil water suspension with Elico, Model-Li-10, pH-meter. The electrical conductivity of the supernatant of 1:2 soil water suspension was determined with the help of Systronix conductivity-meter while organic carbon was determined by walkley and Black's rapid titration method as described by Piper (1950). Calcium carbonate was determined by Puri's (1949) volumetric method. Available cobalt in soils was extracted by shaking 5 g of soil with 25 ml of 2.5 per cent acetic acid (pH 2.5) and 25 ml of 0.05 per cent dithizone-CCl_4 for an hour (Alban and Kubota, 1960). The Co-dithizone-CCl_4 complex after filtration was digested with 60 per cent perchloric acid just to dryness and the residue was brought in solution by adding 0.01 N HCl and heating. The cobalt in the solution was determined by nitroso-R-salt (Sandell, 1958) in the acidic medium with the help of Spectronic-20 Colorimeter at 550 mu wave length. The available phosphorus in the soil was determined by Olsen *et al.* (1954) method as described by Jackson (1958).

RESULTS AND DISCUSSION

The data on the available cobalt, pH, electrical conductivity, organic carbon, $CaCo_3$, available phosphorus, sand and silt plus clay in the soil samples are presented in Table 1.

Available cobalt status of surface samples

The data on the available cobalt (Table 1) has been classified according to criterion laid out by Mitchell (1945), and Stewart (1953). Samples collected from village Bhatla revealed that available cobalt ranged from 0.25-0.80 ppm (0.412 ppm average). About 29 per cent of soil samples were moderately deficient, while rest were in sufficient range. Soil samples of Ramrai village had cobalt content ranging from 0.20-0.88 ppm (0.275 ppm average). About 76 per cent of samples were found to be in the deficient range. The rest had sufficient amount of available cobalt. Samples from village Chiri showed 0.25 to 0.70 ppm of cobalt. About 82 per cent of soil samples had sufficient amount of cobalt and the rest were moderately deficient. Samples from Charkhi village had 0.125-0.375 ppm cobalt. About 6 per cent of samples were in the deficient range, 71 per cent were moderately deficient and the rest had sufficient cobalt. In Gogira soil, available cobalt ranged from 0.125 to 0.550 ppm. About 35 per cent samples were found to be deficient, about the same percentage was in the sufficient range, and the remaining were moderately deficient.

In Chiron soil, available cobalt was in the range of 0.10 to 0.75 ppm. About 12 per cent samples were deficient, 59 per cent were moderately deficient and the rest were sufficient in available cobalt. In samples from Balopur village cobalt ranged from 0.050 to 0.325 ppm.

TABLE 1

Physico-chemical characteristics of *surface soil samples*

S No.	Viliage	Distt.	pH	EC m.mhos/Cm	Oc (%)	$CaCO_3$ (%)	Olsen's p(ppm)	Sand (%)	Silt+ Clay (%)	Available Col ppm.
1.	Bhatla	Hissar	8.15—9.10 (8.62)	0.06—0.600 (0.22)	0.17—0.58 (0.34)	0.13—2.30 (0.69)	5—16 (10.4)	50—63 (55.5)	37—50 (44.5)	0.25—0.800 (0.412)
2.	Ram Rai	Jind	7.20—9.05 (8.45)	0.120—0.420 (0.24)	0.34—0.78 (0.56)	0.35—2.60 (0.96)	5—12 (8.4)	48—62 (54,5)	38—52 (45.4)	0.20—0.880 (0.275)
3.	Chiri	Rohtak	7.60—8.50 (8.15)	0.120—0.900 (0.37)	0 27—0.82 (0.46)	0.41—4.27 (1.42)	6—17 (11.4)	50—70 (62.4)	30—50 (37.6)	0.25—0.700 (0.441)
4.	Charkhi	Mohindergarh	8.10—8.40 (8.27)	0.090—0.240 (0.14)	0.12—0.29 (0.20)	0.35—7.54 (2 22)	5—19 (11.5)	64—86 (77.7)	14—36 (22.3)	0.125—0.375 (0.274)
5.	Gogira	Gurgaon	8.10—8.75 (8.48)	0.120—1.800 (0.52)	0.27—0.82 (0.53)	0.27—0.85 (0.62)	5—16 (9.7)	55—69 (62.3)	31—45 (37.70)	0.125—0.550 (0.261)
6.	Chiron	Karnal	7.35—9.35 (8.97)	0.150—0.300 (0.21)	0.68—0.95 (0.79)	0.32—1.01 (0.58)	5—13 (7.7)	45—59 (49.59)	41—55 (50.4)	0.10—0.75 (0.335)
7.	Balopur	Ambala	6.80—8.50 (7.41)	0.042—0.157 (0.09)	0.48—1.00 (0.72)	0.22—0.75 (0.47)	6—19 (12.1)	59—80 (68.47)	20—41 (31.5)	0.050—0.325 (0.160)
8.	Mani Majra	Ambala	8.15—8.45 (8.33)	0.072—0.390 (0.14)	0.33—0 72 (0.50)	0.18—0.72 (0.42)	5—15 (9.2)	46—74 (55.65)	26—54 (44.35)	0.250—0.80 (0.535)

Figures in parentheses are the means.

70 per cent samples were deficient, 24 per cent moderately deficient and rest were in sufficient range. Soils of Mani Majra had available cobalt in the range of 0.25 to 0.80 ppm. 94 per cent of these samples had sufficient cobalt content and the rest were moderately deficient. The first approximation of the classification of soil samples with respect to available cobalt status of different locations of Haryana is shown in Fig. 1.

Several Indian workers (Reddy and Mehta, 1961, 1962; Raychaudhuri and Datta Biswas, 1964; and Badhe and Zende, 1962) have reported available cobalt in soils of different parts of India in the range of 0.12-2.10, 0.20-0.95 and 0.056-0.460 ppm, respectively.

Mitchell (1945) and Stewart (1953) observed that an amount less than 0.25 ppm acetic acid soluble cobalt could be classed as deficient. In the present study about 75 per cent of the samples were found to contain more than 0.25 ppm acetic acid soluble cobalt. On further categorising these soils it was found that 25 per cent of soil samples were deficient, 29 per cent moderately deficient and rest were sufficient in cobalt content. Mehta *et al.* (1964) reported that 30 per cent of Gujarat soils were also deficient in available cobalt.

Relationship between availability of cobalt and physico-chemical properties of soil

Soil pH and available cobalt

The surface soil samples under study had a pH and available cobalt in the range of 6.80 to 9.35 and 0.05 to 0.88 ppm, respectively. The soils of Bhatla, Ramrai, Chiri, Charkhi, Gogira, Chiron, Balopur and Mani Majra had a pH range of 8.15-9.10, 7.20-9.05, 7.60-8.50, 8.10 to 8.40, 8.10 to 8.75, 7.35-9.35, 6.80-8.50 and 8.15 to 8.45 respectively while available cobalt was in the range of 0.25-0.80, 0.20-0.88, 0.25-0.70, 0.125-0.375,0.125-0.550, 0.10-0.75, 0.050-0.325 and 0.25 to 0.80 ppm, respectively.

A significant positive correlation coefficient ($r=+0.215$ at 5%) was observed between pH and available cobalt (Table 1) for these samples collected from different agroclimatic zones of Haryana. These results are in conformity with the report of Singh and Singh (1966) and Misra and Kishore (1967) for soils of U. P. However, Reddy and Mehta (1961, 62) found negative correlation coefficient between these two factors in Gujarat soils.

Soil organic carbon and available cobalt

Organic carbon in surface samples ranged from 0.12-1.00 per cent. Samples from Bhatla and Mani-Majra; Ramrai, Chiri and Gogira; Chiron and Balopur; and Charkhi were in low to medium; low to high, medium to high and low in organic carbon content, respectively. A perusal of data (Table 1) revealed a significant negative correlation ($r=-0.189$ at 5%) between organic carbon and available cobalt content in these soils. These findings are in line with the results reported by Reddy and Mehta (1961), Singh and Singh (1966) and Rana and Ouellette (1967). According to Bambergs (1959) binding of copper and cobalt by organic matter is an important cause of cobalt deficiency, since in most of the higher rate of decomposition, the cobalt might have been complexed by the degradation products of the organic matter.

Electrical conductivity and available cobalt

The electrical conductivity of soil samples under study varied from 0.042 to 1.800 mmhos/cm. The data on this aspect (Table 1) revealed the existance of a highly significant positive correlation (r=+0.624 at 1%) between the two values.

Calcium carbonate and available cobalt

Calcium carbonate of these soils was found ranging from 0.13 to 7.54 per cent. A calculation of correlation coefficient revealed that no definite relationship (r=+0.021) existed between these factors. Reddy and Mehta (1961) and Singh and Singh (1966) have reported similar results. However, Boddie (1947) suggested that $CaCO_3$ reduced availability of cobalt. Similarly Beeson *et al.* (1948) and Zende (1954) found reduction in the uptake of cobalt by plants when soils were limed.

Finer fraction and availabe cobalt

It is generally believed that finer fraction of soils is the main stay of mineral nutrients (Wahhab and Bhatti, 1958; Wright and Lawton, 1954). The texture of the soil samples under present investigation varied from sand to loam. The data on available cobalt and silt+clay contents (Table 1) indicated a highly significant positive correlation (r=+0.233 at 1%) between these two values. Ranna and Ouellette (1967) and Reddy and Mehta (1962) also found that soils richer in clay were higher in cobalt contents. However, Misra and Kishore (1967) could not observe such relationship in some soils of U. P.

Available cobalt and available phosphorus

The Available phosphorus in the samples under study varied from 5 to 19 ppm. This range of available phosphorus is categorised from a medium to high. The statistical analysis of the data on available cobalt and available phosphorus (Table 1) revealed a significant negative correlation (r=—0.205 at 1%) between these two characters. It may be due to the fact that cobalt is precipitated with phosphates and thus the availability is reduced.

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VARIATION, HERITABILITY AND CORRELATION AMONG YIELD COMPONENTS IN *ARHAR (CAJANUS CAJAN* (L.) MILLAP).

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ABSTRACT

Sixty-five strains were used in a replicated trial for getting the information on genetic variability, heritability estimates and genetic advance and also for identifying major yield components in *arhar.* Sufficient genetic variability was observed for yield and other 9 characters studied. Highest phenotypic variability was observed for pod clusters per five branches followed by pod clusters per plant, pods per plant and grain yield. Plant height, days to maturity, 100-seed weight, seeds per pod and length of pod were also found to have high heritability. Pod clusters per five branches though had average heritability but exhibited highest expected genetic advance when expressed as percent of mean. Correlation analysis showed that pods per plant, pod clusters per plant, pod clusters per five branches and number of branches, were the major yield contributory components. Plant height also showed strong positive association with yield. It is suggested that for effective selection programme, the selection should be based on more number of branches as well as on highest clusters per branch along with higher number of pods per plant.

Pigeon pea *(Cajanus cajan* (L.) Millsp.) commonly known as *arhar*, is one of the major grain legume crops grown all over India. It plays a very important role in the Indian vegetarian diet as the supplier of vegetable proteins. In India, both annual and perennial types of *arhar* are under cultivation. Recent advances, in pulse improvement programme have helped to identify short duration strains of *arhar* which make possible the cultivation of this crop in certain unconventional areas of north India, like, Punjab and Haryana. Recent development of 120-day duration varieties, like, Prabhat and UPAS-120, raises the interesting possibility of an *arhar* wheat rotation in these areas instead of the usual maize-wheat or *bajra* wheat rotation. Data for the last two years on the performance of these early maturing strains are also encouraging. It was, therefore, thought desirable to gather some basic genetic information for formulating an effective arhar breeding programme. In the present study, an attempt has been made to identify the components of yield through correlation studies and to assess the genetic variability through heritability estimates. The information regarding these aspects in the literature is also limited (Sharma *et al.*, 1971; Joshi, 1973; Singh and Malhotra, 1973).

MATERIAL AND METHODS

Sixty-five strains selected from the available germplasm, mostly indigenous, were raised in a randomized block design with two replications during the *kharif* season of 1971 at the Haryana Agricultural University, Hissar. Five competitive plants were scored at random for yield and other economic characters, viz., pods per plant, pod clusters per plant, pod clusters per five branches, number of branches per plant, length of pod, seeds per pod, 100-seed weight, plant height and days to maturity.

Genotypic coefficient of variation, heritability estimates (broad sense), expected genetic gain and different correlation coefficients were estimated using the formulae suggested by Barton (1952), Hanson *et al.* (1956), Johnson *et al.* (1955) and Al'Jibouri *et al.* (1958).

RESULTS AND DISCUSSION

Estimates of mean, range and coefficients of variability for the various characters studied are given in Table 1. A large range of variability was observed for grain yield, pods per plant, pod clusters per plant, pod clusters per five branches, branches per plant, 100-seed weight and plant height. For length of pods and seeds per pod, the range was not very large. The range for maturity revealed that it was more or less limited to medium maturity group and there was, thus, a need to enrich the germplasm by collecting more early maturing lines from indigenous or exotic sources. The estimates of coefficients of variability (C.V.) at phenotypic level also indicated the presence of sufficient genetic variability for characters other than days to maturity, seeds per pod and length of pod. The highest C. V. at phenotypic level was observed for pod clusters per five branches followed by grain yield, pod clusters per plant and pods per plant. At genotypic level, highest C. V. was observed for pods per plant followed by pod clusters per plant, pod clusters per five branches and grain yield. The relative magnitude of C. V.'s indicated that the characters namely, grain yield, pods per plant, clusters per plant or per five branches and number of secondary branches were prone to environmental stimulations to a greater extent than characters, like, length of pod, seed per pod, 100-seed weight, plant height and days to maturity.

Estimates of heritability in broad sense (Table 2) indicated a high heritability for plant height, days to maturity, 100-seed weight, seeds per pod and length of pod. The heritability value was the lowest for yield. For rest of the characters, heritability values were average. For plant height, number of branches and pods per plant, present findings were similar to that of Joshi (1973). For pod length and seed per pod, Joshi (1973) observed low heritability but in the present study, high heritability estimate was recorded. These anomalies usually arise mainly due to different genetic structure of the population and partly due to genotype x environmental interaction. Another reason can be that the results of Joshi (1973) were from an unreplicated trial raised in augmented design as compared to the present replicated trial. However, from the present study as well as that of Joshi (1973) it appears that plant height

TABLE 1

Mean, range and phenotypic, genotypic and environmental coefficients of variation

Characters	Mean	Range	Coefficient of Veriability		
			Pheno-typic	Geno-typic	Environ-mental
1. Grain yield/plant (g)	70.12	24.44 to 150.40	46.12	10.20	44.48
2. Pods per plant	288.22	116.50 to 637.50	43.68	24.58	41.21
3. Clusters per plant	167.86	62.40 to 403.10	45.03	20.26	42.23
4. Clusters/five branches	53.38	16.40 to 198.40	57.01	18.21	51.27
5. Secondary branches per plant	18.08	13.00 to 26.00	21.27	3.57	19.54
6. Length of pod (cm)	5.13	4.40 to 5.70	6.24	0.78	5.18
7. Seeds per pod	3.77	3.35 to 4.25	5.85	0.69	4.62
8. 100-seed weight (g)	9.44	7.35 to 11.66	11.37	2.26	8.65
9. Plant height (cm)	291.56	231.90 to 320.10	8.51	6.15	3.60
10. Days to maturity	186.55	174.00 to 197.50	3.52	3.92	2.07

TABLE 2

Estimates of heritability and genetic advance

Characters	Heritability %	Genetic advance at 5% selection	Genetic advance expressed as per cent of mean
1. Grain yield per plant (gms)	6.97	4.64	6.62
2. Pods per plant	10.99	28.50	9.89
3. Clusters per plant	15.06	23.45	13.97
4. Clusters per five branches	19.12	11.99	22.46
5. Secondary branches per plant	15.58	1.24	6.84
6. Length of pod (cm)	31.09	0.20	3.80
7. Seeds per pod	37.49	0 17	4.58
8. 100-Seed weight (g)	42.10	0.09	0.98
9. Plant height (cm)	65.66	24.29	8.33
10. Days to maturity	65.54	8.88	4.76

TABLE 3

Phenotypic (P), Genotypic (G) and Environmental (E) Correlation coefficients among yield and its components

Characters		2	3	4	5	6	7	8	9	10
1. Grain yield per plant (g)	P	.89**	.80**	.49**	.56**	—.02	.10	—.04	.45**	.16
	G	.65	1.09	.56	1.56	—.29	.36	—.25	1.15	.53
	E	.92**	.78**	.49**	.44**	.03	.06	.01	.36**	.09
2. Pods per plant	P		.85**	.54**	.56**	—.06	.003	—.14	.36**	.26**
	G		1.09	.77	1.12	—.54	—.133	—.71	.50	.52
	E		.82**	.51**	.48**	.05	.040	.02	.40**	.18
3. Clusters per plant	P			.55**	.67**	—.03	—.09	—.11	.32**	.29*
	G			.59	.69	—.21	.01	—.61	.63	.66
	E			.55**	.67**	.01	—.13	.04	.27*	.18
4. Clusters per five secondary branches	P				.34**	—.11	.03	—.15	.31*	.26*
	G				.43	—.49	.01	—.26	.59	.69
	E				.32**	.01	.03	—.12	.18	.03
5. Secondary branches per plant	P					.06	—.04	—.01	.30*	.18
	G					.10	.42	—.22	.70	.32
	E					.04	—.20	.03	.15	.14
6. Length of pod (cm)	P						.07	.34*	.09	.17
	G						—.09	.99	.08	.17
	E						.16	—.01	.09	.19
7. Seeds per pod	P							.05	.39**	—.02
	G							.05	.59	—.23
	E							.05	.21	.21
8. 100-Seed weight (g)	P								.05	—.15
	G								.05	—.22
	E								.06	—.07
9. Plant height (cm)	P									.18
	G									.07
	E									.38**
10. Days to maturity										

*Significant at 5% level (d. f.=63 for P; 64 for E)
**Significant at 1% level.

was a highly heritable character. Alongwith heritability, genetic advance at 5 per cent selection intensity was also computed for each character (Table 2). The expectation of genetic advance was high for pods per plant, plant height, pod clusters per plant and pod clusters per five branches. When genetic advance was expressed as per cent of mean, highest value was recorded for pod clusters per five branches followed by pod clusters per plant.

Another important aspect of the present study was to identify the yield components through correlation analysis. The correlations at phenotypic, genotypic and environmental levels, for yield with other 9 characters and among themselves are given in Table 3. These correlations are not only of interest from the theoretical consideration of the quantitative inheritance of the characters, but of practical value in selection programme. Selection on the basis of major yield components, rather than yield *per se*, has been considered to be more useful (Grafius, 1956; Adam and Grafius, 1971). Till recently, (Sharma *et al.*, 1971; Singh and Malhotra; 1973; Joshi, 1973), studies on correlation in *arhar* among yield components were lacking. Even among these studies, only that of Singh and Malhotra (1973) relates to correlation studies at genotypic level.

In the present study, the genotypic correlation was, in general, higher than phenotypic correlation. This indicated that there was an inherent association existing among various characters. Grain yield was found to have strong positive inherent association with pods per plant, pod clusters per plant, pod cluster per five branches, number of branches and plant height. Length of pod and 100-seed weight showed negative association but of very weak nature. Seeds per pod and days to maturity, though had high positive genetic correlation with yield, but at phenotypic level they were not significant. It is interesting to note that all the major yield contributing characters which had strong positive association with yield also had strong positive association among themselves. Hence, these characters, namely pods per plant, pod clusters per plant, pod cluster per five branches, number of branches and plant height could be identified as major yield components in *arhar*, on which breeder must concentrate their efforts for bringing significant improvement in yield.

It would be desirable to consider these correlations in the light of earlier reports in *arhar* and also with regard to the utility in formulating an effective selection programme. The present association of yield with pods per plant, number of branches and pod clusters per plant were similar to the earlier findings but for other characters, there was some conflicting association. None of the previous workers studied the number of clusters per branch. In the present study, it was found to have strong positive association with yield and had highest phenotypic coefficient of variability and had shown highest genetic advance when expressed as per cent of mean.

In conclusion, based on heritability estimates, genetic advance, coefficient of variability and correlation, it is suggested that it will be easy and profitable to direct the selection programme based on more number of branches per plant alongwith higher number of clusters per branch.

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DISTRIBUTION OF DIFFERENT FORMS OF MANGANESE IN ARID BROWN SOILS OF HARYANA

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ABSTRACT

Distribution of different forms of Mn in arid brown soils of Haryana was studied. Water soluble, exchangeable, reducible and total Mn ranged from traces to 1.40, 0.1 to 7.1, 15 to 154 and 171 to 741 ppm, respectively. There was no definite depthwise distribution pattern of different forms of Mn in various soil profiles, but, generally, content of readily available forms was more in surface soil than sub-soil and reverse was true for total Mn.

Water soluble and exchangeable Mn were positively correlated between themselves and with organic carbon. Total Mn was positively correlated with reducible Mn, pH and clay fraction of the soil. Distribution of different forms of Mn was apparently not influenced by $CaCO_3$ content.

Studies carried out by Shukla and Prasad (1975) indicated that large areas belonging to the arid-brown soil group were deficient in zinc. Gupta (1970) also reported that some surface soils in this agroclimatic zone were low in available Mn content and might require Mn fertilization for achieving maximum yield potential of a crop. Responses to Mn application in various crops are known (Mathur *et al.*, 1959; Kanwar *et al.*, 1958-62; Kanwar and Dhingra, 1961; Bhumbla *et. al.*, 1963-65; Ghosh *et. al.*, 1964; Koraddi and Seth, 1964). Information on profile distribution of Mn in soils is of great significance for suggesting efficient, economical method of correcting Mn deficiency in different crops. However, no systematic study has so far been carried out on the soils mentioned above. Therefore, the present investigation was undertaken to study the distribution of different forms of Mn in relation to soil characteristics in arid brown soils.

MATERIAL AND METHODS

Thirty-eight samples (horizon-wise) representing ten different soil profiles of arid-brown soil group were collected. These soils are primarily distributed in erstwhile Rohtak district (Haryana). Samples were analysed for their pH and electrical conductivity in 1:2, soil-water suspension using a glass electrode Beckman pH meter and Elico conductivity tmeer, respectively. Calcium carbonate was determined by the method described by Puri (1949) and organic carbon by rapid titration method (Walkley and Black, 1934). Mechanical composition of soils was determined using Hydrometer method of Bouyoucos (1951).

Soils were analysed for different forms of Mn. Total Mn was determined in the diluted fused material, dissolved in 6 N HCl, using periodate method as described by Jackson (1958). The soil was fused with the help of fusion mixture (1:1, Na, K carbonates) using soil : fusion mixture ratio of 1 : 12. Water soluble, exchangeable and reducible Mn were determined by the methods described by Jackson (1958).

RESULTS AND DISCUSSION

The data for different forms of Mn and soil characteristics are presented in Table 1.

Water soluble Mn increased with depth in profile 1, 4 and 7 ranging between 0.14 to 1.12 ppm, whereas it decreased with depth in profile 3, 8 and 10 from 1.40 to 0.14 ppm. However, in profiles 2 and 9, it was almost constant (Table 1). The variability in the distribution pattern of water soluble Mn in different soil profiles could be attributed to the expected heterogeniety in the chemical composition of alluvial soil deposits. Biswas (1953) also reported similar variable patterns for the distribution of water soluble Mn in soil profiles representing various agroclimatic zones.

Soil pH, calcium carbonate and clay content had no effect on the distribution of water soluble Mn in these soil profiles (Table 2). There was a positive significant correlation between water soluble Mn and organic carbon ($r=+0.34^*$). This might indicate that a part of water soluble Mn in these soils existed in organic complex forms. The above observation is at variance with the observations of Takkar and Bhumbla (1968 a, 1968 b) who found non-significant correlation between water soluble Mn and organic carbon in non-calcareous soils of Punjab and Haryana. The differences in observations could be explained from the fact that the previous workers included a large heterogeneous area, represented by fewer soil profiles in their study, whereas in the present study a smaller area relatively less heterogeneous, represented by more number of profiles, was included.

Table 2 reveals that water soluble and exchangeable Mn were positively correlated ($r=+0.31^*$). This indicated that water soluble Mn compounds would affect exchangeable Mn content in soils.

Exchangeable Mn content ranged from 0.14 to 7.1 ppm which generally decreased with depth in all the profiles (Table 1). This could be attributed to the higher organic matter content of the surface as compared to lower soil layers. Biswas, (1953, 1955) and Randhawa *et al.* (1961) also found maximum exchangeable Mn content generally at the surface, but observed uniform distribution in calcareous soils.

Exchangeable Mn had non-significant correlation with pH, calcium carbonate and clay content but had highly significant positive correlation with organic carbon ($r=+0.45^{**}$). This indicated that availability and distribution of Mn in these soils would be affected by their

TABLE 1

Forms and distribution of manganese in relation to physico-chemical properties of soils

S. No.	Depth in cm	Mechanical analysis Send %	Silt %	Clay %	pH	Electrical conductivity (mmhos/cm)	$CaCO_3$ %	O.C. %	Manganese (ppm) Water	Exchangeable	Reducible	Total
				Profile 1.	Sasai Aurangabad (Bahadurgarh)							
1.	0-25	90.4	3.7	5.9	7.2	0.21	Nill	.06	0.14	2.0	44	228
2.	25-103	88.4	5.7	5.9	7.2	0.19	Nill	.13	0.28	1.4	40	313
3.	103-150	89.4	4.7	5.9	7.4	0.17	Nill	.05	0.28	0.9	55	342
				Profile 2.	Panchi Gujrain (Ganaur)							
4.	0-40	55.1	31.3	13.6	7.9	0.05	0.30	.21	0.28	2.8	76	399
5.	40-87	40.1	34.3	25.6	7.9	1.23	0.20	.24	0.28	1.4	107	627
6.	87.131	35.1	31.3	33.6	8.2	3.43	0.22	.15	0.28	0.9	46	684
7.	131-160	43.1	27.3	29.6	9.5	1.05	0.22	.13	0.14	0.9	62	570
				Profile 3.	Rukhi (Gohana)							
8.	0-24	70.4	22.7	6.9	7.8	3.75	Nill	.46	1.40	7.1	40	399
9.	24-46	71.4	21.7	6.9	7.5	1.78	Nill	.16	0.21	5.1	100	484
10.	46-76	70.4	22.7	6.9	7.9	0.92	0.12	.16	0.00	3.4	88	484
11.	76-120	70.4	22.7	6.9	8.0	0.92	0.08	.15	0.14	1.4	60	484
12.	120-150	72.4	20.7	6.9	8.3	0.59	Nill	.10	0.00	2.8	83	295
				Profile 4.	Dhainsu Khurd (Kharkhauda)							
13.	0-60	81.1	13.3	5.6	7.4	0.50	0.50	.18	0.14	2.6	49	171
14.	60-98	79.1	15.3	5.6	7.4	0.50	0.50	.22	0.14	1.4	85	313
15.	98-150	77.1	16.3	6.6	7.7	0.87	0.87	.10	0.49	1.1	85	427
				Profile 5.	Meham (Meham)							
16.	0-30	52.4	33.7	13.9	8.3	0.70	1.72	.22	0.14	1.1	77	343

17.	30-60	32.4	45.7	21.9	8.2	0.56	2.20	.27	0.14	1.4	75	598
18.	60.102	34.4	49.7	15.9	7.2	0.49	1.70	.19	0.49	2.0	88	285
19.	102-150	36.4	47.7	15.9	7.8	0.56	1.40	.15	0.28	1.7	45	427
				Profile 6.	**Nahar (Nahar)**							
20.	0-18	52.4	36.7	10.9	8.3	0.30	1.05	0.33	0.14	2.6	95	513
21.	18-37	42.4	27.7	29.9	8.6	0.34	1.12	0.25	0.70	2.3	104	541
22.	37-66	54.4	23.7	21.9	8.7	0.48	1.15	0.21	0.14	2.0	154	684
23.	66-105	52.4	23.7	23.9	8.8	0.43	0.32	0.06	0.28	2.0	142	712
				Profile 7.	**Jakhauli (Rai)**							
24.	0-26	35.1	51.3	13.6	8.7	1.05	1.35	0.42	0.14	5.1	58	399
25.	26-60	33.1	53.3	13.6	8 3	0.50	1.15	0.15	0.42	4.0	48	570
26.	60-107	27.1	53.3	19.6	8.7	0.96	7.12	0.10	0.28	2.8	66	541
27.	107-150	33.1	52.3	14.6	9.6	0.64	3.05	0.07	1.12	3.1	50	541
				Profile 8.	**Himayunpur (Rohtak)**							
28.	0-25	73.1	21.2	5.6	7.4	3,01	0.52	0.30	0.56	1.4	47	513
29.	25-95	41.1	43.3	15.6	7.1	2.15	0.12	0.19	0.42	1.1	44	627
30.	95-150	37.1	41.3	21.6	7.7	1.46	0.32	0.19	0.28	1.1	48	741
				Profile 9.	**Salhawas (Salhawas)**							
31.	0-30	78.4	14.7	6.9	8.5	0.10	Nill	0.12	0.42	2.8	60	285
32.	30-65	76.4	15.7	7.9	8.7	0.35	Nill	0.15	0.42	2.0	46	513
33.	65-105	76.4	16.7	6.9	8.1	0.77	Nill	0.10	0.42	2.0	69	513
34.	105-150	74.4	17.7	7.9	9.1	0.43	6.02	0:10	0.28	1.1	15	399
				Profile 10.	**Bindhroli (Sonepat)**							
35.	0-30	51.1	40 3	8.6	8.5	0.73	0.18	0.29	1.26	1.4	95	427
36.	30-63	43.1	43.3	13.6	7.6	1.80	Nill	0.15	0.28	0.6	81	627
37.	63-98	43.1	47.3	9.6	7.7	1,65	1.20	0.12	0.28	0.1	111	598
38.	98-150	57.1	36.3	6.6	8.1	0.55	3.70	0.15	0.14	0.6	81	513

Note : The name of the block is given in parenthesis.

TABLE 2

Correlation coefficients (r) showing relationship between different forms of manganese and various soil characteristics in arid-brown soil profiles

Soil properties	Forms of manganese			
	Water soluble	Exchangeable	Reducible	Total
Clay	—.04	—.18	.26	.64
pH	0.15	0.10	.10	.30
$CaCO_3$	—.01	—.05	—.18	—.03
O. C.	.31	.45	—.04	—.02
Water soluble Mn		.32	—.14	—.02
Exchangeable Mn			—.07	—.21
Feducible Mn				.32

'r' values for significance at 5 and 1 per cent of level of significance are .30 and .39, respectively, at 36 degree of freedom.

organic matter content due to its Mn complexing ability. Vinayak *et al.* (1967) also found significant correlation between exchangeable Mn and organic carbon.

Correlations among different forms of Mn were also worked out and it was found that exchangeable Mn was not influenced by total or reducible Mn contents of soils (Table 2).

Reducible Mn content in different soil profiles ranged from 15 to 154 ppm and had no definite distribution pattern with respect to depth. Such pattern of distribution is not unexpected in alluvial soil deposits. Similar pattern was observed by Randhawa *et al.* (1961) in the profiles from Jullundur, Ludhiana and Sirsa, representing soils of semi-arid zone. However, Biswas (1953, 1955) observed uniform Mn distribution in calcareous soils.

Reducible Mn had non-significant relationship with pH, organic carbon and calcium carbonate (Table 2). This was consistent with its erratic distribution in different profiles. Sharma and Motiramani (1964) also reported statistically non-significant correlation between reducible Mn and pH. The relationsship between reducible Mn and clay content approached significance (r=0.26). This indicated that reducible forms of Mn were associated with the finer fraction of the soil.

Total Mn content ranged from 171 to 741 ppm which generally increased with the depth in almost all the profiles (Table 1). This was perhaps due to more content of fine textured soil material in lower layers (Table 1) which could be expected to act as a reserve for Mn. Randhawa *et al.* (1961) also observed less total Mn content in surface soils and increase was noticed with increase in the depth of profiles from Jullundur, Ludhiana and Sirsa, representing soils of semi-arid zone.

Total Mn had non-significant relationship with calcium carbonate and organic carbon, whereas pH and clay content had positive significant correlation with total Mn ($r=+0.30^*$ and $+0.64^{**}$), respectively. Thus heavy textured soils are expected to have more reserve of Mn. Further fine textured alluvial deposits could be rich source of Mn. Biswas (1953), Khanna *et al.* (1954) and Mital and Roy (1963) also found that clayey soils were rich in total Mn content. Vinayak *et al.* (1967) also found significant correlation between total Mn and clay content.

In general, the distribution pattern of different forms of Mn in relation to soil characteristics indicated that in alluvial soils which are still immature, the composition of deposited materials in any layer will exert a great influence on the soluble and insoluble contents of *Mn*. Profile distribution of different forms of Mn indicated that sub-soil may be rich source of potentially available forms of Mn.

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RELATIVE PERFORMANCE OF DWARF WHEATS *(TRITICUM AESTICUM* L.) UNDER NORMAL AND LATE SOWN CONDITIONS OF NORTH-WESTERN PLAIN ZONES

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ABSTRACT

Wheat variety W.G. 357 was superior to rest of the varieties tried on all the three dates of sowing (15 Nov, and 6 and 27 Dec). There was, however, a significant decline in its yield when sowing was done after December.

The agro-climatic conditions of Haryana are highly favourable for growing dwarf wheats under multiple cropping where the wheat sowings are likely to be delayed if sown after cotton, sugarcane-ratoon or *toria.* The relative performance of various dwarf wheats has been reported to be variable under normal as well as late sown conditions (Mahay, 1969; Sharma *et al.*, 1971; Agarwal *et al.*, 1972; and Bishnoi and Gill, 1973). Therefore, selection of varieties adapted to the late sown conditions assumes prime importance. Furthermore, the production potential of recently released dwarf wheats under normal as well as late sown conditions as compared to that of Kalyansona has not yet been exploited and hence needs investigation. Therefore, a field experiment was conducted to study the relative suitability of wheat varieties for normal and late sown conditions of the North-western plains zone.

MATERIAL AND METHODS

A field experiment consisting of three dates of planting, viz., Nov 15 (D1), Dec 6 (D2) and December 27 (D3) and nine promising varieties, viz., WG. 357 (V1); UP 310 (V2); WG-377 (V3); WL-212 (V4) HD-1977 (V5); HD-1941 (V6); Kalyan sona (V7); Sonalika (V8) and HD-1925 (V9) was conducted during *rabi* seasons of 1971-72 and 1972-73 at the Haryana Agricultural University, Hissar. During both the years crop was sown after applying a pre-sowing irrigation. Crop sown on November 15 and December 6 received 6 irrigations whereas crop sown on 27th December received 5 irrigations. Each time, a uniform irrigation of about 7.5 cm depth was applied. Split plot design with four replications keeping dates of planting as main plot treatments and varieties as sub-plot treatments was adopted. The crop was fertilised with a basal dose of 70 kg N/ha, 50 kg P_2O_5/ha and 40 kg K_2O/ha just before sowing and the rest of 70 kg N/ha was top dressed just before first irrigation.

RESULTS AND DISCUSSION

Effect of dates of sowing

Data presented in Table 1 indicate that maximum grain yield was obtained during both the years when crop was sown on November 15 and minimum being in December 27 sown crop. Delay in sowing from November 15 (normal date of sowing) to December 6 and 27 resulted in significant reduction in yield. The trend of results remained unchanged when data for both the years were pooled. The reduction in yield in the later sowing dates of December 6 and 27 over the normal sowing date of November 15 were 19.7 and 33.7 per cent, respectively. Sharma *et al.* (1971), Agarwal *et al.* (1972) and Bishnoi and Gill (1973) also reported similar results. The reduction in yield may be attributed to the significant reduction in number of ear heads per running metre (Table 1). The prevailing mean temperature at the time of germination in case of December 6 and 27 sown crop was 15.4°C and 13.4°C and 16.3°C and 14.3°C during 1971 and 1972, respectively. During both the years prevailing temperature was lower than the optimum (25°C) as described by Wilsie (1961), which resulted in poor germination, reduced tillering and low yield. Besides, the late sown crop was also exposed to prevailing high temperature (35-36°C) and low relative humidity in the later half of March and April when it was at developmental stage (Fig. 1) and resulted in substantial reduction in 1000 grain weight.

Similar trends were observed in case of straw yield for both the years (Table 1). Sowing done on November 15 gave significantly higher straw yield over the later sowing dates of December 6 and 27. The per cent reduction in straw yield in the later sowing dates of December 6 and 27 over the normal sowing date of November 15 were 21.4 and 44.8 per cent, respectively.

Effect of varieties

Variety WG. 357 gave significantly higher grain yield per hectare over rest of the varieties tested in this experiment. WG. 377 was also found to be significantly higher yielder than WL 212 during both the years with varieties UP-310 and Kalyan-Sona trailing behind to third and fourth place. The differences among rest of the varieties were statistically non-significant.

WG. 357 and Sonalika gave significantly higher straw yield over UP. 310, WL. 212, HD. 1925, HD-1941 and HD-1977 with varieties Kalyansona and WG. 377 coming at number three and four. However, the differences between WG. 357-Sonalika and Sonalica-Kalyansona-WG. 377 were statistically non-significant. This may be attributed to the tall growing character of WG. 357, Sonalika and Kalyan Sona over other varieties which are three gene dwarf strains.

Effect of dates of sowing × varieties

It was interesting to note that effect of dates of sowing × varieties on grain and straw yield was found to be significant during both the years. In case of grain yield, variety WG. 357, Sonalika, and HD. 1925 did not result in significant

TABLE 1

Effect of dates of sowing and varieties on the grain and straw yield and on various yield attributes

Treatments	Grain yield (q/ha)			Straw yield (q/ha)			No. of tillers/m	No. of Earheads/m	1000 grain wt (g)
	1971-72	1972-73	Mean	1971-72	1972-73	Mean	Mean (1971-73)	Mean (1971-73)	Mean (1971-73)
Date of sowing									
15 November	41.8	39.1	40.4	66.8	65.8	66.3	86.1	85.2	35.6
6 December	33.9	31.1	32.5	52.2	51.9	52.1	79.3	75.7	34.9
27 December	31.1	22.5	26.8	36.9	36.1	36.5	66.2	56.4	33.5
C.D. at 5%	3.7	5.2	4.5	9.2	8.0	8.6	13.0	16.4	N S.
Varieties									
WG. 357	42.1	39.6	40.8	65.2	64.0	64.6	74.0	72.2	34.2
UP. 310	33.5	32.3	32.9	47.9	47.9	47.9	71.0	68.5	35.5
WG. 377	35.0	33.5	34.2	54.4	53.5	54.0	70.8	69.6	33.2
WL. 212	26.1	25.2	25.6	41.9	41.6	41.8	77.8	73.3	33.3
HD. 1977	31.5	29.5	30.5	49.5	48.6	49.0	79.8	73.7	34.4
HD-1941	31.1	28.9	30.0	47.7	46.6	47.1	77.6	71.6	33.5
Kalyansona	32.7	31.1	31.9	55.8	54.9	55.4	74.1	69.5	32.5
Sonalika	32.1	28.7	30.4	59.4	59.4	59.4	82.5	71.8	38.1
HD. 1925	31.0	28.8	29.9	46.1	45.1	45.6	79.3	73.4	37.4
C.D. at 5%	5.5	3.3	4 5	6.8	5.4	6.1	N.S	N.S	N.S

MEAN WEEKLY TEMPERATURE, EVAPORATION, RELATIVE HUMIDITY & TOTAL RAINFALL

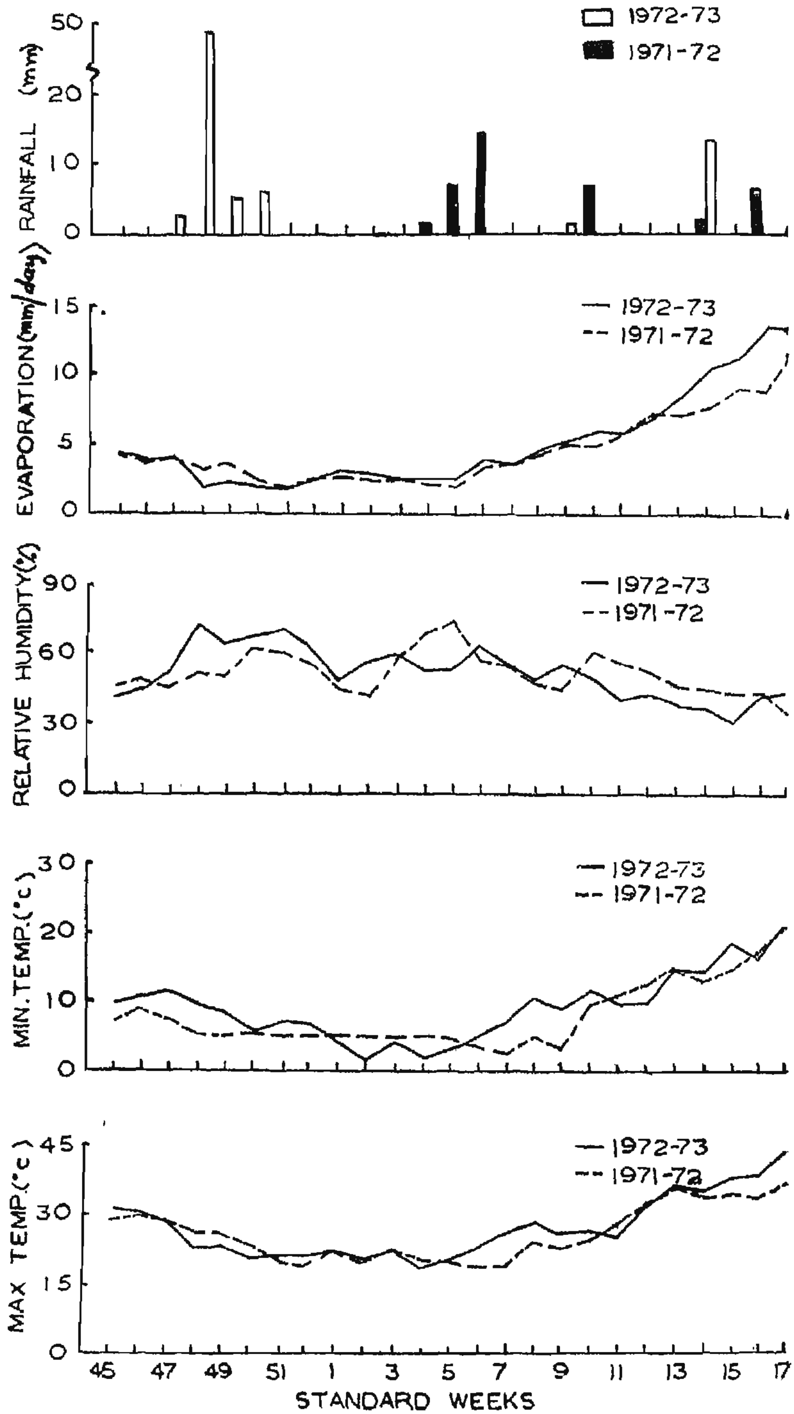

TABLE 2

Effect of dates of sowing on varieties

(Average of two years)

Treatment	V1	V2	V3	V4	V5	V6	V7	V8	V9	Mean
					Grain yield (q/ha)					
D1	46.1	46.8	47.7	31.4	38.0	37.3	43.0	37.9	35.7	40.4
D2	43.8	33.9	33.5	24.1	29.4	30.0	32.4	34.1	31.2	32.5
D3	32.6	18.0	21.5	23.0	24.2	22.6	20.3	19.2	20.3	26.8
Mean	40.8	32.9	34.2	25.6	30.5	30.0	31.9	30.4	29.9	—
C.D. at 5%=6.3										
					Straw yield (q/ha)					
D1	73.5	66.5	75.6	51.8	64.0	59.7	73.6	73.5	58.6	66.3
D2	69.5	49.2	52.0	37.1	47.5	45.4	53.6	67.2	47.3	52.1
D3	50.9	28.0	34.3	36.4	35.3	36.2	38.9	37.5	31.0	26.5
Mean	64.6	47.9	54.0	41.8	49.0	47.1	55.4	59.4	45.6	
C.D. at 5%=10.1										

reduction when sown on 6 December over the normal sowing date of 15 Nov whereas in case of varieties UP. 310, WG. 377, WL. 212, HD-1977, HD-1941 and Kalyansona, significant reduction in grain yield was observed. Further delay in sowing from December 6 to December 27 did not result in significant yield reduction in case of WL. 212 and HD-1977 whereas in rest of the varieties this delay in sowing has resulted in significant reduction in grain yield (Table 2). It may further be mentioned that under late dates of sowing too, the variety WG. 357 out yielded rest of the varieties whereas under normal sowing date of November 15, WG. 357, UP. 310 and WG. 377 were at par.

In case of straw yield delay in sowing from the normal date of November 15 to December 6 did not result in significant reduction in WG. 357 and Sonalika whereas in rest of the varieties this has resulted in significant reduction. Further delay in sowing from December 6 to 27 did not result in significant reduction in straw in WL. 212 and HD-1941 whereas in rest of the varieties, significant reduction was observed (Table 2).

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MOISTURE RETENTION AND STORAGE CHARACTERISTICS OF SOILS OF VARIOUS BIO-CLIMATIC ZONES OF HARYANA

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ABSTRACT

Moisture retention and storage characteristics of fifty-six soil samples collected from fourteen soil profiles exposed all over the state of Haryana, under six different bio-climatic zones are described. Typical moisture retention curves for some of the representative soil textures have been drawn. Variations in moisture retention of the soils within the same bio-climatic zone were observed to be as great as between soils of different zones. It was the physiography of the area and the texture of different horizons, in the soil profile, which 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 qualifiled for coarse loamy. Average figures in terms of centimetres of water per centimetre of soil for each textural class have been estimated.

In most of the areas of Haryana particularly in the north-western plains, the variability of crops yields from year to year is caused mostly, if not entirely, by the discrepancy between the moisture levels in the soil profiles and the 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 becomes essential. The present investigation was, therefore, under-taken to make a detailed study of the moisture retention characteristics and storage capacity of the soils of Haryana.

MATERIAL AND METHODS

Soil profiles were exposed at fourteen different locations, all over the state of Haryana representing various physiographic divisions, occurring under six bio-climatic zones, as shown in Table 1. A classification of the various soil profiles according to "7th Approximation" is also shown in Table 1. Soil samples were collected horizon-wise from each profile, air dried and passed through a 2 mm sieve. Organic carbon estimation was done by Walkley and Black's Rapid Titration Method (Piper, 1966). Mechanical analysis was carried out by International Pipette Method (Piper, 1966).

TABLE 1

Profile sites, geographic locations and soil classification

Profile site	Block	Lat. and longitude	Bio-climate zone (Duggal, 1970)	Physiographic regions	Classification at family level (Kuhad, 1973)
Rania	Rania	29° 30′ N—74° 46′ E	Hot and semi-arid zone along-with Rajasthan border	Flood plains	Fl, Cal, mixed, hyp, Torriorthents. (Fluventic)
Chutala	Dabwali	28° 50′ N—74° 32′ E	—do—	Plains with sand dunes	Cl, Cal, mixed, hyp, Typic Torripsamments.
Bavel	Loharu	28° 42′ N—75° 43′ E	—do—	Plains with Arravali Hills & sand dunes.	Cl, Na, mixed, hyp, Typic Camborthids.
Hamizapur	Ratia	29° 42′ N—75° 32′ E	Hot and dry south western zone	Plains with sand dunes	Cl, Cal, mixed, hyp, Typic Camborthids.
Khanour	Khanour	28° 48′ N—76° 20 ′E	—do—	—do—	Cl, Cal, mixed, hyp, Natric Camborthids.
Ghasola	Gurgaon	28° 29′ N—77° 5′ E	Hot and semi-dry south eastern zone	Plains with Arravali Hills and sand dunes	Cl, Na, mixed, hyp, Typic Ustorthents.
Hodel	Hodel	28° 4′ N—77° 22′ E	—do—	—do—	Fl, Na, mixed, hyp, Typic Ustochrepts.
Rasooe	Rai	28° 52′ N—77° 12′ E	—do—	Flood plains	Cl, Cal, mixed, hyp, Typic Ustipsamments.
Jingheri	Karnal	29° 44′ N—76° 58′ E	Hot & semi-dry west central zone	Upland plains	Fl, Na, mixed, hyp, Aquic Ustorthents.
Jalalpura	Jind	28° 18′ N—76° 4′ E	—do—	—do—	Fl, Na, mixed, hyp, Typic Haplaquents.
Ismalabad	Thanesar	30° 8′ N—76° 42′ E	—do—	Flood plains	Cl, Na, mixed, hyp, Vertic fluvaquents.
Ballopur	Naraingarh	30° 30′ N—77° 8′ E	Hot & sub-humidzone adjoining hills	Dissected rolling plains	Cl, Na, mixed, hyp, Dystric Eutrochrepts.
Tajewala	Jagadhri	30° 15′ N—77° 25′ E	—do—	Flood plains (levees)	Cl, Cal, mixed, hyp, Lithic Udipsamments.
Ratpura	Mani Majra	30° 53′ N—76° 48′ E	Hot & Humid Siwalik	Foot hills	Sl, Na, mixed, hyp, Dystric Eutrochrepts.

Fl—Fine loamy, Cl—Coarse loamy, Cal.—Calcareous, Na—Non—Acid, Mixed, Hyp.—Hyperthermic, Sl—Skeletal loamy

The use of ceramic pressure plate and pressure membrane was made for estimating moisture retained at various tensions (Richards, 1947). Available water holding capacity was calculated for a depth of 150 cm, assuming a constant bulk density of 1.4 g/cc. Samples saturated with normal sodium acetate (pH 7.0) and made salt-free by repeated washing 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. Method outlined by Richards (1954) was followed for the measurement of hydraulic conductivity.

RESULTS AND DISCUSSION

From the results of physical and chemical analysis, presented in Table 2, it seems that the amount of clay and silt increased with depth in most of the soil profiles under study. The values for cation exchange capacity and exchangeable sodium percentage ranged from 5.4 to 27.5 m.e./100g of soil, and 6.8 to 23.5, respectively. Almost all the soil samples had a pH value more than 7.0 except the surface sample from Ballopur. Organic carbon followed more or less a regular decrease with depth except in stratified soil profiles.

A perusal of the data on moisture retention shown 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 texture soil samples than in fine texture 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. Clay, silt and silt plus clay have been reported to have a positively significant correlation with moisture retention by several workers (Jamison and Kroth, 1958; Jagan Nath, 1963; Abrol and Bhumbla, 1966; Sharma, 1972). Further increase in the amounts of available moisture capacity with increase in the content of silt fraction and organic matter have been reported by Lund (1958), and with fine sand by Salter *et al.* (1966). Ali (1965) reported the influence of the type of clay mineral on moisture retention. As the amount of organic carbon decreased with depth in most of the soil profiles and the type of clay mineral remained same (illite as the dominant mineral), the increase in available water with depth in the profiles under investigation could be explained only on the basis of corresponding increase in the amounts of clay and silt fractions with depth. The coefficients of correlation between available water and clay, silt, and silt plus clay for the present study were +0.579, +0.596 and +0.652, respectively. These were significant at 1 per cent level. Organic carbon and cation exchange capacity were also found to bear a significant and positive correlation with available water. Similar results were reported by Sekhon and Arora (1967) for some of the Punjab soils.

Total available moisture stored up to 150 cm depth in the soil profiles from Ghasola and Rania was 16.2 and 35.4 cm, respectively. Rest of the soil profiles stored moisture between the above two limits. Variations in moisture retention of soils within the same bio-climatic zones were as great as between soils of different zones. It seems that

TABLE 2

Physico-chemical characteristics of soils

Depth (cm)	Mechanical composition Coarse sand %	Fine sand %	Silt %	Clay %	O. C. %	pH	C.E.C. me/100g.	E.S.P.
1	2	3	4	5	6	7	8	9
				(Hot and Semi-arid)				
				Rania				
0—9	3.3	62.1	21.7	12.9	0.70	8.3	12.1	10.0
9—25	0.9	54.8	27.1	17.2	0.37	8.2	12.3	11.1
25—94	0.0	28.2	51.2	22.5	0.25	8.3	16.4	9.2
94—122	2.3	20.8	54.2	22.7	0.19	8.5	17.0	11.4
122+	0.0	38.8	46.0	15.1	0.15	8.2	12.0	12.8
				Chutala				
0—10	10.8	80.2	6.7	2.3	0.22	8.4	5.9	14.5
10—76	4.6	76.4	11.4	7.5	0.31	8.5	9.4	11.5
76—110	2.4	69.7	14.2	8.7	0.30	8.5	10.6	9.4
110—160	5 3	71.4	12.7	10.7	0.17	8.2	8.6	11.7
				Bavel				
0—18	21.3	72.1	2.8	3.8	0.19	8.0	5.4	13.3
18—74	17.8	62.2	5.5	14.5	0.25	7.9	10.9	7.2
74—110	12.2	66.3	2.8	18.7	0.22	8.2	11.2	7.6
110—170	17.5	60.6	9.6	12.3	0.17	8.4	11 3	8.8
				(Hot and dry South West zone)				
				Hamizapur				
0—15	4.8	74.4	10.2	10.6	0.38	9.0	8.4	19.3
15—35	8.8	48.3	24.7	18.2	0.25	8.8	10.5	14.4
35—98	8.7	52.3	19.2	19.8	0.22	8.8	11.7	14.1
98—158	5.2	59.6	17.5	17.7	0.20	8.8	12.3	14.3
				Khanour				
0—14	3.7	69.6	11.2	15.5	0.35	8.7	11.0	21.0
14—32	0.8	70.2	12.0	17.0	0.24	8.6	11.6	23.3
32—70	3.5	69.9	13.8	12.8	0.21	8.4	9.7	17.7
70—120	6.0	69.7	10.0	14.3	0.21	8.7	11.0	11.9
120—170	2.9	7.37	31.1	10.3	0.17	8.4	10.4	14.2
				(Hot and semi-dry zone in South East)				
				Ghasola				
0—15	4.6	84.2	6.5	4.7	0.36	8.0	6.7	16.7
15—33	3.6	69.6	16.1	11.7	0.26	8.2	7.1	16.7
33—80	8.5	66.1	13.2	12.2	0.20	8.0	10.6	13.0
80—170	3.2	68.9	12.4	15.5	0.18	8.0	11.7	12.2

1	2	3	4	5	6	7	8	9
				Hodel				
0–18	0.3	61.5	24.5	13.7	0.36	8.4	13.0	16.6
18–50	1.2	48.3	23.5	27.0	0.32	8.6	14.0	17.4
50–76	0.6	50.2	20.7	29.5	0.31	8.4	17.3	14.9
76–100	0.4	57.0	20.3	22.3	0.26	8.7	15.7	17.9
100–118	0.3	63.4	24.3	12.0	0.22	8.6	14.3	19.6
118+	0.7	63.1	19.8	16.3	0.20	8.7	14.4	23.5
				Rasooe				
0–20	21.5	35.0	13.2	10.3	0.63	8.2	10.1	12.8
20–90	24.9	49.4	17.0	8.7	0.25	9.0	9.9	13.2
90–135	53.8	29.9	9.3	7.0	0.21	8.8	6.5	18.6
135+	88.1	6.4	3.7	1.8	0.14	8.8	3.4	16.5
				(Hot and semi-dry West Central Zone)				
				Jinghri				
0–15	0.9	52.1	30.7	16.3	0.67	8.3	14.0	16.9
15–27	0.7	51.6	22.5	25.2	0.45	8.1	13.1	13.2
27–68	0.6	48.2	25.5	25.7	0.31	7.9	17.3	15.4
68–135	0.2	49.5	22.0	28.3	0.27	7.6	13.1	2.3
				Jalalpura				
0–20	0.2	56.0	18.5	25.3	0.67	7.5	12.2	7.6
20–42	0.3	41.2	29.3	29.2	0.33	7.3	9.9	9.3
42–110	2.8	48.2	16.3	22.7	0.25	7.3	12.2	7.6
110–180	0.5	9.0	51.5	39.0	0.27	7.5	22.8	4.6
				Ismalabad				
0–22	0.0	25.0	32.7	42.3	0.55	8.3	27.5	7.3
22–85	0.0	61.2	21.5	17.3	0.31	8.6	20.0	6.8
85–110	5.5	70.3	16.0	8.2	0.19	8.5	7.5	13.4
110–140	8.9	81.8	2.3	7.0	0.15	8.8	7.4	13.4
140–176	5.2	68.3	24.5	12.0	0.17	8.5	15.2	7.5
				(Hot and humid zone)				
				Ballopur				
0–15	12.6	65.7	13.2	8.5	0.56	6.6	7.4	11.4
15–60	7.3	58.3	16.8	17.6	0.28	7.0	9.8	11.2
60–105	2.4	64.2	18.4	14.9	0.22	7.1	12.8	10.6
105–158	2.6	72.0	22.3	13.1	0.20	7.2	10.2	9.8
				Tajewala				
0–58	21.4	35.4	17.3	5.9	0.30	8.3	6.4	19.1
				Ratpura				
0–22	11.3	6.25	17.7	8.5	0.67	7.9	10.1	9.3
22–85	11.3	51.3	26.2	11.2	0.43	8.0	12.7	11.4
85–156	7.4	47.1	27.1	18.4	0.39	8.0	15.8	9.0

TABLE 3

Moisture retention and storage characteristics of soils

Depth (cm)	Hyd.-cond. (cm/hr)	Percent moisture retained by weight at various tensions (atm.)					Av. water by weight (1/3-15)	Av. water (cm)	A.W.H.C. for 150 cm soil depth
		1/10	1/3	5	10	15			
1	2	3	4	5	6	7	8	9	10
				(Hot and semi-arid zone)					
				Rania					
0—9	0.52	26.8	20.8	10.3	8.3	7.5	13.3	1.8	35.4
9—25	0.31	29.9	21.0	10.4	8.6	7.2	13.8	3.0	
25—94	0.17	31.1	26.8	13.2	12.5	11.2	15.7	16.2	
22—122	0.13	30.7	26.4	13.5	12.8	17.9	14.4	6.0	
122+	0.21	31.7	27.0	14.4	8.1	7.4	19.6	8.2	
				Chutala					
0—10	3.88	12.1	5.7	3.1	2.7	1.8	3.9	0.6	21.1
10—75	3.24	22.9	13.6	5.9	5.3	4.8	8.8	8.7	
75—110	2.29	24.1	15.0	5.7	5.3	4.1	9.9	5.0	
110—160	2.21	24.6	15.6	6.8	5.7	4.4	11.2	8.4	
				Bavel					
0—18	7.60	8.6	5.1	2.8	2.5	1.3	3.8	1.0	20.3
18—74	3.12	19.6	14.3	8.3	6.1	4.4	9.1	7.6	
74—110	1.78	19.0	15.3	7.8	7.1	5.1	10.2	5.5	
110—170	1.46	24.1	16.6	8.2	7.4	6.4	10.1	9.1	
				(Hot and dry South Western zone)					
				Hamizapur					
0—15	1.25	24.9	14.1	8.6	6.8	4.3	9.8	2.2	26.0
15—35	1.12	22.9	14.3	9.2	7.0	6.1	3.2	2.5	
35—98	0.91	24.3	18.1	10.0	8.3	6.5	11.6	10.9	
98—158	0.73	25.0	19.4	10.0	7.9	6.1	13.3	11.9	
				Khanour					
0—14	0.48	27.9	20.4	8.6	7.1	5.4	15.0	3.1	22.2
14—32	0.38	25.1	17.0	8.2	6.4	6.4	10.5	2.8	
32—70	1.54	27.3	14.4	9.0	7.6	5.9	8.5	4.8	
70—120	1.66	25.0	15.5	7.8	6.5	5.7	9.8	7.3	
120—170	1.94	25.7	13.4	6.3	5.2	5.2.	9.0	6.7	
				(Hot and semi-dry South Eastern zone)					
				Ghasola					
0—15	2.22	18.9	8.9	5.8	4.6	2.4	6.4	1.4	16.2
15—33	3.99	19.7	7.8	4.3	3.8	3.4	4.4	1.2	
33—80	2.37	25.0	13.5	8.5	5.6	4.9	8.7	6.1	
80—167	1.70	27.1	13.5	8.6	7.0	6.4	7.1	9.5	

1	2	3	4	5	6	7	8	9	10
				Hodel					
0—18	0.59	28.1	20.0	9.2	8.7	6.7	13.4	3.6	33.0
18—50	0.52	32.6	22.9	12.7	11.1	6.4	14.5	7.0	
50—76	0.51	31.0	22.3	12.5	11.8	7.6	14.9	5.8	
76—100	0.62	29.04	21.4	11.1	9.3	6.9	14.5	5.3	
100—118	0.92	29.5	20.4	8.3	6.5	5.1	15.4	4.1	
118+	0.62	27.8	20.4	11.5	8.6	5.3	15.1	7.2	
				Rasooe					
0—20	0.50	20.1	15.4	6.5	4.3	3.5	12.0	3.6	16.4
20—90	0.69	19.7	11.3	5.4	3.8	3.5	7.9	8.2	
90—135	2.50	14.0	9.2	4.6	3.3	2.8	6.4	4.3	
135+	23.65	3.2	2.3	1.5	1.3	0.9	1.4	0.3	
				(Hot and semi-dry West Central zone)					
				Jinghari					
0—15	0.18	27.2	25.9	12.9	10.9	9.2	16.7	3.8	32.2
15—27	0.21	27.0	25.0	13.2	12.4	10.7	14.3	2.6	
27—66	0.16	34.0	24.9	14.3	13.0	11.5	13.0	7.8	
66—153	0.16	33.5	26.3	15.9	13.2	11.7	14.6	18.5	
				Jalalpura					
0—20	0.22	31.6	25.6	13.4	8.9	7.6	18.1	5.4	34.1
20—42	0.26	29.2	23.5	11.1	8.6	7.5	16.0	5.3	
42—110	0.37	29.4	23.3	11.2	8.9	7.1	13.8	14.0	
110—180	0.22	34.7	28.4	18.0	17.2	12.6	15.6	16.4	
				Ismalabad					
0—22	0.16	40.7	35.6	28.4	20.6	20.0	15.6	5.1	22.2
22—85	0.38	27.7	26.0	16.6	14.0	13.4	12.4	11.7	
85—110	2.21	17.6	13.3	5.5	4.8	4.5	8.8	3.3	
110—140	2.18	12.7	4.1	3.3	2.9	2.5	1.6	0.7	
140—176	0.38	28.3	20.5	12.9	10.0	8.8	11.7	6.3	
				(Hot and Sub-humid zone)					
				Ballopur					
0—15	0.73	19.6	12.6	6.4	4.1	3.0	9.7	2.2	27.7
15—80	0.50	26.3	18.2	8.2	7.7	7.2	11.1	7.4	
80—105	0.56	26.5	19.3	8.4	7.6	7.3	12.1	8.1	
105—158	0.52	28.0	20.2	8.3	7.5	6.8	13.4	10.0	
				Tajewala					
0—58	2.13	15.2	10.1	4.0	3.7	2.7	7.4	7.5	
				(Hot and humid zone)					
				Ratpura					
0—22	0.94	18.3	11.4	8.1	7.2	4.6	6.8	2.2	31.2
22—85	0.54	26.8	22.2	10.8	10.0	7.5	14.6	13.8	
85—156	0.49	28.2	23.4	11.6	10.4	9.0	14.4	15.1	

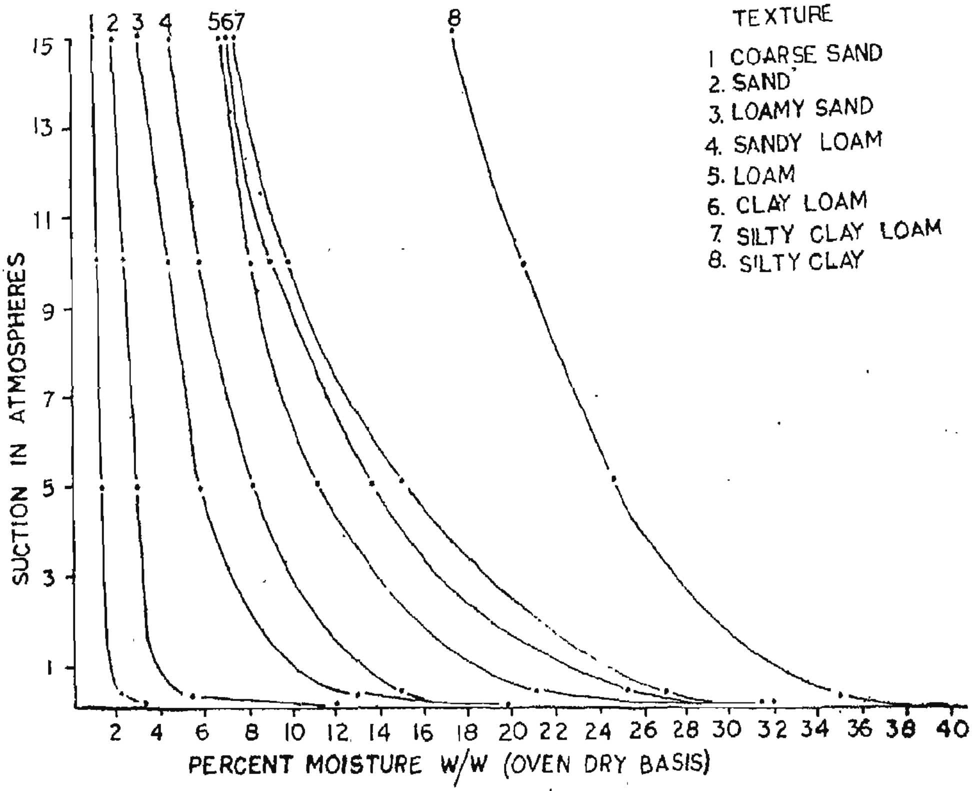
Av.=Available water
A.W.H.C.=Available water holding capacity

the agents of a bio-climatic zone, viz., temperature and rainfall, have not significantly modified the characteristics of the alluvium (parent material) and as such the soil properties, in areas under investigation, were under the influence of parent materials. This becomes much more evident by the perusal of the data on organic carbon of the soils, under various bio-climatic zones. Organic carbon status of all soils under investigation was, irrespective of their bio-climatic zones and in no case more than 0.7 per cent. The only variations in the total amount of rainfall among the various bio-climatic zones coupled with hot temperature do not favour the build up of organic matter status and, therefore, development of good soil structure. Hence it can be safely concluded that those physical and chemical properties of soil which bear significant correlation with moisture retention are not affected significantly by the variations in different bio-climatic zones.

Considering 10, 19 and 25 cm as the lower limits for low, medium and high categories of available water, respectively, soil profiles from Ghasola and Rasooe; Chutala, Bavel, Khanour and Ismalabad; and Rania, Hamizapur, Hodel, Jingheri, Jalalpura and Ratpura qualified for the low, medium and high categories of available water, respectively. Chutala and Bavel profiles, which are physiographically sand dune areas retained comparatively more moisture than Ghasola which represents stablished sand dune. Abichandani (1966) also reported that a recently deposited sand dune had a higher moisture status than that of a stablized dune.

As a readily obtained figure with certain amounts of reliability, available water holding capacity can be estimated and computed for any soil profile from average figures related to a textural class of soil. Average figures in terms of centimetres of water per centimetre of soil for each textural class of soils under investigations have been estimated as 0.06, 0.14, 0.15, 0.18, 0.21, 0.23, 0.26, 0.29, and 0.24 cm for sand, loamy sand, sandy loam, loam, silt loam, clay loam, silty clay loam, silty clay and silt, respectively. In addition to the total available water retaining capacity, the moisture release pattern of a soil is an important factor in scheduling irrigations. Moisture release pattern for these soils has been studied and moisture retention curves for various textural classes, viz., coarse sand, sand, loamy sand, sandy loam, loam, clay loam, silty clay loam and silty clay have been drawn (Fig. 1). The nature of the 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 tension than at higher. 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) show that most of the moisture is released within a tension of 1 to 2 atmospheres. 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 to medium amounts of total available water. On the other hand, fine loamy soils (Rania, Hodel,

FIG. I "TYPICAL MOISTURE RETENTION CURVES OF SOILS OF HARYANA IN THE VARIOUS TEXTURAL GROUPS."



Jinghari, and Jalalpura) could maintain a fair supply of water to plants even at higher tensions. Based upon the above inference the soils which qulified 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 of crops. 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 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 of crops. Soil profiles of Chutala, Bavel and Ghasola, have a very high hydraulic conductivity, and rest of the profiles maintain a low to medium rate.

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EFFECT OF LEVELS OF NITROGEN, PHOSPHORUS AND SEED RATE ON GROWTH, YIELD AND QUALITY OF TEOSINTE FODDER *(EUCHLAENA MAXICANA* SCHRAD)

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ABSTRACT

Studies on the effect of nitrogen and phosphorus in relation to variable seed rates on teosinte fodder crop were carried out during *kharif* seasons of 1971 and 1972. There was a linear response of teosinte to nitrogen application up to 90 kg N/ha. Application of 20 kg P_2O_5/ha also was found beneficial to this crop. A medium seed rate of 45 kg/ha was found to be the optimum. The metabolizable energy, crude protein, crude fat and crude fibre were increased while nutritive ratio was narrowed down due to the application of 90 kg N/ha. The improvement in feed units was also observed by the application of 20 kg P_2O_5/ha. Similarly, metabolizable energy was increased and nutritive ratio reduced markedly with 45 kg seed/ha.

Teosinte *(Euchlaena maxicana* Schrad), a close relative of maize, is a crop of moist and warm regions. It was introduced in India in 1893 at Poona. It is a quick growing, profuse tillering, disease and lodging resistant and high yielding fodder crop. It does well in rainy season and becomes ready for harvesting in October-November when there is a great scarcity of green fodder. Its fodder possesses high percentage of carbohydrates. Like maize, it is free from cynogenetic glucocide and thus can be fed safely to the cattle at any stage of its growth. It does not produce negative calcium balance in animals due to low oxalic acid content unlike napier grass.

Being a cereal, teosinte responds well to the application of nitrogen. Abichandani *et al.* (1970), Miaki (1967) reported beneficial effect of nitrogen on this crop. However, sufficient data are not available to know the optimum dose of nitrogen for this crop, especially in Hissar locality. This is a common belief that forage yields are much improved when a highly populated grass is fertilized with higher level of nitrogen. Phosphorus application plays an important role by improving yield and quality of forage (Tomer, 1969). The efficiency of nitrogen is very much enhanced when phosphorus is supplemented with nitrogen.

MATERIAL AND METHODS

The experiment was conducted on sandy loam soils of the Haryana Agricultural University, Farm, Hissar during *Kharif* seasons of 1971 and 1972. The soil was poor in nitrogen (0.055%), medium in phosphorus (26.82 kg/ha) and rich in potash (0.94%). The treatments comprised four levels of nitrogen (0, 30, 60 and 90 kg N/ha); three seed rates (30, 45 and 60 kg seed/ha) and two levels of phosphorus (0 and 20 kg P_2O_5/ha). Phosphorus in the form of single super phosphate was drilled before sowing whereas the nitrogen in the form of calcium ammonium nitrate was applied in two split doses, i.e., half at sowing and half about one month after sowing. Split-plot design with nitrogen levels in main plots and phosphorus and seed rates treatments in sub plots was used. Treatments were replicated three times.

The experimental crop was sown in lines 30 cm apart on August 9 and July 10 in 1971 and 1972, respectively. In 1971 the crop was harvested on October 21 and in 1972 on September 22. The qualitative studies were made only in the first year.

The quality of the forage was determined only in the year 1971. Forage quality was measured in terms of crude protein, crude fat, crude fibre, nitrogen-free extract, net energy and nutritive ratio. The methods of analysis were as follows :

Crude protein. Nitrogen content in oven dried samples of fodder was determined by colorimetric method (Lindner, 1944). The protein percentage was worked out by multiplying the nitrogen percentage by 6.25.

Crude fat. The crude fat was estimated by Soxh-let apparatus using petroleum ether BP (40-60) as described by Knowles and Watkins (1960).

Crude fibre. It was determined by the method as described by Wright (1939).

Nitrogen-free extract. It was obtained by adding together the percentage of the other constituents and substracting the total from 100 as described by Knowels and Watkins (1960).

Metabolizable energy. Since forage yield is made up of different constituents and these feed units vary under different fertility level, metabolizable energy was worked out to express forage production in terms of some common denominator.

Data pertaining to digestibility coefficients for different constituents as given by Sen and Ray (1964) were utilized for calculating total digestible nutrients percentage. The percentage and production of total digestible nutrients were calculated as under :

T.D.N. percentage=
digestible crude protein per cent+digestible crude fibre per cent+digestible N. F. E. per cent+(digestible crude fat per cent×2.25)
Later on the T. D. N. production values were converted into metabolizable energy by using conversion factor—1 kg. T.D.N. =3.616 Mcal of metabolizable energy (Crampton and Harris, 1969).

Nutritive ratio

The nutritive ratio was calculated as follows :

$$\text{N. R.} = \frac{\text{dig N.F.E.} + \text{dig crude fibre} + (\text{dig crude fat} \times 2.25)}{\text{dig. crude protein}}$$

TABLE 1

Effect of nitrogen and phosphorus levels and seed rates on growth and yield of teosinte forage

Treatment	No. of plants per running metre			No. of tillers per plant			Fodder yield (q/ha)					
							Green			Dry		
	1971	1972	Mean	1971	1972	Mean	1971	1972	Pooled	1971	1972	Pooled
Nitrogen												
0 kg N/ha	12.90	13.86	13.38	1.78	1.80	1.79	245.5	257.9	251.7	76.2	63.4	69.8
30 kg N/ha	13.35	14.60	13.97	1.83	2.16	2.00	292.4	375.7	334.0	90.0	90.1	90.0
60 kg N/ha	15.39	15.04	15.21	2.05	2.40	2.22	333.6	446.9	390.2	97.1	106.7	101.9
90 kg N/ha	15.18	15.10	15.14	2.07	2.86	2.46	356.6	515.8	436.2	104.4	120.1	112.2
SEm ±	0.53	0.37	—	0.061	0.20	—	4.09	12.0	6.53	3.72	2.80	2.48
C. D. at 5 per cent	1.86	1.05	—	0.21	0.57	—	14.15	34.29	18.92	12.87	7.88	7.18
Phosphate												
0 kg P_2O_5/ha	13.82	14.57	14.20	1.86	2.21	2.03	292.9	393.8	343.3	86.8	92.7	89.7
20 kg P_2O_5/ha	14.59	14.73	14.66	2.01	2.40	2.20	322.1	404.4	364.7	97.0	97.5	92.2
SEm ±	0.12	0.99	—	0.067	0.08	—	4.09	8.67	4.62	2.15	3.13	—
C. D. at 5 per cent	N. S.	N. S.	—	N. S.	N. S.	—	11.68	N.S.	N.S.	6.16	N.S.	N.S.
Seed rates												
30 kg seed/ha	10.29	9.90	10.10	2.08	2.71	2.40	290.5	364.6	327.5	86.3	80.4	83.3
45 kg seed/ha	14.11	15.67	14.89	1.93	2.17	2.05	306.3	406.6	356.4	93.9	97.4	95.6
60 kg seed/ha	18.22	18.38	18.30	1.79	2.03	1.91	324.2	426.1	375.1	95.6	107.5	101.6
SEm ±	0.14	0.16	—	0.082	0.12	-	5.01	10.94	4.84	2.64	3.87	1.85
C. D. at 5 per cent	0.40	—0.51	—	N. S.	0.38	—	14.32	34.47	13.69	7.54	12.03	5.22

RESULTS AND DISCUSSION

The variations in the green fodder yield on account of nitrogen application were significant in both the years (Table 1). Maximum green fodder yield (356.60 quintals in 1971 and 515.80 quintals in 1972 per hectare) was obtained with the highest dose of nitrogen (90 kg N/ha) in both the years which was 45.3 and 100.0 per cent more over control in 1971 and 1972, respectively. Similar trend was observed in case of dry matter yield in both the years. The highest forage production obtained with the application of 90 kg N/ha is the combined effect of high plant population and better number of tillers. Similar improvement in plant population and growth with nitrogen application was obtained by Rao (1971) and Singh (1971), Wali and Relwani (1970) had also reported higher yield of teosinte with nitrogen application.

An examination of data (Table 1) shows that green as well as dry matter yields were significantly lower in the first year than in the second year. This is mainly due to late planting in that year (Aug 9) as compared to timely sowing (July 10) in the following year. The better response to nitrogen in the second year may also be ascribed to the good growth of the crop.

Application of 20 kg P_2O_5/ha increased significantly the green as well as dry matter yields of teosinte, during first year only. This improvement in forage production due to phosphate application may be due to increased plant population, number of tillers and fresh and dry matter attainments. Abichandani (1971) also reported that phosphate application benefited teosinte grown for fodder.

The green and dry matter productions were markedly improved with 45 kg seed/ha in both the years. The improvement brought about by 60 kg seed/ha over 45 kg was not significant except in case of green yield in the first year. Wali and Relwani (1968) working at N.D.R.I. Karnal had reported that 50 to 62 kg seed/ha proved to be best seed rate for yield and quality of teosinte fodder.

The interaction of seed rates and

TABLE 2

Effect of seed rates × nitrogen levels on the green and dry fodder yield of teosinte, 1972 (q/ha)

Seed rates (kg/ha)		Nitrogen levels (kg N/ha)					
		0	30	60	90	SEm+	C. D. 5%
30	Green fodder	278.8	324.9	400.9	453.8	20.7	59.0
	Dry matter	61.5	73.4	88.7	98.0	4.91	14.0
45	Green fodder	248.1	385.2	454.9	538.1		
	Dry matter	61.5	93.6	108.6	125.7		
60	Green foddar	246.8	416.9	484.9	555.5		
	Dry matter	67.2	103.3	122.9	136.7		

TABLE 3

Effect of nitrogen, phosphorus levels and seed rates on net energy, nutritive ratio, crude protein, crude fat, crude fibre and N. F. E. in teosinte

Treatment	Metabolizable energy M. cal/ha	N. R.	Crude protein		Crude fat		Crude fibre		N. F. E.	
			per cent	q/ha	per cent	q/ha	per cent	q/ha	per cent	q/ha
Nitrogen										
0 kg N/ha	14008.4	25.73	3.01	2.24	1.86	1.41	28.77	21.92	57.98	44.22
30 kg N/ha	16507.0	22.17	3.46	3.13	1.92	1.73	27.41	24.67	57.87	52.07
60 kg N/ha	17837.7	16.57	4.59	4.45	2.09	2.02	27.31	26.52	56.87	55.20
90 kg N/ha	19743.4	14.35	5.26	5.65	2.24	2.41	26.21	27.36	56.68	60.79
SEm ±	669.0	0.028	0.005	0.19	0.019	0.082	0.006	0.02	0.013	2.11
C. D. 5%	2314.2	0.063	0.018	0.67	0.065	0.28	0.023	0.29	0.046	7.31
Phosphorus										
0 kg P_2O_5/ha	15928.5	19.82	4.06	3.63	2.01	1.76	27.42	23.80	57.37	49.76
20 kg P_2O_5/ha	18119.8	19.58	4.10	4.12	2.04	2.03	27.44	26.63	57.33	56.38
SEm ±	394.9	0.034	0.03	0.095	0.006	0.044	0.006	0.018	0.012	1.23
C. D. 5%	1128.2	0.098	N.S.	0.27	0.017	0.127	N.S.	N.S.	0.028	3.50
Seed rates										
30 kg seed/ha	15841.7	20.02	4.01	3.59	1.99	1.74	27.32	23.58	57.48	49.53
45 kg seed/ha	17624.4	19.28	4.16	4.08	2.04	1.98	27.41	25.74	57.26	54.90
60 kg seed/ha	17602.7	19.80	4.07	3.94	2.04	1.97	27.55	26.34	57.31	54.78
SEm ±	480.9	0.042	0.037	0.11	0.008	0.054	0.007	—	0.012	1.50
C. D. 5%	1381.3	0.12	N.S.	0.33	0.021	0.156	0.021	—	0.035	4.29

nitrogen in respect of green as well as dry fodder yields was found significant during the year 1972 only. It is obvious from the data in table 2 that higher seed rates are required if higher rate of nitrogen are applied to realise higher yields.

Quality

Metabolizable energy (Table 3) was improved with each increase in the level of nitrogen. However, the differences between 30 and 60, and 60 and 90 kg N/ha were not significant. On the other hand, nutritive ratio was significantly narrowed down with each increase in the dose of nitrogen. The highest value of ME and lowest value of NR were recorded with 90 kg N/ha. This is mainly due to high production of crude protein, crude fat, NFE and crude fibre (Table 3) which is the reflection of high dry matter production (Table 1) and increased per cent of protein and fat. An appreciable narrowing down of nutritive ratio in the forage grown with this dose of nitrogen is due to the fact that with this dose protein contents were increased and carbohydrates were reduced. Similar results have been reported by Rao (1971), and Singh (1971).

Like nitrogen, phosphorus application also enhanced the M.E. production appreciably and narrowed the nutritive ratio. The improvement in M.E. is because of increased production of crude protein, crude fat, N.F.E. and crude fibre which is function of high dry matter production and increased per cent contents of protein and fat which ultimately narrowed down the nutritive ratio. These results are in confirmity with those of Singh (1971) and Johari *et al.* (1963).

It was interesting to note that the interaction of nitrogen and phosphorus levels on the production of net metabolizable energy was found significant. Plots fertilized with 90 kg N and 20 kg P_2O_5/ha possessed the maximum metabolizable energy. The improvement was more than 3342 M. Cal/ha over that with any other treatment combination. The poorest performance in this regard was noted when plot was fertilized neither with nitrogen nor with phosphorus (Table 4).

While studying the effect of seed rates it was noted that M.E. production is significantly improved with 45 kg or

TABLE 4

Effect of nitrogen levels × phosphorus levels on the production of metabolizable energy M. Ca./ha

Treatments	Phosphate levels			
	0 kg P_2O_5/ha	20 kg P_2O_5		
Nitrogen level :				
0 kg N/ha	12746.4	15274.0		
30 kg N/ha	15700.7	17313.4	SEm±	788.3
60 kg N/ha	17400.2	18278.9	C. D. at 5%	2256.4
90 kg N/ha	17870.3	21620.1		

60 kg seed/ha over that of 30 kg seed/ha. However, improvement brought about by 60 kg over 45 kg seed/ha was non-significant. The higher metabolizable productions obtained with 45 kg or 60 kg seed/ha was more due to more production of crude protein, crude fat, N.F.E. and crude fibre. Similarly, plots sown with 45 or 60 kg seed/ha possessed narrower nutritive ratio which may also be the reflection of slight increase in protein content and reduction in N.F.E.

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EFFECT OF PLANT REGULATORS AND THEIR CONCENTRATIONS ON THE PERFORMANCE OF SOFT-WOOD CUTTINGS OF GUAVA[1]

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ABSTRACT

The investigation was carried out at Balwant Rajput College, Bichpuri, Agra, during the year 1961. The cuttings were planted in 6 cm×5 cm pots in polythene covers under partial shade of lath house. The cuttings were collected from healthy 8-year old trees of the college orchard. Three plant regulators were used : (i) IBA, (ii) IAA and (iii) NAA at 5 concentrations of each, namely, 0 ppm, 2,500 ppm, 5,000 ppm, 10,000 ppm and 20,000 ppm by the quick dip method. The observations were recorded for a period of 10 weeks from the date of planting. Among the three plant regulators IAA was found to be the best in respect of survival, rooting, number of roots, length of roots, callusing, sprouting, length of sprouts, diameter of sprouts, number of new leaves and establishment. IBA was found next and the performance of NAA was the poorest. The different concentrations did not have any marked effect on the performance of soft wood cuttings. It has been concluded that guava can be successfully propagated by soft wood cuttings even without the aid of plant regulators in the polythene covers under the partial shade of lath house. Treatment of cuttings with IAA at a concentration of 2,500 ppm by quick dip method would, however, improve survival, rooting, sprouting and establishment.

Vegetative propagation is a unique device of regenerating plants as genetic type can be reproduced unchanged because sexual process does not intervene. This results in early bearing and production of uniformly high quality and the high yielding plants. The utility of guava fruit for different purposes is well established and hence needs attention for the propagation of desirable variety of fruits. It is propagated in this country from seeds which results in large amount of variation in its growth and bearing, to get rid of this variability vegetative propagation is irrevocably urgent. Recently plant regulators have been largely used for stimulating rooting in difficult-to-root species. This study has was up to find out

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the effect of different plant regulators in different concentrations on the performance of guava cuttings.

Guava cuttings were successfully propagated by using soft wood cuttings by Hudson (1956). The age of the mother plant has been found to affect the performance of cuttings (Yerkes, 1923; Mahata and Singh, 1959). The vigour of the source plants was reported to be directly associated with the degree of rooting (Singh *et al.* 1957). Many workers have tried to explain the mode of action of plant regulators in producing their effect (Cooper, 1940; Flerov and Kovalen, 1952).

MATERIAL AND METHODS

The experiment was conducted under controlled environments of partial shade of lath house using pots under polythene covers (such conditions have been reported to be very suitable for studies on treated cuttings (Singh *et al.* 1957) during rainy season of 1961 at Balwant Rajput College, Bichpuri, Agra. The station is located in the subtropical region of Uttar Pradesh with extreme temperature rising to 46°C in summer and as low as 2°C in winter. The total precipitation of about 75 cm is usually received, the major drop coming between July and September. A total of 900 cuttings from eight year old healthy trees of Allahabad Safeda variety were collected from college orchard. Water sprouts were selected as a planting material. These cuttings were given 15 treatments arranged in Randomised block design with 4 replications. The average length of cuttings was 9.7 cm. The bottom pair of leaves of each cutting was removed to facilitate planting.

Indole-3-butyric acid (IBA), Indole Acetic Acid (IAA) and Naphthalene Acetic Acid (NAA) were used in the present investigation in 5 different concentrations (0 ppm, 2,500 ppm, 5,000 ppm, 10,000 ppm and 20,000 ppm). These plant regulators were used in alcoholic solution which was stored in cool dark place. Quick dip method was used dipping 20 mm of the lower end in the plant regulator solution for few seconds and the cutting was planted as soon as alcohol dried off. Experiment lasted from 29th July 1961 to 7th October 1961. Observations on rooting survival and establishment were recorded and subjected to statistical analysis.

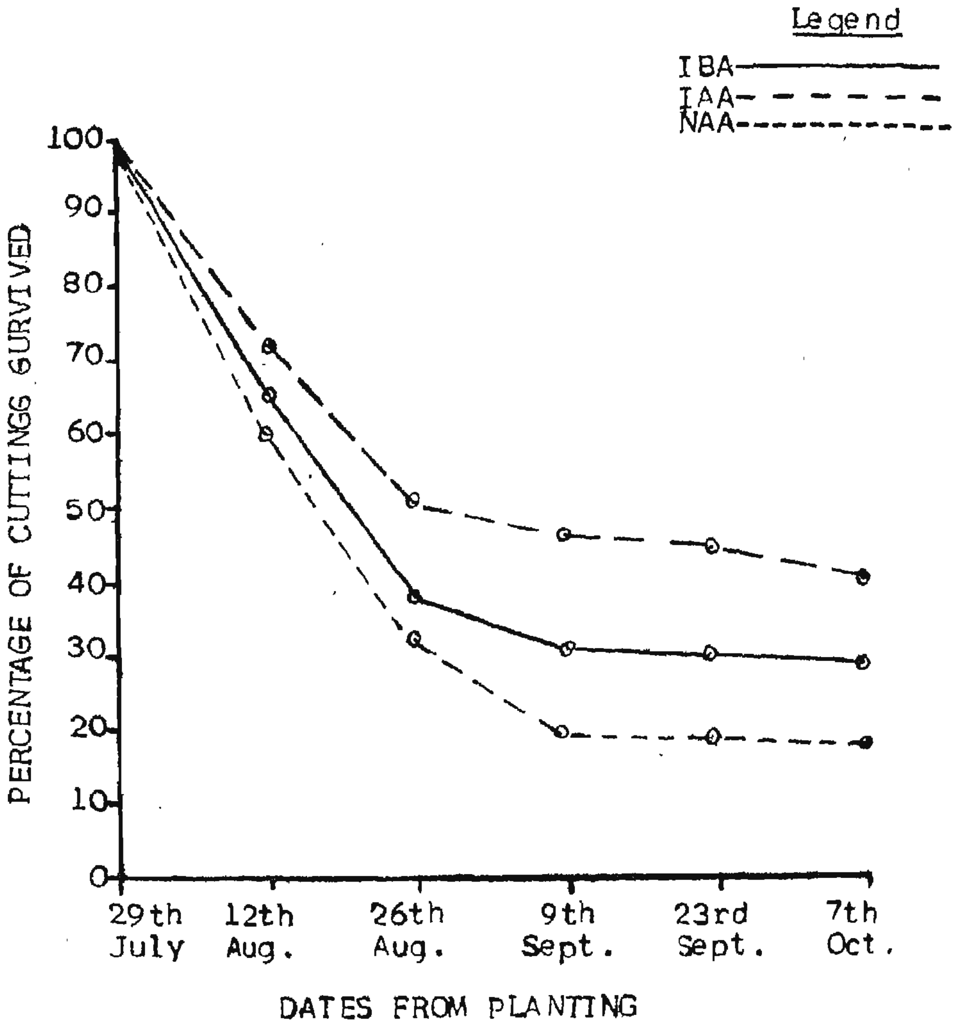
The data were analysed according to Fisher (1950). For root and shoot characters the method used by Singh *et al.* (1957) was followed.

RESULTS AND DISCUSSION

Out of the 15 cuttings planted in each plot 10 were reserved for final recording of various root and shoot characters and the remaining 5 were used for periodical observations.

1. Survival of cutting

The observations were recorded in each plot at a fortnightly interval. The percentage of cuttings alive under the three plant regulators on the different dates of observations is presented in Fig. 1. The period of first 4 weeks of planting was very important for the survival since the death rate was very high during this period with all the three plant regulators. The survival of the cuttings was the best under IAA followed by IBA and NAA this finding is in concurrence with the report



of Garner (1944). The death rate slowed down after 4 weeks, and after 6 weeks the death rate was not marked. As regards the effect of concentration of plant regulators on survival it was interesting to observe that the maximum survival was in the cuttings which were not given any treatment and it was therefore clear that there was no benefit from such treatment. Singh *et al.* (1957) observed that over vigorous softwood cuttings did not require any stimulation and good success was achieved even without the use of plant harmones. The percentage of cuttings survived with different plant regulators at different concentrations has been presented in Table 1.

TABLE 1

Effect of plant regulators in different concentrations on survival and rooting of guava cuttings

Plant regulators	Percentage survived and rooted					
	Average	0 ppm	2500 ppm	5000 ppm	10000 ppm	20000 ppm
IBA	29.0	47.5	32.5	22.5	25.0	17.5
IAA	40.5	45.0	62.5	42.5	27.5	25.0
NAA	18.0	37.5	17.5	22.5	12.5	0

TABLE 2

Analysis of variance to test the effect of plant regulators in different concentrations on survival and rooting

Variation due to	D.F.	M.S.S.
Plant regulators (P)	2	2531.67*
Concentration (C)	4	1654.17*
P×C	8	281.67
Error	45	233.88

*Significant at 1 per cent level

The data were statistically analysed for the effect of plant regulators, their concentration and the interaction (Table 2).

It was observed that the plant regulators were significantly different in their effect from each other and the different concentrations were also significantly different from each other. The interaction between the plant regulators and the concentrations was not significant on overall observations but IAA at a concentration of 2,500 ppm showed the highest survival percentage of 62.5 (Table 1). Teotia and Pandey (1961) reported greater success with IAA and NAA as compared to IBA in their experiment with the stem cuttings of Guava. Lower concentration of IAA with longer duration of treatment proved superior in efficiency as reported by Went *et al.* (1938) Hitchcock and Zimmerman (1939) and Naik (1948).

2. Rooting

The cuttings were studied after 10 weeks of planting when the roots and sprouts had grown to an extent that the cuttings appeared like well-established plants. Each of the 10 cuttings was studied for various root and shoot characters and the percentage of rooted cuttings with different plant regulators at different concentrations is presented in Table 1. From Table 1 it is observed that the percentage of rooting was maximum with IAA at a concentration of 2,500 ppm. The analysis of variance presented in Table 2 indicates that all survived cuttings rooted in a significantly different manner with regard to plant regulators and their concentrations used. On testing the critical difference among the effects of different plant regulators it was found that IAA was significantly superior to IBA and IBA in its turn, was significantly superior to NAA.

3. Percentage of cuttings sprouted and established as plants

This observation was made after 10 weeks of planting of the cuttings. The percentage of cuttings sprouted and established with the use of 3 plant regulators at different concentrations is presented in Table 3.

Table 3 reveals that IAA was superior as compared to other 2 plant regulators and it was most efficacious at a concentration of 2,500 ppm. The higher concentration of all the plant regulators resulted in decline of the percentage of cuttings sprouted as compared to control. Sprouting started after 4 weeks of planting and the rate of sprouting was low upto 6th week and then there was abrupt increase in percentage after 6th week of planting. The data on the percentage of cuttings sprouted were analyed for testing the statistical significance of the above statement. The analysis of variance is presented in Table 4:

TABLE 3

Effect of plant regulators and their concentrations on the percentage of cuttings sprouted

Plant regulators	Percentage of cuttings sprouted					
	Average	0 ppm	2500 ppm	5000 ppm	10000 ppm	20000 ppm
IBA	25.5	42.5	27.5	20.0	20.0	17.5
IAA	35.5	42.5	60.0	35.0	25.0	15.0
NAA	14.0	32.5	7.5	20.0	10.0	0

TABLE 4

Analysis of variance to test the effect of plant regulators in different concentrations on sprouting

Variation due to	D.F.	M.S.S.
Plant regulators (P)	2	2315**
Concentrations (C)	4	1470.80**
P×C	8	379.60
Error	45	190.00

**Significant at 1 per cent level

That the plant regulators were significantly different from each other in affecting the sprouting percentage. Similarly the various concentrations used also produced significantly different effects. Interaction between the plant regulator and their concentration was not significant. The results of this study are very much similar to those reported by Stoutemyer (1935), Adriance and Brison (1955), Singh *et al.* (1957) and Teotia and Pandey (1961).

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INFLUENCE OF SPRINKLER AND SURFACE METHODS OF IRRIGATION AND NITROGEN LEVELS ON THE YIELD OF POTATOES

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ABSTRACT

Investigations were conducted in 1970-71 and 1971-72 at Hissar, Haryana, to study some effects of sprinkler and surface methods of irrigation and nirrogen levels on the yield and tuber size of potatoes. Sprinkler irrigation resulted in significantly higeer yield of potatoes, greater percentage of large and medium sized tubers and increased water-use-efficiency. Nitrogen at the rate of 180 kg/ha gave the best results.

Surface and ground water resources are being exploited even at huge costs for the purpose of bringing more area under irrigation. Nevertheless, large quantities of water are being lost due to inefficient conveyance and application methods. According to the studies made by the Central Water and Power Commission, the effective water utilization under canal commanded areas under the present irrigation practices varies from 20 to 46 per cent. Shahi and Kumar (1968) observed that irrigation efficiency of 12 farms in Ludhiana district ranged from 35 to 61 per cent. The sprinkler method of irrigation in the tube-well irrigated areas has been suggested as a means for increasing the irrigation efficiency. However, the high initial investment and operational costs associated with this method warrant careful consideration of the factors which govern the choice of verious irrigation methods.

Although the suitability of sprinkler method with regard to topography, soil type, water supply and its economic aspects in relatively well understood, its effect on crop yield has not been studied in India. Therefore, the studies reported herein were conducted.

MATERIAL AND METHODS

The investigations were carried out at the Research Farm of the Haryana Agricultural University, Hissar, during 1970-71 and 1971-72. The soil of the

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experimental site was sandy loam in texture, medium in phosphorus, high in potash and low in organic matter and nitrogen. The mean values of field capacity, permanent wilting point and bulk density of the soil samples taken from various depths down to 120 cm were 18.25 per cent, 7.80 per cent and 1.50 g/cc, respectively. The basic infiltration rate at the end of 3 hr approached a value 0.6 cm/hr.

The treatments included the sprinkler and surface methods of irrigation and four nitrogen levels, viz., 0 (N_0), 60 (N_1), 120 (N_2) and 180 (N_3) kg/ha. The experimental design was a split-plot arrangement having two main plots for sprinkler and surface methods of irrigation with four sub-plots of nitrogen levels in each main plot. Each sub-treatment was replicated four times with an ultimate plot size of 45 sq m. The sprinkler irrigation plots were sufficiently away from surface method plots to avoid water drifting during sprinkler irrigation. Potato, variety Kufri Sindhuri, was planted on 23.10.1970 and 18.10.1971. The crops were harvested on 26.2.1971 and 20.2.1972, respectively The rainfall received during the growing seasons was 74 and 56 mm during the first and second seasons, respectively. Except the experimental treatments all the other agronomic practices followed were those recommended by the Haryana Agricultural University, Hissar.

A portable sprinkler set driven by 13.5 H. P. diesel engine and consisting of 10 cm diametre main line and 7.5 cm lateral line and risers of 1 metre height were used. The sprinklers used were revolving type having twin nozzeles and operated at 3 kg/sq. cm pressure. The water application rate through the sprinklers was maintained approximately equal to the basic infiltration rate of the soil.

The laterals and sprinklers were laid out at the spacing of 18×12 metres resulting in uniformity coefficient of water application of about 80 per cent. The quantity of water applied under both the irrigation methods was measured with the help of integrated line water meter. The irrigations were accorded simultaneously under both the methods when the tensiometers at 30 cm depth indicated 0.4 bar tension.

The effect of treatments was observed on the crop yields. For studying the influence on market quality of potato as measured by its tuber size, the whole produce was graded into three size classes, viz., large-greater than 6 cm, medium-between 4-6 cm and small-less than 4 cm in diametre.

RESULTS AND DISCUSSION

The data with regard to the yield and water-use-efficiency for potato in relation to varying treatments are presented in Table 1. The yields are on the lower side and this is primarily attributed to the relatively lower initial fertility status of the soil used in the experiment.

Effect of method of irrigation

With regard to the effect on yield, the first year data show that sprinkler method of irrigation produced significantly more (50%) tubers as compared with the surface method. In the second year, however, the differences in yield between the two methods were statistically non-significant although the sprinkler method

TABLE 1

Yield and water-use-efficiency of potato in relation to treatments

Treatment	Yield (q/ha)		WUE (kg/ha-cm)	
	I yr	II yr	I yr	II yr
Method of irrigation				
Sprinkler	153.8	138.9	616	436
Surface	103.4	123.6	323	346
C. D. 5%	21.6	N. S.	—	—
Nitrogen				
O	89.4	117.0	—	—
N_1	131.0	132.0	—	—
N_2	134.3	119.0	—	—
N_3	159.6	156.1	—	—
C. D. 5%	21.6	29.8	—	—

of irrigation recorded 12 per cent higher production as against the other method.

For the effect of irrigation methods on the tuber size, it is revealed from Table 2 that the percentage of large and medium sized tubers was relatively higher under the sprinkler method. The per plant yield (data not shown) was also greater under this method as compared to the surface method meaning thereby that the increase in yield noticed under the sprinkler method of irrigation was a function of both higher per plant yield as also the larger size of tubers. Krogman and Torforson (1967) also reported that surface method of irrigation tended to produce higher percentage of unmarketable potatoes in Canada.

TABLE 2

Tuber size distribution in relation to treatment (in percentage)

Seed grade	Large		Medium		Small	
	I yr	II yr	I yr	II yr	I yr	II yr
Method of irrigation						
Sprinkler	9.05	6.45	47.26	63 39	43.69	30.16
Surface	7.06	6.19	37.16	57.55	55.78	36.26
Nitrogen						
N_0	2.26	4.88	39.14	60.16	58.70	34.96
N_1	7.80	5.59	41.88	58.88	50.32	35.33
N_2	10.07	5.20	43.80	59.30	46.13	35.50
N_3	9.11	8.80	41.50	63.80	48.29	27.40

The increase in yield under the sprinkler method of irrigation as evidenced here may be due to the availability of more water on the terminal buds of the plant which increased the turgidity and cell elongation of the growing portions resulting in better growth, higher rate of photosynthesis and ultimately higher yield. Similar yield increased under sprinkler method over the surface method of irrigation have been reported by Fallon (1961) and Hellings (1961). The decreased aeration under the surface method could be another cause for the reduced yield observed under this method of irrigation.

This idea is in line with the work of Finkel and Dov Nir (1959). Better soil physical conditions as evidenced by higher infiltration rate and lower bulk density in sprinkler irrigated field might be another factor contributing towards higher yield under the above method (Finkel and Dov Nir, 1959; Robinson *et al.*, 1968).

Effect of nitrogen

Nitrogen fertilization had a consistent remarkable effect on the potato yield. In the first year, the 180 kg/ha produced significantly the highest yield as compared to all the other levels tried. The 60 and 120 kg/ha doses, being at par, were also significantly superior to the no-N treatment. In the following year, the 180 kg N/ha treatment again recorded the highest yield. Statistically this yield was at par with that obtained with the 60 kg/ha level and significantly superior to the rest of the treatments.

For the nitrogen effect on the tuber size distribution of potato, the relevant data show that higher percentage of large and small tubers was usually attributed to the higher (120 and 180 kg/ha) nitrogen doses with a concomitant increase in the percentage production of small tubers under the 60 kg/ha and no-N treatments. Kapoor (1952) and Hukkeri (1968) have also reported higher percentage of large size tubers with application of higher nitrogen rates. The higher tuber yields as observed may be attributed to the increased photosynthetic activity by the plant as a result of nitrogen nutrition. The beneficial effect of higher N levels on the potato yield has also been reported in the literature (Kanwar, 1962; Pushkarnath and Sardana, 1962; Benepal, 1967; Reddy and Suryanarayana, 1967; Singh and Sharma, 1968; Tabata and Takaŝa, 1968; Singh and Singh, 1971).

Effect of interaction

The interaction between the method of irrigation and nitrogen was found to be non significant in both the years for the yield as well as tuber size distribution.

Water use efficiency

The relevant data in Table 1 show that the productivity per centimetre of water added as irrigation was appreciably higher under the sprinkler irrigation. The low water-use-efficiencies recorded under the surface method might be primarily due to the losses occuring in seepage and deep percolation (Israelsen and Hansen, 1962).

Economics of sprinkler vs. surface method of irrigation

Comparative cost analysis of irrigating potatoes by these two methods is given in Table 3. For the cost analysis, the farm size of 6 hectare and prices existing in the year 1972-73 have been taken.

The economic analysis shows that inspite of much higher cost of sprinkler irrigation, it is profitable to irrigate potato crop by sprinkler.

TABLE 3

Comparative cost analysis of sprinkler and surface method of irrigation (Rs./ha)

Particulars	Sprinkler		Surface	
	1970-71	1971-72	1970-71	1971-72
Fixed cost on equipment etc.	1.33	1.33	—	—
Variable cost per irrigation (labour, fuel, maintenance)	43.67	43.67	10.0	10.0
Total cost per irrigation	45.0	45.0	10.0	10.0
Total cost of irrigations 7 irrigations in First year and 8 irrigations in Second year	315.0	360.0	70.0	80.0
Value of produce (Rs.) @ Rs 30 per quintal	4614.0	4167.0	3102.0	3708.0
Net return by sprinkler method over surface	1267.0	179.0	—	—

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PROMISE OF CASTOR BEAN IN LOW RAINFALL AREAS AT HISSAR

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ABSTRACT

Trial of 9 promising *castor bean* strains including Pb. Castor No. 1 (Control), the recommended variety for Haryana, was conducted during 1972-73 and 1973-74 in rainfed conditions at Hissar. Climatological parameters during these years differed considerably. Seedlings up to 4 leaf stage invariably succumbed to intense drought. Partial reseeding in both years was found suitable to stabilize population even in adverse years. Aruna gave consistently higher yield (11.73 q/ha) than the control (4.25 q/ha). Approaches likely to boost castor bean production in rainfed areas have been discussed.

Castor bean (*Ricinus communis* L.) is known for its industrially and medicinally important oil extracted from its seeds (Kulkarni, 1966). Oil of inferior quality is used for burning. Castor thrives well in arid climate because of its deep root system capable of extracting soil moisture from deeper layers. Bloom may be helpful in imparting atmospheric drought tolerance. Castor bean is often sown on bunds to save inside crop from grazing and its tall plants in high population density serve as windbreak. This work was conducted to explore the possibility of regular castor bean cultivation in rainfed areas.

MATERIAL AND METHODS

Seeds of promising 8 varieties received from the Project Co-ordinator (Oilseeds), Indian Agricultural Research Institute, New Delhi, with Pb Castor No. 1 as control, were dibbled on July 12, 1972 (4 replications) and July 31, 1973 (4 replications) at Dry Land Main Research Centre, Haryana Agricultural University, Hissar. A basal dose of 40 kg N/ha (CAN), 40 kg P_2O_5 (superphosphate) and 20 kg K_2O (murate of potash) was given. Top dressing of 40 kg N/ha could be given after 70 days in 1972-73 and not in 1973-74 because of drought. The plot size 6.6×7.6 sq metre accommodated 11 rows spaced at 60 cm. Distance between plants was 45 cm. Considerable non-synchronous germination observed in all treatments with drought during 2-4 leaved stage necessitated partial reseeding of all treatments on Aug 14, 1972. Similarly gap filling was done on Aug 11, 1973. Drought before 4-leaved stage in both years killed seedlings in all treatments. Climatological parameters for the years 1972-73 and 1973-74 have been presented in Table 1. It would be seen that these two years were different from each other in respect of rainfall distribution and other climatological parameters.

Produce was harvested separately from middle (35.64 sq m) and border (14.52 sq m) rows. Characters were observed on plot basis, whereas 100 seed weight was determined by averaging values of 3 randomly picked plots of seeds from the produce of each treatment. Pooling of data to determine interactions was done according to Cochran and Cox (1957).

RESULTS AND DISCUSSION

Climatological parameters suggested rainless periods of 43 and 77 days, respectively, during vegetative and seed formation stages in the year 1972-73. Correspondig values for the year 1973-74 were 0 and 119 days. Further, continuous cold spell of (35 days) was followed by intense frost (14 days) in the year 1973-74. Moisture stress before 4-leaved stage of castor almost invariably killed castor seedlings, which indicated this stage was vulnerable to water stress. Such super-impositions adversely affected the crop growth and production. These years could be considered as drought years. Based on 56 years (1915-1970) data Bishnoi *et al.* (1972) indicated rare chances for the recurrence of such prolonged rainless gaps.

Data presented in Table 2 indicated that Aruna (11.73 q/ha) not only gave 176 per cent more yield than Pb Castor No. 1 (4.25 q/ha), but its yield was more than the next best strain 1-32 (11.07 q/ha) yielding 160.5% more than Pb Castor No. 1. This increase ranged from 40.7 to 123.5 per cent in remaining strains. High yielding potential of Aruna and 1-32 appeared to be due to relatively early onset of generative phase and short duration of seed filling phase and maturity. Almost synchronous maturity could be another reason. On the other hand, poor performance of Pb Castor No. 1, the recommended variety of castor bean for Haryana, appeared to be due to the longest vegetative phase which enforced high evapotranspirational demands with insufficient soil moisture to cope with its maturity of 190 days.

Population mean (average of two years) indicated that border rows yielded (13.82 q/ha) 56.9 per cent more than middle rows (8.81 q/ha). This suggested that 60 and 45 cm inter and intra-row spacing, respectively, resulted in competition for soil moisture at the cost of yield. Border rows of Aruna giving the maximum of 17.07 q/ha seed yield as against 11.07 q from middle rows showed 45.5 per cent increase. With regard to yield of border rows of Pb Castor No. 1 (10.85 q/ha) corresponding increase in favour of Aruna was 57.3 per cent. Within genotypes, increased yield of border rows as compared to that from their respective middle rows ranged from—4.0 (strain 239) to 155.3 (Pb Castor No. 1) per cent. This behaviour not only suggested differential genotype × row spacing interactions but also indicated that interpolation of one such finding with another genotype is unscientific. Estimation of economically viable plant densities in different soil moisture regimes could be another approach for boosting castor bean production.

Further, there was highly significant varietal influence for duration of the first,

TABLE 1

Climatological parameters at Hissar

Met weeks	1972-73 Weekly rainfall	Evaporation open pan	Temperature °C Max.	Min.	1973-74 Weekly rainfall	Evaporation open pan	Temperature °C Max.	Min.
27	34	11.0	37.8	26.2	—	11.8	38.9	26.6
28	23	6.9	34.0	25.0	50	11.8	39.1	28.4
29	–	11.4	38.4	27.3	35	7.4	35.7	25.6
30	—	16.7	39.8	28.9	—	9.8	36.5	27.0
31	–	14.7	41 0	30.6	6	8.9	37.4	26.2
32	16	7.5	35.5	25.7	15	3 6	31.7	25.0
33	59	5.0	31.3	24.0	32	5.8	32.6	24.7
34	39	5.5	32.8	24.6	3	6.9	35.9	25.6
35	—	5.8	32.7	24.4	–	6.2	33.4	24.5
36	—	8.7	37.1	22.1	3	7.3	35.9	24.9
37	—	7.6	34.9	22.4	44	5 3	34.9	23.7
38	—	8.3	36.3	18.8	—	7.2	38.9	22.7
39	—	7.5	36.0	14.1	—	7.0	36.4	22.5
40	—	6.9	36.1	17.1	—	6.1	33.1	18.6
41	—	5.8	34.2	14.8	—	5.8	33.6	15.8
42	—	7.0	35.8	16.3	—	6.5	35.1	14.7
43	—	5.8	30.7	11.6	—	4.6	32.2	13.7
44	—	4.3	30.5	10.6	—	4.9	31.2	10.3
45	—	4.4	31 2	9.9	—	4.3	29.5	10.2
46	—	3.9	30.8	10.3	—	4.2	26.7	5.4
47	—	4.2	28.7	11.6	—	3.1	27.6	6.2
48	37	1.8	23.2	9.3	2	3.5	26.8	7.2
49	—	2.3	23.7	8.2	—	2.8	22.3	5.0
50	—	2.0	20.4	5.7	—	3.3	22.4	—
51	—	1.3	22.0	7.2	—	1.4	16.5	3.6
52	—	2.4	21.2	6.4	—	0.9	13.9	—0.6
1	—	3.1	21.7	4.0	—	2.3	21.3	1.1
2	—	2.8	20.5	1.9	—	3.4	21.5	0.1
3	15	2.5	21.5	7.3	—	2.7	19.0	3.2
4	—	2.7	18.1	1.8	—	3.7	20.5	2.5
5	—	2.6	19.6	3.1	—	3.3	22.1	3.4
6	—	4.1	22.4	5.3	—	3.6	17.4	–0.5
7	—	3 5	26.2	7.6	—	3.7	22.2	3.8
8	—	4.8	28.7	11.1	—	5.1	26.8	7.1
9	—	5 2	26.4	9.4	—	5.0	24 0	4.5
10	—	6.1	26.7	12.1	—	6.2	29.9	10.1
11	—	5.8	25.3	5.8	—	5.9	30.8	9.1
12	—	6.9	31.5	10.1	—	7.5	33.4	15.1
13	—	8.4	36.1	15.4	—	8 0	34.0	16.9
14	14	10.5	35.7	14.8	—	8.9	35.8	15.7
15	—	11.2	37.4	18.8	—	9.5	36.9	16.2

TABLE 2

Performance castor varieties during 1972-73 and 1973-74 at Dry Land Main Centre, Hissar

S. No.	Var/strem	Yield 1972-73		Q/ha 1973-74		Average yield q/ha		Days from seeding to flowering			Reproductive phase (days)	Maturity 80% (Days)	100 grain weight (g)
		M	B	M	B	M	B	Ist	50%	75%			
1.	1—32	15.47	22.62	6.67	8.11	11.07	15.37	73	91	102	64	166	15.96
2.	Aruna	10.28	19.78	13.17	14.35	11.73	17,07	63	71	97	72	169	15.26
3.	144	9.86	13.72	10.55	15.65	10.21	14.69	60	70	81	89	170	17.83
4.	239	9.54	12.96	10.55	8.20	10.50	10.08	57	65	79	84	163	24.04
5.	63—1—21	9.16	15.53	10.55	8.05	9.86	11.79	61	74	86	74	160	21.43
6.	HBA	8.33	17.53	6.11	10.26	7.22	13.90	71	83	97	72	160	23.05
7.	224	8.12	16.03	8.80	16.40	8.50	16.22	63	77	89	76	165	16.28
8.	157B	5.68	13.15	6 28	15.58	5 98	14.37	75	95	109	64	173	15.15
9.	Pb No. 1 (Control)	2 67	13.38	5.83	8.31	4.25	10.85	90	102	103	78	191	31.80
	Pop mean	8 79	16 08	8.73	11.66	8.81	13 82	68	81	95	75	170	20.09
	B/MS	NS	NS	NS	NS	NS	NS	*	NS	NS	NS	NS	NS
	V MS	NS	NS	NS	*	*	NS	**	**	**	**	**	**
	VXY	—	—	—	—	NS	NS	—	—	—	—	—	—
	Er ±	3 63	6.31	3.71	3.23	3.76	3.01	3.2	5.11	6.48	6.24	3.49	1.85
	CD 5%	—	—	—	6.46	7.52	—	6.4	10.55	13.37	12.88	7.20	3.82
	CV %	53 44	59.88	53.17	65.72	63.12	58.23	6.7	7.2	9.85	10.66	29.2	13.04

M = Middle rows

B = Border rows

50 and 75 per cent flowering, reproductive phase and maturity, and 100 grain weight. The C. V. estimates for these characters ranged from 2.9 to 13.0 per cent indicated low environmental influence on these expressions. On the other hand, the C. V. estimates for yield were relatively high in both the years, because of uncontrollable effects of non-synchronous germination, drought, cold spell and frost. Another reason could be partial reseeding which gave productive plants.

It is interesting to observe that significant block influences for the duration of first flowering turned non-significant for the durations of 50 and 75 per cent flowering. These expressions suggested that in spite of delayed partial reseeding and moisture stress at different stages of plants, there was a trend for physiological recoupement. Thus, reduced gaps between reseedings appeared to be a measure for stabilising plant densities and yield even in adverse years.

On an average, there was difference of 13 and 14 days, respectively between durations of the first, 50 and 75 per cent flowering. Corresponding differences of 28 and 26 days in Aruna suggested the possibility of inducing synchrony in flowering by isolating suitable recombinations. Non-synchronous germination, in general, and more so in rainfed areas results in wide physiological differences in plants (Slatyer, 1969), which might be responsible for non-synchronous flowering and maturity. Therefore, breeding for synchronous germination might result in synchronous flowering and maturity, which in return would economise production by reducing frequency of pickings and losses caused by shattering of capsules. Another advantage of synchronous maturity would be low free fatty acid content of oil.

Contrary to popular belief that large seeds (Stebbins, 1950 and Asana and Sinha, 1970) are important for moisture stress areas, this investigation (Table 2) suggested that in contrast to Pb No. 1 having the boldest seed size (31.80 g/100 seeds), strains namely, 1-32, Aruna and 144 with smaller seeds (15.96, 15.26 and 17.88 g/100 seeds, respectively) gave more yield than the control (Pb Castor No. 1). Therefore, instead of laying emphasis on one character, suitable growth rhythm and duration (Swaminathan, 1970) of Castor bean material is necessary for stabilizing and increasing production in low rainfall areas.

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AN ANALYSIS OF PRICE BEHAVIOUR OF RAPESEED AND MUSTARD IN HARYANA

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ABSTRACT

The analysis of the time series data of the arrivals and prices of rapeseed and mustard showed that the prices of both rapeseed and mustard increased significantly overtime in the Hissar and Rewari markets. The growth of the arrivals was found insignificant in both the markets. The seasonal indices of prices and arrivals of rapeseed and mustard indicated that both the commodities were highly seasonal in nature, however, prices and arrivals moved in the opposite directions. Two markets were found integrated with respect to prices. The study suggests establishment of ware-houses for the storage of the commodity by the producers so that the farmers may be able to sell their produce when the prices in the markets are more remunerative. The Government should also fix minimum support price of both the commodities to minimize the price fluctuations.

Rapeseed and mustard is one of the most important oil-seed crops of India in general and of northern States in particular. India is the second largest producer of rapeseed and mustard in the world contributing about 12 per cent of the world production. Production of rapeseed and mustard in India was 1,858 thousand tonnes in the year 1972-73. In India, Haryana State ranks fourth in production of rapeseed and mustard which accounted for 6.20 per cent of the area and 5.37 per cent of the production of rapeseed and mustard in India in 1972-73.

Since both these crops are commonly grown in the dry farming regions of the state, therefore, great fluctuations were observed both in acreage and production of these crops. The substantial increase and decrease in the production of rapeseed and mustard created many problems in the markets, such as unfavourable price structure, lack of market integration, high marketing margins and costs, high processing costs etc. As price is one of the major factors responsible for the variation in the production, it is of utmost importance to study the price behaviour of rapeseed and mustard. The specific objectives of the study were as follows :

1. To examine the structure, arrivals and prices of rapeseed and mustard
2. To study the extent of market integration.

MATERIAL AND METHODS

Selection of districts

Rapeseed and mustard is mainly grown in the Hissar, Bhiwani, Gurgaon and Mahendergarh districts of Haryana State which contributed 71.30 per cent of the total production and 73.73 per cent of the total area in 1972-73. Hence Hissar and Mahendergarh districts which were major rapeseed and mustard producing districts were purposively selected for the study.

Selection of markets

In the selected districts there were five main markets for rapeseed and mustard. The total arrivals of the rapeseed and mustard were highests in the Hissar market of the Hissar district and Rewari market of Mahendergarh district. Therefore, these two markets were selected purposively for this study.

Data

To study the trend and seasonal variations of the market arrivals and prices, time series data from 1964-65 to 1973-74 were collected from the market Committees of the selected markets.

Analysis

Linear trend equation of the following form was fitted. $Y_e = a + bt$. Where

Y_e = the estimated arrivals in the quintal/price in rupees per quintal of rapeseed and mustard.

a = value of intercept or value of Y_e when t = o.

b = rate of change in dependent variable Y_e by one unit change in it.

t = number of time units in months (1964-65 to 1973-74).

The average of all the years was assumed to be equal to 100 to calculate the yearly indices of arrivals and prices of rapeseed and mustard from 1964-65 to 1973-74. The behaviour of arrivals and prices were studied by spliting the year into three periods namely peak (March to June), medium (July to October) and lean (November to February). Percentage of arrivals and average prices of mustard during three marketing periods for Hissar and Rewari markets (1964-65 to 1973-74) were also worked out.

Rapeseed arrivals were confined from April to June in all the years in both the markets. Therefore, seasonal variation in case of rapeseed was not studied. There are many methods of finding out the seasonal variation of arrivals and prices namely, moving average method, link relative method, percentage to trend method, monthly means method and monthly average method. Each method was tried but monthly means method gave stable, clear and definite seasonal variation, therefore, this method was used to work out seasonal variation in prices and arrivals of mustard[1] (Green Wold, 1963).

1. The Averages were computed for the original observations for each month in the period. These averages were converted into relatives by equating their aggregates to 1200. Then a trend adjustment of these indices was computed from the annual total of the years in the seasonal period. First the annual totals were converted into relative form and aggregated to (N × 100) where N stands for number of years involved. A trend equation was fitted to the annual relatives. Since middle of the series of indices was the centre of the period, trend adjustments were made in the index from centre of the year. The centre of the year was between June and July and all months were divided by half month.

To study the horizontal market integration the average price differences of the ten years were taken and paired 't' test was applied to know whether the two markets were integrated or not. The incidental charges were also compared with the price differences to see whether it was profitable to buy rapeseed and mustard from one market and sell into another market or not.

RESULTS AND DISCUSSION

Time series data are composed of trend, seasonal, cyclical and irregular movements. The first two are more important than the last two, for the farmers, market intermediaries and the policy makers. Hence the trend and seasonal variation in the prices and arrivals of rapeseed and mustard were studied.

(a) The secular trend

Annual indices of rapeseed and mustard arrivals and prices were worked out in order to examine the year to year changes in arrivals and prices of rapeseed and mustard in Hissar and Rewari markets from 1964-65 to 1973-74. Table 1 showed that the prices had a general tendency to rise in both the markets with each passing year, except some years, both in case of rapeseed and mustard. In case of arrivals of rapeseed and mustard there were great fluctuations in both the markets without showing any apparent trend. This was perhaps mainly due to dependence of rapeseed and mustard production on winter rains and temperature variation which are always almost irregular and uncertain.

Since no clear cut trend was visible from the indices, trend equation was fitted and results are presented in Table 2.

It is apparent from Table 2 that prices of rapeseed and mustard in both the markets have increased significantly with the passage of time. The arrivals of mustard in both the markets increased a bit

TABLE 1

Indices of arrivals and prices of rapeseed and mustard

Year	Rapeseed				Mustard			
	Hissar		Rewari		Hissar		Rewari	
	Arrivals	Prices	Arrivals	Prices	Arrivals	Prices	Arrivals	Prices
1964-65	102.8	53.5	51.7	72.3	73.8	74.6	61.5	76.1
1965-66	172.2	89.9	125.4	73.9	213.8	80.2	89.8	81.3
1966-67	32.7	88.9	13.8	101.6	61.8	86.9	121.3	88.8
1967-68	67.2	122.9	5.5	111.9	87.8	98.4	52.1	101.0
1968-69	185.8	71.7	104.4	79.4	114.7	83.5	65.0	84.8
1969-70	7.5	94.1	12.8	98.2	14.7	94.0	60.7	96.2
1970-71	218.0	110.4	56.5	107.6	117.6	104.0	105.6	106.3
1971-72	79.8	114.9	235.8	101.1	150.1	101.3	135.8	101.2
1972-73	54.7	114.8	106.8	116.6	78.3	107.6	120.5	103.7
1973-74	78.8	124.1	111.8	138.7	85.8	150.3	170.0	158.9

TABLE 2

Trends of arrivals and prices of rapeseed and mustard

Market	Commodity	Constant (a)	Co-efficient (b)
		Prices	
Hissar	Mustard	171.19	0.90**(0.02)
Rewari	Mustard	172.74	1.16**(0.04)
Hissar	Rapeseed	130.73	2.74**(0.20)
Rewari	Rapeseed	128.62	2.44**(0.15)
		Arrivals	
Hissar	Mustard	5100.79	13.60(32.42)
Rewari	Mustard	4772.38	11.74(8.6)
Hissar	Rapeseed	386.68	−5.78(4.60)
Rewari	Rapeseed	70.10	1.98(0.86)

Figures in parentheses show standard error of the co-efficient.

*Significant at 5 per cent level. **Significant at 1 per cent level.

TABLE 3

Seasonal indices of the prices and arrivals

	Hisser		Rewari	
Months	Arrivals	Prices	Arrivals	Prices
March	329	89	158	85
April	401	91	479	86
May	178	93	213	94
June	99	97	109	98
July	61	99	51	100
August	25	101	34	103
September	30	104	36	106
October	28	105	33	106
November	20	107	28	107
December	12	108	23	110
January	8	108	23	106
February	12	99	13	106

TABLE 4

Average of monthly prices of rapeseed in Hissar and Rewari markets from 1964-65 to 1973-74

Month	Average price in Hissar Rs./Qtl.	Average price in Rewari Rs./Qtl.	Price difference Rs./Qtl.
April	124.8	113.12	11.68
May	120.5	117.37	3.13
June	120.6	124.20	3.60

TABLE 5

Average of monthly prices of mustard in Hissar and Rewari markets from 1964-65 to 1973-74

Months	Average price in Rewari Rs./Qtl.	Average price in Hissar Rs./Qtl.	Price difference Rs./Qtl.
March	147.5	148.2	0.7
April	149.4	153.0	3.6
May	162.1	155.7	6.4
June	167.6	163.1	4.5
July	171.7	161.5	4.2
August	179.7	172.5	7.4
September	181.3	176.4	4.9
October	181.8	178.5	3.3
November	180.9	182.0	11.1
December	187.6	183.0	3.8
January	180.7	185.3	4.6
February	180.0	170.5	9.5

overtime, while the arrivals of rapeseed increased only in Rewari market. However the rate of increase was insignificant in both the markets. In case of Hissar marked declining trend in the arrivals was observed.

(2) Seasonal variation

The seasonal indices of mustard prices and arrivals are shown in Table 3.

Majority of the farmers (especially small and medium) sold their produce during the post-harvest period, called the peak marketing period, at the lowest price. The traders bought the produce at the lowest price and sold same produce at the highest price when the farmers again bought the commodity for seed or home consumption during the later part of the year (November to December). The traders accumulated their stock during the post-harvest period and started releasing it from September onwards and thus took full advantages of seasonal fluctuations in mustard price. Though the seasonal fluctuations of prices could not be eleminated altogether, yet it could be reduced to a great extent by providing ware-housing facilities to the farmers, financial assistance to the small and medium farmers to meet their crop input requirements of the coming crops and by fixing minimum support price.

Table 3 revealed that in both the markets namely Hissar and Rewari the arrivals were highest during the peak marketing period (March to June) ranging from 94 to 401 per cent in Hissar market and 108 to 479 per cent in Rewari market. The arrivals ranged from 22 per cent to 61 per cent in Hissar market and from 28 per cent to 51 per cent in Rewari market during the medium marketing period (July to October). During the lean marketing period the arrivals were lowest in both the markets ranging from 8 per cent to 12 per cent and 13 per cent to 23 per cent in Hissar and Rewari markets, respectively.

The price behaviour was just opposite to that of arrivals. The prices were maximum during the lean marketing period (November to February) ranging from 99 per cent to 108 per cent in Hissar market and 106 to 110 per cent in Rewari market. The prices were lowest during the peak marketing period from 89 to 97 per cent and 85 to 95 per cent in Hissar and Rewari markets, respectively. It indicated that prices were lowest during the period when the arrivals were the highest and on the other side the prices were the highest in the months when the arrivals were lowest.

(b) Market integration

Rapeseed and mustard are such crops as can be stored for a fairly long period and the arrivals may not lead to wider price difference from market to market immediately. The real differences in the prices cannot be worked out by taking the short period. Hence to provide true picture the average prices of many years were considered.

The paired 't' test was applied in both the cases to know whether two markets were integrated or not. It was observed that in case of rapeseed and mustard the differences were found to be insignificant at 1 per cent level of significance, showing that the two markets were integrated. These price differences were compared with incidental charges and the result was that with the exception of February the markets were found to be integrated with each other. Hence there was no advantage for the traders to buy the mustard in one market and sell it in other market. In case of rapeseed also the two markets were also integrated but, on the whole, prices remained high in Hissar market as compared to Rewari markets.

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EFFICIENCY OF FEEDS AND FODDER RESOURCE ALLOCATION ON MIXED FARMS IN ETAH DISTRICT (U.P.)*

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ABSTRACT

The study revealed that sample farmers were using their *feeds* and fodder resources optimally. It refuted the view that farmers are indifferent to the dairy enterprise. The results emphasised the critical role played by green fodders in feeding plans The study suggests that for the success of any dairy development programme, it is essential to provide suitable green fodder crops. For minimisation of cost of milk production new and cheap fodder and concentrates must be made available. Among concentrates *sarson* cake was found more economical than other concentrates for lower level of milk production but for higher levels of milk production feeding plans call for some amount of 'gold mohur' or barley alongwith *sarson* cake.

Most studies pertaining to efficiency of resource use in Indian agriculture have ignored the livestock enterprise. The assumption is usually made that it is a supplementary enterprise and does not compete for resources with the main crop enterprises. Ramsubhan and Goel (1965) observed that milk production was not a profitable proposition and that it formed part of the farm business because farm families had a very high preference for milk consumption.

The above assumption may hold for some farmers or for some parts of the country but it would be unrealistic to assume so for all the farmers particularly where milk production has been commercialized. In view of the growing awareness of the nutrition and other implications of a viable livestock sector, specially in arid and semi-arid regions, it would not be appropriate to assume away this alternative. An examination of the nature of resource use efficiency in milk production with particular reference to areas where it has been commercialised is, therefore, relevant in more than one context. The present study attempts on this aspect for farms in Etah District of Uttar Pradesh. The Hindustan Levers milk processing plant at Etah has been operative since

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1963, and incentives are being provided to participating farmers by way of loans for purchase of feed inputs, better breeds of buffaloes and an assured market for their product.

The main objectives of this study were (a) to evaluate the existing feeding practices in terms of nutritional requirements and (b) to examine the rationality of existing feed and fodder use pattern of milk production and to explore possibilities of minimising milk production costs by optimal combination of these inputs.

MATERIAL AND METHODS

This study relates to the area covered by the Hindustan Levers milk processing plant in Etah district. The data were collected from 60 farmers selling milk to the processing plant from 4 villages selected by multi-stage stratified random sampling and pertain to the 1967-68 agricultural year.

The major emphasis of the study was on murrah buffaloes, the common improved breed of the area. Since a considerable amount of variation in input-output relation for milk production accurs because of lactation differences, the animals were classified according to this factor and subsequent analysis relates to second lactation animals only.

Feeding practices differ significantly between seasons, mainly on account of availability or otherwise of seasonal fodders. It was, therefore, necessary to develop feed-mix plans for different seasons separately. These were: (i) rainy season-mid-July to mid-October (ii) Winter I-mid-October to November, (iii) Winter II-December to February and (iv) Summer-March to mid-July.

Linear progamming technique was adopted to develop least-cost feedings plans for three levels of milk production: 4 kg, 5 kg and 6 kg per day. The average yield for animals in the second lactation varied from 4 to 6 kg per day, for each of the four seasons. The cost minimising model contained a number of concentrate and fodder activities in the technological matrices for different seasons (Table 1). The concentrates remained the same in all the seasons while the fodder activities differed. The constraints considered in the model included minimum restrictions on the amounts of total digestible nutrients (TDN) digestible crude protein (DCP), Calcium (Ca) and Phosphorus (P). Maximum restrictions on the amount of dry matter in the ration and for the amount of leguminous greens available in Winter II season were also imposed. The levels of nutrients required for different levels of milk yield were based on actual feedings and transformed with the help of Sen's bulletin (1964). These have been given in Table 2 which also shows

TABLE 1

Feed and fodder activities in different seasons

Concentrates	Fodders
Sarson Cake	Rainy Season-Jowar *Chari*, Wheat *Bhoosa*
Cotton Seed	Winter-I-Bajra *Karabi*,
Gram	Wheat *Bhoosa*
Barley	Winter-II-Bajra *Karabi*, Wheat *Bhoosa*,
Maize	leguminous greens
Jowar	
Gold Mohur	Summer-Wheat *Bhoosa*

the corresponding requirements based on Morrison's standard (1954). The input coefficients for different activities were obtained from the Sen's bulletin (1964). The input coefficient of different feeds and fodder have been given in Table 4.

The Table 1 gives the existing level of nutrient uptake in different seasons and also the requirements in terms of total ration (maintenance plus produc tion) calculated for 950 lb body weight and 6.5 per cent fat content as indiceted by Morrison's standard.

The average figures indicated that the levels of TDN, Ca and P in the diets of animals were generally higher as compared to Morrison's recommendations. With respect to DCP also, only for 5 kg milk yield the actual was marginally lower. On the whole, the averages indicated a fairly satisfactory position.

When seasonal feeding patterns were examined against the recommendations, a more detailed picture emerged. In all seasons, the ration fed to animals contained more of TDN, Ca and P than the

TABLE 2

Actual nutrient levels and Morrison's nutrient requirements for different levels of milk production in kilogrammes per day

Milk yield level	Existing/ recommended level	Season	Dry matter (DM)	Total digestible nutrients (TDN)	Digestible crude protein (DCP)	Calcium (Ca)	Phosphorus (P)
4 kg	Existing	Rainy	*	—	—	—	—
		Winter-I	*	—	—	—	—
		Winter-II	11.2272	6.4724	0.6553	0.0523	0.0262
		Summer	10.7128	5.5714	0.3854	0.0377	0.0201
		Average	10.9700	6.0219	0.5203	0.0450	0.0231
	Recommended		11.5000	4.9832	0.5079	0.0183	0.0163
5 kg	Existing	Rainy	11.4177	6.6712	0.5720	0.0422	0.0344
		Winter-I	10.0728	6.3735	0.4573	0.0377	0.0246
		Winter-II	10.0178	6.9508	0.7202	0.0558	0.0287
		Summer	11.2001	5.9114	0.4547	0.0399	0.0226
		Average	11.4271	6.4767	0.5510	0.0439	0.0276
	Recommended		11.5000	5.4182	0.5674	0.0205	0.0180
6 kg	Existing	Rainy	12.2927	7.1289	0.5863	0.0445	0.0358
		Winter-I	11.5155	6.6045	0.4999	0.0401	0.0262
		Winter-II	12.3816	7.1224	0.7670	0.0574	0.0305
		Summer	11.5813	6.1805	0.4963	0.0413	0.0241
		Average	11.9428	6.7591	0.5874	0.0458	0.0291
	Recommended		11.50000	5.8532	0.6269	0.0227	0.0197

*There were no observations for 4 kg yield level in rainy and winter-I seasons.

required level. With respect to DCP, however, the deficiencies were marked in the averages discussed above. Except in winter-II when the actual level of DCP fed to animals was 22 to 29 per cent higher than the required amount for different yield levels, and to some extent in the rainy season, the diets were deficient in winter-I and summer season by about one fifth of the standard. This supports the findings of Amble (1965) who observed that the animals in milk received about 70 per cent of their required DCP through stall feeding.

Analysis of the current feeding plans provided further insight into the matter. Table 4 gives the nutrient level of different feeds and fodders. In the summer season concentrates were the only source of DCP because wheat bhoosa, the sole fodder available, did not contain any DCP at all. In rainy and winter-I, *jowar chari* and *bajra karabi*, respectively, provided, partially, the required amount of DCP. In the former case, even though the DCP level was lower in *jowar chari* as compared to that in *bajra karabi*, the possibility of feeding a greater bulk without the dry matter restriction being operative, allowed for a generally satisfactory level of this nutrient component in the feed. In winter-II, the availability of leguminous greens, rich in DCP, ensured a more than adequate digestible protein content in the ration.

Least cost feed plans were developed for each of the four seasons and three levels of milk yield. The costs in the existing as well as optimum plans have been presented in Table 3.

As examination of the total and average costs of producing different levels of milk in different seasons revealed that optimum use of feed and fodder inputs results in a reduction in the cost by 3.98 to 12.68 per cent only as compared to the existing costs. It implied, therefore, that the farmer's existing input use pattern was nearly optimal and that readjustments indicated by the optimal plans would bring about only marginal decreases in costs. This established the fact that the commercial milk producing farmers of Etah managed their milch animals efficiently and that there was no basis for assuming that the livestock enterprise was just a part of their way of life rather than a business proposition.

It was also observed that for all the three levels of milk yield, costs were lowest in winter-I and highest in winter-II in both existing as well as optimal plans. The inter-seasonal variation in average cost ranged between 6-8 paise per kilogram for different levels of milk yield. This, as will be clear from the discussion on feeding plans, results largely from the differences in green and dry fodder availability in different seasons. The average cost per kilogram of milk was also found to decrease with increase in level of milk yield.

In the existing plans, except in the winter-II season, the cost of roughages was invariably lower than the cost of concentrates. In winter-II, leguminous green fodders were available while in other seasons farmers placed relatively more emphasis on concentrates as source of nutrients. The least-cost plans, however, indicated that even in the rainy and winter-I season, in addition to winter-II, roughages proved to be cheaper source of nutrients. It must be borne in mind that these adjustments have only a

TABLE 3

Comparison of costs in optimal and existing plans

(Amount in rupees)

Season	Costs	4 kg of milk			5 kg of milk			6 kg of milk		
		Existing plan	Optimum plan	Percentage cost minimised	Existing plan	Optimum plan	Percentage cost minimised	Existing plan	Optimum plan	Percentage cost minimised
Rainy	Total *				2.61	2.30	11.88	2.76	2.41	12.68
	Cost of roughages				1.27	1.35		1.37	1.46	
	Cost of concentrates				1.34	0 95		1.39	0.95	
	Cost/kg of Milk				0.52	0.47		0.46	0.40	
Winter-I	Total *				2.39	2.20	7.95	2.47	2.27	8.10
	Cost of roughages				1.12	1.14		1.16	1.20	
	Cost of concentrates				1.27	1.06		1.31	1.07	
	Cost/kg of milk				0.48	0.44		0.41	0.38	
Winter-II	Total Cost	2.49	2.29	8.04	2.73	2.50	8.43	2 92	2.67	8.56
	Cost of roughages	1.40	1.44		1.48	1.51		1.50	1.53	
	Cost of concentrates	1.09	0.85		1.25	0.99		1.42	1.14	
	Cost/kg of milk	0.62	0.57		0.54	0.50		0.49	0.44	
Summer	Total Cost	2.26	2.17	3.98	2.54	2.41	5.12	2.76	2.59	6.16
	Cost of roughages	1.10	1.10		1.11	1.12		1.13	1.14	
	Cost of concentrates	1.16	1.07		1.43	1.29		1.63	1.55	
	Cost/kg of milk	0.56	0.54		0.51	0.48		0.46	0.43	

*There were no observations for 4 kg yield level in rainy and winter I seasons.

TABLE 4

Nutrient level of different feeds and fodders per kilogramme

Nutrient	*Sarson* cake	Cotton seed	Barley	Gram	Maize	*Jowar*	Gold Mohur[1]	Wheat *bhoosa*	*Bajra karabi*	Leguminous Greens[2]	*Jowar* chari
Dry Matter	0.9000	0.9000	0.9000	0.9000	0.9000	0.9000	0.9000	0.9000	0.9000	0.2000	0.3000
Total Digestible Nutrients	0.742	0.8000	0.7870	0.7450	0.8490	0.7360	0.6900	0.4210	0.4810	0.1220	0.1660
Digestible crude protein	0.2761	0.1124	0.0807	0.1076	0.0740	0.0657	0.1600	—	0.0084	0.0290	0.0050
Calcium	0.0076	0.0027	0.0014	0.0023	0.0006	—	—	0.0027	0.0027	0.0023	0.0010
Phosphorus	0.0099	0.0047	0 0035	0.0037	0.0036	—	—	0.0006	0.0011	0.0005	0.0007

1. A concentrate manufactured by Hindustan lever.
2. More than 90 per cent of this is green pea. A small amount of berseem, lucerne and other greens makes up the rest.

TABLE 5

Feed and fodder activities in existing and optimum plans in kilogrammes

Season/Activities	4 kg of milk		5 kg of milk		6 kg of milk	
	Existing plan	Optimum plan	Existing plan	Optimum plan	Existing plan	Optimum plan
Rainy						
Jowar chari	*		27.160	33 652	28.210	36.400
Wheat *bhoosa*			1.667	—	2.222	—
Total fodder			28.827	33.652	30 432	36.400
Sarson cake			1.333	1.462	1.344	1.464
Gram			0.633	—	0.689	—
Total concentrates			1.966	1.462	2.033	1.464
Winter-I						
Bajra karabi	*		8.920	10.638	9.259	11.120
What *bhoosa*			1.500	—	1.595	—
Total fodder			10.240	10.638	10.854	11.120
Sarson cake			1.167	1.196	1.333	1.388
Gram			0.217	—	0.267	—
Barley			—	0.470	—	0.287
Maize			0.500	—	0.344	—
Total concentrates			1.884	1.666	1.944	1.675
Winter-II						
Bajra karabi	7.940	9.369	8.486	10.034	8.437	10.199
Wheat *bhoosa*	1.207	—	1.250	—	1.477	—
Leguminous greens	7.778	8.006	7.987	8.006	8.167	8.006
Total fodder	16.925	17 375	17.723	18.040	18.021	18.205
Sarson cake	1.333	1.215	1.300	1.430	1.413	1.564
Gram	0.467	—	0.542	—	0.582	—
Maize	—	—	—	—	0.094	—
Barley	—	0.111	—	0.110	—	0.216
Total concentrates	1.600	1.326	1.842	1.540	2.089	1.780
Summer						
Wheat *bhoosa*	10.195	10.216	10.352	10.424	10.500	10.587
Total fodder	10.195	10.216	10.352	10.424	10.500	10.587
Sarson cake	1.217	1.275	1.364	1.493	1.433	1.598
Gram	0.392	—	0.727	—	0.935	—
Barley	—	0.412	—	0.528	—	0.683
Maize	0.100	—	—	—	—	—
Total concentrates	1.709	1.687	2.091	2.021	2.368	2.281

*There were no observations for 4 kg yield level in rainy and winter I seasons.

marginal impact on the total cost of production.

The information on cost of feed and fodder in the existing as well as optimal plans provides some interesting insight into the structure of milk prices. On an average, this cost comes to about 50 paise per kg of milk. If we add other variable costs like labour and supervision and the average fixed costs pertaining to housing, depreciation, interest and the maintenance costs during dry periods and also of dry animals in the herd, it becomes clear that the price of 90 paise per kg of milk paid by Levers does not leave a fair margin of profit for the farmers. This is an important point and needs more detailed analysis.

Feeding Plans

Table 5 gives the existing and optimum feeding plans for different seasons and levels of milk yield. There was not much difference between the existing and least-cost plans with regard to total fodder and concentrate quantities. However, it was indicated that it would be generally profitable to decrease the use of concentrates slightly and increase the level of fodders.

The composition of the existing and optimal feed mixes differed more than the aggregates. Among fodders, the existing feeding plans included wheat *bhoosa* in all seasons; it was the only fodder available in summer season. The least-cost plans indicated that it was not profitable to feed wheat *bhoosa* in any season except summer. The other important point which emerged was the superiority of green fodders over dry fodders. A study for the Delhi region by Singh (1965) also recommended substitution of wheat *bhoosa* by *karabi* and increase in the use of leguminous greens. Among concentrates, the least-cost plans preferred *sarson* cake along with some quantity of barley. The former was the most important concentrate in the existing plans also, gram and maize being the other supplements. The amount of concentrates fed was highest in the summer season in both existing and optimum plans. This was because of the non-availability of green fodder in this season.

On the whole, it appeared that the existing plans were quite in agreement with the least-cost ones, and this was responsible for only marginal reductions in costs on optimisation. The possibility of greeter cost economy by using more of greens in the ration was also observed. In the rainy and winter-II seasons, the optimum plans suggested a larger increase in the amount of greens and the cost reductions were also relatively larger.

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EFFECT OF SOME ENVIRONMENTAL AND PHYSIOLOGICAL FACTORS ON REPRODUCTION AND PRODUCTION TRAITS IN INDIAN BUFFALOES

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ABSTRACT

Data on reproduction and production performance of 674 buffaloes from two Military Farms in Punjab were analysed using least squares procedure of fitting constants. Farms, periods, seasons of calving, lactation order, age and weight at calving had significant effect on all the reproduction and production traits except for the dry period, in which case the farm differences were non-significant. The contribution to variation (R^2) in all traits was, however, very low. There was a decline in service period, calving interval and dry period with advance in lactation order. Milk yield increased up to fourth lactation and then it declined. The least squares averages for service period, calving interval, lactation yield, lactation length and dry period were 112.71±2.14 days, 430.11±2.04 days, 1736.29±10.12 kg, 272.88±1.12 days and 159.70±1.98 days, respectively.

Knowledge of the effects of various non-genetic factors on economic characters is important both for the adjustment of data in predicting breeding values of the animals and computing estimates of genetic and phenotypic parameters. Further, it may help in devising management practices and, therefore, in maximising production.

Several studies (Kohli and Malik, 1960*a*; *Singh and Desai,* 1962; *Khisin et al.*, 1963; Sekhon and Gehlon, 1966; Goswami and Kumar, 1967; Singh and Singh, 1971) have been conducted for this purpose, but no meaningful conclusions are possible as the effects of different factors were not studied simultaneously. This study was, therefore, conducted to find the independent influence of sequence of lactation, farm, period and season of calving, and age and weight at calving on service period, calving interval, milk yield, lactation length and dry period in Indian buffaloes.

MATERIAL AND METHODS

Two thousand five hundred and ninety six records on 674 farm bred Indian buffaloes for service period, calving interval, milk yield, lactation length and dry period and spread over a period of 25 years (1944 through 1968), from two Military Farms of Ferozepur and Jullundur, were used in this study.

Because of the possible occurrence of environmental and genetic trends over the whole period of study, the duration was divided into five periods of 5 years each. Again, the year of calving was classified into two seasons: least calving season-from January to June and most calving season-from July to December. As the number of observations in each sub-class was unequal and disproportionate, the method of fitting constants (Harvey, 1960) was used for the analysis. A linear model with the effect of farms, periods, seasons of calving, order of lactation, age and weight at calving was assumed. The effects of farm, period, season of calving and order of lactation were assumed to be fixed, whereas the effects of other two factors were taken as random. No interaction among these fixed effects was further assumed.

RESULTS AND DISCUSSION

The least squares constants with standard errors for each sub-class for reproduction and production traits are given in Tables 1 and 2 and the least squares analysis of variance in Tables 3 and 4. The least squares averages were 112.71 ± 2.14 days, 430.11 ± 2.04 days, 1736.29 ± 10.12 kg, 272.88 ± 1.12 days and 159.70 ± 1.98 days, for service period, calving interval, milk yield, lactation length and dry period, respectively. The average service period was similar to that reported by (Goswami and Kumar 1968). Much higher averages than the present one have been reported in other herds by various workers (Venkayya and Anantakrishnan, 1957; 1966; Kohli and Malik, 1960b; Rai, 1966; Singh *et al.*, 1972). The average for calving interval was similar to that reported by Sunkunny (1964), Goswami and Nair (1965) and Hadi (1965), whereas the higher average calving interval have been reported by various other workers in other herds (Tomar and Tomar, 1960; Bhatnagar *et al.*, 1961; Singh and Desai, 1962; Rai, 1966; William *et al.*, 1969). This shows that the herds under study were better from the point of view of reproduction standards than the other herds on which averages have been reported in the literature. The average lactation milk yield was similar to that reported by Dhinsa (1963). Higher average lactation milk yield has been reported by various other workers (Venkayya and Anantakrishnan, 1957; Tomar and Tomar, 1960; Arora *et al.*, 1962; Desai and Kumar, 1964; Venkayya and Anantakrishnan, 1964). The average lactation length and dry period were lower than those reported by various other workers (Tomar and Tomar, 1960; Bhatnagar *et al.*, 1961; Desai and Kumar, 1964; Venkayya and Anantakrishnan, 1964; Hadi, 1965; Rai, 1966).

Effect of farms

Farm differences were significant for all the reproduction and production traits except that for dry period. The R^2 did not exceed 0.79 per cent. This may be because of standard managerial practices being followed at Military Farms.

Effect of periods

Differences among periods were significant for all the reproduction and production traits. This effect accounted for 0.42 to 1.01 per cent of the total

TABLE 1

Least squares constants with standard errors for reproduction traits for different sub-classes

Traits/Subclass description	Service period (days)			Calving interval (days)		
	No. of obs.	Least squares constants	Standard error	No. of obs.	Least squares constants	Standard error
Overall (μ)	2154	112.71	2.14	2358	430.11	2.04
Farms						
1. Ferozepur	1257	8.79	2.73	1393	8.03	2.62
2. Jullundur	897	—8.79	2.73	965	—8.03	2.62
Periods						
1. (1944-48)	27	—34.21	17.73	32	—20.99	16.34
2. (1949-53)	124	7.00	9.45	134	3.54	8.99
3. (1954-58)	505	—5.17	6.46	508	—9.81	7.14
4. (1959-63)	843	19.38	6.03	961	14.93	5.62
5. (1964-68)	655	13.10	6.32	723	12.33	5.95
Seasons						
1. Least Calving (January-June)	438	24.37	3.06	477	25.79	2.93
2. Most calving (July-December)	1716	—24.37	3.06	1881	—25.79	2.93
Lactation Order						
1.	584	112.03	17.74	634	95.99	16.69
2.	470	72.97	14.01	502	65.33	13.16
3.	321	46.84	11.02	358	42.64	10.44
4.	233	17.69	9.16	261	14.04	8.66
5.	199	2.69	8.31	208	—1.99	8.06
6.	154	—16.94	9.41	165	—11.81	9.05
7.	83	—24.69	13.05	100	—20.51	11.98
8.	57	—61.67	16.59	66	—45.12	15.62
9.	32	—70.30	21.44	41	—60.72	19.56
10.	21	—78.62	21.65	23	—77.84	25.58
Regressions						
1. On age at calving	—	1.19	0.26	—	1.08	0.25
2. On weight at calving	—	—0.18	0.05	—	—0.18	0.05

TABLE 2

Least squares constants with standard errors for production traits for different sub-classes

Traits/Sub-Class description	Milk Yield (Kg)			Lactation length (days)			Dry period (days)		
	No. of obs.	Least sq. const.	Stand-ard error	No. of obs.	Least sq. const.	Stand-ard error	No. of obs.	Least sq. const.	Stand-ard error
Overall (μ)	2581	1763.29	10.12	2596	272.88	1.12	2419	159.70	1.98
Farms									
1. Ferozepur	1495	39.95	11.13	1504	5.86	1.26	1427	1.98	2.10
2. Jullundur	1086	—39.95	11.13	1092	—5.86	1.26	992	—1.98	2.10
Periods									
1. (1944-48)	32	—17.44	72.76	32	—13.43	8.27	32	—7.46	40.23
2. (1949-53)	144	113.63	39.00	144	5.13	4.44	137	—6.06	7.24
3. (1954-58)	550	26.41	26.95	551	—2.48	3.06	517	—7.45	5.00
4. (1959-63)	1012	—85.45	24.69	1022	3.45	2.88	994	16.09	4.53
5. (1964-68)	843	—37.15	25.76	847	7.33	2.93	739	4.88	4.81
Seasons									
1. Least Calving (Jan.-June)	527	99.30	12.46	528	9.79	1.42	493	14.30	2.35
2. Most calving (July-Dec.)	2054	—99.30	12.46	2068	—9.79	1.42	1926	—14.30	2.35
Lactation Order									
1.	670	97.42	70.97	674	45.13	8.04	649	47.08	13.32
2.	551	203.03	55.94	554	33.64	6.34	517	22.56	10.51
3.	402	212.41	44.33	403	22.30	5.02	364	13.26	8.33
4.	284	175.62	36.77	285	13.64	4.16	267	0.92	6.95
5.	225	120.88	34.38	228	2.95	3.89	215	—9.35	6.44
6.	187	25.14	37.96	187	—7.70	4.32	167	—10.50	7.29
7.	112	—7.47	50.60	114	—12.35	5.71	101	—8.12	9.67
8.	76	—244.86	65.25	76	—26.98	7.41	70	—13.16	12.40
9.	48	—345.54	81.33	49	—39.05	9.26	46	—20.45	15.14
10.	26	—136.26	108.56	26	—31.58	12.28	23	—22.64	16.51
Regressions									
1. On age at calving	—	3.72	1.04	—	0.60	0.12	—	0.37	0.19
2. On weight at calving	—	1.01	0.22	—	—0.03	0.03	—	—0.10	0.04

TABLE 3

Least squares analysis of variance for reproduction traits
(Method of fitting constants)

Source	Service period			Calving interval		
	d.f.	Mean squares	R^2%	d.f.	Mean squares	R^2%
Farms	1	131850.39**	0.44	1	120112 07**	0.37
Periods	4	58345.23**	0.78	4	58168.47**	0.72
Seasons	1	804783.94**	2.71	1	987465.26**	3.05
Lactation Orders	9	64792.31**	1.96	9	53459.45**	1.49
Regression 1[a]	1	262576.87**	0.88	1	244630.03**	0.76
Regression 2[b]	1	164420.71**	0.55	1	170996.36**	0.53
Error	2136	12729.59	91.47	2340	12781.53	92.49

**P∠0.01

[a] Regression 1. Partial regression on age at calving.
[b] Regression 2. Partial regression on weight at calving.

TABLE 4

Least squares analysis of variance for production traits
(Method of fitting constants)

Source	Milk yield			Lactation length			Dry period		
	d.f.	Mean squares	R^2%	d.f.	Mean squares	R^2%	d.f.	Mean squares	R^2%
Farms	1	3275070.32**	0.45	1	70915.68**	0.79	1	7623.23	0.04
Periods	4	1847179.69**	1.01	4	9550.46**	0.42	4	52700.46**	0.98
Seasons	1	16168480.14**	2.22	1	157515.70**	1.76	1	313486.34**	1.47
Lactation Orders	9	2461175.34**	3.04	9	12771 67**	1.29	9	24275.62**	1.02
Regression 1[a]	1	3215829.35**	0.44	1	85128.99**	0.95	1	30336 33	0 14
Regression 2[b]	1	5996493.31**	0.82	1	4150.82	0.05	1	55356.73*	0.26
Error	2563	254478.94	89.47	2578	3295 90	95.00	2401	8447.40	94 09

*P∠0.05
**P∠0.01

[a]Regression 1 Partial regression on age at calving.
[b]Regression 2. Partial regression on weight at calving.

variability in the various traits, the lowest being for the lactation length and highest being for the milk yield. Perusal of the least squares constants does not show any consistent trend in the differences due to periods in these traits. But it is possible to conclude from the magnitude of the constants that the buffaloes which calved during 1944 to 1948 had lower service period and calving interval as compared to those which calved between 1959 and 1968. This may probably be due to introduction of artificial insemination in these herds in the later years. Regarding the production traits, the magnitude of the constants indicate that the buffaloes which calved during 1949 to 1953 had comparatively higher milk yield, longer lactation length and shorter dry period as compared to those which calved between 1959 and 1968, which shows a decreased milk production and increased dry period. The differences in production traits may be attributed to the differential nutritional and managerial practices prevalent over different times.

Effect of season

The seasonal differences were significant for all the reproduction and production traits. The variability (R^2%) accounted for by this factor ranged between 1.47 and 3.05 per cent of the total variability amongst the various traits. The seasonal differences are not surprising as it has already been convincingly established that the buffaloes are seasonal breeders (Bhatnagar *et al.*, 1961; Singh, 1966). It is, therefore, expected that a large majority of the animals would calve in a manner that they could be bred on the ensuing breeding season. Furthermore, these would have comparatively shorter service period and thus shorter calving interval than those calving in the off season. The present findings regarding significant effect of season of calving on calving interval are in close agreement with those of Goswami and Nair (1965).

Regarding the production traits, a perusal of the least squares constants shows that the buffaloes which calved during least calving season (January to June) produced on an average more milk, had longer lactation length and dry period than their contemporaries which calved during the most calving season.

Effect of order of lactations

The order of lactation had a significant effect on all the reproduction and production traits. The variability explained by this factor varied between 1.02 and 3.04 per cent, the highest being for milk yield. The perusal of least squares constants shows that there was a gradual decline both in service period and calving interval from first to tenth lactation. Decline in service period with an advance in lactation number was also observed by Khisin *et al.* (1963) in Egyptian buffaloes. The decrease in calving interval with increase in lactation number was also reported by Goswami and Kumar (1967). The decline in service period and calving interval with the advancement in lactation order can be attributed to the fact that the rhythmic activity of physiological functions becomes more pronounced and thus the decline in the traits is obvious.

With respect to production traits, the perusal of the least squares constants shows that there was an increasing trend in the milk yield with the advance in lactation order. The yield was highest in the third lactation but there was no striking difference in least squares means of third and fourth lactations. The milk yield increased upto fourth lactation and remained more or less constant in the fifth lactation. From these results, it may be concluded that the buffaloes in the present herds reached lactational maturity somewhere in the fourth lactation. Thereafter the decline in the fifth lactation was small, but in subsequent lactations, it was substantial. Kohli and Malik (1960a), Singh and Desai (1962) and Sekhon and Gehlon (1966) also observed the lactational maturity in the fourth lactation. On the other hand, Singh and Singh (1971) observed lactational maturity in the fifth lactation. Perusal of their results showed that buffaloes in their study had much higher first lactation milk yield.

The sequence of lactation had a decreasing trend on the lactation length and dry period. There was a gradual decrease in lactation length as the age of the animal advanced. In case of dry period, the decline was more pronounced up to fourth lactation but, later on, it was gradual. The decline in dry period may be consequential to decline in service period of the later lactations, because dry period was dependent on service period.

Effect of age at calving

Age at calving had significant effect on both the reproduction and production traits with the exception of dry period where non-significant effect was observed. Though, the effect was statistically significant yet it did not contribute more than 0.95 per cent towards the total variability, which shows no biological significance of this factor.

Effect of weight at calving

Weight of calving had significant effect on the reproduction and production traits as well, with the exception of lactation length. As explained earlier, it also did not contribute much towards the total variability (maximum $R^2\%$ being 0.82 in case of service period) of these traits and thus no biological significance can be attached to this effect. Similar conclusion can be drawn from the perusal of the estimates of regression co-efficients.

From the above findings, it can be concluded that in terms of reproduction and production performance, the buffaloes of two herds did not differ much to each other. The differences among periods were significant for all the reproduction and production traits under study, but the megnitude of differences as revealed by R^2 value was of no biological significance. Seasonal differences were significant for all the traits. It is, therefore, expected that a large majority of animals would calve in a manner that they could be bred in the ensuing breeding season. The order of lactation had a significant effect on all the reproduction and production traits. Here a trend was revealed that there was a significant decline in service period and calving interval as the lactation order advanced. The milk yield increased up to fourth lactation and was nearly the same in the fifth lactation as well, after which there was a decline. Both the age and weight at calving had significant effects on reproduction and production traits, but as the R^2 values were low, no biological significance can be attached to these effects. As almost all the factors contributed less than four per cent towards the total variability in all the traits, no importance can be attached to them, and hence no adjustment is needed in data for conducting any genetic investigations on various reproduction and production traits of buffaloes of the two herds.

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FERTILITY AND HATCHABILITY OF INDIGENOUS AND EXOTIC BREEDS OF CHICKENS

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ABSTRACT

The fertility and hatchability of indigenous breeds (Desi, BB,NN, Aseel), exotic breeds (WL, RIR, WC) and some of the reciprocal mating groups involving indigenous and exotic breeds were studied. In general fertility was higher in the indigenous pure breeding as well as in crossbreeding groups having hens of indigenous breeds. However, hatchability on fertile eggs was higher in exotic purebreeding groups as well as in crossbreeding groups having hens of exotic breeds. The study indicated that the embryonic mortality in the indigenous breeds was higher as compared to the exotic breeds.

The cost of production of chicks is dependent on the reproduction efficiency of the breeding flock, the essential attributes of which are rate of lay and fertility and hatchability percentage.

Little information is available on the fertility and hatchability of indigenous chickens especially when crossed with exotic breeds. Such information is important when using natural/artificial breeding in producing breed crosses as mating incompatability or some other factors may create problem for adequate fertility and hatchability particularly when indigenous breeds are involved. This study was, therefore, undertaken to provide some information on fertility and hatchability of some available indigenous breeds, exotic breeds and their cross mating groups.

MATERIAL AND METHODS

Data collected under a PL 480 project 'Collection and evaluation of native fowl germ plasm' were available. In the year 1967, the breeding programme involved purebreeding of Desi (non-descript), White Leghorn (WL) and reciprocal crossing between these two breeds and in the year 1968, purebreeding of Desi, Rhode Island Red (RIR) and reciprocal crossing between these two breeds. There were 10 cocks in each group, each cock was mated to 10 hens. In the year 1969, purebreeds of Desi, Black Bengal (BB) and Naked Neck (NN) were produced and there were 26 cocks of Desi, 4 of BB and 2 of NN, each cock was mated to 5-10 hens. Hatching was done from February to April. In November 1969, 3 exotic (WL, RIR, WC)

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TABLE 1

Fertility and hatchability of Desi, WL, RIR and their mating groups

Year	Mating groups	No. of eggs set	No. of chicks hatched	Fertility %	Hatchability (%) TES	FES
1967	Desi x Desi	1498	1167	93.12[a]	77.90[a]	63.65[a]
"	Desi x WL	2477	1496	71.13[d]	60.39[c]	84.90[a]
"	WL x Desi	1251	882	85.61[b]	70.50[b]	82.35[a]
"	WL x WL	2504	1722	78.15[c]	68.76[b]	87.99[b]
1968	Desi x Desi	985	700	90.76[a]	71.06[a]	78.29[a]
"	Desi x RIR	1289	862	87.58[b]	66.87[b]	76.35[b]
"	RIR x Desi	827	591	90.32[a]	71.46[a]	79.11[a]
"	RIR x RIR	1387	900	86.40[b]	65.07[b]	75.31[b]

Percentage superscript with different letters within a year differed significantly

TABLE 2

Analysis of variance of unweighted means

Source of variation	Mean Squares: Desi and WL (1967) D. F.	Fertility	Hatchability TES	FES	Desi & RIR (1968) D. F.	Fertility	Hatchability TES	FES
Among mating groups	3	378.40**	87.62**	23.60	3	34.16	32.11	6.53
Among hatches	5	105.96**	62.96**	84.57**	4	30.87	247.91**	288.47**
Hatch x mating group	15	11.92	9.11	20.44	12	10.08	25.40	32.62
Residual	191	12.59	8.55	13.94	117	18.33	13.28	15.88

**$P \angle 0.01$.

TABLE 3

Fertility and hatchability of Desi, Black Bengal and Naked Neck

Breeds	No. of eggs set	No. of chicks hatched	Fertility %	Hatchability TES	FES
Desi	1787	985	81.25	55.12	67.83
Black Bengal	364	248	86.81	68.13	78.48
Nacked Neck	123	77	80.00	61.60	70.00

and 3 indigenous (Aseel, NN, BB) breeds were crossed in order to have 6 pure-breeding and 18 crossbreeding mating groups. In each group one cock was mated to 10 hens. The hens were alloted to cocks at random in all breeding programmes.

The eggs were stored at 55°F before incubation. Fertility percentage was calculated on the basis of candling on 18th day after incubation. Hatchability was worked out on total egg basis (TES) as well as on fertile basis (FES). The fertility and hatchability percentages were calculated hatchwise for each sire (mate) group and transformed to $Sine^{-1}$. The analysis of variance of unweighted means (Snedecor and Cochran, 1967) was run to find out the differences among mating groups, among hatches and mating group X hatch interaction. Further comparison of group mean was done by Duncan's multiple range test.

RESULTS AND DISCUSSION

The results of fertility and hatchability of different mating groups are presented in Table 1 to 6.

Desi, WL and their reciprocal mating groups

Highest fertility and hatchability (TES) was observed for Desi x Desi, followed, in descending order, by WL x Desi, WL x WL and Desi x WL. However, highest hatchability on FES was observed for WL x WL and lowest for WL x Desi. Significant differences were observed among the four mating groups for fertility and hatchability on TES and among hatches for all the three traits. The mating group x hatch interaction was not significant statistically. For fertility all the four mating groups were significantly different from each other. The hatchability on TES was significantly higher in Desi x Desi as compared to other mating groups. However, there little difference between WL x WL and WL x Desi but these groups were definitely superior to Desi x WL. The hatchability on FES was significantly higher in WL x WL than the other mating groups whereas no significant differences were observed among the other mating groups.

Desi, RIR and their reciprocal mating groups

The differences among groups in fertility and hatchability were not significant, however, the groups having Desi dams were found to be superior to the other two groups having RIR dams. Hatch differences were significant for both measures of hatchability and not for fertility indicating that embroynic mortality is affected by the date of hatch. The mating group x hatch interaction was not significant statistically.

Desi, NN and BB

Per cent fertility and hatchability, the latter expressed on total egg and fertile egg, did not differ significantly among the three breeds, and among hatches. NN had highest fertility followed in descending order by BB and Desi. However, the hatchability was highest in BB followed by NN and Desi. The hatchability of Desi observed in this year was much less than in the previous two years. This decline may be partly due to differences in the environmental factors and partly genetic, probably due to the inadvertent

TABLE 4

Analysis of variance of unweighted means

Source of variation	D. F.	Mean Squares		
		Fertility	Hatchability	
			TES	FES
Among breeds	2	64.61	117.75	77.79
Among hatches	4	41.82	73.84	48.48
Hatch x Breed	8	33.29	86.07	133.14
Residual	139	68.75	107.70	124.40

TABLE 5

Average fertility and hatchability for 3-indigenous, 3-exotic and their mating groups

Groups	No. of eggs set	No. of chicks hatched	Fertility %	Hatchability	
				TES	FES
All indigenous breeds	229	132	83.84	57.64	68.75
All exotic breeds	496	298	72.17	60.08	83.24
All groups with indigenous dams	953	444	71.66	46.58	65.00
All groups with exotic dams	2018	1273	75.91	63.08	83.09
All purebreeding groups	725	430	74.48	59.31	79.62
All crossbreeding groups	2246	1287	74 57	57.30	76.83

TABLE 6

Analysis of variance for fertility and hatchability in 3-indigenous x 3-exotic breed crosses

Source of variation	D. F.	Mean Squares		
		Fertility	Hatchability	
			TES	FES
Among mating groups	23	585.99**	662.52**	663.04**
Among hatches	2	1154.33**	122.29	131.42
Residual	46	99 51	188.29	201.30

**P∠0.01.

increase in the inbreeding coefficient (F=.05) since the flock size was small. Similar decline in fertility and hatchability was observed by Iyer (1949) in a close flock of Desi. The hatchability was 85 per cent during the year 1940–41 and it declined to 62 per cent during the year 1946–47. In latter years this value further declined to 57 per cent (Iyer, 1952). The hatchability in BB and NN was also low compared to any other exotic breeds. This may also be due to increase in inbreeding coefficient since the flock size was also small in these two breeds.

3–indigenous, 3 exotic and their reciprocal mating groups

Since there was one sire in each group, the results are being presented in various combinations (Table 5) to minimize the chance of error. The number of egg set was smaller in the groups where indigenous breeds were represented as females, however, the fertility and hatchability differed significantly among the various groups. Hatch differences were found to be significant for fertility. The fertility was higher in indigenous pure breeding groups as well as in all the crossbreeding groups having indigenous hens as compared to exotic purebreeding groups and also the crossbreeding groups having exotic hens. However, the hatchability (FES) was superior in the latter groups. There were little differences in the fertility and hatchability of purebreeding and crossbreeding groups.

The hatchability (FES) recorded at the Indian Veterinary Institute, Izatnagar, for WL, WL x Desi, RIR, RIR x Desi and Desi was 61, 69, 64, 63 and 62 per cent, respectively. These values are less compared to those obtained in the present study for the similiar mating groups. The per cent hatchability (TES) recorded at Agriculture College, Udaipur (Anon; 1968) was 65 for Desi, 72 for WL x Desi, 79 for WL x WL, 82 for Desi x WL, 55 for RIR x RIR, 76 for Desi x RIR and 62 for RIR x Desi mating groups. These values are slightly lower than those obtained in the present study except for Desi x WL and Desi x RIR groups. The fertility and hatchability (FES) of Aseel reported by Reddy (1972) was 80 and 86 per cent The fertility obtained in the present study for Aseel is almost similar but the hatchability was too low. Sharma (1974) reported the fertility of Aseel as 41 per cent and hatchability (FES) as 63 per cent. Evidence of mating incompatability was observed by him in Aseel x WR groups since the fertility was lowest (39%) in this group. The fertility and hatchability obtained in the present study for WL and RIR are in close agreement with those reported by Sharma and Bora (1965). Arora *et al.* (1971) reported the fertility and hatchability (TES) of Desi, BB, NN and Aseel. The values for per cent fertility were 86, 82, 95 and 85 for Desi, BB, NN and Aseel, respectively. The corresponding percentages for hatchability were 71, 56, 56 and 66. The fertility observed in the present study may be biased downward and hatchability (FES) upward since the candling was done on 18th day and, therefore, the very early embroynic mortality might have added to the infertility. The fertility may also be low since pen mating was adopted. In general the fertility was higher in groups having indigenous females whereas hatchability (FES) was higher in groups having exotic females.

This may probably be due to higher embryonic mortality in the eggs of indigenous breeds. This hypothesis is confirmed to some extent by the report of Arora and Arneja (1972). They observed that the effect of preincubation storage on the embryonic mortality was higher in the eggs of Desi than WL. The eggs were also stored at 50°F prior to incubation in the present study. Higher embryonic mortality in the indigenous breeds lead to the conclusion that probably the artificial incubation requirement is not the same as recommended for the exotic breeds. Further studies are required to confirm this hypothesis.

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THE ZUUR-VERHOEVEN METHOD FOR CALCULATING WATER MOVEMENT IN SALINE SOILS AND ITS APPLICATION TO SOME INDIAN DATA

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ABSTRACT

An attempt was made to apply the Zuur-Verhoeven method for calculating leaching and capillary rise for Indian conditions, using published data. Although estimates had to be made concerning the moisture content of the soils and the dilution factor of the saturation extract, the results seem promising. Calculated leaching from the upper 40 cm of uncultivated Rajasthan soil during monsoon was about 30 per cent of the rainfall. Capillary rise of 58 mm during rabi season was calculated for a maize-wheat crop rotation in Punjab, irrigated by tubewell water.

In combination with analyses of moisture content, the method can be used to evaluate the actual evapotranspiration from cropped as well as from fallow fields.

In the Netherlands, Zuur (1938) devised a method for estimating upward and downward movements of moisture in saline soils, using chloride ions as a tracer. Later on, this method was further refined and extensively tested by Verhoeven (1953).

The method is based on data, obtained by repeated sampling at fixed "standard spots"; the samples are analyzed for chloride ions and moisture contents. Careful sampling procedures are essential, as saline soils are usually characterized by considerable local variations in salinity.

In India, many observations have been made concerning salinity and its variations, as caused by monsoon rains, dry seasons and irrigation with water from tubewells. The results are usually expressed in terms of electrical conductivity and ionic composition of saturation extracts.

This work is an attempt to apply the Zuur-Verhoeven method to data published by Gupta and Abichandani (1970) and Arjan Singh (1969).

Principle of the method

The salt content of the soil is repeatedly determined by sampling layers of 20 cm thickness. For the upper layers (e.g., the upper 80 cm of the soil), the results are expressed as grammes of chlorides present under a standard area of 1 dm^2.

By sampling the soil profile before and after the wet season (with rainfall exceeding evapotranspiration; in the Netherlands the period October to March), the chloride losses due to leaching of the upper layers can be evaluated. The chlorides leached from the upper layers must have passed the underlying soil (e.g., the layer 80-100 cm). It is assumed that during this passage the salt concentration of the leacheate has been equal to the average salt concentration of the soil moisture in this layer, as found from sampling before and after the wet period. In other words, for this underlying layer the leaching efficiency is taken as unity.

From these data the amount of water leached can be calculated, dividing the salt losses from the upper layers (g/dm^2 area) by the average concentration of the soil moisture in the underlying layer (g/1); the result is found in dm.

In a similar way, capillary rise during the dry period can be found, dividing the increase in salts in the upper layers by the average salt concentration in the underlying soil.

Application to Indian data

The data used were the chloride contents of saturation extracts, as published by Gupta and Abichandani (1970) and Arjan Singh (1969). Chlorides were chosen as a base for calculation, because these ionsare neither adsorbed nor involved in precipitation reactions. In the profiles investigated, salinization is mainly of NaCl-type and there exists an excellent correlation between EC and Cl. However, as EC tends to become markedly influenced by other ions at low salt contents, chlorides are to be preferred.

In the following it is assumed that during monsoon salt and water movements take place at moisture contents near "field capacity". In these light-textured soils, field capacity is tentatively put at 30 per cent moisture by volume. More data should be collected about this moisture level.

To obtain a saturation extract, water has to be added. It is supposed that the amount of soil moisture present at saturation is n times the amount of soil moisture at field capacity. For leaching due to monsoon rains, the exact value of n is immaterial. In case of irrigation from tubewells, a value $n=2$ has been taken as a first approximation. Again, more research about this value is needed.

Percolation during monsoon in Rajasthan

As appears from Table 1, desalinization occurred during monsoon, but it was limited to the upper 40 cm of the soil. In the layer 0-40 cm, the chloride concentration in the extract averaged 95.75 meq/l before monsoon and dropped to 17.75 meq/l, a difference of 78.00 meq/l.

Under I dm^2 surface area, the volume of soil (0-40 cm) is 4 litres and the amount of moisture (at field capacity) is put at $0.3 \times 4 = 1.2$ litres. As the saturation extract is n times more diluted, the volume of extract from these 4 litres of soil would have been 1.2 n litres. Hence, the salt losses from the topsoil amounted to 78.00 meq/l $\times$ 1.2 n litres/$dm^2 = 93.60$ n meq/dm^2.

TABLE 1

Chloride concentrations in saturation extracts from a soil profile in Rajasthan, Dantiwada (Jodhpur), in 1964 (Gupta and Abichandani, 1970)

Depth cm	Cl-concentration in saturation extract meq/l before monsoon	after monsoon	Remarks
0-20	111.5	13.0	decrease
20-40	80.0	22.5	,,
40-60	70.0	118.5	average 94.25
60-100	58 0	99.0	*increase*
100-150	45.5	70.0	,,
150-200	45.0	90.0	,,
average	68.33	68.83	no difference

In the underlying layer (40-60 cm), the average chloride concentration of the extract was 94.25 meq/l. As the extract is n times diluted, the concentration of the soil moisture at field capacity will have been 94.25 n meq/l. Division of salt losses by this concentration gives a calculated percolation of 0.99 dm or 9.9 cm of water. The dilution factor n cancels, provided it is the same throughout the *soil profile*. Compared to a rainfall of 35 cm, the percolation (at a depth of 40 cm) was 28 per cent of the total precipitation.

For all profiles investigated, results are listed in Table 2. In three cases out of four, percolation was about 30 per cent of the rainfall. At the fourth location, at Shikarpur, leaching was surprisingly deep and rapid and no percolation could be computed.

TABLE 2

Calculated leaching in Rajastan profiles during the 1964 monsoon (Gupta and Abichandani, 1970)

Location	Depth cm	Rainfall cm	Leaching cm	Leaching in % of rainfall
Dantiwada	0-40	35	9.9	28%
Kaparda	0-40	35	11.6	33%
Jelwa	0-40	40	12 7	32%
Shikarpur	—	45	could not be calculated	

TABLE 3

Chloride concentrations in saturation extracts from a soil profile in Punjab, Manoke (Ludhiana) in 1968–1969. (Arjan Singh, 1969 : values read from his Fig. 4)

Depth cm	Cl-concentration in saturation extract meq/l 22-8-1968	21-6-1969	Remarks
0-10	4.2	7.8	increase
10-20	5.1	11.9	"
20-30	6.6	13.8	"
30-40	7.1	15.4	"
40-50	7.6	14.7	"
50-60	8.2	13.8	"
60-70	7.6	11.4	"
70-80	8.5	9.6	"
80-90	average 7.94 meq/l		almost constant

Resalinization due to supply of tubewell water and capillary rise in Punjab

As appears from Table 3, the upper 80 cm of the profile showed considerable increase in salinity during the period between monsoons. The soil was under maize-wheat rotation and was irrigated by tubewell-water, containing 1.40 meq/l of chlorides.

During the period of observation, the chloride content of the extract, averaged over the upper 80 cm, rose from 6.86 to 12.30 meq/1, an increase of 5.44 meq/1. Under 1 dm^2 of surface area, soil moisture (taken as 30 per cent by volume at field capacity) amounted to 2.4 litres.

Assuming $n=2$, this corresponds with 4.8 litres of saturation extract, so that the increase in chlorides in the upper 80 cm becomes 26.11 meq/dm^2. This increase is partly due to supply of water containing some salt. In total 80 cm of water was used for irrigation, corresponding with an addition of salts of $8 \times 1.40 = 11.20$ meq/m^2.

The remainder, being 14.91 meq/dm^2, represents the influence of capillary rise. The chloride concentration in the extract from the underlying 80-90 cm layer hardly varied and averaged 7.94 meq/l. At $n=2$ this would correspond with 15.88 meq/l in the soil moisture at field capacity.

However, the soil had become markedly drier during the rabi season. Field capacity (1/3 bar percentage) was 22.01 per cent by weight in this soil layer; at a dry bulk density of 1.4 this would correspond to 30.8 per cent by volume, in close agreement with the volume used above. From soil sampling it appeared, however, that at 90 cm depth soil moisture decreased from 19.7 per cent by weight to 10.0 per cent by weight; over the season the average moisture content was only 13.64 per cent by weight. Hence, the average concentration of the ascending water was $\frac{22.01}{13.64}$ times as high as at field capacity : this yields 25.62 meq/l Cl for the rising moisture.

Division of the salt gains in the upper 80 cm by this concentration results in a calculated capillary rise of 0.58 dm or 5.8 cm over a period of about 300 days.

This means that leaching during monsoon will probably be sufficient to maintain a low salinity level in this soil under the existing conditions of land use.

Water balance

From the foregoing account and from data on moisture contents given by Arjan Singh (1969), the water balance of the Punjab soil can be derived. The balance reads :

$$P+I+C=ET_{act}+\triangle ST$$

where : P : precipitation cm
I : irrigation ,,
C : capillary rise ,,
ET_{act} : actual evapotranspiration ,,
$\triangle ST$: increase in soil moisture storage ,,

In the case studied P=9.85 I=80.0 C=5.8 and $\triangle ST=-7.9$ cm for the upper layers of the soil. Therefore, the actual evapotranspiration has been 103.55 cm.

As no losses towards the ground-water occurred during the period of observation, the data prove that irrigation had been highly efficient.

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CHEMICAL CONTROL OF TERMITES* IN WHEAT WITH BHC AND ALDRIN APPLIED BY DIFFERENT TECHNIQUES

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ABSTRACT

Field experiments for the control of termites in wheat crop were conducted under irrigated and *barani* conditions using BHC dust and aldrin dust and EC by different techniques. Seventeen treatments, including the control, were compared during the period 1971-72 to 1973-74 and for their assessment, termite infestation and yield data were recorded. On the basis of both the effectiveness and the economics aldrin EC at 125.0 g actual per quintal seed proved the best. Seed treatment with dusts of BHC at 125.0 g and aldrin at 62.5 g actual per quintal though less effective in checking termite attack, gave enhanced yields. Pre-sowing soil application with BHC dust at 2.5 kg actual per hectare was not effective and that with aldrin dust at 1.875 kg actual per hectare not economical, though the latter was at par with BHC or aldrin dry-seed-treatment method so far as yield was concerned.

About 23 per cent of the total cropped area in Haryana is put under wheat, and the average wheat yield works out to a mere 2041 kg per hectare (Anon., 1973). Termites which are the only major insect pest of wheat, particularly in light soils and under conditions of low moisture, play a decisive role in lowering the yields of this crop in the State. Pre-sowing soil treatment with BHC or aldrin dusts or application of aldrin emulsion with the first irrigation water has earlier been recommended for the control of termites in wheat (Anon., 1974). These treatments are not only less effective in checking termite damage but are also costly. Therefore, studies to work out cheaper and more effective methods were undertaken.

Verma *et al.* (1974) observed that pre-sowing soil treatment with aldrin and BHC proved better than their application, at the same doses, with first irrigation water. It has also been found (Verma *et al.*, 1971) that dry-seed-treatment with BHC wettable powder or smearing the seeds with aldrin emulsion at doses higher than 250 g actual per quintal seed hampered seed germination. In seed

*Identified to be *Microtermes obesi* Holmgren.

treatment experiments with aldrin and BHC dusts (Verma, 1974) it was observed that wet-seed-treatment with aldrin 5 per cent dust even at 3.75 kg actual per quintal seed did not hamper wheat germination, whereas with BHC 10 per cent dust the adverse effects were seen at doses higher than 0.25 kg. During these studies it was noticed that for dry-seed-treatment, a maximum of 1.25 kg of insecticidal dust was taken up by one quintal of seed. The results obtained in these studies formed the basis for selecting the treatments for the termite control experiments conducted during 1971-72 to 1973-74.

MATERIAL AND METHODS

The studies were conducted at the Haryana Agricultural University Farm, Hissar. The experiments during 1971-72 and 1972-73 were conducted under irrigated and during 1973-74 under dry farming conditions. The lay-out of the experiment was always on randomised block design with three replications and between any two sub-plots one metre wide buffer area was provided. Wheat variety C-306 was used with a seed rate of 100 kg/ha. Recommended agronomic practices in respect of fertilizers and irrigations were followed. Doses of insecticides used for seed treatment have always been expressed as actual toxicant per quintal seed.

For dry-seed-treatment, required quantity of insecticidal dust/WP was added directly to the seed in a glass jar which was then shaken well to ensure uniform coating of the toxicant over the seeds. For seed treatment with aldrin emulsion, calculated volume of Aldrex 30 EC was diluted with tap water to a volume which was just sufficient to moisten the required quantity of seed. The seed was then treated with thus prepared emulsion. It was found that 50 ml of aldrin emulsion was enough to moisten 1 kg of seed. Wet-seed-treatment was done by adding calculated quantity of insecticidal dust to water-wetted seed in a glass jar which was then shaken well to get a uniform coating of the dust over the seeds. Unless otherwise mentioned, the seed was treated with insecticides 12 to 16 hr before sowing. During this period the treated seed was kept spread on paper sheets under laboratory conditions. Pre-sowing soil treatment with insecticidal dust was done by taking the required quantity of the toxicant, mixing it with some damp soil and then spreading the mixture in a given plot.

During 1971-72, the seed treatments used were : 62.5 and 125.0 g BHC as 10 per cent dust; 62.5, 125.0, 187.5 and 250.0 g BHC as 50 WP; 62.5 g aldrin as 5 per cent dust; and 62.5, 125.0, 187.5 and 250.0 g aldrin as 30 EC. Thus the twelve treatments, including the control (Table 1) were compared in plots of the size of 16×5 m. Sowings were done during the first week of December, 1971.

The six treatments which performed better during 1971-72 were retested during 1972-73 (Table 2). The sowings were done during the third week of December, 1972. The plot size was 13×3.3 metres.

During 1973-74 a total of 11 insecticidal treatments were compared (Table 3). These comprised the six treatments which had been tried during 1972-73; wet-seed-treatments with 125.0, 250.0 and 625.0 g aldrin as 5 per cent dust;

TABLE 1

Effect of seed treatment with BHC and aldrin on plant damage by termites and yield of wheat under irrigated conditions during 1971–72

Insecticide (actual/q seed) used as seed treatment (g)	Formulation of insecticide used	Mean number of tillers per plot* damaged during growth and earing stages	Mean grain yield per plot* (kg)	Percentage gain in yield due to treatment over the control	Cost of insecticide per hectare (Rs)	Net gain per hectare (Rs)
BHC 62.5	BHC 10% dust	324.3(17.57)**	7.67	—	—	—
BHC 62.5	BHC 50 WP	259.0(16.00)	8.50	—	—	—
BHC 125.0	BHC 10% dust	192.3(13.88)	13.33	35.6	1.62	654.62
BHC 125.0	BHC 50 WP	268.0(14.73)	9.67	—	—	—
BHC 187.5	-do-	244.0(14.69)	9.00	—	—	—
BHC 250.0	-do-	229.0(14.21)	8.50	—	—	—
Aldrin 62.5	Aldrin 5% dust	28.0(4.68)	17.83	81.4	5.92	1494.07
Aldrin 62 5	Aldrin 30 EC	13.0(3.37)	19.17	95.0	4.67	1746.57
Aldrin 125.0	-do-	4.9(2.19)	19.33	96.6	9.38	1771.87
Aldrin 187 5	-do-	20 0(3.60)	16.17	64.5	14.05	1174.70
Aldrin 250.0	-do-	2.3(1.69)	18.35	66.1	18.88	1578.62
Control	—	601.0(24.38)	9.83	—	—	—
Statistical constants :						
'F' test		Sig.	Sig.			
C. D at 5%		(6.93)	5.39			

*16×5 metres

** $\sqrt{n+1}$ transformation

Rates for cost calculations : BHC 10% dust @ Rs. 1.30/kg; BHC 50 WP @ Rs. 7.00/kg; aldrin 5% dust @ Rs. 4.75/kg; aldrin 30 EC @ Rs. 22.50/L and wheat @ Rs. 150.00/q.

TABLE 2

Effect of seed treatment with BHC and aldrin on plant damaged by termites and yield of wheat under irrigated conditions during 1972–73

Insecticide (actual/q seed) used as seed treatment (g)	Formulation of insecticide used	Mean number of tillers per plot* damaged by termites during growth and earing stages	Mean number of tillers per 100 plants damaged by shoot fly	Mean grain yield per plot (kg)	Percentage gain in yield due to treatment over the control	Cost of insecticide per hectare (Rs.)	Net grain per hectare (Rs.)
BHC 125 0	BHC 10% dust	176.7(13.05)**	83.0(9.10)**	5.00	195.9	1.62	1155 62
Aldrin 62.5	Aldrin 5% dust	196.3(14.01)	83.3(9.18)	4.93	191.7	5.92	1126.95
Aldrin 62.5	Aldrin 30 EC	13.0(3.71)	87.0(9.70)	5.68	238.1	4.67	1390.32
Aldrin 125.0	-do-	20.7(4.65)	94.3(9.72)	5.70	237.3	9.38	1392.75
Aldrin 187.5	-do-	13.3(3.64)	93.0(9.66)	6.30	272.8	14.05	1595.20
Aldrin 250.0	-do-	25.7(5.08)	102.7(10.17)	5.91	249.7	18 88	1456.37
Control	—	178 7(13 27)	205.7(14.38)	1.69	—	—	—
Statistical constants							
'F' test		Sig.	Sig.	Sig.			
C. D. at 5%		(3.01)	(1.39)	1.25			

*13×3.30 metres

**$\sqrt{n+1}$ transformation

Rates of insecticides and wheat given as foot note in Table 1.

TABLE 3

Effect of seed treatment and soil application with BHC and aldrin on plant damaged by termites and yield of wheat under dry farming conditions during 1973–74

Insecticide (actual/q seed) as seed treatment or as pre-sowing soil application per hectare (g)	Mean number of germinated plants per 4 rows of 11 m each	Mean number of tillers per plot* damaged during growth & earing stages	Mean grain yield per plot* (kg)	Percentage gain in yield due to treatment over the control	Cost of insecticide per hec. (Rs)	Net gain per hec. (Rs)
1. Seed treatment with BHC 10% or aldrin 5% dust :						
(a) Soon before sowing without wetting the seed						
BHC 125.0	1511.3(38.78)**	168.0(10.80)**	4.54	76.0	1.62	555.25
Aldrin 62.5	1610.0(40.06)	416.7(13.27)	4.19	62.4	5.92	451.20
(b) 12-16 hr before sowing after wetting the seed						
Aldrin 125.0	1627.0(40.35)	8.0(2.27)	2.51	—	11.87	—
Aldrin 250.0	1843.0(42.91)	0.0(1.00)	3.74	45.0	23.75	305.50
Aldrin 625.0	1558.7(39.46)	0.0(1.00)	3.38	31.0	59.37	167.87
2. Seed treatment with aldrin 30 EC 12-16 hr before sowing :						
Aldrin 62.5	1840.0(42.80)	0.0(1.00)	4.59	77.9	4.67	554.82
Aldrin 125.0	1735.3(41.55)	0.0(1.00)	4.74	83.7	9.38	604.12
Aldrin 187.5	1367.3(38.92)	0.0(1.00)	4.47	73.3	14.05	522.57
Aldrin 250.0	1260.3(35.17)	0.0(1.00)	2 60	0.8	18.88	—
3. Pre-sowing soil application as dust :						
BHC 2.5 kg	1471.3(38.33)	356.0(16.53)	2.67	3.5	32.50	—
Aldrin 1.875 kg	1744.0(41.74)	151.7(10.80)	4.83	87.2	178.12	460.87
Control	1602.3(39.96)	354.0(16.05)	2.58	—	—	—
Statistical Constants :						
'F' test	N.S.	Sig.	Sig.			
C. D. at 5%	—	(5.97)	1.35			

$*11 \times 4.8$ metres

$**\sqrt{n+1}$ transformation

Rates of insecticides and wheat given as foot note in Table 1.

and pre-sowing soil treatment with BHC and aldrin dusts at 2.5 and 1.875 kg, actual, per hectare, respectively. The plot size was 11×4.8 m and the sowings were done during the first week of November, 1973.

Germination counts, recorded only during 1973-74 studies, were taken 21 days after sowing. The termite infested tillers per plot were always collected and counted 50, 80 (growth stage) and 110 (earing stage) days after sowing. Crop in individual plots was harvested and yield was determined in all the plots separately. The data on germination counts, termite infestation and yield were subjected to analysis of variance.

RESULTS AND DISCUSSION

Results of the experiment conducted during 1971-72 revealed that termite infestation was lower in aldrin than in BHC treatments. Among the aldrin treatments, as also among the BHC ones, the differences were non-significant. The only treatment which proved no better than the control was 62.5 g BHC used as 10 per cent dust. The yield data show that all the aldrin, and none of the BHC, treatments proved better than the control. The differences among the aldrin treatments as also among the BHC ones were non-significant. 125.0 g BHC used as dust, though no better than the control, gave wheat yield comparable with 62.5, 187.5 and 250.0 g aldrin treatments (Table 1).

Different aldrin treatments gave 64.5 to 96.6 per cent higher yields than the control and the corresponding value for BHC 125.0 g, used as 10 per cent dust, was 35.6. All the remaining BHC treatments gave no better performance than the control. In subsequent studies all the five aldrin and only one BHC (125.0 g, as dust) levels were used for seed treatment purposes.

The data for the field trial undertaken during 1972-73 are given in Table 2. During this year, probably due to the late sowing of the crop, there was a very high incidence of the shoot fly, *Atherigona naqvii* Steyskal. Mean values for the tillers damaged per 100 plants by the shoot fly in different treatments (Table 2) reveal the highest incidence of the pest in the control plots. Among the various treatments the differences for shoot fly damage were, however, non-significant. Relatively low yields in the control plots may be ascribed to the excessive losses caused by this pest. Termite attack in the crop was found lower in case of seed treatment with aldrin emulsion than either with BHC or aldrin dust. The latter two treatments proved no better than the control. As regards the grain yield, all the insecticidal treatments proved better than the control. Among the insecticidal treatments, the differences were found to be non-significant except that aldrin 187.5 g (emulsion) proved superior to BHC 125.0 g (dust) and aldrin 62.5 g (dust).

The figures for the percentage increase in yield due to the treatments over the control worked out to be very high and this was primarily due to exceptionally lower yields in the control plots. Nevertheless, the superiority of aldrin emulsion and BHC or aldrin dust treatments was very well evident during this year also.

The data for the experiment conducted under dry farming conditions during the year 1973-74 are given in Table 3. In this experiment germination counts of the plants were also recorded. The differences among all the treatments were non-significant. Termite attack was the minimum when seeds were treated either with any of the doses of aldrin emulsion or after their water-wetting, with aldrin dust. The differences among the four emulsion and the three dust treatments were non-significant. Termite damage was the maximum, and at par with the control, when BHC and aldrin dusts were used both for dry-seed-treatment and for pre-sowing soil applications. The differences among these four treatments and the control were non-significant. For grain yield, 125.0, 250.0 and 625.0 g aldrin as dust for wet-seed-treatment, 250.0 g aldrin, as emulsion for seed treatment and 2.5 kg BHC as dust for pre-sowing soil application, did not prove better than the control. The remaining six treatments, viz., BHC 125.0 and aldrin 62.5 g as dust, aldrin 62.5, 125.0 and 187.5 g as emulsion for seed treatment and aldrin 1.875 kg as dust for pre-sowing soil application proved better than the control. These effective treatments, though at par with aldrin 250 g as dust for wet-seed-treatment, proved better than aldrin 125.0 g dust for wet-seed-treatment, aldrin 250.0 g as emulsion for seed treatment and BHC 2.5 kg as dust for pre-sowing soil application. Aldrin 125.0 g as emulsion for seed treatment and aldrin 1.875 kg as dust for pre-sowing soil application also proved better than aldrin 625.0 g dust used for wet-seed-treatment. All other differences among insecticidal treatments were non-significant.

The figures for percentage increase in yield due to the treatments over the control revealed the superiority of 1.875 kg aldrin, as dust for pre-sowing soil application; 62.5, 125.0 and 187.5 g aldrin, as emulsion, for seed treatment; and 125.0 g BHC and 62.5 g aldrin as dusts for dryseed-treatment. Wet-seed-treatment with aldrin dust or pre-sowing soil application of BHC dust did not prove promising treatments.

For all the three experiments conducted during the period 1971-72 to 1973-74 cost of insecticides required and the net gains expected per hectare have also been worked out (Tables 1 to 3).

On the basis of these studies the following points may be kept in view before giving the final recommendations :

(a) As pre-sowing soil treatment, 1.875 kg aldrin proved better than 2.5 kg BHC per hectare. There being no difference between these two treatments in checking termite infestation, the higher yields with aldrin, as compared both to BHC or the control seemed to be due to its growth stimulating effect. These findings are in conformity with the observations earlier recorded by Bindra (1961). Since application of BHC to soil was not superior to the control either for checking termite infestation or in giving higher yields this treatment seems to serve no useful purpose as was expected.

(b) Dry-seed-treatment with BHC and aldrin dusts at 62.5 and 125.0 g/q seed respectively, were not effective in checking termite infestation though both these treatments proved better than the control so far as yield of crop was concerned. Sahni and Butani (1966) also reported the superiority of seed treatment with BHC dust (doses not mentioned) over the control as evidenced by higher wheat yields.

(c) BHC dust as seed treatment was comparable with BHC pre-sowing soil application in checking termite infestation but for crop yield purposes the former proved better than the latter. Thus, if at all BHC dust is put to use, it should be used only for treating the seed. This will also have an additional advantage of cutting down the cost by one-twentieth. In case of aldrin, there was no difference in its performance when used either for seed treatment or for soil application. The former method, should obviously be preferred because this would cut down the cost of insecticide by one-thirtieth.

(d) Termite infestation was almost negligible when wheat seed was treated with different doses of aldrin emulsion or even with different levels of aldrin dust after wetting the seed with water. All the dust and the highest emulsion (250.0 g/q) treatments, however, did not prove effective in giving enhanced wheat yields. The three aldrin emulsion doses viz., 62.5, 125.0 and 187.5 g/q not only checked the termite infestation effectively but also gave enhanced wheat yields.

In the light of the fore going discussion and considering the effectiveness of the treatments in terms of checking termite incidence, giving enhanced yields as well as the economics of their application the ideal treatment obviously would be the seed treatment with aldrin emulsion at the rate of 125.0 g/q. In case aldrin EC is not available, the seed may be treated with BHC or aldrin dusts at 125.0 and 62.5 g/q, respectively. Pre-sowing soil application with BHC or aldrin dusts may be avoided.

In these experiments, particularly when the seed was treated with the insecticides, there were indications that in addition to checking termite damage the insecticides also produced some useful physiological effects in the plants probably by way of affecting soil microflora which might have led to better absorption and utilization of nutrients available in soil. This, however, needs confirmation and the work in this direction is underway.

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RESPONSE OF DWARF WHEATS *(TRITICUM AESTIVUM* L.) TO GRADED DOSES OF NITROGEN

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ABSTRACT

To determine the response of dwarf wheat (*Triticum aestivum* L.) varieties, viz., Kalyan Sona, EA-222-1, U.P. 301, HD-1941 and HD-1949 to graded doses of nitrogen, viz., 0, 40, 80, 120, 160 and 200 kg nitrogen per hectare, a field experiment was conducted during rabi season of 1969-70 and 1970-71 on sandy loam soils, at the Haryana Agricultural University, Hissar.

Based on grain yield data, it is recommended that 120 kg nitrogen per hectare be applied to Kalyan Sona, whereas for three gene dwarf varieties, 160 kg nitrogen per hectare may be applied. Among varieties, highest yield came out to be with HD-1949 which also responded up to 160 kg nitrogen per hectare application owing to stiff straw and less height of the plant.

With the introduction of double and triple gene dwarfs, the yield of crop can be enhanced substantially by the use of adequate quantity of nitrogen in irrigated areas owing to their shorter height and stiffer straw, resulting in resistance to lodging. Among the various factors affecting the yield of crop, nitrogen application can be considered as one of the important factors in determining the yield potential of various dwarf wheats. Sharma *et al.* (1970), Bhardwaj and Wright (1967), Suri and Singh (1970), Dubey and Lal (1970), Saxena (1967) and Agarwal *et al.* (1972) have reported that increase in grain yield of two gene dwarf wheats can be obtained with the application of nitrogen up to 120 kg per hectare. Sharma *et al.* (1972) and Shukla *et al.* (1974) obtained higher yield of three gene dwarf wheats by the application of 160-180 kg nitrogen per hectare. Hence, a field experiment was undertaken to determine the response of dwarf wheats to graded doses of nitrogen.

MATERIAL AND METHODS

A field experiment was carried out during the *rabi* season of 1969-70 and 1970-71 at the Agronomy Research Farm, Haryana Agricultural University, Hissar, to determine the response of three dwarf varieties of wheat in each season to six doses of nitrogen, viz., 0, 40, 80, 120, 160 and 200 kg nitrogen per hectare.

During 1969-70 the varieties were Kalyan Sona, EA-222-1, U.P. 301, while in 1970-71, Kalyan Sona, HD-1941 and HD-1949. The experiment was laid out in split plot design with six replications. The rates of nitrogen were kept in main plots and varieties in sub plots. Half quantity of nitrogen through urea and 75 kg P_2O_5 per hectare through single superphosphate were applied at sowing and remaining quantity of nitrogen was applied after first irrigation.

The mechanical and chemical analysis of soil of experimental field showed 62.2, 20.7, 15.9 per cent sand, silt, clay in sandy loam soil, 8.0 pH and available N, P_2O_5 and K_2O were 245.4, 21.5 and 421.7 kg per hectare, respectively. The weather data prevailing during crop season are given in Table 1.

The weather data are more or less the same in both the years and were favourable for the growth of the crop. The grain and straw yield data were analysed statistically.

RESULTS AND DISCUSSION

A perusal of data in Table 2 reveals that nitrogen application exerted remarkable effect on the yield of dwarf wheats. In 1969-70, a significant increase in grain yield was obtained by applying 160 kg nitrogen per hectare and further addition of nitrogen did not show any response. During 1970-71, maximum grain yield was received with 160 kg nitrogen but the increase was not significant over 120 kg nitrogen per hectare application. A similar observation was also made by Singh and Verma (1970), Garg and Tomaria (1970), Agarwal *et al.* (1972) and Sharma *et al.* (1970). It was further confirmed by Singh *et al.* (1971) who reported that the application of 120 kg N in the first year and 160 kg N in the second year was found to be the suitable dose which enhanced the grain and straw yield by 10.92 and 12.69 per cent, respectively, over 80 kg N per hectare. Maximum response was recorded by the application of 40 kg nitrogen per hectare and further addition of nitrogen did not increase the yield in the same proportion. In case of straw yield, significant increase in yield was noted with 120 kg nitrogen per hectare application during both the years. Among varieties, Kalyan Sona produced 6.65 and 9.16 q/ha more grain yield than EA-222-1 and U.P. 301. During 1970-71, HD-1949 have out yielded and gave 7.0 and 19.5 per cent more grain yield than HD-1941 and Kalyan Sona, respectively, whereas HD-1941 gave 11.6 per cent more grain yield than Kalyan Sona. Maximum yield of straw was recorded with Kalyan Sona variety in both the years, which is also significantly higher than all other varieties except HD-1949, owing to more height of Kalyan Sona than three gene plant type.

The interaction of rate of nitrogen and varieties was also found to be significant. In both the years Kalyan Sona responded to 120 kg nitrogen per hectare application and further increase of nitrogen did not exhibit any response, rather low yield is recorded owing to lodging of the crop. These results are in line with the reports of Dubey and Lal (1970) and Swaminathan *et al.* (1966). The fresh weight and dry matter accumulation of Kalyan Sona increased significantly with an increase in the application of nitrogen up to 150 kg per hectare, as also reported by Singh and Anderson (1973) and Lal

TABLE 1

Mean Monthly weather data during crop season

Months	Min. temp. °C		Max. temp. °C		Humidity %		Total rainfall (mm)	
	1969-70	1970-71	1969-70	1970-71	1969-70	1970-71	1969-70	1970-71
November	10.3	7.2	29.0	28.2	54.0	49.0	Nil	Nil
December	3.2	5.9	24.0	23.5	58 5	61,5	Nil	Nil
January	5.0	3.9	20.4	19.8	69.0	70 0	19.1	18.8
February	6.3	8.2	21.7	24.5	69.5	65.5	42.0	13.1
March	11.7	*	28.9	29.5	67.5	67.5	14.8	9.5
April	17.3	*	37.5	37.6	33.0	43.5	Nil	3.0

*Data not available.

TABLE 2

Effect of levels of nitrogen on dwarf wheats

Nitrogen levels (Kg/ha)	1969-70				1970-71			
	Kalyan Sona	EA-222-1	UP-301	Mean	Kalyan Sona	HD-1941	HD-1949	Mean
(a) **Grain yield (q/ha) :**								
0	19.54	11.46	8.63	13.21	19.27	20.72	24.63	21.54
40	31.82	23.30	19.07	24.73	31.87	28.98	32.31	31.05
80	39.09	32.53	28.37	33.33	35.50	35.50	36.65	35.88
120	49.89	38.44	35.98	41.44	43.47	44.62	47.67	45.25
160	47.75	46.30	44.31	46.11	42.45	51.58	54.48	49.50
200	47.40	43.59	44.20	45.07	38.54	54.33	56.65	49.84
Mean	39.25	32.60	30.09		35.18	39.29	42.06	
C. D. at 5%								
Nitrogen (N)		3.27				5.57		
Varieties (V)		1.13				2.43		
N×V		3.11				5.99		
(b) **Straw yield (q/ha) :**								
0	32.36	23.54	22.50	26.12	43.47	41.44	44.33	43.08
40	55.40	39.49	38.40	44.43	61.00	50.13	51.58	54.24
80	68.12	49.09	50.59	55.93	67.37	55.93	59.84	61.05
120	78.83	54.05	56.02	62.96	81.28	68.82	76.94	75.68
160	76.88	60.93	60.73	66.18	80.56	78.68	81.57	80.27
200	80.59	58.33	60.62	66.51	81.57	78.97	84.47	81.67
Mean	65.35	47.57	48.14		69.21	60.66	66.45	
C. D. at 5%								
Nitrogen (N)		4.76				8.40		
Varieties (V)		1.69				3.18		
N×V		4.26				N.S.		

and Sharma (1973). Three gene dwarf varieties which have stiff straw responded significantly up to 160 kg nitrogen per hectare application. However, maximum yields of HD-1941 and HD-1949 were found with highest dose of nitrogen. Shukla *et al.* (1974) also observed significant and positive yield response of HD-1593, HD-1553 and RR-21 varieties to nitrogen application and 180 kg nitrogen per hectare was found as optimum dose. Variety and rate of nitrogen interaction of straw yield was found to be significant during 1969-70 and the response was similar to that of grain yield.

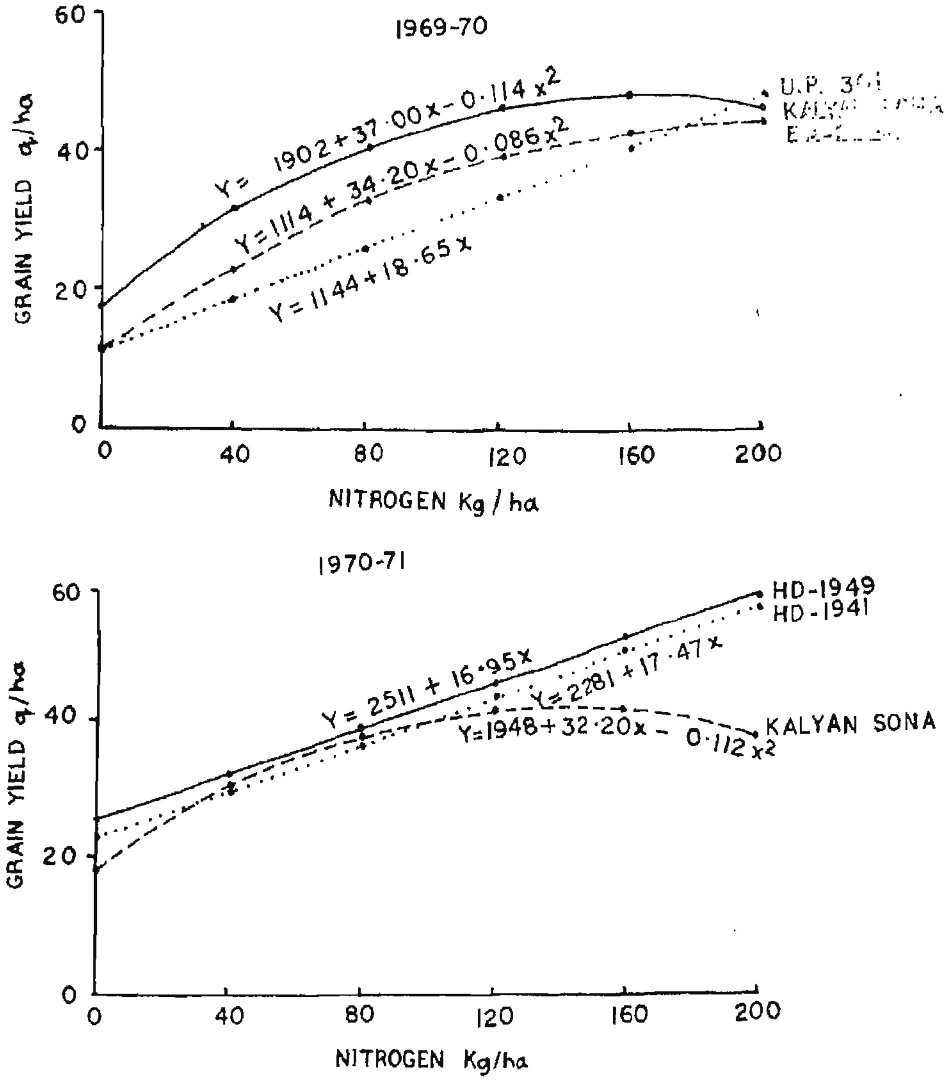

FIG. I. RESPONSE OF THREE WHEAT VARIETIES TO NITROGEN

Response analysis

Data of grain yield reveal significant response to levels of nitrogen. To determine the exact nature of the response to nitrogen application, the variance was further sublined in linear and quadratic. In 1969-70, the nature of response curve came out to be quadratic for Kalyan Sona and EA-222-1 and linear for U. P. 301, while in 1970-71, Kalyan Sona showed quadratic response and other two varieties came out to be linear (Fig. 1). Lal and Sharma (1973) also found that the response of Kalyan Sona to nitrogen was quadratic.

A perusal of Fig. 1 makes it clear that the expected values closely correspond for the actual values, which proves that the yield increased in quadratic or linear manner with the graded increase of nitrogen. The economic optimum fertilizer dose of nitrogen was also investigated for the varieties came out to be quadratic. Optimum dose of nitrogen were found to be 141.78 (average) and 183.37 kg while the dose for maximum production were 153.66 and 198.83 kg for Kalyan Sona and EA-222-1 varieties, respectively. Lal and Sharma (1973) reported that the most profitable level of fertilization for Kalyan Sona was 133 and 152 kg nitrogen per hectare in 1968-69 and in 1969-70, respectively. While Sharma *et al.* (1972) observed economic optimum dose to a maximum of 161 kg nitrogen per hectare for HD-1949 and 220 kg nitrogen per hectare for U. P. 301 varieties of three gene dwarf wheats.

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INFLUENCE OF ROOTSTOCKS ON MICRONUTRIENT UPTAKE IN CITRUS

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ABSTRACT

Uptake of copper (Cu), iron (Fe), manganese (Mn), and aluminium (Al) was more or less around the optimum range in all the stock-scion combinations which were two years old. Among all, wood apple rootstock appeared to be highly efficient in uptake of Cu, Mn, Fe and Al. The iron status of citrus soil at Tirupati was highly excessive (150 ppm.) in Sathgudi and Rangpurlime, which are presently recommended as suitable rootstocks for sathgudi orange in Andhra Pradesh, appeared to be good in micronutrient uptake.

Rootstocks exert profound influence on vigour, shape, uptake of nutrients, precocity, productivity, fruit quality, pest, disease and drought resistance and longevity of the scion variety. Therefore, different rootstocks are employed in different parts of the world to suit the scion variety, type of soil, climate, culture and other circumstances. In Andhra Pradesh, Sathgudi oranges (*Citrus sinensis* (L.) Osb.) budded on jamberi (*C. jambheri* Lush) are grown all over the State. These orchards are meeting with early decline within 10-15 years of orchard life as against an expected life span of 30 years, causing enormous loss to the growers. Such decline may be due to the unsuitability of rootstock, soil, incidence of virus diseases and other factors. In order, therefore, to determine a better rootstock for Sathgudi oranges, Sathgudi budlings on jamberi, Sathgudi, Rangpur lime (*C. reticulata* var. *austera* hyb.), trifoliate orange (*Poncirus trifoliata* (L.) Raf., Troyer citrange (*P. trifoliate* $\times$ *C. sinensis*), cleopatra mandarin (*C. reticulata* Blanco) and wood apple (*Feronia limonia* Swingle) were prepared and planted in the red sandy soil at the S. V. Agricultural College, Tirupati, during July, 1972.

Uptake of nutrients may vary in different rootstocks and the same may have significant influence on the health condition and cropping of the scion variety. But experimental data is not available in this regard. Hence, attempts

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were made to determine the uptake of micronutrients by the seven rootstocks by spectrochemical analysis.

MATERIAL AND METHODS

Sampling

From the two years old sathgudi plants budded on seven different rootstocks four months old leaves were collected on 15.5.74. Detailed investigation on the composite soil sample was also made along with the above samples. These samples were dried in an aluminium coated electric oven and then they were crushed to particle size in an agate mortor. The leaf samples were later subjected to spectrochemical emission analysis.

Qualitative analysis

Each sample was transferred to a specpure carbon electrode shaped in the fashion as that employed by Mitchell (1964).

Making one carbon electrode as the cathode and using another similar upper carbon electrode as the anode, a 220 volts D. C. arc was struck. While the current in the arc was varied from 4 to 8 amperes, light from the arc was photographed on a Higher-large-quartz spectrograph in the wavelength region λ 5000—λ 2000 A° on Ilford N—30 plates. In juxta position, iron and R. U. powder spectra were also given for ease in the identification of the lines.

Semi-quantitative analysis

The photographic plate was calibrated in the spectral region λ 3500 A°—λ 2500 A°, employing known intensities of iron lines (Ahrens, 1961). The wavelengths and the intensities of the iron lines in this spectral region are given in Table 1. The

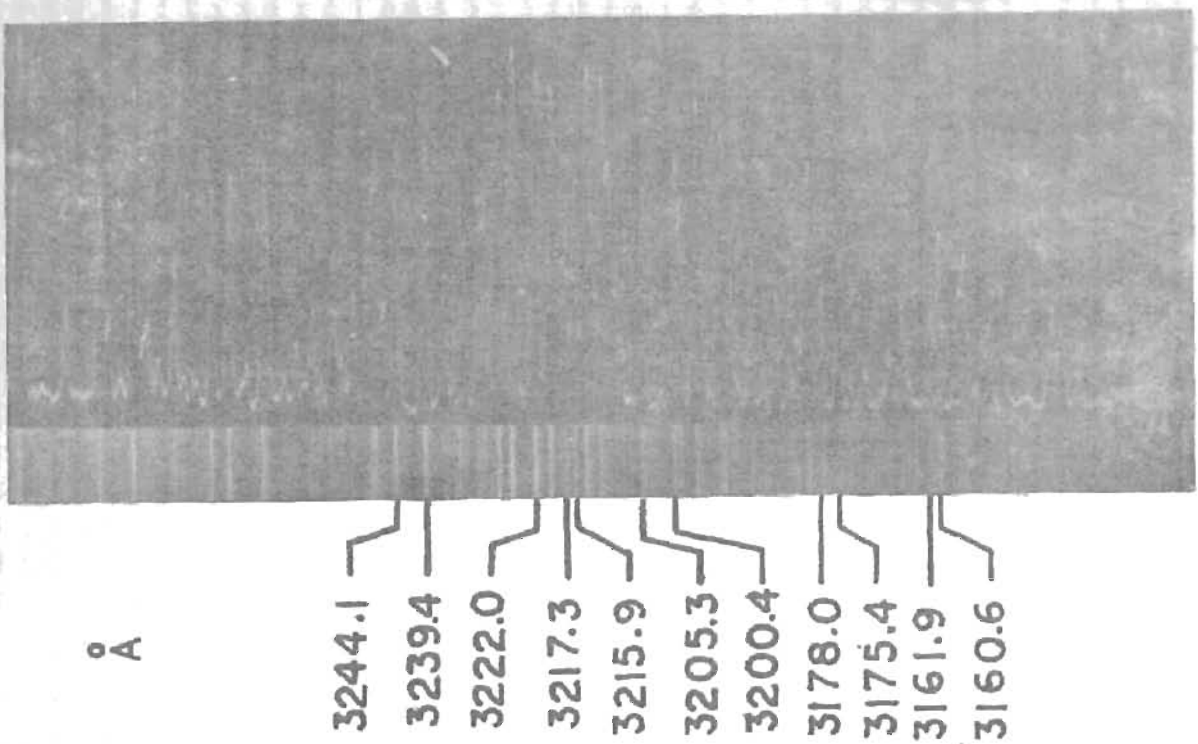

Fig. 1 Microphotometer record of the iron arc spectrum in the wave length region 3250-3150 A

microphotometric profile taken on a recording microphotometer of the iron lines is shown in Fig. 1. A calibration curve is drawn on a log-log graph between $\frac{do}{d}$ (do : deflection for the clear glass plate, d: deflection for the spectral line) and intensity as shown in Fig. 2.

TABLE 1

The wave lengths and the intensities of *the selected iron lines*

Wavelength A°	Intensity
3160.6	0.63
3161.9	0.36
3175.4	0.69
3178.0	0.52
3200.4	1.65
3205.3	1.34
3215.9	1.50
3217.3	1.00
3222.0	4.90
3239.4	2.22
3244.1	1.93

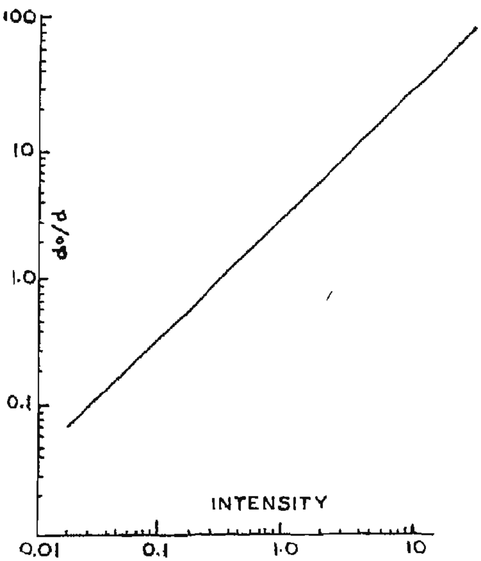

Fig. 2. Calibration (characteristic) curve for *ilford N 30 plate at 3200 A°*

Four semiquantitative powder (Jarell-Ash, U.S.A.) samples containing different concentrations (1, 10, 100 and 1000 ppm.) of the analysis elements were next arced in spectroscopically pure carbon electrodes and their spectra were recorded.

Using the deflections obtained for the different analysis lines, their intensities were noted from the calibration curve shown in Fig. 2. For each analysis element, a separate (log-log) graph is drawn between intensity and concentration. The four graphs (working curve) for the four analysis elements namely Al, Fe, Mn and Cu are shown in Fig. 3(a), 3(b), 3(c) and 3(d).

In the present work, the wavelengths of the lines employed for the estimation of Al, Fe, Mn and Cu were 3082.15 A°, 3020.64 A°, 2794.82 A° and 3247.54 A°, respectively.

The same amount of the samples was used in each case. Further, the time of exposure, the time of development and the time of fixing were kept the same in all the cases studied. Every care was taken to maintain identity of experimental conditions in all the cases, as the estimation was made without adding an internal standard.

RESULTS AND DISCUSSION

Large quartz Littrow spectrogram exhibiting the emission lines of Al, Fe, Mn and Cu in the citrus leaves of Rangpur lime is shown in Fig. 4. The micronutrient levels in sathgudi orange on different rootstocks are presented in Table 2.

The uptake of micronutrients by different rootstocks was as follows :

Copper (Cu)

The uptake of Cu by different rootstocks was between 8 and 14 ppm. Chapman (1973) found the optimum range to be 4–10 ppm. Thus, uptake of Cu was within the optimum range in Sathgudi, Rangpur lime, jamberi and trifoliate orange. Uptake of Cu was slightly high in cleopatra mandarin, troyer citrange and wood apple rootstocks.

Manganese (Mn)

The uptake of Mn by different rootstocks was between 55 and 95 ppm.

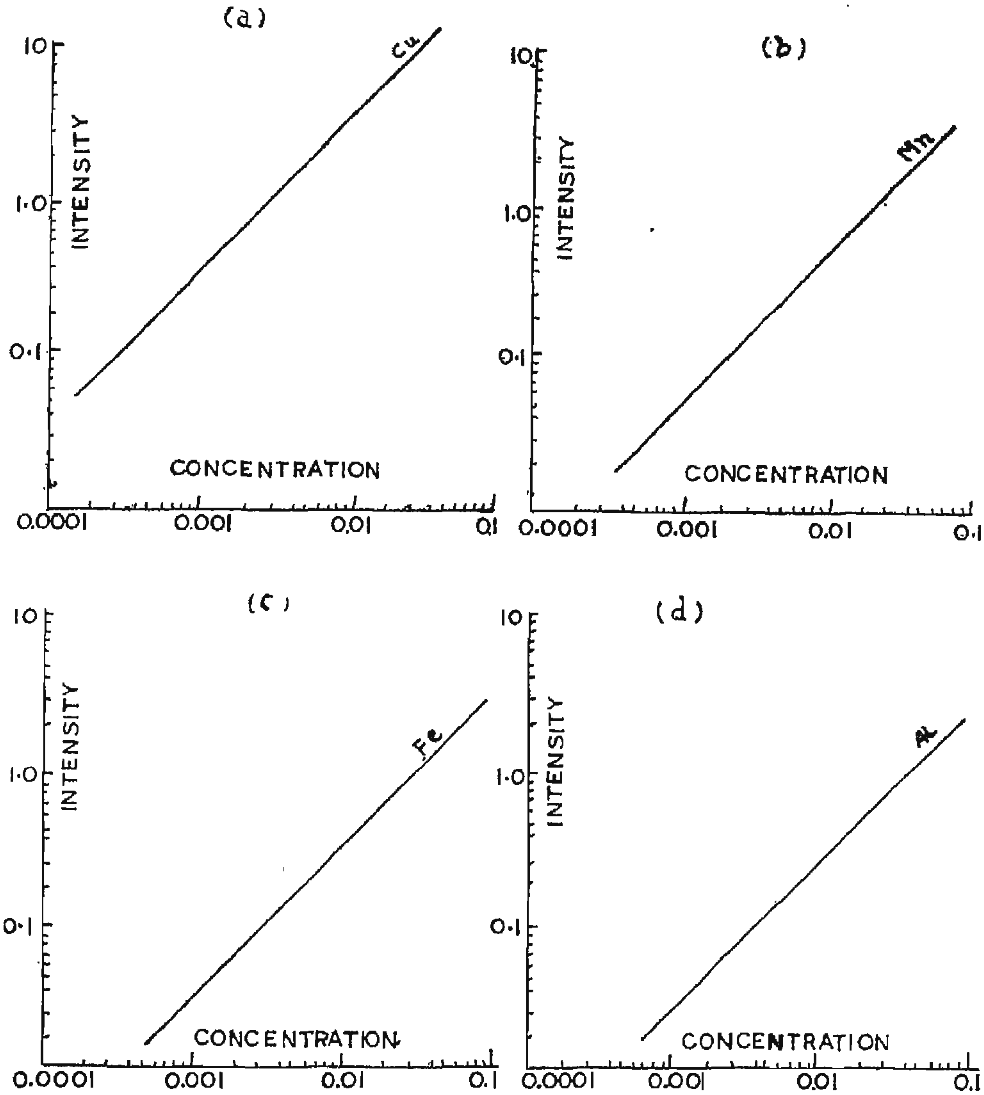

Fig. 3. Typical working curve for the estimation of
(a) Copper (b) Manganese (c) Iron (d) Aluminium.

TABLE 2

Micronutrient levels in Sathgudi orange on different rootstocks

I Rootstock	Range in dry matter (ppm)			
	Copper	Manganese	Iron	Aluminium
1. Trifoliate	10	63	60	18
2. Troyercitrange	12	67	55	10
3. Sathgudi	8	80	50	12
4. Wood apple	14	95	140	25
5. Cleopatra Mandarin	11	55	52	15
6. Rangpur lime	9	75	70	13
7. Jamberi	10	60	57	17
II Soil	15	100	150	30

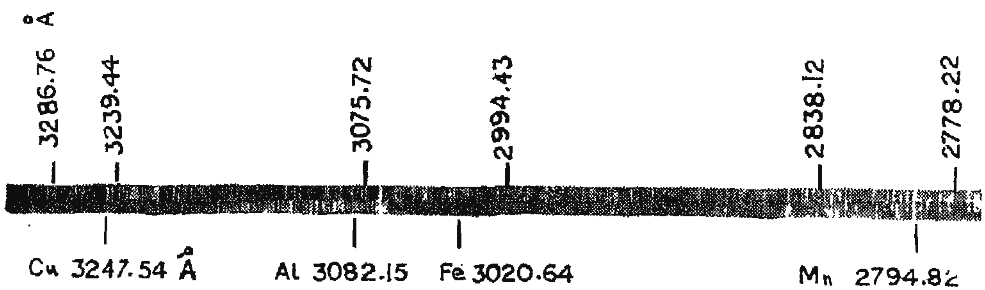

Fig. 1. Emission spectrum of citrus leaves in the wave length region λ 3300-2700 A° for Rangpur lime rootstock.

This was slightly on the higher side because 20–50 ppm is the optimum range and up to 1000 ppm is the excess range as per Chapman (1973).

Iron (Fe)

The uptake of Fe by different rootstocks ranged from 52—104 ppm. This was within the optimum range of 40–150 ppm (Chapman, 1973).

Aluminium (Al)

The uptake of Al by different rootstocks was between 10—25 ppm which is within the optimum range of 6—30 ppm (Chapman, 1960).

Zinc (Zn) and Boron (B)

Zn and B could not be determined for want of Ilford Q 2 photographic plates and carbon electrodes.

Micronutrient status of soil

A composite soil sample collected from the experimental site contained 15, 100, 150, 30 ppm of Cu, Mn, Fe and Al, respectively. Optimum range of micronutrient availability in the soil for citrus was rather difficult to determine. However, Chapman (1960) considered that 2—40 ppm of Fe constituted the excess range for citrus. Hence Fe status of 150 ppm in Tirupati soil was on the highly excessive range. It is not known if this range of Fe is adverse to growth of citrus plants.

ACKNOWLEDGEMENTS

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SULPHUR STATUS OF HISSAR SOILS AND AVAILABILITY OF SULPHUR AND PHOSPHORUS AFFECTED BY FERTILIZER APPLICATION

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ABSTRACT

Sulphur status of Hissar soils and its availability to groundnut crop was studied in laboratory and green-house experiment. The light soils, low in clay (less than 10%), were generally in deficient range of available sulphur. Their percentage was about 36.7 over all and 90 in zone A around Hissar. Heat soluble and water soluble sulphur had positive significant correlation with EC (mmhos/cm), organic carbon and clay.

Sulphur availability increased significantly with increased level of sulphur through any source but decreased with phosphorus over control and lower doses while available phosphorus increased with added phosphorus levels in both normal and sodic soils. Different sources did not show a significant difference in the availability of sulphur and phosphorus at anytime of incubation except at 3rd week with triple superphosphate when available sulphur increased significantly and at zero and 3rd week with monocalcium phosphate+$(NH_4)_2SO_4$ when it decreased significantly. Available sulphur and phosphorus were generally low in sodic than in normal soil.

The dry matter yield of groundnut at 50 days as well as its maturity increased with all the fertilizers over control. Single superphosphate was the best, followed by triple superphosphate. The concentration and uptake of sulphur, phosphorus and nitrogen increased significantly over control but all the fertilizers were at par in their effect.

Sulphur is grouped with nitrogen in its importance for plant growth, and up to 80 per cent of sulphur is supplied by organic matter in the soil. The soils which are poor in organic matter and coarse in texture are likely to be deficient in sulphur. Kanwar (1963) reported that about 75 per cent of the samples in Samrala tehsil were light textured and deficient in available sulphur. Goyal *et al.* (1970) also reported that groundnut growing soils of north west India were primarily sand to sandy loam and majority of them were deficient in sulphur and phosphorus. 82 and 78 per cent of groundnut growing soils of Ambala and

Gurgaon, respectively, were found deficient in available sulphur by Chahal and Rathee (1975).

Since legumes and oilseed crops are heavy feeders of sulphur, the application of sulphur was found to increase the yield of legumes up to 100 per cent (Conard, 1950). The application of superphosphate was also found to increase the yield of groundnut (Venkat Rao and Govind Rajan, 1954). Most of the soils in Hissar District are low in organic matter and coarse in texture, where oilseeds, like, groundnut and sarson are grown. For better performance the survey of these soils for sulphur status, and assessment for best source among the available sulphur and phosphorus containing fertilizers was called for, and hence the present study was undertaken.

MATERIAL AND METHODS

Ninety surface samples (0-15 cm) were collected from adjoining areas of Hissar which were divided into various zones arbitrarily (Fig. 1), as in such a small area no microclimate based zonation was feasible. However, arbitrary zonation was based, to a great extent, on the management practices and textural differences.

The samples were processed and analysed for physico-chemical properties using Jackson's (1958) methods and heat soluble and water soluble sulphur by turbidimetric methods of Chesnin and Yien (1950).

In the second experiment five phosphatic fertilizers, viz. single superphosphate, triple superphosphate, diammonium phosphate+$CaSO_4$, monocalcium phosphate+$CaSO_4$ and monocalcium phosphate+$(NH_4)_2SO_4$, were mixed in 150 g of each of sandy loam, normal and sodic soil (Table 1) at the rate of 0, 40, and 80 ppm of phosphorus. Sulphur level was kept constant (100 ppm) by adding up the differences by $CaSO_4$ and $(NH_4)_2SO_4$. The samples were then incubated in duplicate at field capacity and room temperature for 0, 3 and 6 weeks and then analysed for available phosphorus (Olsen *et al.*, 1950), heat soluble and water soluble sulphur.

The third experiment was conducted in sandy soil (Table 1). Fertilizers were mixed in 70 kg of soil filled in 100 kg capacity drums at the rate of 0 and 80 ppm phosphorus and 100 ppm sulphur by adding the difference of sulphur through $CaSO_4$ and $(NH_4)_2SO_4$. Differences of calcium and nitrogen were also equalized. Ten seeds of groundnut (*Arachis hypogea* L. var. C-501) were sown in each drum which were thinned to four plants after germination and setting. Crop was raised with proper irrigation with distilled water and plant protection measures in six replications. Three replications were harvested at 50 days and rest three at maturity. After drying and recording dry matter and pod yield, dry matter was analysed for sulphur and phosphorus after digesting in HNO_3 : $HClO_4$(9:1) by Chesnin and Yien (1950), and Koenig and Johnson (1942) method, respectively. Nitrogen was analysed by Nessler's reagent method in H_2SO_4 digest (Lindner and Harley, 1942).

RESULTS AND DISCUSSION

It is evident from soil analysis (Table 2) that samples did not differ much in

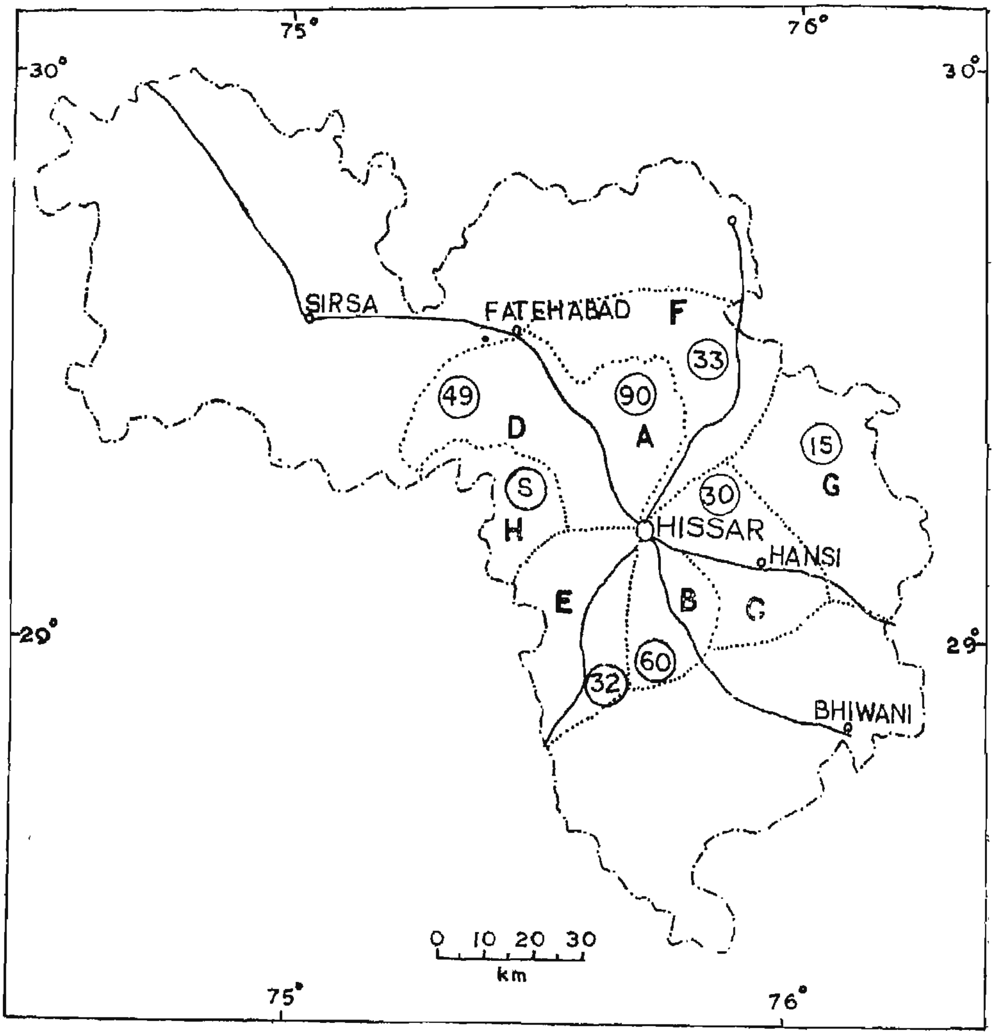

Fig. 1. Showing area from where soil samples were collected.

pH. Except few samples, most of the soils were in the range of 8.4 to 9.1 pH. Only one sample had E.Ce of 1.02 mmhos/cm, all others were below 0.9 mmhos/cm. The lowest average of 0.20 was recorded in zone A and maximum of 0.44 in zone F. Organic carbon ranged from 0.06 to 0.74 per cent. However, zonal average were not much different. As regards clay content almost all soils in zone A and H had less than 9 per cent clay while highest average clay percentage was observed in zone G. Regarding available phosphorus, potassium, sulphur, available phosphorus ranged in most of the soils from low to medium while potassium was in low to high range. All soils in zone A and more than half in zone B were deficient in available sulphur as per limits reported by Chopra and

TABLE 1

Physico-chemical properties of soils used in green-house and laboratory experiments

S. No.	Texture	pH (1:2)	O.C. (%)	E.Ce. (mm hos/cm).	ESP	CEC (meq/100g)	$CaCO_3$ (%)	Available phosphorus (ppm)	Available sulphur (ppm)	Available nitrogen (3)	Clay (%)	Silt (%)	Sand (%)
1.	Sandy loam (Normal)	7.60	0.48	1.05	4.84	13.75	Absent	12.00	8	0.02	24.00	24.30	50.00
2.	Sandy loam (Sodic)	8.80	0.45	1.10	20.00	13.50	,,	11.50	7	0.18	24.30	24.45	50.00
3.	Sand	8 05	0.08	0.98	6.50	1.50	Traces	8.00	4	0.01	2.00	2.80	94.00

TABLE 2

Showing available sulphur in relation to physico-chemical properties

Area & number of samples	pH (1:2)	E. Ce. (mmhos/cm)	O. C. (%)	Available phosphorus (ppm)	Available potassium (ppm)	Clay (%)	Heat soluble sulphur (ppm)	Water soluble S (ppm)
Zone A	7.9-8.9	0.12-0.29	0.21-0.51	6-22	217-425	2-12	1.25-10.50	0.50-8.5
10	(8.3)	(0.20)	(0.32)	(12.0)	(289.3)	(5.9)	(5.97)	(4.5)
B	8.4-9.1	0.08-0.84	0.15-0.49	2-18	175-530	2-22	1.25-70.0	1.0-55.0
11	(8.7)	(0.33)	(0.36)	(6.2)	(293)	(10.5)	(15.0)	(11 80)
C	8.6-9.1	0.20-0.84	0.15-0.62	2-23	212-562	8-25	5.0-50.0	4.0-70.0
7	(8.7)	(0.43)	(0.32)	(14.7)	(313.7)	(12.7)	(21.3)	(18.6)
D	8.6-9 5	0.24-0.40	0.26-0.74	4-44	175-670	5-20	6.25-30.0	5.0-27.5
11	(8 3)	(0.32)	(0.37)	(14.2)	(305)	(11.1)	(20.3)	(16.5)
E	8.5-9.1	0 16-0.33	0.12-0.36	2-14	135-425	2-20	1.25-35.0	0.50-30.0
22	(8.8)	(0.22)	(0.23)	(8.0)	(242)	(9.7)	(15.1)	(12.7)
F	8.5-9.0	0.27-0.90	0.24-0.57	2-23	225-362	2.18	1.25-25.0	1.0-23.0
9	(8.9)	(0 44)	(0.41)	(10)	(295)	(9)	(16.3)	(13.8)
G	8.0-9.5	0.17-1.02	0.06-0.73	4-45	88-650	10.20	9.0-30.0	7.50-28.0
13	(8.9)	(0.38)	(0 38)	(21)	(365.7)	(15.4)	(16.2)	(13.7)
H	8.7-9.1	027-0.70	0.16-0.59	6-25	225-375	5-9	22-50	19-45.0
	(8.9)	(0.41)	(0.41)	(11.7)	(257)	(7.7)	(33)	(30.8)

Figures in parentheses are averages.

TABLE 3

Showing correlation coefficient between available sulphur and physico-chemical properties of soils

Soil properties	Available sulphur	Water soluble sulphur
pH (1 : 2)	−0.208	−0.135
EC(mmhos/cm)	0.522**	0.421**
O.C. (%)	0.601**	0.276**
Phosphorus (ppm)	0.163	0.172
Potassium (ppm)	0.129	0.127
Clay (%)	0.569**	0.633**

*Significant at 5 per cent **Significant at 1 per cent

Kanwar (1966). Except in the soils where either there was high clay content, high organic carbon or high salt deposition, soils were either in deficient or marginal range of sulphur availability. As the soluble salts contain high amounts of sulphate, a positive significant correlation (r=0.522 and 0.421) was observed with available and water soluble sulphur (Table 3). Since sulphur is a constituent of organic matter, and clay has high sulphur adsorption capacity (Kamprath *et al.*, 1956) highly significant positive correlations of heat soluble and water soluble sulphur were observed with organic carbon (0.601 and 0.276) and clay content (r=.596 and .633) of soils.

Sulphur is generally applied as a secondary constituent of phosphatic or nitrogenous fertilizers. In all the five fertilizer treatments (Table 4), the available sulphur was significantly higher than control at all the intervals of incubation. However, there was no significant difference among the sources in this respect except at three weeks in case of triple superphosphate where available sulphur was significantly higher.

Available sulphur decreased with the increase in incubation time from 0–6 weeks which was probably due mainly to immobilization and retention by clay in due course of time. With the increase in phosphorus concentration, there was decrease in available sulphur at all times which was due to antagonistic relationship of both. Ensminger (1954) observed that increasing amount of superphosphate applied to sandy clay loam soil resulted in decrease of soluble sulphate. The maximum decrease was observed in monocalcium phosphate+ $(NH_4)_2SO_4$ treated samples. The availability was less in sodic soils than in normal soils which was probably due to unfavourable pH conditions; however, the trend was the same as in case of normal soils.

The soils orginally had more available phosphorus than sulphur. The addition of all fertilizer sources increased available phosphorus concentration significantly over control while there was no significant difference among various sources. Phosphorus availability decreased with time during incubation due to fixation. Sodic soil showed less available phosphorus with all the treatments in

TABLE 4

Showing availability of sulphur and phosphorus as affected by fertilizers

Fertilizer	Treatment		Available sulphur at weeks of incubation						Available phosphorus at weeks of incubation					
	Phos-phorus	Sul-phur	Normal soils			Sodic soils			Normal soils			Sodic soils		
	(ppm)		0	3	6	0	3	6	0	3	6	0	3	8
Control	0	0	8.0	6.0	4.0	7.0	5.0	3.0	12.0	5.0	3.0	11.5	6.0	2.0
Single super	40	100	25.0	18.0	8.0	23 0	14.0	7.0	30.0	16.0	6.0	25.0	13.0	5.0
phosphate	80	100	15.0	10.0	5.0	15 0	10.0	5.0	55.0	25.0	12.0	50.0	22.0	10.0
Triple super	40	100	26.0	17.0	9.0	24.8	17.5	7.8	31.0	17.0	6.5	26.0	14.0	5.2
phosphate+ $CaSO_4$	80	100	15.5	11.0	6.2	14.0	9.8	5.5	54.0	24.8	13.0	51.0	18.0	8.0
Diamm phosphate+	40	100	25.0	17.0	9.0	25.0	17.0	8.0	32.0	16.0	6.6	24.0	12.0	4.0
$CaSO_4$	80	100	15.0	8.0	4.0	14.5	10.0	6.0	56.0	23.0	10.0	48.0	17.0	4.0
Monocalcium	40	100	24.0	16.0	7.0	21.0	13.0	7.0	29.0	15.0	5.0	23.0	15.0	6.0
Phosphate+ $CaSO_4$	80	100	14.0	7.0	3.5	12.5	8.0	5.0	12.0	22.0	10.0	49.0	16.5	8.0
Monocalcium	40	100	23.0	15.0	8 0	18.0	11 0	6.5	30.0	15.5	5.6	26.0	14.0	5.8
Phosphate+ $(NH_4)_2SO_4$	80	100	11.0	5 0	4.0	13.0	7.0	4.5	49.5	24.0	10.5	47.0	16.0	7.0
C.D. at 5%			2.85	1.88	2.72	2.90	1.79	1.91	6.87	4.21	2.40	7.11	4.85	2.30

TABLE 5

Showing yield and uptake of nitrogen, phosphorus and sulphur in groundnut affected by fertilizers

Fertilizers	Yield of harvest		Yield at	Sulphur		Phosphorus		Nitrogen	
	Groundnut (g/pot)	Dry matter (g/pot)	50 days (g/pot)	Concent-ration(%)	Uptake (mg/pot)	Concent-ration(%)	Uptake (mg/pot)	Concent-ration(%)	Uptake (mg/pot)
Control	18.1	28.5	11.4	0 40	45.73	0.16	18.58	1.71	195.85
Single super phosphate	38.5	71.6	14.9	0.44	65.71	0.42	62.72	2.40	385.40
Triple super phosphate+ $CaSO_4$	34.5	59 8	14.06	0.49	68.93	0.46	65.05	2.53	355.18
Diammonium phos-phate+$CaSO_4$	32.5	50 8	14.2	0.48	67.47	0.45	64.26	2.39	338.95
Monocalcium phos-phate+$CaSO_4$	29.0	41.8	13.10	0.48	62.98	0.48	62.40	2.86	375.10
Monocalcium phos-phate+$(NH_4)_2SO_4$	33.7	41.8	13.10	0.48	62.98	0.48	62.40	2.86	375.10
C.D. (5%)	3.18	6.36	1.58	0.9	7.96	0.2	7.23	.502	35.58

comparison to normal soil, however, trend was the same.

When all the phosphatic fertilizers were tested on groundnut (Table 5) the dry matter yield at 50 days as well as, at maturity increased significantly with all the fertilizers over control, as also observed by Gulati (1968). The highest dry matter yield was observed with single superphosphate at both the stages which was significantly higher than control, monocalcium phosphate+ $CaSO_4$, and monocalcium phosphate+ $(NH_4)_2SO_4$, at 50 days, and than all fertilizers at maturity, followed by triple superphosphate+$CaSO_4$ which was also significantly higher than control and other fertilizers. Single superphosphate also gave significantly higher pod yield than other sources of phosphate which was closely followed by triple superphosphate+$CaSO_4$. Renouleau (1953) observed best response of granular form of super phosphate on groundnut yield, whereas Venkat Rao and Govind Rajan (1954) and Chahal and Virmani (1973) observed significant increase in groundnut pod yield with the superphosphate application.

The concentration of sulphur in groundnut increasad by the application of all fertilizers at 50 days but the differences were not significant except in case of triple superphosphate. However, the total uptake of sulphur per pot was significantly higher with all fertilizers over control, the highest being in triple superphosphate. In case of phosphorus, highest phosphorus concentration was recorded with monocalcium phosphate, with $CaSO_4$ and $(NH_4)_2SO_4$ which were not significantly higher than other fertilizers. This difference was probably due to higher soluble phosphorus in these sources than in other fertilizers. The concentration of phosphorus with all the fertilizers was significantly higher than control. The total uptake of phosphorus with all the fertilizers was significantly higher over control, but at par among themselves.

The concentration and uptake of nitrogen increased significantly with all the fertilizers over control, the highest being in monocalcium phosphate + $(NH_4)_2SO_4$ which may be because of $(NH_4)_2SO_4$ but lowest was recorded with diammonium phosphate.

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EFFECT OF PHOSPHORUS AND NITROGEN LEVELS ON THE GRAIN YIELD AND PROTEIN CONTENT OF MOONG (*PHASEOLUS AUREUS* ROXB.) VARIETIES

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ABSTRACT

A field experiment comprising four rates of phosphorus, two rates of nitrogen and two varieties of moong was conducted during *kharif* seasons of 1970 and 1971 at the Research Farm of the Haryana Agricultural University, Hissar. The highest grain yield was obtained with 25 kg N and 50 kg P_2O_5/ha. H-45 variety of moong gave higher grain yield as compared to J-781. Protein content of moong was increased significantly by the application of 50 kg P_2O_5/ha over no application.

Moong (*Phaseolus aureus* Roxb.) is an important crop in low rainfall areas of the Haryana State. It occupies 12.7 thousand hectares of area with a production of 6.9 thousand tons in the State. It is widely grown on the soils generally low in nitrogen and medium in phosphorus. Among the broad spectrum of over a dozen varieties of pulses belonging to several genera and species, moong is known to have varieties having short maturity period, which fit well in multiple cropping. In spite of such importance of this crop in Indian agriculture, this group of plants have more or less remained neglected from the point of view of production improvement. In pulse farming, absence of adequate management and package of practices, and lack of information about the fertilizer requirement of moong are the important factors responsible for low production.

For realising the potentiality of high yielding varieties of moong, fertilizers may play an important role. The beneficial effects of phosphate fertilization to legumes have been reported by Deshpande and Bathkal (1965), Moolani and Jana (1965) and Prasad *et al.* (1968). Therefore, the present study was carried out to investigate the effect of rates of nitrogen and phosphorus on the grain yield and quality of two prominent varieties, during *kharif* seasons of 1970 and 1971 at the Research Farm of the Haryana Agricultural University, Hissar.

MATERIAL AND METHODS

The present investigation comprising two varieties (J-781 and H-45), four levels of phosphorus (0, 25, 50 and 75 kg P_2O_5/ha) and two rates of nitrogen (0 and 25 kg N/ha) was conducted on sandy loam soil during the *kharif* seasons of 1970 and 1971. The chemical analysis of the experimental soil showed 136 and 153 kg of available nitrogen/ha, 16 and 18 kg of available phosphorus/ha and a pH of 8.5 and 8.2 in the year 1970 and 1971, respectively. J-781 is a bold-seeded variety of moong and it matures in 65-70 days. It can also be grown as a catch crop. H-45 possesses bright attractive grain. Its average yield is 8-10 q/ha and its duration is 85-90 days. The experiment was laid out in randomised block design with three replications. The gross plot size was 10 metres × 3 metres and net plot size was 8 metres × 1.8 metres. In the experimental fields, a uniform crop of wheat was grown before moong trail in order to minimise the fertility variation. Phosphorus through single super phosphate was drilled before sowing as per treatments. Sowing of the experiment was done on 17th July, 1970 and 10th July, 1971, drilling 15 kg seed/ha in rows 30 cm apart. After this, nitrogen through calcium ammonium nitrate was drilled parallel to the rows of seed. Crop was raised completely as rainfed with normal interculture, weeding and plant protection measures. The crop was harvested on 25th October in 1970 and on 15th October in 1971.

RESULTS AND DISCUSSION

The data on the grain yield and the per cent content of protein as affected by varying rates of fertility treatments are presented in Table 1. H-45 gave 11.9 and 25.0 per cent more grain yield than J-781 during 1970 and 1971, respectively. During both the years the grain yield of H-45 was significantly superior to that of J-781. The per cent content of protein in grain was also found higher in H-45 than in J-781.

The application of nitrogen increased the grain yield significantly over no nitrogen in both the years. Application of 25 Kg N/ha increased the grain yield by 20.44 and 15.13 per cent over no nitrogen in 1970 and 1971, respectively. Singh and Virk (1965) and Shekhawat *et al.* (1972) also reported favourable effect of N application on the grain yield of moong.

TABLE 1

Yield and protein content in relation to varieties, levels of nitrogen and phosphorus

Grain yield kg/ha

Treatments	1970	1971	Mean	Crude protein (%) 1970
J-781	836	948	842	23.32
H-45	936	1185	1060	24.10
C. D. at 5%	43	54		0.45
N_0	807	997	902	23.63
N_{25}	965	1142	1053	23.79
C. D. at 5%	43	54		N. S
P_0	584	762	673	22.69
P_{25}	872	1044	958	22.88
P_{50}	1027	1232	1129	24.58
P_{75}	1061	1244	1152	24.70
C. D. at 5%	67	77		0.89

Slightly higher protein content was obtained with the application of nitrogen in 1970.

The grain yield of moong was increased with increasing levels of P_2O_5 application in both the years. Application of 25, 50 and 75 Kg P_2O_5/ha increased the grain yield (mean) by 42, 68 and 71 per cent, respectively, over no P_2O_5 application. Deshpande and Bathkal (1965), Singh and Virk (1965), and Shekhawat *et al.* (1972) also obtained significant incrcese in grain yield by the application of phosphorus in moong. Similarly, Prasad *et al.* (1968) observed 25 per cent increase in grain yield of legumes by fertilizing them with 36.3 kg P_2O_5/ha.

An improvement in the protein percentage was obtained by the application of phosphorus. 50 and 75 kg P_2O_5/ha treatments produced significantly higher protein percentage in grain over 25 kg P_2O_5/ha and control, but the latter two levels did not differ significantly. Singh and Yadav (1971) have also reported significant increase in the protein content of gram.

The data in Table 2 revealed that the interactions between varieties and nitrogen as well as between varieties and phosphorus were found significant in both the years. Among N and V interaction, H-45 variety of moong responded to 25 kg N/ha application which was significantly higher than J-781. However, both the varieties responded significantly better to nitrogen application. In 1970 both the varieties remained at par under no nitrogen when the initial N content of the soil was 136 kg of available nitrogen per hectare. But in 1971, under no nitrogen H-45 variety of moong gave significantly higher grain yield than J-781. This may be attributed to higher initial available N content of soil which was 153 kg per hectare.

The varieties and phosphorus interaction revealed (Table 2) that both the varieties gave significantly higher grain yield of moong when fertilized with phosphorus as compared to no phosphorus application during both the years. However, H-45 moong variety responded to phosphorus application significantly better over J-781. This was true under each level of phosphorus application in 1970 and also in 1971. Both the varieties did not differ from each other when no phosphorus was added to the soil in 1970, but in 1971, H-45 yielded significantly higher grain yield of moong than J-781 under the same treatment. This may be because of higher initial available phosphorus content of the soil in 1971, although the differences in the initial fertility were not marked. Therefore, it may be concluded from this interaction effect that H-45 variety of moong has higher potentiality of grain yield because of higher response to phosphorus application than J-781. The response of both the varieties to phosphorus was found to be quadratic and the equations are given below :

$$\text{J-781}—Y = 608.55 + 315.45x — 53.25x^2$$

$$\text{H-45}—Y = 848.35 + 418.35x — 82.75x^2$$

The interaction between nitrogen and phosphorus was also found to be significant (Table 3). The grain yield of moong was increased significantly in both the years when 25 kg N plus 50 kg P_2O_5 or 25 kg N plus 75 kg P_2O_5/ha was applied as compared to any other treatment combination. However, both these combina-

TABLE 2

Yield of moong varieties (kg/ha) in relation to nitrogen and phosphorus

Variety	Nitrogen levels (kg/ha)		Phosphorus levels (P_2O_5 kg/ha)			
	0	25	0	25	50	75
			1970			
J-781	797	876	549	808	975	1013
H-45	818	1046	620	937	1079	1108
C. D. at 5%	67		81			
			1971			
J-781	901	996	681	895	1118	1126
H-45	1083	1287	845	1194	1344	1362
C. D. at 5%	76		113			

TABLE 3

Interaction effect of nitrogen and phosphorus on grain yield of moong (kg/ha)

Levels of—P_2O_5 (kg/ha)	Levels of nitrogen (kg/ha)			
	1970		**1971**	
	0	25	0	25
0	520	649	752	772
25	775	970	954	1134
50	942	1112	1136	1328
75	992	1130	1150	1333
C. D. at 5%	81		113	

tions did not differ significantly among themselves. The combination of 25 kg N plus 25 kg P_2O_5/ha application was also significantly better than 25 kg N plus no P_2O_5 application. Under no N, application of 25,50 and 75 kg P_2O_5/ha increased the moong grain yield but the differences between no N plus 50 kg P_2O_5 and no N plus 75 kg P_2O_5 per hectare were not significant. Chowdhary *et al.* (1972) also observed substantially higher yield of pulses when 25 kg N was applied along with 50 kg P_2O_5 per hectare. The higher grain yield of moong under P_2O_5 application along with nitrogen may be because of more number of nodules resulting in the higher nitrogen fixation. The starter dose of N application might have helped the plant to use the N until the time it fixed its own nitrogen.

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CROPPING PATTERNS IN HARYANA. I. RAINFALL AND CROPPING PATTERNS UNDER UNIRRIGATED CONDITIONS

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ABSTRACT

Haryana State has been demarcated into 7 rainfall zones/patterns in relation to broad water requirements of the crops. The taxonomy of existing cropping patterns has been analysed for various blocks covered under each of the rainfall zones. The position of area under *kharif*, *rabi*, and double cropping reveals the intensity of cropping under unirrigated conditions.

In Haryana which is predominantly an agricultural State, about 82 per cent of the total population is directly or indirectly dependant on agriculture. Agriculture alone contributes about 60 per cent to the net income of the State. The agriculture, besides providing food to the masses and fodder to the livestock, also supplies raw material to the various agro-based industries. Therefore, the study of existing cropping patterns of the State was considered to be of immense use and great significance. The study of existing cropping patterns under rainfed conditions is the outcome of prevailing physical, social and economic conditions. This study has been carried out to know the existing cropping patterns being followed by the cultivators of the State. In this work, the following chief features have been introduced in order to study the finer details of cropping patterns :

(i) Use of block as a unit of area, it being an agricultural sub-division of a tehsil.

(ii) The area under rainfed conditions alone has been analysed for various blocks.

(iii) Inclusion of block-wise information on soil characteristics, such as, soil texture, N-P-K available status, electrical conductivity and soil PH (1 : 2) values to indicate degree of salinity and alkalinity hazards and the quality of soils.

(iv) The use of rainfall data from rain gauge stations in the State for the preparation of rainfall patterns.

(v) The use of relative yield index of various crops under rainfed conditions to indicate the yield potential in the zone.

MATERIAL AND METHODS

Rainfall patterns

The average monthly rainfall data (1941-70) for the rain gauge stations of the State have been used. In examining the monthly rainfall, it is not only the monthly/seasonal totals but the distribution of rainfall during the various crop growth stages which is more important. To facilitate this, the limits of rainfall close to monthly water requirement of crops have been assigned. *Kharif* crops are normally of 90 to 120 days duration.

(i) Rainfall greater than 300 mm per month (A) for at least three consecutive months (July to September) would be suitable for paddy (P) whose water requirement is very high.

(ii) Rainfall of 200-300 mm per month (B) for the three consecutive months would be suitable for crops, like, maize (M), *arhar* (A), *urd* (U).

(iii) Rainfall of 100-200 mm per month (C) for at least three consecutive months would be suitable for low water requirement crops like *bajra* (B), *guar* (GU).

(iv) Rainfall of 50-100 mm per month (D) is just sufficient for crops which has low water requirement like *moong* (MO), moth (MH) and ephemeral grasses (GS).

(v) Rainfall 20-50 mm per month (E) will be used in meeting the climatic demand and is of little significance for the *kharif* crops, but during the winter season 20 to 50 mm of monthly rainfall will have significant effects on the *rabi* crops like wheat (W), gram (G), barley (BA), rape and mustard (RO) etc., in addition to the accumulated soil moisture storage conserved during the S. W. monson seasoon (July to September) for winter crops.

(vi) Rainfall less than 20 mm per month (F) will have little significance in agriculture.

A numerical subscript has been assigned to these rainfall alphabelts in order to indicate the number of months in which particular amount of rainfall is received. As June to September S. W. monsoon period is important in all the parts of Haryana, it has been shown in the coded form by a bracket, the three months, March to May, on its left and the other five months, October to February, on the right. As an example of yearly distribution at Ambala, the rainfall pattern is $E_1 F_2 (B_2 C_1 D_1) E_2 F_3$. Its numerical interpretation is as follows :

(i) March to May--$E_1 F_2$—one month (March) is in 20-50 mm class and the remaining two months (April and May) get less than 20 mm each.

(ii) June to September—$B_2 C_1 D_1$-- Two months (starting from July) one in 200-300 mm class, one month (September) in 100-200 mm class, and one month (June at the end) is in 50-100 mm class.

(iii) October to February–$E_2 F_3$—Two winter months (January and February) are in 20-50 mm class and three months (October to December) are in less than 20 mm class.

Cropping patterns

Suitable codes have been assigned to express the distribution of crops in the various blocks. Suitable notations for various crops is given above while assigning the limits of rainfall for various crops. The following numerical codes have been used as subscript to indicate their distribution.

Subscript code	*Explanation*
1	70 per cent or more of the total cultivated area.

2	50-70 per cent or more of the total cultivated area.
3	30-50 per cent or more of the total cultivated area.
4	10-30 per cent or more of the total cultivated area.
5	5-10 per cent or more of the total cultivated area.
6	Less than 5 per cent of the total cultivated area.

The distribution have been studied for all the 85 blocks in the State and crops which together form at least 80 per cent or more of the total cropped area of a block are denoted to constitute a pattern. The crops considered for making up a pattern are those which individually occupy 5 per cent or more of the total cropped area in the block.

Name of crop	*Code representation*
Kharif fodder	KF
Rabi fodder	RF
Jowar	J
Rabi pulses	RP
Kharif pulses	KP
Sugarcane	S
Groundnut	GR
Cotton	C
Kharif Vegetables	KV
Rabi Vegetables	RV
Potato	PT
Kharif others	KOT
Rabi others	ROT

Intensity of cropping

The cultivated area in *kharif*, *rabi* and the double cultivated area have been put as a percentage of net sown area to indicate the intensity of cropping under unirrigated conditions in the various blocks as shown in Figs. 2, 3 and 4.

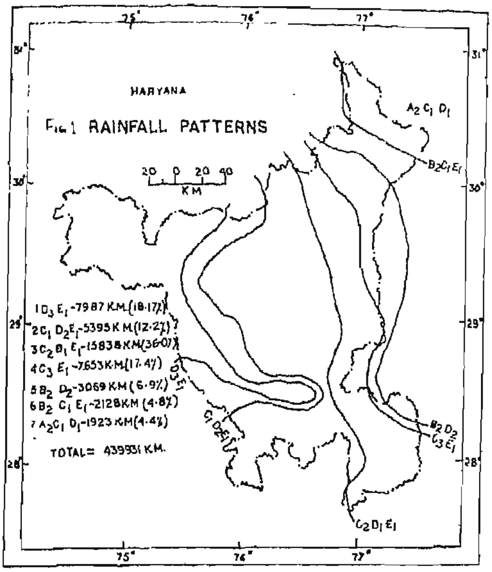
RESULTS AND DISCUSSION

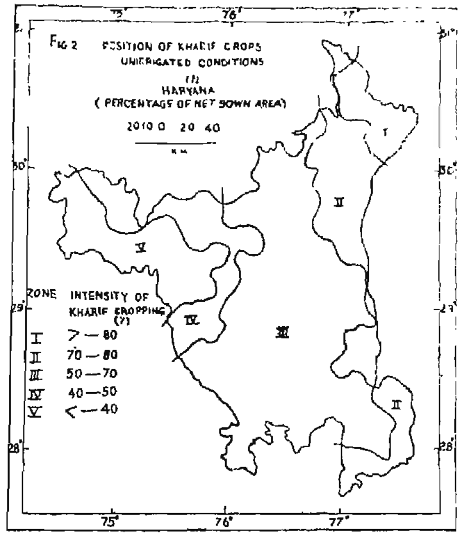
Rainfall zones of Haryana

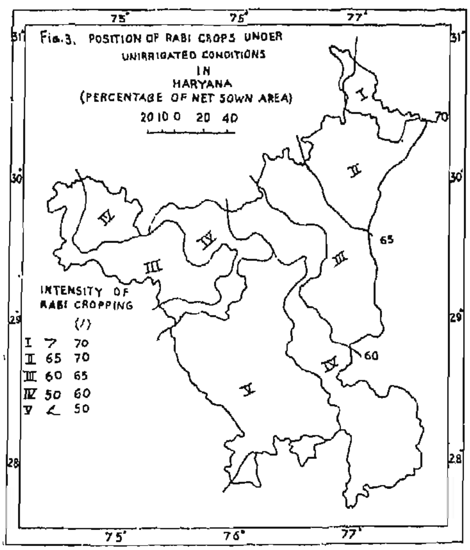
It has been possible to identify 7 rainfall patterns/zones during the S. W. monsoon seasons (Fig. 1). The pattern $C_2D_1E_1$ has the largest area which is 36.0 per cent of the total geographical area of the State. The next largest is D_3E_1 with 18.1 per cent area. The western region of the State is covered under the rainfall pattern D_3E_1 indicating that during each of the monsoon months (July to September) only 50 to 100 mm rainfall is received and this region can be well exploited for low water requirement crops like *moth*, *taramira* and ephemeral grasses. The region under $C_1D_2E_1$ rainfall pattern is also useful for low water requirement crops like *moong*, *moth*, taramira and *bajra* crops. The next important belt is under the rainfall patterns of $C_2D_1E_1/F_1$ indicating that July and August will receive 100-200 mm rainfall per month and during September 50-100 mm rainfall. This zone can be well used for crops like *bajra*, *jowar* fodder, *guar*, *moong* and raya. The area under rainfall pattern C_3 D_1 indicates the suitability for crops, like, *sarson*, gram, *bajra*, *jowar* and *guar*. The area under rainfall pattern B_2 D_2 is suitable for crops, like, maize, gram and barley. The area under B_2 C_1 D_1 rainfall pattern is suitable for maize, *arhar*, *urd*, wheat and groundnut. The area under rainfall pattern A_2 C_1 D_1 is suitable for high water requirement crops, like, paddy, *arhar* and wheat.

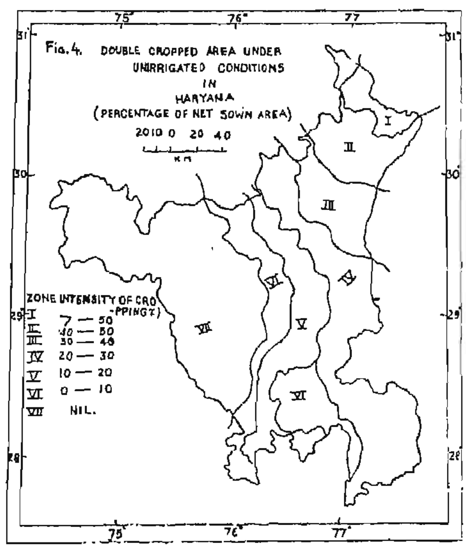
Zonal analysis of rainfall and cropping patterns

Based on the above described methodology the rainfall patterns, soil characterstics (texture, organic carbon, available









phosphorous and potasium), electrical conductivity to indicate the degree of salinity hazards, soil PH (1 : 2) to indicate the degree of alkalinity hazards, and soil quality and the existing cropping patterns have been described blockwise according to various zones of rainfall and the relative index of various crops under unirrigated conditions is given in Table 1.

TABLE 1

Relative yield index of various crops under unirrigated conditions in Haryana

District	Relative yield index (%) of								
	Bajra	Gram	*Jowar*	Wheat	Barley	Maize	Paddy	*Rabi* oil-seeds	*Kharif* pulses
Hissar	98	94	84	65	67	—	—	75	73
Bhiwani	68	39	73	—	46	—	—	91	82
Rohtak	123	106	114	70	120	100	—	93	—
Jind	110	156	89	100	65	60	—	85	—
Mahendergarh	123	88	77	68	113	—	—	121	160
Gurgaon	118	108	78	77	113	63	100	111	175
Sonepat	119	89	130	76	100	66	79	100	—
Karnal	99	187	89	143	152	84	100	107	—
Kurukshetra	116	205	102	146	97	114	123	145	110
Ambala	100	187	—	112	100	108	99	118	85

Zone I

The rainfall pattern is F_3 (D_3 E_1) F_5 and covers 18.1 per cent of the geographical area in the State.

March–May		June–September		October–February	
m	mm pm	m	mm pm	m	mm pm
3	Less than 20	3	50-100	5	Less than 20
		1	20-50		

The blocks with their cropping patterns covered in this zone are :

District	*Block*	*Cropping Pattern*
Sirsa	1. *Sirsa*	G_3 B_3 KF_4 RO_5
	2. Rania	G_2 B_4 RO_4 KF_4
	3. Baragudha	G_3 B_4 RO_4 KF_4
	4. Dabwali	G_3 B_4 RO_5 KF_4
Hissar	5. Fatehabad	G_3 B_3 RO_4
	6. Ratia	G_3 B_4 RO_4
	7. Bhuna	G_3 B_3 RO_4
Rohtak	8. Nahar	G_3 B_4 J_4 GU_5
	9. Salhawas	B_3 G_4 GU_4 J_4 RO_5
Bhiwani	10. Tosham	G_3 B_3 RO_5

Forests are negligible. Fallow land have about 5 per cent area. Soils are loamy sandy to sand loam in texture. This is the driest zone. Gram is the principal crop of the zone with 42.1 per cent area. The other important crops are *bajra*, *rabi* oilseeds and *kharif* fodder crops, covering 30.2, 8.2 and 8.7 per cent area, respectively, in the zone under rainfed conditions.

The yield potential for *bajra* and gram in Hissar, Sirsa and Rohtak districts is very close to the state level yield, whereas in the case of *rabi* oilseeds it is slightly less as compared to the average yield potential of the State. Yield potential in Bhiwani district is very poor in case of *bajra* and Gram.

Zone II

The rainfall pattern is F_3 (C_1 D_2 E_1) F_5 and it covers 12.2 per cent geographical area in the State :

March–May		June–September		October–February	
m	mm pm	m	mm pm	m	mm pm
		1	100-200		
3	Less than 20	2	50-100	5	Less than 20
		1	20-50		

The blocks with their cropping pattern covered in the zone are as follows:

District	*Block*	*Cropping Pattern*
Hissar	1. Tohana	B_2 G_4 RO_5
	2. Hissar II	B_3 G_3 RO_4
	3. Hansi II	B_3 G_3
Bhiwani	4. Bawanikhera	B_3 G_4 RO_4 GU_4
	5. Bhiwani	B_3 G_4 GU_4 RO_5
	6. Loharu	B_3 G_4 GU_4 RO_5
	7. Badhra	B_2 G_3 KF_4 GU_5
Jind	8. Narwana	B_3 G_3 J_4

Rainfall in this zone is less than 350 mm annually. During the S.W. monsoon months it is nearly 300 mm. July is the month of maximum rainfall. August and September however, receive, less rainfall. In this zone *bajra* is the predominant crop covering 45.3 per cent area. Gram, *rabi* oilseeds and *guar* cover 28.8, 8.5 and 8.8 per cent area respectively. Soils are sandy in Tosham and loamy sand to sandy loam in texture in other blocks.

The yield potential of various crops in Bhiwani district is much lower than the average yield potential of the State. The yield potential for the Narwana block will be less, though the yield potential of the district Jind is quite high due to better rainfall distribution and sandy loam soils in the other blocks.

Zone III

The rainfall pattern of this zone is F_3 (C_2 D_1 E_1) F_5 and covers 36.0 per cent geographical area of the State.

March–May		June–September		October–February	
m	mm pm	m	mm pm	m	mm pm
3	Less than 20	2	100-200		
		1	50-100	5	Less than 20.
		1	20-50		

This zone receives 500 mm rainfall annually of which 450 mm is received during the S.W. monsoon season.

The block covered under the zone has following cropping patterns :

District	*Block*	*Cropping Pattern*
Kurukshetra	1. Gulah	G_3 M_5 B_5 W_5 KF_5
	2. Kaithal	G_4 B_4 W_4 KF_4 BA_5 J_5 M_5.
Jind	3. Kalayat	B_3 G_3 J_5 BA_5
	4. Uchana	G_3 B_3 RG_4 J_5
	5. Rajaud	B_3 G_3 J_5
	6. Jind	B_3 G_3 J_4 BA_5
	7. Saffidon	B_3 G_4 J_4 RO_5 BA_5
	8. Julana	B_3 G_3 J_4
Hissar	9. Narnaund	B_2 G_3 KF_5 BA_5
	10. Hansi–I	B_2 G_4 RO_5
	11. Barwala	G_2 B_3 RO_5
	12. Hissar–I	G_2 B_3
Karnal	13. Asandh	G_4 B_4 W_4 KF_4 GU_3
Rohtak	14. Maham	B_3 J_4 G_4 GU_5
	15. Rohtak	G_4 B_4 J_4 W_4 GU_5.
	16. Sampla	W_4 B_4 G_4 J_4 GU_4
	17. Beri	G_2 B_4 J_4 GU_5
	18. Kalanaur	B_4 G_4 W_4 J_4 GU_4 RO_5.
Sonepat	19. Mundlana	W_4 B_4 KF_4 G_4
	20. Gohana	W_3 B_4 KF_4 G_4 BA_5
	21. Kharkhauda	B_3 W_4 KF_4 G_4 BA_5
	22. Kathura	W_3 B_4 KF_4 G_4
Bhiwani	23. Dadri I	B_2 G_3 GU_5 KF_5
	24. Dadri II	B_2 G_3 KF_5 GU_5

Mahendergarh	25. Mahendergarh II	$B_2\ G_4\ GU_4\ RO_5$
	26. Mahendergarh I	$B_3\ G_4\ GU_4\ BA_5\ RO_5$
	27. Narnaul I	$B_3\ G_3\ GU_5\ BA_5\ RO_5$
	28. Narnaul II	$G_3\ B_4\ RO_4\ BA_5\ GU_5$
	29. Khol	$B_2\ G_4\ RO_4\ GU_5\ BA_5$
	30. Bawal	$B_2\ G_4\ RO_4$
	31. Rewari	$B_2\ G_4\ GU_4\ RO_5$
	32. Nagal Chaudhary	$B_3\ G_4\ RO_5\ RP_5\ BA_5$
Gurgaon	33. Pataudi	$B_2\ G_4\ BA_5\ KF_5$
	34. Nuh	$B_4\ G_4\ RO_4\ W_4\ BA_4\ KF_4$
	35. Hodal	$B_4\ G_4\ BA_4\ GU_4\ KF_4$

Bajra is the predominant crop of the region covering 39.9 per cent area. gram, *jowar, rabi* oilseeds and wheat crop cover 27.9, 7.7, 5.1 and 4.9 per cent area, respectively, in the zone under rainfed conditions. The relative yield index of various crops in this zone showed wide variation (Table 1).

Zone IV

The rainfall pattern of the zone is F_3 (C_3 D_1) covering 17.4 per cent of the geographical area in the State.

March-May		June-September	
m	mm pm	m	mm pm
3	Less than 20	3	100–200
		1	50–100

The winter rainfall pattern in the blocks of Sonepat, Karnal and Kurukshetra district covered under the zone is E_1 F_4. This indicates that January will receive a rainfall of 20-50 mm and the remaining period will have less than 20 mm rainfall during each month. Jhajjar and Bahadurgarh blocks have winter rainfall pattern as F_5 indicating that during each of the winter month less than 20 mm rainfall is received. In the Gurgaon district blocks covered under the zone has winter rainfall pattern as F_2 E_1 F_2. It means that during January and February less than 20 mm of rainfall is received, whereas during October 20-50 mm of rainfall is received. The November and December months again received less than 20 mm of rainfall.

The blocks with their cropping patterns covered under the zone are as follows :

District	*Block*	*Cropping patterns*
Gurgaon	1. Ferozpurjhirka	$G_4\ B_4\ RO_4\ W_4\ BA_4\ KF_4$
	2. Hathin	$B_2\ G_4\ KF_5\ GU_5$
	3. Gurgaon	$G_3\ B_3\ GU_5\ W_5\ BA_5\ RO_5$
	4. Punhana	$G_4\ B_4\ W_4\ BA_4\ RO_5\ GU_5$

	5. Palwal	B_4 G_4 BA_4 GU_5 W_5 KF_5
	6. Sohna	B_8 G_4 W_4 BA_4 RO_5 GU_5
	7. Ballabhgarh	BA_4 W_4 G_4 B_4 GU_4 RO_5 KF_5
Rohtak	8. Jhajjar	G_4 B_4 J_4 GU_4 W_5 BA_5 RO_5
	9. Bahadurgarh	B_3 G_4 J_4 GU_5
Sonepat	10. Rai	W_4 B_4 G_4 BA_5 KF_5
	11. Sonepat	B_4 W_4 M_4 G_5 KF_5
	12. Ganaur	G_4 B_4 W_4 M_4 KF_5
Karnal	13. Smalkha	W_4 B_4 M_4 G_4 KF_5
	14. Madlauda	W_4 B_4 KF_4 G_4
	15. Nissang	M_4 G_4 W_5 B_5 RP_5 KF_5
	16. Nilokheri	G_4 M_4 W_4 RP_5 KF_5
Kurukshetra	17. Pundri	G_4 B_4 W_4 BA_5 M_5 KF_5

An annual rainfall of 650 mm is received in this zone, of which 500 mm is received during the SW monsoon season. Soils are loamy sand to loamy in texture with slight to moderate salinity-alkalinity hazards. *Bajra* and gram are the main crops of the region covering 24.9 and 22.3 per cent area, respectively, in the zone. The other secondary important crops are wheat, barley, *guar*, *rabi* oilseeds and *jowar* (80 per cent grown for fodder) with 12.5, 7.8, 5.5, 5.1 and 11.3 per cent area, respectively, in this zone.

Table 1 indicates that *bajra*, gram, barley, and *rabi* oilseeds crops have high yield potential in this zone. In Rohtak and Sonepat district Jowar has also a high potential. In Karnal and Kurukshetra districts all the crops have high yield potential with respect to the State level yields.

Zone V

The rainfall pattern of the zone is F_3 (B_2 D_2) covering 6.9 per cent geographical area in the State.

March-May		June-September	
m	mm pm	m	mm pm
3	Less than 20	2	200–300
		2	50–100

During the winter season, the blocks of district Karnal covered under this zone received 20-50 mm rainfall in January and less than 20 mm in each of the October, November, December and February months. The zone covered in Kurukshetra district has winter rainfall pattern as F_5 indicating that less than 20 mm of the rainfall will be received. Nearly 800 mm of annual rainfall is received in this zone of which 700 mm is received during the SW monsoon season. Soils are sandy loam to loamy in texture. Nearly 20-30 per cent soil samples in this zone indicate moderate salinily-alkalinily hazards. This reduces the quality of soils.

The cropping patterns in the zone are as follows :

District	*Block*	*Cropping pattern*
Karnal	1. Panipat	W_4 M_4 B_4 G_4 KF_4
	2. Gharunda	W_3 M_3 KF_4 G_4
	3. Karnal	M_4 W_4 G_4 KF_4
Kurukshetra	4. Ladwa	G_4 M_4 W_4 BP_5 S_5 KF_5
	5. Kurukshetra	G_4 M_4 W_4 RP_5 KF_5
	6. Shahabad	G_4 M_4 W_4 RP_5 KF_5

The predominant crop of the region is wheat covering 21.4 per cent area. Maize, gram, *rabi* pulses, and *kharif* fodder occupies 18.9, 16.5, 4.9 and 20.1 per cent area in the zone under rainfed conditions.

The yield potential of gram is relatively very high because it is grown all over the State, but its yield potential index varies much from 39 in the Bhiwani district to 204 in Kurukshetra district.

Zone VI

The *kharif* rainfall pattern of the zone is (B_2 C_1 E_1) and covers 4.8 per cent of the geographical area in the State.

June-September	
m	mm pm
2	200–300
1	100–200
1	20–50

In the pre-monsoon months Faridabad block receives less than 20 mm rainfall and during the winter season October receives 20-50 mm and November to February, each month have less than 20 mm rainfall. This indicates assured *rabi* sowing of various crops in October. In Jagadhari, Ambala and Barara blocks during the pre-monsoon months the pattern is E_1 F_2 and during the winter season it is E_2 F_3. That is during January to March, a 20-50 mm per month rainfall is received, whereas during the months of October, November, April and May less than 20 mm rainfall is received. In this belt 900 mm of average annual rainfall is received, of which 750 mm is received during the S.W. monsoon months. Soils are sandy loam in texture with slight to moderate salinily hazards.

The blocks covered under the zone with their cropping patterns are as follows :

District	*Block*	*Cropping pattern*
Gurgaon	1. Faridabad	B_3 G_4 KF_5 W_5 GU_5
Ambala	2. Jagadhari	M_3 W_4 G_4 P_4 S_4 KP_4 KF_5
	3. Ambala	W_4 G_4 M_4 P_4 KF_4
	4. Barara	W_4 M_4 G_4 P_4 S_5 KP_5 KF_5

Wheat is the predominant crop of the zone covering 21.8 per cent area under rainfed conditions. Gram, maize, paddy, *bajra* and *kharif* fodder crops cover 17.5, 13.9, 8.3, 7.4 and 16.1 per cent area, respectively. The relative yield index of various crops in the zone under rainfed conditions are very close to state level yields.

Zone VII

The rainfall pattern of the zone is E_1 F_2 (A_2 C_1 D_1) E_3 F_2

March-May		June-September		October-February	
m	mm pm	m	mm pm	m	mm pm
1	20–50	2	Greater than 300	3	20–20–50
2	Less than 20	1	100–200	2	Less than 20
		1	50–100		

This is the smallest zone covering 4.4 per cent of the geographical area in the state. This area is 300-900 m.a. S. l. In Naraingarh, Raipur Rani and Kalka blocks forests occupy 30 per cent area and in Bilaspur, Chhachhrauli area it is 12 per cent. Soils are loamy sand in texture with slight salinity hazards.

The blocks covered under this zone have the following cropping patterns.

District	*Block*	*Cropping pattern*
Ambala	1. Naraingarh	M_4 G_4 W_4 P_4 KP_4 B_5 KF_4
	2. Raipur Rani	G_4 W_4 M_4 RP_4 KF_5 P_5
	3. Kalka	G_4 M_4 W_4 KF_4 KP_4
	4. Bilaspur	W_4 G_4 M_4 P_4 S_4 KF_5 KP_5
	5. Chhachhrauli	M_4 W_4 G_4 S_4 P_5 B_5 KP_5 KF_5

Gram, maize and wheat crops cover 20.9, 18.4 and 17.5 per cent area in the zone. Paddy occupies only 8.1 per cent area. Sugarcane, groundnut and *kharif* pulses cover 6.0, 5.1, 4.9 per cent area, respectively, in the zone. *Jowar* crop mostly grown as fodder covers 11.3 per cent area in this zone.

This zone gets on an average about 325 mm rainfall per month in July and August 150 mm in September and 80 mm in June. The distribution of rainfall is sufficient for cultivation of rice crop under rainfed conditions in this belt. The yield potential of maize, wheat, gram and paddy is quite above the state level yield potential.

Intensity of kharif cropping

The position of *kharif* crop depend on the rainfall patterns in the state. In the western region due to low and erratic nature of rainfall, less than 50 per cent of the net sown area is cultivated during the *kharif* season. In western Dabwali, Rania, Sirsa, Fatehabad, Hissar I, Hissar II, Tohana and Barwala blocks less than 40 per cent area is cropped during *kharif* under the rainfed conditions. In North Dabwali, Baragudah, Ratia, Bhuna, Tohana, Uchana, Hansi II and Bawani Khera blocks, 40-50% intensity of *kharif* cropping is achieved. 50-70% intensity of *kharif* crops is attained in district Jind, Mahendragarh, Rohtak, Sonepat and Sohna, Hathin, Gurgaon, Pataudi, Loharu, Bhiwani, Badhra, Dadri I, Dadri II, Hansi I, Narnaund, Asandh, Kaithal, Pundri, Gulah and western Ambala blocks. In the high rainfall areas more than 70 per cent intensity of *kharif* cropping is achieved. In Ferozpur jhirka, Punhana, Hodal, Palwal, Ballabgarh, Faridabad, Karnal, Gharunda, Panipat, Nissang, Nilokheri, Thanesar, Shababad, Ladwa, NE Ambala and Kalka blocks, 70-80 per cent of net sown area is cultivated during the *kharif* season. Jagadhari, Chhachhrauli, Bilaspur, Naraingarh and Raipur Rani blocks acquire 80-100 per cent intensity during the *kharif* season under the rainfed conditions.

Intensity of rabi cropping

The intensity of *rabi* cropping varies considerably in the state. It will depend upon the soil type and the amount of soil moisture conserved. In Rania, Sirsa, Fatehabad, Barwala, Hissar II and Hissar I blocks, 60-65 per cent intensity of *rabi* cropping is attained. In Dabwali, Baragudah, Ratia, Bhuna, Tohana, Uchana, Hissar I and Hansi II, blocks only 50-60 per cent intensity is achieved. In Mahendragarh and Bhiwani districts, Hansi I, Narnaund, Jind, Maham, Nahar and Salhawas blocks, only 20-50 per cent intensity *rabi* cropping exist. In Gurgaon district, Jhajjar, Bahadurgarh, Beri, Kalanaur, Rohtak, Kathura, Saffidon, Asandh, Rajand, Narwana and Kalayat blocks, 50-60 per cent intensity of *rabi* cropping is achieved. In Sonepat district, Kharkhauda, Gharaunda, Panipat, Samalkha, Nissang, Madlauda, Pundri, Kaithal and Gulah blocks attain 60-65 per cent of intensity of *rabi* cropping under the rainfed condition in this zone. Karnal, Nilokheri, Ladwa, Thanesar, Shahabad, Ambala, Barrara, Jagadhari, Kalka and Chhachhrauli blocks acquire 65-70 per cent of intensity of *rabi* cropping. 70 per cent intensity is attained during the *rabi* season in the Bilaspur Naraingarh, and Raipur Rani blocks under the rainfed condition.

Intensity of double cropping

The intensity of double cropping under rainfed condition will depend on the amount of soil moisture available in October after the *kharif* crop during the monsoon season and the amount of winter rainfall received. In high rainfall areas (greater than 600 mm annual rainfall), the double cropping is possible with the suitable choice of crops/varieties and conservation practices. In these areas, late monsoon rains and more than 50 mm of winter rainfall is expected and the *rabi* crops can be successfully grown after the first crop with the S.W. monsoon season. In Raipur Rani, Northern Naraingarh, Bilaspur, and Chhachhrauli blocks, 50-55 per cent of the net sown area is cultivated for two crops in the year under the rainfed conditions. Kalka, Jagadhari, Barara, Ambala, Ladwa, Thanesar, and Shahabad blocks attain 40-50 per cent intensity of double cropping under the rainfed condition. In Karnal, Gharaunda, Nilokheri, Nissang, Pundri and Pehowa acquire 30-40 per cent of net sown area by the double cropping under the unirrigated conditions. 20-30 per cent intensity of double cropping is attained in the Gulah, Kaithal, Asandh, Panipat, Smalkha, Madlauda, Sonepat, Ganaur, Kharkhauda, Sampla, Bahadurgarh, Jhajjar, Gurgaon, Sohna, Faridabad, Ballabgarh, Palwal, Hodal, Hathin, Punhana, Nuh and Ferozpur Jhirka blocks. In Kalayat, Rajaund, Saffidon, Gohana, Mundlana, Kathura, Rohtak, Kalanaur, Beri, Dadri I, Mahendragarh II, Narnaul I and Bawal blocks. In Narwana, Uchana, Jind, Maham, Dadri II, Mahendragarh I, Narnaul II, Nagal Chaudhary, Rewari, Khol, Pataudi, Nahar and Salhawas blocks less than 10 per cent of double cropping intensity exists under the unirrigated conditions.

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HISTOCHEMICAL STUDIES ON EXPERIMENTAL SPIROCHAETOSIS IN POULTRY*

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ABSTRACT

Histochemical studies on experimental spirochaetosis in 15 weeks old White Leghorn chicks, at the different stages of infection, with and without penicillin therapy, were conducted. The progressive changes in the staining reaction of DNA, PAS and alkaline phosphatase in the various organs of chicks have been discussed.

Spirochaetosis is one of the important diseases responsible for heavy losses among the poultry flocks in India. Enough information is available in the literature regarding the pathology of the disease, but no attempt seems to have been made to undertake the detailed histochemical studies.

MATERIAL AND METHODS

Sixty White Leghorn chicks, 15 weeks old, were taken and divided into two groups A and B of 30 each. In each group 24 chicks were infected with one millilitre of infected chick blood showing a ++++ concentration of spirochaetes, i.e., 20-25 organisms in each microscopic field. The remaining six chicks, in both the groups, were kept as healthy controls. In group A, four infected chicks along with one control were sacrificed 24, 48, 72, 96, 120 and 144 hours post-infection. The pieces of the duodenum, spleen, liver and kidneys were collected in the appropriate fixatives for histochemical studies.

In group B, all the chicks inclusive of controls, were injected intramuscularly, 96 hours after the introduction of infection, with a single dose of 10, 000 I. U. of procaine penicillin. Four infected treated and one control chicks were sacrificed at the intervals of 24, 48, 72, 96, 120 and 144 hours post-treatment and pieces of different organs collected as in group A.

The histochemical techniques, viz., periodic-acid-Schiff staining (PAS) for polysaccharides, nuclear feulgen reaction for DNA and *Gomori calcium cobalt* staining for alkaline phosphatase were employed (Thompson, 1966).

OBSERVATIONS

PAS reaction

Normal (Control) group. In the duodenum, the positive PAS staining was

*Part of approved M. Sc. thesis submitted by first author to the Haryana Agricultural University, Hissar (1970).

observed in the luminal border of the lining epithelial cells of villi and intestinal glands, in the goblet cells and in the wall of vascular channels. A bright staining was evident in the hepatic cells and in the wall of hepatic vessels. In the kidneys, the glomeruli, luminal border of lining epithelium of convoluted tubules and its basement membrane revealed the positive reaction. The whole of the splenic parenchyma exhibited positive PAS staining; the capsule, wall of vascular channels, reticulin network and reticuloendothelial cells revealed an intense staining.

Infected group. In the duodenum, an increased staining reaction, at the sites normally observed, was seen 24, 48, 72, 96, 120 and 144 hours post-infection, which appeared to be maximum at 48-72 hours. In the hepatic parenchyma and vascular channels, a strong PAS reaction was apparent 24 and 48 hours post-infection. Thereafter, the hepatic parenchyma revealed a weak reaction. In the kidneys, no change was observed at 24 hours interval but from 48 to 144 hours, an increased staining reaction was apparent at all the sites referred to earlier. No significant change in the staining reaction was apparent in the spleen at any stage of infection studied.

Infected penicillin treated group. In the duodenum, a strong PAS reaction was observed from 24 to 72 hours after treatment. Later, the staining was comparable to that seen in normal controls. In hepatic parenchyma, a weak PAS staining was apparent 24 to 96 hours after treatment. At 120 and 144 hours interval, though the staining reaction appeared comparatively increased, it was weaker than that observed in control group.

In the kidneys, a strong PAS reaction, comparable to that seen in the infected group, was noticeable. PAS reaction in spleen was almost similar to that observed in the normal and infected groups.

Nuclear feulgen reaction for DNA

Normal (Control) group. In the duodenum, the nuclei of epithelial cells lining the villi revealed intensely stained DNA granules, while in the cells of intestinal glands, they were stained comparatively light. The bright DNA granules were also seen in the spleen. In the hepatic cells and in the lining cells of convoluted tubules of kidneys, they were stained lightly. But in the glomeruli and erythrocytes, a strong staining reaction was observed.

Infected group. In the duodenum, the staining reaction for DNA appeared to be more intense than normal from 24 to 144 hours post-infection at both the sites already referred to. Similarly, in the spleen and kidneys an increased staining reaction was evident. In the case of hepatic cells, there was an increased staining activity 24 hours post-infection, but later, at 48 and 72 hour interval, there was, in general, a clear evidence of diminished DNA activity. At 96, 120 and 144 hours interval the activity was found increased, as compared to that seen at 24 hours post-infection. Besides, the strong staining reaction, the number of visible DNA granules also appeared more than in the normal group.

Infected penicillin treated group. In the duodenum, there appeared a general decrease in DNA activity at 24 to 72 hours after treatment, as compared to that observed in the healthy chicks, but thereafter it tended to increase. An increased DNA activity was also evident in the spleen at 24 and 48 hours after treatment, which was comparable to that seen in the untreated infected cases at the same period of post-infection. At 72 hours after treatment, DNA activity seemed to be more, but it was less than that seen in the infected untreated cases. However, the staining reaction at 96 to 144 hours after treatment was similar to that seen in the untreated infected cases. In the kidney sections, no significant difference in DNA staining was evident at any of the post-treatment intervals. Similar was the case with hepatic parenchyma; only at 24 hours there appeared a slight increase in the staining reaction.

Alkaline phosphatase reaction

The alkaline phosphatase reaction was studied only in two organs, viz., duodenum and kidneys.

Normal (control) group. In the duodenum, a light positive reaction for alkaline phosphatase was noticeable in the striated border of lining epithelium of villi. Similar reaction was apparent in the luminal border of epithelial cells lining the convoluted tubules in the kidneys; no reaction was observed in the collecting tubules and glomeruli.

Infected group. In the duodenum, an increased alkaline phosphatase activity was apparent at 24 to 144 hours post-infection. In addition, in many cases, the reaction was seen in the luminal border of epithelial cells lining the glands of Lieberkuhn. In the kidneys, a strong reaction was observed at 24 and 48 hours post-infection at the site mentioned above. Though a few small foci of strong reaction were seen at 72 to 144 hours post-infection, there was clear evidence of diminished activity of alkaline phosphatase at these stages of infection.

Infected penicillin treated group. In the duodenum, a strong staining reaction for alkaline phosphatase was seen 24 to 144 hours after treatment. Similarly, in the kidneys a strong reaction was observed 24 and 48 hours after treatment. At 72 to 144 hours post-penicillin therapy, a more diffuse and stronger reaction was evident.

Administration of penicillin to healthy chicks, however, had no effect on PAS, DNA and alkaline phosphatase reaction in the organs studied.

DISCUSSION

In the present histochemical studies of *experimental spirochaetosis in poultry*, DNA reaction in the duodenum, spleen, kidney and liver at 24 to 144 hours post-infection appeared stronger than that seen in the tissues of healthy chicks. In the spleen, the activity appeared to be maximum. In the penicillin treated infected cases, the spleen showed increased DNA reaction, but there was no appreciable difference in reaction in the other tissues, except that, 24 to 72 hours after treatment, the duodenum revealed a decrease in DNA reaction.

Moustafa *et al.* (1966) appear to be the only previous workers, who attempted the histochemical studies of spirochaetosis in chicks. They demonstrated an increased amount of break down products of DNA in the infected cases. In the sections of liver of rabbits infected with

Fasciola, a stronger DNA reaction was observed by Furmaga (1964). He concluded that in the acute phase of infection the increased DNA staining reaction suggested a higher metabolism of DNA. Further, when *Fasciola* was not present in hepatic tissue, the increased activity was supposed to be related to the processes of regeneration and repair. The same explanation for the increased DNA reaction in the present cases of spirochaetosis seems to be true.

PAS staining reaction in the duodenum, liver, kidneys and spleen studied at different stages of infection, presented quite a variable picture. In the duodenum, a progressive increase in PAS reaction, reaching its peak at 72 hours post-infection was observed. Similarly, a steady increase in the kidney from 48 to 144 hours was apparent. On the contrary, in the liver, a decrease was observed from 72 to 144 hours post-infection. No change was apparent in the spleen. Almost similar observations were recorded in the organs of penicillin treated chicks with the difference that in the liver, a relatively strong reaction was demonstrable 120 hours after treatment. In poultry, an increased production of mucopolysaccharides in the intestinal tissues in the cases of experimental ascaridiasis has been reported by Chatterjee and Singh (1968) and Kaushik (1970). In the present cases of spirochaetosis, the increased PAS reaction in the duodenum might be due to the copious amount of mucus, secreted as a result of the irritation caused by the toxins of spirochaetes.

During the course of spirochaetosis, the chicks go off feed and suffer from degenerative processes. Consequently, in the liver of infected chicks, a weak PAS reaction for glycogen content was observed. Kaushik (1970) observed a weak PAS reaction for glycogen reaction in the liver of chicks infected with *Ascaridia galli*. The increased PAS reaction in the penicillin treated cases might be due to the fact that by that time the chicks started to consume feed and the degenerative changes subsided.

Alkaline phosphatase reaction in the duodenum was found to be more throughout the course of infection. In the kidneys, though an increased activity at 24 and 48 hours was recorded, it decreased thereafter and remained low till 144 hours post-infection. Almost similar changes were observed in the duodenum of the penicillin treated birds. But in the kidneys, a steadily increasing activity from 24 to 144 hours after treatment was demonstrable. Chatterjee and Singh (1968) observed an increased activity of alkaline phosphatase in the damaged epithelium and also over the brush border of the intestinal villi of chicks suffering from ascaridiasis. Furmaga (1964) put forth the same view for the increased alkaline phosphatase activity as already described for DNA activity. From the histopathological observations it was evident that after the penicillin therepy there was steady regression of degenerative changes. This may explain, as suggested by Furmaga (1964), the increased alkaline phosphatase activity in cases of experimental spirochaetosis.

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STUDIES ON SOME BLOOD CONSTITUENTS IN CHICKEN WITH MODIFIED THYROID ACTIVITY

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ABSTRACT

Investigations were conducted to study the possible changes in some of the biochemical constituents in blood of chicken by experimentally altering the functional status of their thyroid. The values of calcium, magnesium, proteins, sodium and cholesterol were decreased in hyperthyroid birds. Hypothyroid birds had higher blood levels of protein and cholesterol, whereas sodium contents decreased.

Since blood composition tends to reflect tissue metabolism, it becomes essential to study the blood picture in order to understand a pathological condition or a metabolic disorder. The present investigations were conducted to study the possible changes in some of the biochemical constituents in blood of chicken under varying thyroid status with a view to understand the role of thyroid hormone function in metabolic processes.

MATERIAL AND METHODS

Sixty, day-old, cross-bred (New Hampshire × White cornish) chicks were procured from HAU Poultry Farm. They were kept in the brooder battery with temperature adjusted to 37°C for the first 15 days and, thereafter, at room temperature. They were fed *ad lib* the standard chick feed obtained from the Haryana Agro-Industries. They were divided into 3 groups of 20 birds each (groups I to III). Group I served as the normal control group, while the birds in group II were given daily the goitrogen-methimazole (1-methyl-2 mercapto-emidazole) as 0.05 per cent solution in drinking water to prevent the formation of endogenous thyroxine. This group served as hypothyroid group. Birds in group III, in addition to methimazole water, received daily injections of 5 μg thyroxine/100 g.b.w. subcutaneously. This group served as hyperthyroid group. Since the protein-bound iodine (PBI) level is a fairly good index of measuring qualitative activity of the thyroid gland, the PBI level was kept as a criterion for judging the hypo and hyper-thyroid state of the birds. The average values of PBI found in birds of group II and III were 2.03 μg/100 ml and 3.19 μg/100 ml, respectively, as compared to the value of 2.87 μg/100 ml in control birds (Dixit *et al.*, 1970). The hyperthyroid condition could have been produced directly in the birds by exogenous administration of thyroxine, but the treatment given in the present investigations (methimazole+thyroxine) was necessitated as we were interested to find out the normal thyroid secretion rate (TSR) in these birds by goitre prevention assay method. The TSR in control birds was found to be 2.9 μg thyroxine/100 g.b.w. (Dixit *et al.*, 1970). Thus in view of the higher doses of thyroxine administered to these birds than their normal TSR and also their higher PBI level, the group III was considered as hyperthyroid group.

The treatment was continued for 30 days, thereafter the blood samples were collected from each bird. The estimation of the following blood constituents was done by the standard methods. Calcium was estimated by the method of Roe and Kahn (1929). Magnesium was estimated by Titan yellow method as described by Neil and Nealy (1956). Total plasma proteins were estimated by biuret method as suggested by Henry *et al.*, (1957). Sodium and potassium were estimated by flame photometric technique as given by Oser (1965). Cholesterol was estimated by the method of Zak (1957).

RESULTS AND DISCUSSION

The average values of blood constituents studied have been presented in Table 1. The statistical analysis has been shown in Table 2.

Calcium

The average values of calcium recorded in mg per cent were 15.27±0.33, 15.33±0.85 and 12.82±0.46 in groups I, II and III, respectively. The results indicated that the level of calcium decreased significantly in hyperthyroid group, whereas calcium level of blood remained unchanged in hypothyroid birds (Table 2).

Snapier and Perek (1970) also observed a decrease in calcium level in young chicken as well as in old hens receiving 0.05 per cent thyroprotein supplementation in feed. Gulati (1972) reported a decrease in calcium level of blood in laying hens injected with 2.5 μg thyroxine/100 g.b.w., whereas methimazole treated birds had no change in blood calcium. Geschwind (1961) also observed that serum calcium levels of blood remained unchanged in hypothyroid rats. The observations recorded here are in agreement with the findings of these workers.

It has been observed that hyperthyroid animals exhibited increased requirements for vitamins and minerals (Drill, 1943). A decrease in the level of calcium in hyperthyroid state may be due to increased mobilization of calcium from the skeleton and increased loss through urine and faeces (Turner, 1966). Greater excretion of calcium through urine and faeces suggests defective absorption since large amounts of vitamin D are required to reverse the excessive calcium loss. It had been reported that if hyperthyroid patients were maintained on a diet with a low calcium content, they excreted it to a large extent than healthy people and in general hypothyroid persons showed tendency to excrete less calcium than healthy ones (Turakulov, 1959).

Magnesium

The average values of magnesium in mg per cent were found to be 2.53±0.12, 2.14±0.16 and 1.87±0.16 in groups I, II and III respectively.

TABLE 1

Average values of blood constituents studied in different groups of birds

Groups	Calcium (mg%)	Magnesium (mg%)	Protein (mg%)	Potassium (mg%)	Sodium (mg%)	Cholesterol (mg%)
I—Normal	15.27±0.33	2.53±0.12	4.01±0.10	22.57±1.02	332.85±5.00	150.01±1.34
II—Hypo-thyroid	15.33±0.85	2.14±0.16	5.48±0.11	24.78±0.98	282.50±9.03	167.32±0.97
III—Hyper-thyroid	12.82±0.46	1.87±0.16	3.09±0.13	22.82±0.65	310.18±4.47	142.46±1.17
Critical $P<0.05$	1.6716	0.3582	0.3184	—	5 6715	3.2994
Difference $P<0.01$	2.2176	0.4752	0.4224	—	7.5240	4.3771

TABLE 2

Analysis of Variance of the data on blood constituents

Source of variation	d.f.	M.S.S. (Calcium)	M.S.S. (Magnesium)	M.S.S. (Protein)	M.S.S. (Potassium)	M.S S. (Sodium)	M.S.S. (Cholesterol)
Between groups	2	57.31**	3.1989**	38.87**	41.02 NS	11992**	4537.71**
Error	81	9.93	0.4436	0.35	22 69	114	38.48

NS—Not significant.

**—Significant at 1% level ($P\angle 0.01$).

The results have shown decreased magnesium level in blood of chicken made hyperthyroid. No published report seems to be available on this blood constituent under different functional level of thyroid in birds. The absorption of magnesium from the bowel resembles that of calcium in many respects. Like calcium, magnesium is excreted in faeces and urine. Hypomagnesemia observed in hyperthyroid birds may be the result of defective intestinal absorption and excessive loss of magnesium in the urine on similar lines as found in calcium.

Proteins

The average values of protein in g per cent found in the present study were 4.01 ± 0.10, 5.48 ± 0.11 and 3.09 ± 0.13 in groups I, II and III respectively. The statistical analysis revealed a significant increase in protein contents under hypothyroidism (group II), whereas a significant decrease was observed under hyperthyriodism (group III) as compared to control group of birds. Similar results under both the conditions, have been reported by Bhardwaj (1969) and Gulati (1972) in young chicken and laying hens, respectively.

The stimulating effect of thyroprotein on metabolic rate in chicken had been reported to last as long as supplementation is maintained (McCartney and Shaffner, 1950). The higher metabolic rate undoubtedly means accelerated enzyme turnover with a resultant increased demand for coenzymes and protein as well as increased breakdown of these essential materials. There is increased nitrogen excretion indicating accelerated rate of protein catabolism during hyperthyroidism. Therefore, the young chicken made hyperthyroid by exogenous administration of thyroxine had been reported to have lesser growth rate (Bhardwaj, 1969; Nangia and Gulati; 1973) as compared to that of normal birds.

A depression in metabolic rate following thyroidectomy occurs in many avian species (Marvin and Smith, 1943; Mellen and Wentworth, 1962). Hypothyroidism results in depressed cellular activity producing decreased intestinal absorption accompanied by diminished ability on the part of specialized cells to utilize the nutrients. It seems likely that thyroid hormone deficiency strikes more closely at utilization of food stuffs required by the rapidly developing cells. Thus the improper utilization of food protein results in excessive blood protein contents. On the basis of defective utilization of food stuffs by the cells under hypothyroidism, the goitrogens have been found to retard the growth of birds (Singh *et al.*, 1968; Bhardwaj, 1969; Nangia and Gulati, 1973).

Cholesterol

The average value of the cholesterol in mg per cent were found to be 150.01 ± 1.34, 167.32 ± 0.97 and 142.46 ± 1.17 in groups I, II and III respectively. The results indicated that the cholesterol level was significantly higher in hypothyroid birds (Group II), whereas the level decreased in hyperthyroid birds (Group III). Similar findings have been reported earlier (Snedecor and Mellen, 1965; Elmer *et al.*, 1967; Tapperman 1968; Bhardwaj 1969).

The thyroid hormones affect both the synthesis and degradation of lipids. Catabolic reactions of lipids are stimulated by thyroid hormones; these actions may predominate even at moderate dosages so that marked decreases in body fat depots result inspite of no change or increases in synthetic rates. Especially in case of cholesterol, increased excretion and conversion to bile acids have been held responsible for the decreased plasma cholesterol levels induced by hyperthyroidism (Weiss and Marx, 1955; Bergstrom, 1959). The increase of androsterone produced by excess thyroid hormones *may contribute to the fall in cholesterol.* (Gallagher *et al.*, 1960).

A more specific change in lipid metabolism is the increase in plasma cholesterol seen in human myxoedema independent of neutral fat changes (Peters and Man, 1950). A similar rise had been reported in experimentally created hypothyroid animals to a smaller extent (Kurland and Freedberg, 1960). Isotopic studies have shown that hepatic synthesis and release of cholesterol from acetate in the hypothyroid animal is sub-normal (Fletcher and Myant, 1958), although liver cholesterol content was correspondingly high (Ruegamer and Silverman, 1961). The process of periphereal breakdown and biliary excretion are lowered still more resulting in the observed elevated plasma levels. The importance of the lowered rate of destruction of cholesterol can be emphasized by placing the hypothyroid animal on a high cholesterol diet which resulted in an even greater rise in circulating plasma values (Kurland and Freedberg, 1960).

Sodium and Potassium

The average values of sodium in mg per cent were 332.85±5.00, 282.50±9.03 and 310.18±4.47 in groups I, II and III, respectively. The average values of potassium in mg per cent in groups I, II and III were found to be 22.57±1.02, 24.78±0.98 and 22.82±0.65, respectively.

The statistical analysis revealed significant lowering of sodium level in both the groups of experimental birds (groups II and III) as compared to that of normal values in group I (Table 2). The potassium level of blood did not vary significantly in different groups.

There seems to be no published report available in the literature on electrolyte handling by birds under different thyroid activity.

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ASSOCIATION OF YIELD COMPONENTS AND THEIR FUNCTIONS IN BLACK GRAM *(PHASEOLUS MUNGO)*

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ABSTRACT

The study of correlation coefficients and path-analysis has been adopted to understand the association between yield and its related components in black gram. Selection indices were computed with the help of discriminant function, selecting main yield components in all possible combinations along with the yield. The number of pods on side branches and seed size were main yield contributing components as revealed by correlation and path-coefficient analyses. Among the selection indices, number of pods on side branches in combination with yield gave the highest relative selection efficiency over the direct selection.

Improvement in yield is the ultimate aim of a breeder. Yield is a complex character and is the resultant of many factors which are relatively simply inherited. Selection of these components has been considered more useful as compared to selection of yield *perse* as suggested by Grafius (1956). In a selection programme a study of association among yield and its components is of prime importance. But the understanding of this type of association becomes more complex as the number of components is increased. Wright (1921) developed the most potent technique, path coefficient analysis, to understand the extent and nature of direct and indirect effects of the component characters.

The present study was undertaken to assess the extent and nature of direct and indirect effects of the yield components and to construct a suitable selection index in black gram.

MATERIAL AND METHODS

Twenty-five varieties of black gram were grown in a randomized block design with four replications. Each plot consisted of five rows spaced 60 cm apart, distance among plants within rows being 15 cm. Observations were recorded on 10 randomly selected plants in each plot for (i) days to 50 per cent flowering, (ii) plant height, (iii) branches per plant, (iv) pods on main shoot, (v) pods on side branches, (vi) total pods/plant, (vii) length of pods, (viii) seeds per pod, (ix) 100-seed weight and (x) yield per plant.

Phenotypic, genotypic and environmental correlation coefficients for all possible combinations were worked out by the method described by Al-jibouri *et al.* (1958). Genotypic correlation coefficients were partitioned in to components of direct and indirect effects by the path-coefficient analysis as suggested by Dewey and Lu (1959), taking into consideration five characters contributing to yield. Only three characters influencing yield directly as revealed by path-coefficient were selected for constructing the selection indices. Selection indices were constructed for all possible combinations of the four characters studied, according to the procedure given by Robinson *et al.* (1951). The grain yield per plant was also included as one of the independant characters as suggested by them.

RESULTS AND DISCUSSION

Correlation coefficients

Genotypic correlations, in general, were higher than the corresponding phenotypic correlations (Table 1). This was in agreement with the results of Singh *et al.* (1972), Singh and Malhotra (1970) and Johnson *et al.* (1955).

Highly significant and positive relationship of seed yield with number of pods on side branches and total number of pods per plant was observed. The length of pods and number of pods on main shoot had positive and significant association with seed yield, but height of the plant and seed weight had non-significant association with yield. The number of branches had a substantial positive associations with number of pods on main shoot, number of pods on side branches, total number of pods per plant, length of the pod. Seeds per pod was negatively correlated with seed weight but it exhibited no association with seed yield. Number of pods on main shoot was also found highly positively correlated with number of pods on side branches, total number of pods per plant and seeds per pod.

Plant height had an appreciable positive correlation with number of pods on main shoot, total number of pods per plant and seed size. Days to flowering had significant negative correlation with length of pod, seed size and negative (but low) correlation with seed yield and was positively correlated with number of branches.

From above discussion it appears that seed yield is highly dependent on number of pods on side branches, total number of pods per plant and length of pods. Similar findings, except that of seed size and seeds per pod, had been reported in various pulse crops by Parsad (1959), Anand and Torrie (1963), Singh and Bhatnagar (1965), Singh and Mehndiratta (1969), Singh and Malhotra (1970) and Singh *et al.*, (1972). It seems to be perplexing that the two main yield components viz., seed size and seeds/pod are associated with yield. Similar results were obtained with regard to seed size in soyabean by Lal and Haque (1971). Further, it was clear from correlation study that yield can be increased by making selection for total number of pods per plant and number of pods on side branches.

Path-coefficient

Considering that selection indices based on only those characters that have direct association with seed yield will be more reliable, the path coefficient analysis

TABLE 1

		Days to flowering	Plant height	No. of branches	Number of pods on main shoot	Number of pods on side branches	Number of pods per plant	Length of pods	Seeds/ pod	Seed size	Yield/ plant
		1	2	3	4	5	6	7	8	9	10
1.	g	—	−0.02	0.48	0.05	0.02	0.07	−0.45	−0.05	−0.62	−0.26
	p	—	−0.02	0.42	0.05	0.03	0.09	−0.41*	0.01	−0.44*	−0.10
	e	—	0.01	0.12	0.05	0.11	−0.38	−0.08	0.20	−0.15	0.04
2.	g	—		−0.37	0.60	0.03	0.43	0.35	0.30	0.66	0.31
	p			−0.35	0.55**	0.15	0.45*	0.23	0.23	0.57**	0.32
	e			−0.02	0.06	0.22	0.31	0.24	0.05	−0.13	0.13
3.	g				0.46	0.55	0.59	−0.50	0.55	−0.90	−0.08
	p				0.56**	0.54**	0.64**	0.48*	0.59**	−0.49*	−0.20
	e				−0.36	0.53**	0.53**	−0.01	0.54**	−0.26	−0.28
4.	g					0.45	0.46	0.48	0.56	−0.26	0.43
	p					0.75**	0.87**	0.47*	0.54**	−0.14	0.47*
	e					0.84	0.97	0.75	0.02	−0.28	0.95
5.	g						0.99	−0.16	0.31	−0.23	0.83
	p						0.99**	−0.01	0.38*	−0.09	0.89**
	e						0.98	0.10	−0.02	−0.05	0.91
6.	g							0.30	0.34	−0.28	0.80
	p							0.32	0.33	−0.07	0.88**
	e							−0.18	−0.02	0.09	0.91
7.	g								0.31	0.98	0.43
	p								0.37	0.70**	0.40*
	e								0.19	−0.37*	0.11
8.	g									−0.37	0.12
	p									−0.38*	0.06
	e									−0.33	0.05
9.	g										0.37
	p										0 36
	e										−0.15
10.	g										—
	p										—
	e										—

g = genotypic correlation coefficient P = Phenotypic correlation coefficient
e = environmental correlation coefficient
* = Significant at 5% level of significance
** = Significant at 1% level of significance

was used to determine the direct and indirect effects of number of pods on side branches, total number of pods per plant, length of the pods, seeds per pod and seed size on seed yield. These relationships are shown in Table 2. The correlation studies showed that seeds per pod and seed size were not correlated with yield but path coefficient analysis revealed that they had their substantial direct contribution to yield. Seed size showed sizable positive direct contribution (0.762) that had been nullified by its negative indirect contribution via number of pods on side branches and seeds per pod. Total number of pods per plant and length of the pods had substantial positive correlation with the seed yield (0.80) but their direct contribution was negligible (—0.084). Their high correlation with seed yield was because of their indirect contribution through number of pods on side branches (1.262) and seed size (0.74).

A perusal of the result obtained in path-coefficient analysis, further revealed that the two characters, namely total number of pods per plant and length of the pods neither contributed directly nor assisted any other character to exhibit indirect effect. Seeds per pod had negative (—0.55) direct effect on seed yield. It produced sizable indirect effects via number of pods on side branches and seed size.

When the whole picture is considered, it appears that pods on side branches had the highest direct assocation at the genetic level, followed by seed weight. A critical examination of Table-2 also revealed that almost all the yield components contributed to yield through number of pods on side branches and seed size.

It is clear from the above discussion that the complex situation created by simple correlation study of yield with its components has been simplified by path-coefficient analysis, where correlation study indicated pods per plant, and number of pods on side branches to be the main yield components but path coefficient analysis revealed the number of pods on side branches, seed size and seeds per pod as the main yield components influencing the seed yield directly as well as indirectly. Hence yield can be increased by selecting for number of pods on side branches or seeds per pod alone, while keeping other components constant.

Selection index

The different selection indices constructed on the basis of these three characters, namely, number of pods on side branches, seed size and length of pods on side branches are given in Table 3. An examination of the relative efficiencies indicated that selection for any one of the characters alone is not effective. But when any of these characters is selected along with the yield, the selection becomes more effective. Number of pods on side branches had given highest value of genetic advance followed by seed size. The genetic advance and relative selection efficiency over the straight selection were high whenever these two components appeared with the seed yield. The path-coefficient analysis also indicated the importance of these two yield components. For seed yield the efficiency was low but when this was taken as an independant variable alongwith the other variables, the efficiency of selection was increased. This is in confirmity with the work of Hazel (1943), Abraham *et al.* (1954), Panse (1957) and Paroda and Joshi (1970).

TABLE 2

Path-coefficient of some yield components in black gram

Characters	Effect via					
	Number of pods on side branches	Number of pods/plant	Length of pods	Seeds/pod	Seed size	Correlation with seed yield
Number of pods on side branches	1.275	−0.084	−0.014	−0.172	−0.175	+0.830
Number of pods/plant	1.262	−0.084	0.025	−0.189	−0.214	+0.800
Length of pod	−0.204	−0.025	0.085	−0.172	0.747	+0.431
Seeds/pod	0.395	−0.029	0.026	−0.554	0.282	+0.120
Seed size	−0.293	0.023	0.083	−0.205	0.762	+0.370

Values on diagonal are the direct effects.

TABLE 3

	Selection indices	Genetic Advance	Relative efficiency over straight selection in percentage
1.	$0.2185Y$	4.3775	— 0.07
2.	$0.0444\ X_1$	3.9156	−10.62
3.	$0.58882\ X_2$	1.2238	−72 07
4.	$1.5893\ X_3$	2.4495	—44.09
5.	$0.2157\ Y+0.3336\ X_1$	5.4813	22.38
6.	$0.2146\ Y+0.4109\ X_2$	4.4578	1.76
7.	$0.2186\ Y+1.3283\ X_3$	4.9193	12.30
8.	$0.0444\ X_1+0.5925\ X_2$	4.1033	− 6.33
9.	$0.0473\ X_1+1.8369\ X_3$	4.8241	10.12
10.	$0.3690\ X_2+1.4903\ X_3$	2.5631	—41.49
11.	$0.1973\ Y+0.0044\ X_1+0.4263\ X_2$	4.4640	1.90
12.	$0.1098\ Y+0.0247\ X_1+2.6843\ X_3$	5.3189	21.42
13.	$0.2070\ Y+0.2312\ X_2+1.1750\ X_3$	4.8163	9.95
14.	$0.0069\ X_1+0.3352\ X_2+1.7518\ X_3$	3.1343	—28.45
15.	$0.1147\ Y+0.0231\ X_1+0.2793\ X_2+1.5354\ X_3$	4.9543	13.10

Y=seed yield/plant X_1=number of pods on side branches
X_2=Length of pod X_3=seed size

The highest selection efficiency was obtained when selection was based on seed yield and number of pods on side branches or seed yield, seed size and number of pods on side branches. But practically it is more convenient to select for few characters rather than to make selection for a large number of characters simultaneously. Thus, it appears that selection should be based on seed yield and number of pods on side branches if an improvement in yield of black gram is to be achieved.

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A STUDY INTO THE EMERGING FARM RELATIONS UNDER THE IMPACT OF FARM MECHANIZATION

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ABSTRACT

Purchase of tractor by the farmers was not cherished by about one-third of their neighbours for immediate socio-psychological reasons. The reactions of tractor owning farmers to their unhappy neighbours were not of the type of tit for tat. Farm mechanization has brought large scale changes in the old pattern of relations of these farmers with their neighbours, relatives, traditional service-cum-jajmani groups, agricultural labour and other groups. These relations strengthened with those in the same profession while with others a declining trend was observed. A decreasing trend in old relations as per land size was also observed indicating an increasing urban orientation. The dominating trend was of the change from primary to secondary relations.

A perusal of the traditional system of rural life and relations reveals an interactional pattern of reciprocity and mutual-aid between the various rural groups and services. The new forces, after independence, and the adoption of new technology, have, in addition to increased welfare, led to disruptions in this system of life and relations in rural as well as urban areas.

Patel (1970), Haldipur (1970), and Sriniwasan (1970) have pointed out the need for scientific studies into the socio-psychological and cultural consequences of farm mechanization. Hunter (1969), Sharma *et al.* (1969) and Kahlon (1969) had observed that the adoption of machine power to farm operations led to discruptive changes in the traditional patterns of social living. Ishikava (1969), Sharma *et al.* (1969), Kaushal (1969), Kahlon (1969, 1970) have pointed out the changes in group relations, community relations, displacement of personal by a business attitude, undermining of jajmani system and various others eroding the foundations of traditional rural relations. Frankel (1971) opined that increased production as the objective of farm mechanization leads to social injustice. Deb (1971-72) found a feeling of status-rise among the farmers owning tractors.

It is essential for scientists to find out the social costs and benefits of this process and for the sociologists specifically to find out the changes in the traditional system of jajmani and work relations between the different groups. This study was conducted in Haryana, because farmers in this state have increasingly adopted farm mechanization.

The following were the specific objectives of the study :

1. To understand the mutual reactions of the neighbours and respondents at the latter's purchase of tractor.

2. To analyse the changes effected in the customary mutual-aid and work relations.

3. To discern the related forces and locate the emerging trends.

MATERIAL AND METHODS

The study covered all but two of the 17 development blocks in Hissar district of Haryana. Only those blocks, having villages with 5 or more tractors, were included in the study. The total number of such villages in these blocks was 126. Out of these, 42 villages were included in the sample for study. The villages were selected as per blocks, in a randomized way. From each village three tractor owning farmers were selected in the stratified random manner (one farmer with largest, another with lowest and the third with medium land holding). The total respondents who could actually be interviewed, on a personally administered and pretested interview schedule, were 110. The analysis was made in terms of the size of the land holding of the respondents with regard to the objectives of the study (land group — A=upto 50 acres, B=51 to 100 acres, C=101 to 150 acres, D=151 and above).

RESULTS AND DISCUSSION

The adoption of an innovation by a person is supposed to be reacted to differently by the community. This eventually tailors the pattern of adopters' relations to the community groups. The respondents were asked to recall the main reactions of their community groups immediately as observed on the purchase of their tractors.

It was revealed that about 37 per cent neighbours did not feel happy on the purchase of tractors by the respondents. Their reactions consisted of jealousy, tractor purchase as bad omens, farming with the tractor being bad, named it a foolish purchase, and indicated social withdrawal etc.

The reactions of respondents to those in the community who felt happy on the purchase of tractor comprised of concession in work charges, preference in personal relations, preference in doing their work and continual of normal dealings.

The rank order of reactions of respondents for unhappy neighbours was—charging heavily for work done, having decreased personal relations, giving them low priority for custom service work etc. This indicated an attitude of not minding much. This was in consonance with the dominant human tendency in traditional societies of conformity and adherance to status-quo. They told that considerations of living together and good neighbourliness and the neighbour being their potential client for custom work, were the important determinants for this tendency of reactions.

Customary jajmani and work relations were supposed to be affected with the adoption of the new technology in terms of their form, content and level. It was found that in the traditional jajmani relations highest increase occured with the blacksmiths, washerman, Brahmin and carpenter. In case of blacksmiths the increase was almost similar in all the land holding groups while in other three services, the increase was highest in lower land holding groups. There was significant increase in their relations with several new service agencies like repairers, suppliers of fuel/oil and spares, the tractor dealers and other technical services

In traditional jajmani services a tendency of decreasing contacts, while for the new services an increasingly rising tendency of relations as per land size, was observed. Thus a new complex of rural relations in the context of new technology, oriented to service-cum-facilities, was emerging.

Some also reported decrease in relations with shoe-makers, bullock traders, carpenters, washermen, Brahmin etc. This points out to the prospective new training needs of these old jajmani groups for their rehabilitation. The average decrease in relations accompanied the rising size of land holdings. Besides, a set of personal and work relations had continued in rural areas in the bullock-operated farming. These were apprehended slackened in the machine operated farming system. Inquiry into this aspect revealed the facts as listed in Table 1.

TABLE 1

Reasons for the slackening of old relations after tractor purchase as per land size

Reasons	A	B	C	D	Total
Jealous of me and talk bad of my tractor	24 75.00	17 77.27	8 88.88	11 91.56	60 80.00
Constant demand nuisance	22 68.75	17 77.27	9 100.00	11 91.56	59 78.68
Do not find time to sit with them	21 65.63	10 45.50	7 77.77	12 100.00	56 74.66
They are with-drawing from me	3 9.39	8 36.40	5 55.55	8 64.84	24 36.00
New relations are developing	1 3.13	3 13.65	2 22.22	9 72.56	15 20.00
Cannot exactly make out	3 9.38	2 9 10	0 0.0	0 0.0	5 5.67
Unable to meet their expectation of priority	2 6.26	1 4.55	1 11.11	3 25.00	7 9.33
Total No.	76	64	32	54	226
Average	2.47	2.91	3.50	4.3	3.05

TABLE 2

Mutual aid practices of tractor owning farmers as per land size

Mutual aids	A		B		C		D		Total	
	TOs	NTOs	TOs	NTOs	TOs	NTOs	TOs	NTOs	TOs	NTOs
Timely help	47 100.00	45 91.94	34 100.00	32 94.12	13 92.86	13 92.86	15 100.00	14 93.33	109 99.09	104 93.64
Farming work	43 91.49	20 42.55	33 97.06	16 17.06	13 92.86	6 42.86	13 86.67	10 66.67	102 93.64	52 47.27
Farm total borrowing	42 89.36	25 53.19	31 91.18	7 50.00	13 92.86	5 35.71	14 93.33	10 66.67	100 91.82	52 47.27
Agricultural consultations	41 57.23	35 74.47	29 85.29	19 55.88	10 71.43	7 50.00	12 80.89	11 73.37	92 83.64	62 56.42
Participation events	37 87.72	34 72 34	25 73.53	25 73.53	10 71.43	12 85.57	14 93.33	14 93.33	86 78.18	86 78.18
Social gatherings	34 72.34	34 77.34	26 76.47	26 76.47	9 64.29	11 78.57	12 80.89	14 93.33	81 71.82	85 77.27
Sitting together for advice	30 63.83	35 74.47	25 73.53	25 76 47	10 71.43	10 71.43	13 86.67	13 86.67	78 70.62	82 74.60
Family visits	29 61.70	32 68.09	24 70.59	24 70.59	9 69.28	8 57.14	11 73.37	15 100.00	73 65.8	82 74.60
General family consultations	32 68.09	35 76.50	21 61.76	28 82.35	10 71.43	10 71.43	12 80.89	14 93.33	75 68.18	84 76.44
Money lending	27 57.45	21 44.68	18 52.94	24 70.59	7 50.00	11 78.57	8 56.67	15 100.00	60 54.55	86 78.18
Total	362	316	266	236	104	93	124	130	856	775
Average of %	3.62	3.16	2.66	2.36	1.04	9.3	1.24	1.30	8.56	7.75

Thus 68 per cent respondents admitted slackening of relations with their kith and kins after the purchase of tractor.

The traditional system of kinship relations was observed loosening its grip as the axis of relations was getting diffused and increasing elements of affective neutrality were clearly visible. The altered contextual exigencies were sprouting a liberalising attitude, culminating into cosmopolite relations. The adoption of the new innovation was a vital force being reacted to jeolously and with high expectations of gaining from the tractor owning relatives. However, the machine owner was irritated by the growing free service demands of the relatives and neighbours and that too on priority without realizing that the machine was very costly and precious to the owner. He was unable to socially sit with them as his pattern of work had changed demanding more attention. The Kinsmen construed this as if the respondent was withdrawing from them. His widened contacts were also partaking his time. He was becoming conscious of their selfish ends which were much to the detriment of his own. The respondent, to ease out his tension, was reviewing his relations anew and adopting an attitude of indifference to his traditional system of relations and work.

The hall-mark of community living in India had been a pattern of reciprocal help called variously like Dangwara, Bhaichara etc., which undergoes modifications as per changes in context and elements of the system. The use of mechanical power in the process of agricultural work is supposed to change this. The answers of the respondents in this regard are presented in Table 2.

It is thus seen that they had relations both with the tractor owning and non-owning farmers. With other tractor owners these were more frequent and of a professional type on aspects like timely help, farming work, farm tools borrowing, agricultural consultation etc. With the non-tractor owners, these were more of a personal type and were more frequent on aspects like-money-lending, general and family consultation, sitting together, family visits and social get-together etc. Personal relations clearly skewed towards non tractor owning farmers. The relations of highest land holders were more with the non-tractor owning farmers. Probably it was for reasons to gain leadership position by winning their support. The relations showed separatist tendencies among the various land holding groups denoting the dominance of their ulterior motives. Deb found the old sense of belongingness to a group being gradually lost in farmers with mechanization of farms.

Finally, they were asked to state about their old work relations with other farmers, agricultural labour, service groups and others.

It was found that comparatively the relations of respondents with agricultural labour were least intimate, gradually improving with service groups and fellow farmers. Numerically also these were more with other farmers than with service groups, labour and others. Their relations were almost the same with only a small number of these groups, on top being the others, followed by fellow farmers, service groups, and agricultural labour.

In this manner what several other researchers especially Sharma 1969, Kaushal 1969, Kahlon 1970, Deb 1971-

72 found out was largely substantiated by this study.

This was however, a transitory phase and could eventually lead to the evolution of a new system of relations. All these added to organic solidarity and were shaking the foundations of the old mechanistic service-cum-jajmani system. However, this problem needs to be intensively probed by further empirical studies in different agro-climatic zones of India to add valid and reliable knowledge.

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EFFECT OF VARIOUS LEVELS OF PROTEIN SUPPLEMENTATION ON GROWTH RATE OF NALI LAMBS UNDER STALLFED CONDITIONS

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ABSTRACT

Weekly body weight gains of stallfed Nali lambs kept on four levels of protein were studied and compared. Effect of protein supplementation was found to have significant effect. Groups of lambs with 20 and 16 per cent showed the maximum gains. Due to high cost of protein supplementation, 16 per cent protein ration was found to be most efficacious during growing-cum-fattening period of lambs. Economics worked out for the various groups also revealed 16 per cent of protein level ration to be most efficient.

For various stages of growth of sheep under stall feeding, feeding standards have been formulated for the elite exotic breeds in other countries. A review of the results of some of the experiments conducted at different centres in India (Patnayak and Singh, 1972) showed that dry matter consumption of an adult sheep was about 2 to 3 per cent of body weight when fed on forage alone. Therefore, an average Indian sheep weighing about 30 kg would consume 600-900 g of dry matter. Considering the maximum digestible crude protein (D.C.P.) and total digestible nutrient (T.D.N.) requirement for the maintenance of sheep as 40 g and 400 g, respectively, the pasture or fodder to be made available should, therefore, contain 4 to 6 per cent of DCP and 60 to 70 per cent of TDN. Non-leguminous fodders also do not have DCP higher than 4 per cent. It is, thus, imperative that with low level of dry matter consumption, i.e., from pastures, suitable grazing or cereal crops fodder, additional amount of protein and energy have to be provided for body maintenance.

There are some isolated reports (Khote *et al.*, 1962; Bhatia *et al.*, 1971; Srivastava *et al.*, 1971) indicating that supplemental feeding improved the mutton production but no systematic work with regard to quality and level of nutrients to be fed to sheep appears to have been carried out. Keeping this in view, this work on the economic production of sheep under stall fed conditions, was initiated.

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MATERIAL AND METHODS

Thirty-two Nali lambs (ranging between five to six months in age) were randomly divided into four groups of eight lambs each, based on their age and body weight. Lucern hay containing 17 per cent of crude protein and 60 per cent of TDN *ad lib.* consistuted the basal ration for all the four groups, while three groups, i.e., Group II, III and IV were fed 200 g of concentrate mixture containing 20, 16 and 12 per cent of crude protein and 75 per cent of TDN, respectively. The body weights of the lambs were recorded at weekly intervals up to the 12th week. The data, thus collected, were analysed using standard statistical techniques.

RESULTS AND DISCUSSION

The average weekly gains, feed efficiencies and daily dry matter consumption per animal of Nali sheep for the four groups during the three months of study are presented in Table 1. The group with 20 per cent protein consumed maximum dry matter as compared to other groups.

Since the average weekly gain represented the eventual effect in terms of increased weight of lambs due to varying stimulus of the increasing protein levels in the rations, more critical statistical evaluation for this trait was made. As some of the animals showed almost no weekly increment in body weights, the

TABLE 1

Average weekly body gains and feed efficiencies and daily dry matter consumption for the four levels of protein

	Group I (No protein supplement)	Group II 20% protein supplement	Group III 16% protein supplement	Group IV 12% protein supplement
Average weekly body gains in grams.	300.7	820.9	800.9	596.54
Average weekly feed efficiencies.	0.104	0.172	0.179	0.145
Average daily dry matter consumption per animal	0.488	0.760	0.661	0.651

TABLE 2

Analysis of variance of fortnightly weight gains for various levels of protein and animals during the three months period

Source of variation	d. f.	M. S.
Between groups	3	4.09**
Between animals	31	0.62
Residual	317	0.41

** P $<$ 0.01

TABLE 3

Month-wise analysis of variance of fortnightly weight gains for various levels of protein

Source of variation	d. f.	I month M. S.	II month M. S.	III month M. S.
Between groups	3	98.49**	6.27*	3.18*
Residual	28	1.50	0.53	0.45

$* P \angle 0.05$ $** P \angle 0.01$

TABLE 4

Month-wise weekly weight gains in grams and initial monthly body weight (kg)

	Ist month		II month		III month	
	Av. Initial wt.	Av. weekly gain	Av. Initial wt.	Av. weekly gain	Av. Initial wt.	Av. weekly gain
Group I	10.7	347	12.1	232	12.6	330
Group II	10.9	871	13.9	767	16.1	825
Group III	10.8	892	12.8	830	15.3	640
Group IV	11.3	638	13.5	634	15.5	492

analysis of variance for the fortnightly weights gains during the complete duration of the study is presented in Table 2. The results revealed that the differences among the animals for fortnightly weight gains were not statistically significant, indicating the non-existence of any bias to be introduced by the animals in comparing the effects of groups on this trait. The effect of groups, however, was significant at $P \angle 0.01$. The lambs under study were still in the growing phase, the group differences were analysed month-wise, so as to know more precisely the degree of influence exerted on the body gain by the different levels of protein supplement rations. Month-wise analysis of variance of this trait for the four groups is presented in Table 3. The differences among the groups were significant at $P \angle 0.01$ for 2nd and 3rd months of study whereas for Ist month the differences were significant at $P \angle 0.05$. This indicated that the different levels of protein supplementation resulted in the differential body weight gains of lambs. Maximum growth gains were observed in group with 20 per cent of protein supplement ration, but as compared to 16 per cent, the difference was marginal, i.e., only 20 g. The weekly gain in body weight recorded, conformed to the trends of weight gains and protein increments in the ration. Increasing of protein supplementation from 16 to 20 per cent in feed, however, showed a little decline in feed efficiency.

TABLE 5

*Economic comparison of lambs fed on different protein levels

	Group I	Group II	Group III	Group IV
Approx. of weekly feeding cost per lamb in rupees	0.68	2.53	2.04	1.89
Cost of one kg gain in weight in rupees	2.26	3.09	2.55	3.17

* Cost of conc. 20 per cent protein — Rs. 125 per q.
16 -do- — Rs. 100 per q.
12 -do- — Rs. 90 per q.
Cost of hay — Rs. 20/- per qunital.

The average weekly gain month-wise in various feeding groups showed highest response right in the first month (Table 4). In the subsequent months, the response in body weight gains present was slightly less. However, the maximum gain was recorded in the 2nd and 3rd groups during this period.

This study, thus, suggested that 16 per cent of protein supplementation was the best for obtaining optimum body weight gains of Nali lambs during the growing-cum-fattening period.

Economics of feeding

Relative economics of feeding lambs on different levels of protein is presented in Table 5. It indicates that the lambs fed on hay alone had the lowest cost per unit gain in the body weight, but the growth rate observed in this group was the lowest. It is, thus, evident that the stall fed lambs exclusively on hay cannot achieve the targeted body weight in a fixed feeding time as compared to lambs supplemented on protein rations. Lambs in group III with 16 per cent of protein were most efficient feed convertor, and also the cost incurred on them, per kg body weight gain, was lowest next to hay feeding group, i.e., Rs. 2.55, whereas Group II (20 per cent of protein) and Group IV (12 per cent of protein) required Rs. 3.09 and 3.17 per kg body weight gain, respectively.

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STUDIES ON THE PERFORMANCE OF 3×3 DIALLEL CROSSES INVOLVING BROILER BREEDS OF CHICKENS—

EFFECT ON SOME OF THE PRODUCTION CHARACTERS IN CROSSBREDS*

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ABSTRACT

Nine genetic groups were obtained in diallel crossing involving Australorp, New Hampshire and White Cornish breeds of poultry. The different genetic groups thus obtained were compared with respect to production characters, viz., age at first egg, weight at first egg and rate of lay to test the effect of genetic factors (genetic groups) and non-genetic factors (hatches) on these characters. It was found that Australorp × New Hampshire Crossbred group was significantly superior to all other Crossbred and pure bred groups in age at first egg and rate of lay whereas other groups didn't differ significantly from each other. The Australorp × White Cornish Crossbred group was significantly superior as compared to all the Crossbred and purebred groups in weight at first egg. Thus Australorp × New Hampshire Crossbred group was found to be superior in aggregate with regard to production characters.

While the economic gain in live weight in the shortest period of life in chicken is most important for broiler industry, the superiority in production characters, specially when evolving a new strain is involved, cannot be ignored. Cross breeding has proved to be of immense value in improving the efficiency of live weight gain, the extent of improvement in production characters in the strain so evolved also needs due consideration so as to stand further propagation.

Large number of evidences have accumulated from the studies conducted in the past indicating that the genetic differences exist between breeds, strains and individuals with regard to production traits, viz., age at first egg, weight at first egg and rate of lay. The Crossbreds

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have been reported to be having lower age and higher body weight at first egg by many workers (Harmosura and Quiazon, 1968; Misra *et al.* 1969; Lund, 1971; Acharya and Kumar, 1971). Similarly the Crossbreds of broiler type Chickens have been reported to have higher rate of lay as compared to the purebreds (Petrov 1965; Erasmus 1966; Marais and Joubert 1968; Acharya and Kumar 1971; Wessals 1971). Craig *et al.* (1969) reported that there was no depletion in additive genetic variance for rate of lay generation after generation.

MATERIAL AND METHODS

The present investigations were carried out in the Department of Animal Breeding, Haryana Agricultural University, Hissar, during the year 1972-73. Nine genetic groups were produced using 3×3 diallel crossing involving Australorp. New Hampshire and White Cornish. In all 478 progenies of 13 sires of each breed in a single shift of mating were produced in 3 hatches. Different genetic groups in different hatches were reared separately under uniform conditions of housing, feeding and management till 260 days of age. Feed containing 18 per cent of protein was made freely available. The production traits were recorded on 369 females as and when the characters appeared. Age and body weight at first egg was recorded on the day the first egg was laid by particular hen. The rate of lay was calculated on the basis of egg production during the first 260 days of age.

To test the effect of genetic factors (breed of sire, breed of dam) and the effect of non genetic factors (hatches) and the interaction of breed of sire and breed of dam, for estimation of heterosis in age at first egg and body weight at first egg, the following model was used :

$$Y_{ijkl} = \mu + H_i + S_j + D_k + (SD)_{jk} + e_{ijkl}$$

Where μ = the population mean, an effect common to all the observations.

H_i = the effect due to ith hatch

S_j = the effect due to jth breed of sire

D_k = the effect due to kth breed of dam

$(SD)_{jk}$ = the effect due to interaction between the jth breed of sire and kth breed of dam, and

e_{ijkl} = a random effect peculiar to the ijklth individual, assumed to be N.I.D. (0, σ^2 e)

Since the data were non orthogonal, the least squares technique was used to analyse the data as proposed by Harvey (1960). The data were adjusted for significant hatch effect, wherever necessary, before proceeding in the analysis of variance components. The test for differences among genetic groups was made assuming the following model :

$$Y_{ij} = \mu + g_i + e_{ij}$$

Where μ = the general mean, an effect common to all genetic groups.

g_i = the effect due to ith genetic group.

e_{ij} = the random effect peculiar to ijth individual, assumed to be N.I.D. (0, σ^2 e).

RESULTS AND DISCUSSION

Age at first egg

The least squares means for age at first egg along with their standard error

TABLE 1

Least squares means for age at first egg (days), weight at first egg (gms) and transformed mean for rate of lay (Arcsin transformation)

Character		Genetic Groups								
		Aust × Aust	Aust × NH	Aust × WC	NH × Aust	NH × NH	NH × WC	WC × Aust	WC × NH	WC × WC
Age at	A	182.00	168.00	187.00	180 00	185.00	175.00	174.00	177.00	185.00
first egg	B	2.54	2.14	4.30	5.15	5.55	2.55	4.94	5.28	4.13
(days)	C	7.25	8.57	16.20	11.05	14.70	10.90	13.20	21.30	13.62
	D	27	45	50	34	24	57	46	49	37
Weight at	A	1442.86	1559.23	1633.30	1544.55	1435.83	1422.45	1480.65	1453.06	1533.51
first egg	B	32.34	28.36	30.96	32.02	35.83	19.32	23.28	25.10	29.25
(gms)	C	11.65	12.18	13.41	12.01	12.22	10.18	10.53	12.11	11.60
	D	27	45	50	34	24	57	46	49	37
Rate of lay	A	36.61	47.70	36.58	44.81	36.62	41.33	44.71	43.05	39.41
(transformed	B	1.85	0.69	0.90	1.67	1.08	1.04	1.55	1.12	1.03
mean)	C	21.93	7.66	17.50	17.63	13.94	15.29	18.24	14.62	14.31
	D	27	45	50	34	24	57	46	49	37

Where A=Adjusted mean
B=Standard error
C=Coefficient of variation
D=No. of observations

and coefficient of variation for all the nine genetic groups are presented in Table 1. Lowest age at first egg was observed in the case of Australorp × New Hampshire Crossbred group (168± 2.14 days) and the highest age at first egg was found to be in Austrolorp × White Cornish Crossbred group (187± 4.3 days). Most of the Crossbred groups, with the exception of Australorp × White Cornish group, had lower age at first egg as compared to purebreds. All the three purebred groups did not differ significantly from each other, whereas Australorp × New Hampshire group differed significantly from all other groups.

Highly significant differences were observed among genetic groups($P \angle 0.01$) with regard to this trait (Table 2). The Crossbreds on an average matured 7.2 days earlier than the purebreds. Interaction between the breed of sire and breed of dam was highly significant indicating that heterosis may be of some importance for this trait (Table 3). In this study the crossbred groups on an average were superior to purebreds indicating the presence of heterosis for this trait among crosses. Similar results were reported by Lund (1971) and Acharya and Kumar (1971).

TABLE 2

Analysis of variance for age at first egg, weignt at first egg and rate of lay for different genetic groups

		Age at first egg	Weight at first egg	Rate of lay
S. V.	D. F.	M.S.S.	M.S.S.	M.S.S.
Between genetic group	8	1482.40**	225628.12**	660.01**
Error	360	125.23	32070.90	65.25

**Significant at 1% level

TABLE 3

Least squares analysis of variance for age at first egg and weight at first egg

		Age at first egg	Weight at first egg
S. V.	D. F.	M. S. S.	M. S. S.
Hatch	2	95.67*	182256.88**
Sire Breed	2	39.54	386670.25**
Dam breed	2	162.14**	73547.06
Sire breed × Dam breed	4	148.41**	358620.22**
Error	358	24.43	32599.02

*Significant at 5% level
**Significant at 1% level

TABLE 4

Comparison of means for age at first egg, weight at first egg and rate of lay

Character									
Age at first egg	AN	NW	WA	WN	NA	AA	WW	NN	AW
Weight at first egg	NW	NN	AA	WN	WA	WW	NA	AN	AW
Rate of lay	AW	AA	NN	WW	NW	WN	WA	NA	AN

Where A=Australorp
N=New Hampshire
W=White Cornish

Note : 1. The means have been arranged in ascending order
2. Any two means underscored by the same line are not significantly different
3. Any two means not underscored by the same line are *significantly* different (P∠0.05)

Body weight at first egg

Least squares means for weight at first egg along with their standard errors and coefficient of variations for all the nine genetic groups are presented in Table 1. The highest weight at first egg was observed in Australorp × White Cornish crossbred group (1633.30± 30.96 gm) and the lowest weight at first egg was observed in New Hampshire × White Cornish group (1422.45±19.32 gm). Australorp × White Cornish crossbred group was significantly different from all other groups with regard to *this trait* (Table 4). Highly significant differences (P∠0.01) were observed among genetic groups (Table 2) and also among hatches (Table 3). Interaction between the breed of sire and breed of dam was found to be highly significant indicating that heterosis may be of some importance for this trait (Table 3). On an average crossbreds weighed 45 g more as compared to purebreds at the age of first egg.

Rate of lay

Transformed means for rate of lay (Arcsin transformation) have been presented in Table 1. Highest rate of lay was observed in Australorp × New Hampshire crossbred group (47.70± 0.69) and the lowest rate of lay was observed in Australorp × White Cornish group (36.58±0.90). Most of crossbred groups with the exception of Australorp × White Cornish group exceeded purebred groups in the rate of lay and the three purebred groups did not differ significantly from each other with respect to this trait. Australorp × New Hampshire, New Hampshire × Australorp and White Cornish × Australorp crossbred groups did not differ significantly from each other (Table 4). On an average the rate of lay was more to the extent of 5.48 per cent among the crossbreds as compared to the purebreds. Statistically highly significant differences were observed among genetic groups (Table 2), whereas the differences between hatches were found to be non-significant (Table 3), with regard to this trait. The crossbreds on an average were superior to the purebreds indicating the presence of heterosis for rate of lay among the crossbred groups. Similar results were also reported by Marais (1965), Erasmus (1966) Marais and Joubert (1968) and Lund (1971).

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EFFECT OF SOIL APPLICATION OF ZINC AND COPPER ON THE YIELD, ITS ATTRIBUTES AND OIL CONTENT OF TORIA (*BRASSICA CAMPESTRIS* VAR. *TORIA* DUTH AND FULL)

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Micronutrient deficiency affects the various crops and occurs in a wide range of soils in the world. Kanwar and Randhava (1965) reported zinc deficiency to be widely spread in India. It has been found that the soil application of zinc builds up the zinc status of soil which lasts for many years (Grewal *et al.*, 1968).

Copper is essential for the normal growth of many plants. Pillai (1967) reported the beneficial effects of copper on the yield of rice.

The present experiment was laid out to study the response of *toria* variety 'ITSA' to varying levels of zinc and copper. A randomized block design field experiment, with four replications, was conducted during 1970-71 and 1971-72 at the University Farm, Hissar, on loamy sand soil. The important physio-chemical characteristics of the soil are given in Table 1. Three levels each of zinc sulphate (Zn_0=0 kg, Zn_1=5 kg and Zn_2=10 kg/ha) and copper sulphate (Cu_0=0 kg, Cu_1 = 5 kg and Cu_2=10 kg/ha) formed the treatments. Both zinc sulphate and copper sulphate were drilled in separate treatments below seed level at the time of sowing. A basal dose of 40 kg/N/ha in the form of calcium ammonium nitrate and 20 kg P_2O_5/ha as single superphosphate were also applied at the time of sowing. The seed samples were analysed by Soxhlet extraction method for oil content.

The soil application of zinc sulphate to the *toria* crop failed to increase the ancillary plant characters during the two years of investigation significantly (Table 2). The data in Table 2 revealed that zinc sulphate application at Zn_1 level resulted in significant increase in the seed yield over treatment Zn_0 and Zn_2 during 1970-71 and 1971-72. In 1970-71 treatments, Zn_0 and Zn_2 were at par but, in the second year, Zn_0 treatment proved significantly superior over treatment Zn_2. The treatment Zn_2 gave the lowest seed yield of 1351 kg/ha and 1190 kg/ha in the first and second year. It showed that when the soil was on the threshold of zinc deficiency, the application of zinc increased available zinc content in the soil and mobilized unavailable soil zinc to plant roots. As the soil contained only 0.72 ppm extractable zinc, application of 5 kg/ha of zinc (Zn_1) benefited the crop, thereby increasing the seed

TABLE 1

Physio-chemical analysis of soil

Depth	Course sand	Fine sand	Silt	Clay	pH	Organic carbon %	Available N (kg/ha)	Available P (kg/ha)	Extractable Zn (ppm)	Extractable Cu (ppm)
0-23 cm	—	56.4	18.2	24.4	8.2	0.28	252	5	0.72	1.32

TABLE 2

Effect of zinc and copper application on the yield attributes and seed yield, oil content and oil yield of *toria*

Characters	Year	Treatment Zn_0	Zn_1	Zn_2	C.D. at 5%	Cu_0	Cu_1	Cu_2	C.D. at 5%
Primary branches	Y_1	5.51	5.55	5.75	NS	5.66	5.50	5.70	NS
	Y_2	4.41	4.56	4.88	NS	4.58	4.35	4.93	NS
Secondary branches	Y_1	5.88	6.00	6.25	NS	5.99	6.00	6.00	NS
	Y_2	5 13	5.36	6.00	NS	6.03	5.00	5.40	NS
Pods per mainshoot	Y_1	38.13	39.80	39.20	NS	35.76	39.50	41.80	NS
	Y_2	35.71	37.83	37.58	NS	36.31	37.41	37.00	NS
Seeds per pod	Y_1	15 58	15 92	15.70	NS	15.63	16.30	14.80	NS
	Y_2	16 57	16.93	15.77	NS	16.35	16.66	16.25	NS
1000 seed weight	Y_1	2 56	2.72	2.72	NS	2.30	2.69	2.75	NS
	Y_2	2.24	2.43	2.44	NS	2.30	2.37	2.44	NS
Seed yield kg/ha	Y_1	1356.00	1436.00	1351.00	31.00	1361.00	1391.00	1390.00	NS
	Y_2	1359.00	1468.00	1190.00	47.00	1318.00	1358.00	1342.00	NS
Oil per cent	Y_1	43.89	42.86	44.03	—	43.26	44.09	43.41	—
	Y_2	46.50	43 23	45.47	—	45.75	45.50	44.28	—
Oil yield kg/ha	Y_1	591.15	615.47	594.84	—	588.77	613.29	603.39	—
	Y_2	631.93	634.62	541.09	—	602.98	617.89	549.23	—

Y_1 and Y_2 stand for 1970-71 and 1971-72, respectively, and NS for not significant yield. Similar findings have been reported by Gopal Rao and Govind Rajan (1950). The dose of 10 kg/ha $ZnSO_4$ proved deleterious due to higher concentration than the optimum requirement. Gupta (1962) recorded the deleterious effect on plant growth with high concentration of zinc application. Govindan (1952) also found that higher concentration of zinc injured large number of flowers of tomato crop. Trend in oil content (per cent) was not much conspicious, though treatment Zn_1 resulted in decrease in the percentage of oil content in seed, and it again increased at Zn_2 level during both the years. However, the trend on oil yield followed that of seed yield during both the years.

Application of copper sulphate to *toria* did not manifest its effect on ancillary plant characters, primary and secondary branches, pods per main shoot, seeds per pod, 1000 seed weight and seed yield in any of the year of investigation (Table 2). Datta and Bains (1969) found no significant effect of copper on yield of rapeseed.

From this study it is inferred that application of zinc sulphate at 5 kg/ha significantly increased the yield of *toria*, whereas the higher rates (10 kg/ha) decreased the yield during both the years. There was no effect on yield attributing plant characters due to varying levels of zinc sulphate and copper sulphate. Application of copper sulphate also failed to increase the toria yield. The oil content in the seeds gave inconclusive results during both the years of investigation.

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CROPPING PATTERNS IN HARYANA. II. CROPPING PATTERNS AND CROP BELTS UNDER IRRIGATED CONDITIONS

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ABSTRACT

Haryana State has been demarcated into six major crop belts according to the geographical distribution of crops under irrigated conditions. The taxonomy of existing cropping patterns has been brought out blockwise, covered under each of these major crop belts. The position of area under *kharif*, *rabi* and double cropping reveals the intensity of cropping in various blocks under irrigated conditions.

The cropping patterns under irrigated conditions depend on the irrigation facilities, fertilizers, availability of seeds of high yielding varieties and soil-climatic conditions of the region. Irrigation is an important source of increasing agricultural production. 42 per cent of area is under irrigation facilities in the State. The 80 per cent of area under irrigation facilities is covered by canals. Land being a limited natural resource, there is a need for good land use planning and adoption of suitable cropping patterns with the available resources to increase the food production under irrigated conditions. Therefore, the study of existing cropping patterns is of great significance to enable the efficient utilisation of land, water and benefit from the natural resources. In order to study the finer details of cropping patterns, following chief features have been introduced in the study.

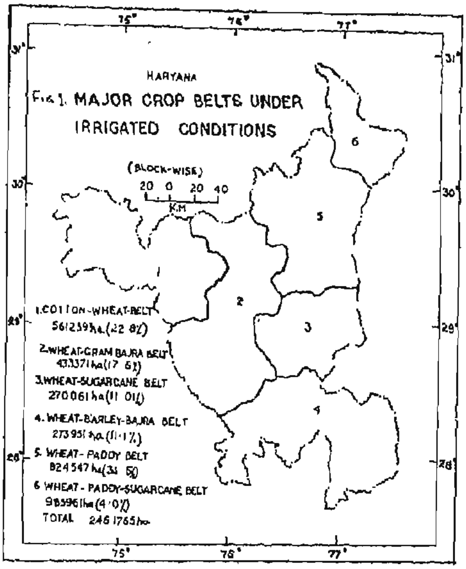
(i) Use of block as a unit of area, it being an agricultural sub-division of a tehsil.

(ii) The area under irrigated conditions alone have been analysed blockwise.

(iii) Use of blockwise informations on soil characteristics such as soil texture, available N-P-K status, electrical conductivity and soil pH (1:2) to indicate degree of salinity and alkalinity hazards and the quality of soils.

(iv) The use of relative yield index of various crops under irrigated conditions to indicate the yield potential in the belt.

(v) Blockwise information on the percentage irrigated area, and the quality of underground water.


HARYANA
Fig. 1. MAJOR CROP BELTS UNDER IRRIGATED CONDITIONS
(BLOCK-WISE)
20 0 20 40
K.M
1. COTTON-WHEAT-BELT
561239 ha.(22.8%)
2. WHEAT-GRAM BAJRA BELT
433371 ha(17.6%)
3. WHEAT-SUGARCANE BELT
270061 ha(11.01%)
4. WHEAT-BARLEY-BAJRA BELT
273951 ha.(11.1%)
5. WHEAT-PADDY BELT
824547 ha(33.5%)
6 WHEAT-PADDY-SUGARCANE BELT
98596 ha(4.0%)
TOTAL 2461765 ha
75°
76°
77°
31°
30°
29°
28°

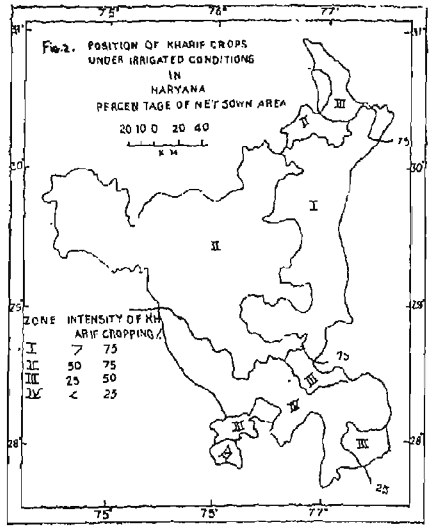


Fig. 2. POSITION OF KHARIF CROPS
UNDER IRRIGATED CONDITIONS
IN
HARYANA
PERCENTAGE OF NET SOWN AREA
20 10 0 20 40
K M
ZONE INTENSITY OF KHARIF CROPPING %
I > 75
II 50 75
III 25 50
IV < 25

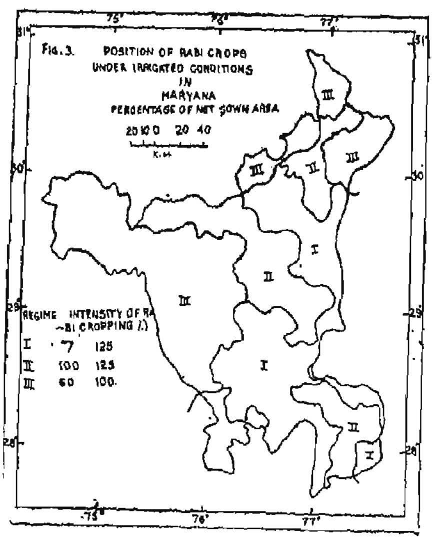


Fig. 3. POSITION OF RABI CROPS
UNDER IRRIGATED CONDITIONS
IN
HARYANA
PERCENTAGE OF NET SOWN AREA
20 10 0 20 40
K.M
REGIME INTENSITY OF RABI CROPPING %
I > 125
II 100 125
III 60 100.

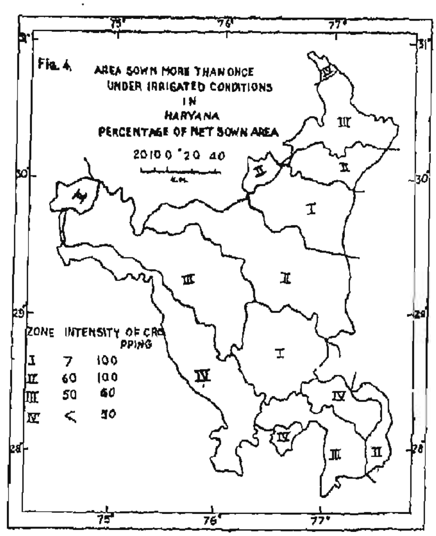


Fig. 4. AREA SOWN MORE THAN ONCE
UNDER IRRIGATED CONDITIONS
IN
HARYANA
PERCENTAGE OF NET SOWN AREA
20 10 0 20 40
ZONE INTENSITY OF CROPPING
I > 100
II 60 100
III 50 60
IV < 50

MATERIAL AND METHODS

Crop belts and cropping patterns

Based on the existing cropping patterns under irrigated conditions, the State has been divided into 6 major crop belts (Fig. 1). The cropping patterns have been discussed according to these principal crop belts. The crops which together from 80 per cent or more of the total cultivated area of a block are denoted to constitute a cropping pattern. The crops considered for making up a pattern are those which individually occupy 5 per cent or more of the total cropped cultivated area in the block. The following notations have been used for crops : Gram, G; Bajra, B; *Kharif* fodder, KF; *Rabi* fodder, RF; Potato, PT; *Rabi* oilseeds, RO; Barley, BA; Guar, GU; Wheat, W; Jowar, J; *Rabi* pulses, RP; *Rabi* vegetables, RV; *Kharif* Pulses, KP., *Kharif* vegetables, KV; Maize, M; Sugarcane, S; Paddy, P; Groundnut, GR; *Kharif* others, KOT, *Rabi* others, ROT.

The following numerical codes have been used as sub-script to indicate distribution of crops in the block.

Sub-script code	Explanation
1.	70 per cent or more of the total cultivated area.
2.	50-70 per cent or more of the total cultivated area.
3.	30-50 per cent or more of the total cultivated area.
4.	10-30 per cent or more of the total cultivated area.
5.	5-10 per cent or more of the total cultivated area.
6.	Less than 5 per cent of the total cultivated area.

Intensity of cropping

The area under *kharif*, *rabi* and double cropping area has been put up as percentage of the net sown area to indicate the intensity of cropping and the crop rotations followed in the various blocks are shown in Figs. 2, 3, and 4.

RESULTS AND DISCUSSION

Crop belts and cropping patterns under irrigated conditions

Based on the geographical distribution of crops, the State can be divided into the following belts under irrigated conditions.

1. Cotton-Wheat belt
2. Wheat-Gram-Bajra belt
3. Wheat-Sugarcane belt
4. Wheat-Barley-Bajra belt
5. Wheat-Paddy belt
6. Wheat-Paddy-Sugarcane belt

Relative distribution of crops in these belts is given in Table 1. The districtwise analysis of area under high yielding dwarf/hybrids is given in Table 2 to indicate the possibilities of putting more area under high yielding varieties. The relative yield index of various crops under irrigated conditions is given in Table 3 to indicate the yield potential. The existing cropping patterns under irrigated conditions have been discussed according to crop belts.

1. Cotton-Wheat belt

This belt covers Sirsa, Rania, Baragudah. Dabawali, Fatehabad, Ratia, Bhuna, Hissar I, Hissar II, Barwala and Hansi I blocks in the Hissar and Sirsa districts.

TABLE 1

Distribution of Crops in various crop belts under irrigated conditions (ha)

Crop belt	Total Crops Cropped area	P	B	M	W	BA	J	KF	RF
1. Cotton-Wheat	561239	13813	28487	1457	170398	5678	413	27160	6457
		(22.8)	(2.4)	(5.0)	(0.2)	(1.0)	(0.7)	(4.8)	(1.1)
2. Wheat-Gram-Bajra	45371	11175	44480	3238	148585	9814	21427	2600	800
	(17.6)	(2.5)	(10.0)	(0.7)	(34.2)	(2.2)	(4.9)	(0.6)	(0.2)
3. Wheat Sugarcane	270061	13699	7718	6142	140985	2519	19620	2613	3692
	(11.0)	(5.0)	(2.8)	(2.3)	(52.2)	(0.9)	(7.2)	(0.9)	(1.3)
4. Bajra-Wheat-Barley	273951	1712	23022	3025	181373	32104	6402	43	455
	(11.1)	(0.6)	(8.4)	(1.1)	(66.2)	(11.7)	(2.7)	—	(0.1)
5. Wheat-Paddy	824547	216291	3719	20087	414840	4866	2852	16000	23230
	(33.5)	(26.2)	(0.4)	(2.4)	(50.3)	(0.6)	(0.3)	(1.9)	(2.3)
6. Wheat-Paddy-Sugarcane	98596	22190	65	4067	48723	51	1882	—	5875
	(4.0)	(22.5)	—	(4.1)	(49.4)	—	(1.9)	—	(5.9)
Total	2461765	278880	107491	38016	1104904	55026	55396	48416	40509
		(11.3)	(4.3)	(1.5)	(44.9)	(2.2)	(2.3)	(1.9)	(1.6)

G	KP	RP	KO	RD	KOT	ROT	C	S	GR	KV	RV	GU	PT
80941	776	1155	188	19329	22525	3121	169052	4555	—	193	1847	—	—
(14.4)	(0.1)	(0.2)	(—)	(3.4)	(4 0)	(0.5)	(30.1)	(0.8)	—	(—)	(0.3)	—	—
97113	169	1100	—	11058	9800	2500	45733	18842	—	1548	489	2900	—
(22.4)	(—)	(0.2)	(—)	(2.5)	(2.2)	(0.5)	(10.5)	(4.3)	—	(0.3)	(0.1)	(0.6)	—
11274	312	1041	—	2725	—	—	8718	41533	182	3445	2069	1754	—
(4.1)	(0.1)	(0.4)	—	(1.0)	—	—	(3.2)	(15.4)	—	(1.3)	(0.7)	(0.6)	—
2459	263	59	—	6895	—	—	58	12966	240	588	845	1842	—
(0.9)	(0.1)	—	—	(2.5)	—	—	—	(4.7)	(0.1)	(0.2)	(0.3)	(0.5)	—
10278	5456	600	—	8350	17600	35200	10678	32993	—	717	579	—	200
(1.2)	(0.2)	—	—	(1.0)	(2.1)	(4.2)	(1.3)	(4.2)	—	—	—	—	(0.3)
232	1340	—	—	888	—	—	348	10217	94	616	1149	—	859
(0.2)	(1.8)	—	—	(0.9)	—	—	(0.3)	(10.3)	—	(0.6)	(1.1)	(0.6)	(0.8)
202297	8316	3955	188	49245	49925	40821	234587	121125	527	7107	6978	5996	1059

TABLE 2

Area under high yielding varieties in Haryana (1972-73)

(per thousand hectares)

District	Rice	Maize	Bajra	Wheat
Hissar	12	1	130	230
Rohtak	2	—	33	138
Gurgaon	1	—	134	121
Karnal	105	6	17	365
Ambala	25	3	1	81
Jind	5	—	77	52
Mahendragarh	—	—	48	13
Total	150	10	440	1,000

It occupies 5, 62, 139 ha of area under irrigated conditions. It covers 45.6 per cent in Hissar II block to 76.2 per cent in Hansi I block under irrigated conditions to the total cropped area in the block. More than 30 per cent of the underground water samples in Baragudha, Dabawali, Fatehabab, Bhuna, Hissar I, Hissar II, Barwala and Hansi I belong to F quality water and as such they can not be utilised for irrigation. More then 30 per cent of water samples in Sirsa, Rania Fatehadad, Ratia and Barwala blocks belong to A quality water and can be utilised for irrigation purposes.

Also more than 20 per cent of water samples in Sirsa, Rania, Baragudha, Fatehabad and Ratia blocks belong to C quality of water.

Soils are sandy to sandy loam in this region with slight to moderate salinity-alkalinity hazards. This region gets an average of 250 mm annual rainfall. The existing cropping patterns of the various blocks are as follows:

District	*Block*	*Cropping pattern*
Sirsa	1. Sirsa	$C_3W_3G_5KF_5P_5$
	2. Rania	$W_3C_4G_5P_5KF_5$
	3. Baragudha	$C_3W_4G_4KF_5$
	4. Dabawali	$C_3W_4G_4RO_5KF_5$
Hissar	5. Fatehabad	$C_3W_4G_4B_4$
	6. Ratia	$W_3C_4G_4B_5RO_5$
	7. Bhuna	$C_3W_4G_4B_5RO_5$
	8. Hissar I	$C_4W_4G_4B_5KF_5$
	9. Hissar II	$C_4W_4G_4$
	10. Barwala	$W_4C_4G_4B_5$
	11. Hansi I	$W_4C_4G_4B_5$

Cotton and wheat are the predominant crops of this region covering 30.1 and 30.3 per cent of the cultivated area under irrigated conditions. The other secondary crops of the region under irrigated conditions are gram, *bajra* and *kharif* fodder crops covering 14.4, 5.0, 4.8 per cent of the cultivated area under irrigated conditions in this belt. The relative yield index of various crops under irrigated conditions in the Hissar and Sirsa districts are as close to the state level yields.

TABLE 3

Relative yield index (%) of various crops under irrigated conditions in Haryana

District	Paddy	Bajra	Maize	Jowar	Wheat	Gram	Barley	Cotton	Sugarcane	Rabi oil seeds
Hissar	92	92	109	82	89	90	76	106	106	100
Bhiwani	—	104	—	78	80	109	64	103	90	79
Rohtak	66	112	100	110	85	99	62	68	106	76
Sonepat	68	94	75	142	91	101	100	66	87	100
Gurgaon	100	93	72	69	89	83	106	100	73	122
Karnal	96	79	89	89	122	169	84	65	103	117
Kurukshetra	111	108	133	104	118	156	72	74	93	130
Ambala	93	—	108	—	75	116	—	57	122	—
Jind	80	108	62	99	99	108	54	71	105	82
Mahendragarh	—	—	—	—	120	100	137	—	—	96

2. Wheat-gram-bajra belt

It covers all the blocks of Bhiwani district and Jind, Julana, Rajaund, Narwana, Kalayat, Hansi II, Narnaud, Tohana, Uchana blocks covering 4, 33, 371 ha of area under irrigated conditions. Irrigation facilities are very poor in Bhiwani district. In Badhra, Loharu and Tosham areas only 2 to 4 per cent of area is under irrigated conditions. In Hansi II, Narnaud, Tohana and blocks of Jind district have more than 60 per cent of area under irrigation facilities.

More than 30 per cent of under ground water samples in Bhiwani district, Hansi II, Narnaud, Jind, Saffidon, Uchana, Narwana and Kalayat blocks belong to F quality water which is not suitable for crops. Soils are sandy to sandy loam in texture.

Slight to moderate salinity alkalinity hazards exist in Dadri I, Dadri II and Jind district blocks.

The blocks with their cropping patterns are as follows:

District	*Block*	*Cropping pattern*
Hissar	1. Hansi II	$W_4G_4C_4B_4S_5$
	2. Narnaud	$W_3G_4C_4KF_5$
	3. Tohana	$W_3C_4G_4B_5P_5RO_5$
Bhiwani	4. Bhiwani	$G_3W_4B_4C_5KF_5J_5$
	5. Tosham	$G_3W_4B_5BA_5GU_5KF_5$
	6. Dadri I	$W_3G_4S_5GU_5KF_5$
	7. Dadri II	$W_2G_4BA_4KF_5GU_5$
	8. Badhra	$W_3BA_4RF_5B_5KF_5G_5$
	9. Loharu	$W_3G_3BA_5$
	10. Bwanikhera	$G_3W_4C_4BA_5$
Jind	11. Jind	$W_3G_4B_5J_5C_5P_5$
	12. Julana	$W_3G_4S_4B_5J_5$
	13. Rajaund	$W_3G_4B_5C_5S_5P_5J_5$
	14. Uchana	$W_4B_4G_4C_4J_5S_5$
	15. Narwana	$W_4G_4B_4C_4J_5$
	16. Kalayat	$W_3G_4B_4C_5J_5RO_5$

Wheat and gram are the principal crops of this zone, covering 34.2 and 22.4 per cent of area under irrigated conditions. The other important crops in the belt are cotton, *bajra*, *jowar* and sugarcane covering 10.5, 10.0, 4.9 and 4.3 per cent of area in this belt. The relative yield index in this zone is given in Table 3 to indicate variation in the yield potential.

3. Wheat-sugarcane belt

This zone covers Rohtak, Kalanaur, Sampla, Maham, Bahadurgarh, Beri, Sonepat, Rai, Kharkhauda, Gohana, Mundlana, Kathura and Smalkha blocks covering 2,70,061 ha of irrigated area. In Rohtak, 40 to 50 per cent of area is under irrigation facilities, whearas in Sonepat 50 to 75 per cent of area is under irrigation facilities. More than 30 per cent of underground water samples from Rohtak, Kalanaur, Sampla, Maham, Bahadurgarh, Sonepat, Kharkhauda, Mundlana and Kathura blocks belong to F quality water indicating its unsuitability for crops. Soils are loamy sand to sandy loam in these areas. Moderate to high salinity-alkalinity hazards exist in this belt.

The blocks covered under the zone with their cropping patterns are as follows:

District	*Block*	*Cropping pattern*
Rohtak	1. Rohtak	$W_2S_4J_4C_5P_5$
	2. Kalanaur	$W_4S_4J_4G_4C_5M_5$
	3. Sampla	$W_2S_4J_4$

	4. Maham	$W_3S_4C_5J_5$
	5. Bahadurgarh	$W_2S_4C_5$
	6. Beri	$W_2S_4G_4J_5$
Sonepat	7. Sonepat	$W_2S_4G_5KF_5$
	8. Ganaur	$W_2S_4P_5M_5$
	9. Rai	$W_3S_4KF_5B_5$
	10. Kharkhauda	$W_2S_4G_4B_5KF_5$
	11. Gohana	$W_3S_4P_4KF_5$
	12. Mundlana	$W_3S_4P_4KF_5$
	13. Kathura	$W_2S_4G_5P_5KF_5$
Karnal	14. Smalkha	$W_2S_4P_5KF_5M_5$ RF_5

Wheat and sugarcane are the predominant crops of this region covering 52.2 and 15.4 per cent of area under irrigated conditions. The other important crops of the region are *jowar* and paddy covering 7.2 and 5.0 per cent of area under irrigated conditions. The relative yield index of these crops in this zone is close to state level yields except for Paddy.

4. Wheat-barley-bajra belt

It covers Jhajjar, Nahar, Salhawas, district Mahendergarh and district Gurgaon blocks covering a total of 2,73,951, ha of area under irrigated conditions. More than 30 per cent of the underground water samples from Nahar, Jhajjar, Salhawas, Rewari, Khol, Bawal, Padaudi II, Nuh, Hathin, Ferozpurjhirka, Punhana, Palwal, and Hodel blocks belong to F quality water indicating its unsuitability to the crops. But in Narnaul II, Nagal Chaudhry, Gurgaon, Sohana, Panipat, Nuh, Ballabhgarh and Faridabad blocks have A quality water suitable to the crops. Only 10 to 33 per cent of area in Mahendergarh district, Sohna, Nuh, Ferozpurjhirka and Punhana blocks is under irrigated conditions. Soils are sandy to sandy loam. Slight to moderate salinity-alkalinity hazards exist in this region.

The blocks covered under the zone have following cropping patterns :

District	*Block*	*Croppig pattern*
Rohtak	1. Jhajjar	W_1BA_5
	2. Nahar	$W_1B_5BA_5GU_5$
	3. Salhawas	W_2BA_4
Mahendergarh	4. Narnaul II	$W_2B_3BA_5$
	5. Nagal Chaudary	$W_2B_4BA_5$
	6. Narnaul I	W_2B_3
	7. Mahendergarh I	$W_1B_4RV_5$
	8. Mahendergarh II	$W_1BA_4G_5B_5$
	9. Rewari	$W_3BA_3B_5$
	10. Khol	$W_3B_4BA_4RO_5$
	11. Bawal	$W_2BA_4RO_5KF_5$
Gurgaon	12. Gurgaon	$W_2B_4BA_5$
	13. Sohna	$W_2B_4BA_4KF_4$
	14. Pataudi	W_2BA_4
	15. Nuh	$W_2BA_4S_5$
	16. Hathin	$W_1S_4BA_5$
	17. Ferozpurjhirka	W_1BA_5
	18. Punhana	$W_2S_4BA_4KF_5$
	19. Palwal	$W_1BA_5S_5$
	20. Hodal	$W_2BA_4S_5$
	21. Ballabhgarh	$W_2B_4M_5S_5$
	22. Faridabad	W_1M_5

Wheat is the predominant crop of this region covering 66.2 per cent of area under irrigated conditions. Barley, *bajra* sugarcane cover 11.7, 8.4 and 4.7 per cent of area respectively, under irrigated conditions in this belt. The relative yield index of wheat, barley and *bajra* in Rohtak district is less than the state level yields.

5. Wheat-paddy belt

It covers Saffidon, Karnal, Nilokheri, Gharaunda, Nissang, Asandh, Panipat, Madlauda, Kurukshetra, Ladwa, Shahbad, Kaithal, Pundri, Gulah, and Ambala blocks covering 8,24,547 ha of area under irrigated conditions. More than 60 per cent of area is under irrigated conditions in this belt. Except in Asandh, A quality water has been found for more than 30 per cent of underground water samples in this zone. Soils are sandy loam to loamy soils in texture. Moderate to high salinity-alkalinity exists in this region.

The following cropping patterns exits in this region under the various blocks.

District	*Block*	*Cropping pattern*
Jind	1. Saffidon	$W_2P_5S_5$
Karnal	2. Karnal	$W_3P_4RO_5M_5$
	3. Nilokheri	$W_3P_3RF_5$
	4. Gharunda	$W_2P_4RF_5$
	5. Nissang	$W_3P_3KF_5$
	6. Asandh	$W_3P_4RF_5$
	7. Panipat	$W_2P_4S_5RF_5$
	8. Madlaudha	$W_2P_4RF_5S_5$
Kuruk-shetra	9. Kurukshetra	$W_3P_3RF_5$
	10. Ladwa	$W_3P_4S_5RF_5$
	11. Shahabad	$W_3P_3RF_5$
	12. Kaithal	W_2P_4
	13. Pundri	W_3P_4
	14. Gulah	W_2P_3
Ambala	15. Ambala	$W_3P_3RF_5$

Wheat and paddy are the predominant crops of the region covering 50.3 and 26.2 per cent of area under irrigated conditions. The other important crop in this belt is sugarcane covering the 4.0 per cent of area under irrigated conditions. The relative yield index of these crops in this belt under irrigated conditions is close to the state level yields and indicates the productivity in this zone.

6. Wheat-Paddy-Sugarcane belt

It covers the Barara, Jagadhari, Chhachhrauli, Bilaspur, Raipur Rani, Nariangarh and Kalka blocks covering 98,596 ha of area under the irrigation facilities. In this belt 15 to 75 per cent of area exists under irrigated conditions.

The underground water is 100 per cent A quality, i. e., useful for irrigation purposes. Soils are sandy loam to loamy sand in texture. Only slight salinity hazard exists in the Raipur Rani, Kalka and Barara blocks.

The blocks covered under this belt with their cropping patterns under irrigated conditions are as follows :

District	*Block*	*Cropping pattern*
Ambala	1. Barara	$W_2P_3S_5RF_5$
	2. Jagadhari	$W_3P_4S_4RF_5$
	3. Chhachhrauli	$W_3P_4S_4RF_4$
	4. Bilaspur	$W_3P_4M_4S_4RF_5$
	5. Raipur Rani	$W_3KP_4P_4S_4RF_5$
	6. Nariangarh	W_2P_4
	7. Kalka	$W_2M_4P_4KF_5$

Wheat, paddy and sugarcane are the predominant crops in this belt covering 49.4, 22.5 and 10.3 per cent of area under irrigation facilities. The other important crops in this belt are *rabi* fodder and maize crops covering 5.9 and 4.1 per cent of area, respectively, under irrigation facilities. The relative yield index of these crops in the Ambala belt under irrigated conditions is as follows :

Crop	Relative yield index (%)
Wheat	75
Paddy	93
Sugarcane	122
Maize	108

Intensity of kharif cropping

The intensity of *kharif* cropping under the irrigated conditions will depend on the irrigation and input facilities, and amount of S. W. Monsoon rainfall received in the region concerned. In Tosham, Loharu, Badhra, Mahendragarh I, Mahendragarh II, Nagal Chaudhary, Nahar, Salhawas, Rewari, Pataudi, Bawal, Sohna, Nuh, Ferozepurjhirka, Hathin, Palwal. Ballabgarh and Faridabad. blocks only 25 per cent of the net sown area is cropped during the *kharif* season under irrigated conditions. In Hodal, Punhana, Gurgaon, Narnaul I, Narnaul II, Khol, Chhachhrauli, Nariangarh, Raipur Rani and Kalka blocks attain 25-50 per cent intensity of *kharif* cropping under the irrigated conditions. 50-75 per cent of net sown area under the irrigated conditions is cultivated during the *kharif* season in the districts of Sirsa, Hissar, Jind and the blocks of Ambala, Barara, Shahabad, Gulha, Kaithal, Asandh, Gohana, Kathura, Bwanikhera, Bhiwani, Dadri I, Dadri II and Beri. 75-95 per cent intensity of *kharif* cropping is achieved in the blocks of Jagadhari, Bilaspur, Ladwa, Thanesar, Karnal, Nilokheri, Pundri, Nissang, Gharunda, Panipat, Madlauda, Smalkha, Mundlana, Sonepat, Gohana, Rai, Kharkhauda, Sampla, Bahadurgarh, Rohtak, Maham and Kalanaur.

Intensity of rabi cropping

The irrigation facilities are highly desired during the *rabi* season as less amount of winter rainfall is received. Water storage and conservation practices will meet the acute requirement of water during the rainless period. 60-100 per cent intensity of *rabi* cropping is achieved in the Ladwa, Jagadhari, Bilaspur, Chhachhrauli, Raipur Rani, Kalka, Ambala, Gulah, Loharu, Tosham, Badhra, Bhiwani, Bwanikhera, Hissar I, Hissar, Hansi I, Hansi II, Narnaud, Uchana, Barwala, Bhuna, Fatehabad, and district Sirsa blocks. In Hathin, Punhana, Palwal, Ballabgarh, Sohna, Gurgaon, Mahendergarh I, Narnaul II, Narnaul I, Khol, Nagal Chaudhary, Ratia, Tohana, Narwana, Kalayat, Rajond, Saffidon, Assandh, Mundlana, Kathura, Gohana, Sampla, Kharkhauda, Ganaur, Nilokheri, Thanesar, Shahabad, Nariangarh blocks, 100-125 per cent intensity is achieved. 125-150 per cent intensity is acquired under the irrigated conditions in the blocks of Hodal, Faridabad, Ferozpurjhirka, Nuh, Rewari, Pataudi, Bawal, Nahar, Salhawas, Mahendragarh II, Dadri I, Dadri II, Jhajjar, Bahadurgarh, Beri, Rohtak, Kalanaur, Maham, Rai, Sonepat, Smalkha, Panipat, Madlauda, Gharunda, Karnal, Nissang, Kaithal, and Pundri blocks.

Intensity of double cropping

Intensity of double cropping depends on the amount of irrigation facilities available. Less than 50 per cent of net sown area is cultivated for the double cropping in the blocks of Dabawali, Sirsa, Hissar II, Tosham, Loharu, Badhra, Mahendragarh I, Mahendragarh II, Narnaul I, Narnaul II, Nagal Chaudhary, Bawal, Gurgaon, Sohna, Ballabhgarh, Palwal and Kalka under the irrigated conditions. Baragudah, Rania, Fatehabad, Bhuna, Barwala, Hissar I, Hansi I, Hansi II, Narnaud, Bwanikhera, Bhiwani, Khol, Rewari, Pataudi, Nuh, Nahar, Salhawas, Ferozpurjhirka, Hathin, Punhana, Ambala, Barara, Chhachhrauli, Bilaspur, Nariangarh and Raipur Rani blocks acquire 50-60 per cent of net sown area under the double cropping under irrigation facilities. 60-100 per cent intensity of double cropping is attained in the blocks of Hodal, Faridabad, Rai, Sonepat, Ganaur, Smalkha, Panipat, Gohana, Mundlana, Madlauda, Kathura, Saffidon, Jind, Kharkhauda, Rajound, Assand, Uchana, Ratia, Tohana, Narwana, Kalayat, Gulah, Shahabad, Thanesar, Ladwa and Jagadhari under irrigated conditions. More than 100 per cent intensity of double cropping is achieved in the blocks of Sampla, Jhajjar, Bahadurgarh, Beri, Dadri I, Dadri II, Rohtak, Maham, Kalanaur, Gharunda, Karnal, Nissang, Nilokheri, Pundri and Kaithal blocks under the irrigated conditions.

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STUDIES ON THE EFFECT OF BIURET CONTAINING UREA SPRAYS ON PHYTOTOXICITY IN GRAPE AND PEACH

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ABSTRACT

Effect of various levels of biuret, i.e., 0,0.5, 1.0, 1.5 and 2.0 per cent in 1.5 per cent (W/W) of urea on leaf injury, total nitrogen and true protein nitrogen on Delight cultivar of grape and sub-tropical peach seedlings was studied during April-May, 1974. Biuret caused phytotoxicity with progressively higher levels. Even 1.5 per cent of urea without any biuret injured 56.31 per cent of grape leaves, whereas in peach the damage was only 2.86 per cent. Addition of biuret up to a concentration of 1.0 per cent in peach and up to 0.5 per cent in grape increased N content in leaves. At concentrations higher than this, urea caused a decrease in leaf nitrogen content. But addition of biuret decreased the protein nitrogen in grape significantly, whereas decrease in peach was recorded only at the highest concentration of 2.0 per cent of biuret, which was non-significant.

An experiment was designed to find out the safe permissible limit of biuret in urea for spray purposes and to compare the nitrogen status for healthy and biuret injured Delight grape and peach seedling leaves. It was surmised that disruption in nitrogen metabolism may be reflected in changes in protein synthesis which was also evaluated.

MATERIAL AND METHODS

The studies were conducted during April-May 1974, at the Experimental Orchard of Haryana Agricultural University, Hissar. A preliminary trial was laid out on one-year-old rooted cuttings of Delight cultivar of grape and peach seedlings in the nursery, where in 0.5 and 1.0 per cent urea sprays containing 0,0.25, 0.5 and 1.0 per cent biuret (W/W) was applied and apparently no injury was observed on eight week old leaves. For the regular experiment the concentration of urea was raised to 1.5 per cent and concentrations of biuret in urea tried were 0,0.5, 1.0, 1.5 and 2.0 per cent. So in all there were five treatments, replicated four times with four plants as the treatment unit. The experiment was laid out in a Randomised Block Design. These treatments were applied on 15th May, 1974, when the leaves were ten weeks old. After a week of spray application, observations were recorded on per cent injured leaves. Also leaf and petiole samples of recently mature leaves respectively of peach and grape were collected. For nitrogen estimation micro-Kjeldahl method described by Jackson (1967) and for true protein nitrogen estimation the procedure described by Kanwar and Chopra (1967) was adopted.

RESULTS AND DISCUSSION

Effect of various concentrations of biuret in urea on foliage injury given in Table I shows that 1.5 per cent of urea, free from biuret, caused negligible injury to peach leaves, i.e., only 2.86 per cent of leaves were damaged, whereas in grape the injury was very high, i.e., 56.31 per cent of leaves were injured. Biuret added to urea at the rate of 0.5, 1.0, 1.5 and 2.0 per cent progressively increased the extent of injured leaves significantly over biuret-free urea but there was no significant difference between various concentrations of biuret. These observations reveal that sub-tropical peach can tolerate relatively higher concentrations of urea and biuret than grape. Similar species differences to the tolerance of biuret injury are evident from the observations of Iwaski and Schichijo (1962) who found that citrus could tolerate 1 per cent urea containing 1.8 per cent biuret. Demetriades and Gavalas (1964) observed lemons and grapefruit leaves were injured with 1.0 per cent urea containing 1 per cent biuret in it. However, Jones (1954) observed injury at 2 per cent urea containing as little as 0.2 per cent biuret. Dhillon and Aulakh (1972) observed injury to grapevine cultivar Anab-e-Shahi with biuret-free urea at concentrations higher than 0.7 per cent but later sprays up to 0.9 per cent did not injure the leaves. It seems that not only species but also the age of the leaves is quite important. In the present studies leaves were 8 to 10 weeks old at the time of treatment so it explains why lower concentrations of urea and biuret did not injure the leaves which prompted higher rates of application. Further investigations to determine the response of various concentrations of biuret on leaves from emergence to different ages are, therefore, necessary.

Data on the effect of urea, containing biuret, on nitrogen content of leaves in peach and grape (Table 2) and response curve based on quadratic equations (Figs. 2 and 3) show that addition of biuret in urea significantly improved the nitrogen content up to 1.0 per cent biuret content.

TABLE 1

Effect of various concentrations of biuret in urea on foliage injury

Concentration of biuret in 1.5 per cent solution of urea	Per cent injury	
	Peach	Grape
Control (no biuret)	2.86 a	56.31 a
0.5	70.42 b	80.44 b
1.0	68.19 b	93.08 c
1.5	90.94 b	92.92 c
2.0	97.65 b	97.65 c
C.D. at 5% level of significance	34.79	10.81

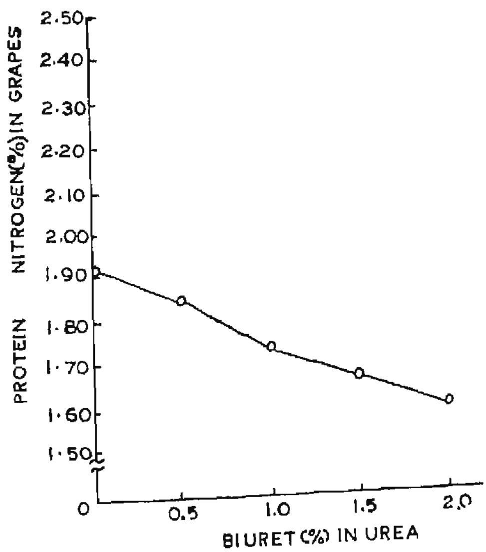

FIG. 1

Fig. 1. Response curve of protein nitrogen in grapes in relation to biuret concentrations.

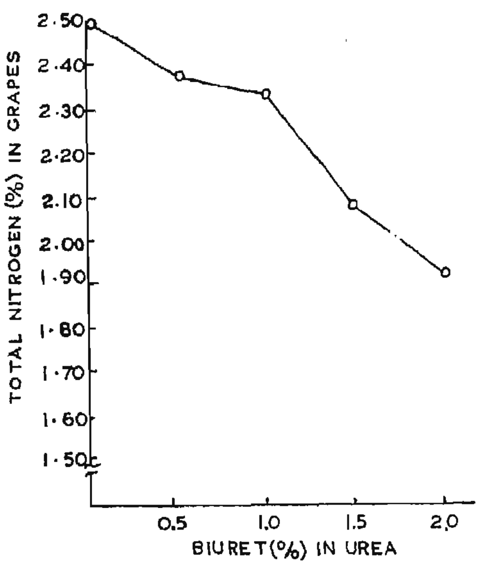

FIG. 2

Fig. 2. Response curve of total nitrogen in grapes in relation to buiret concentrations.

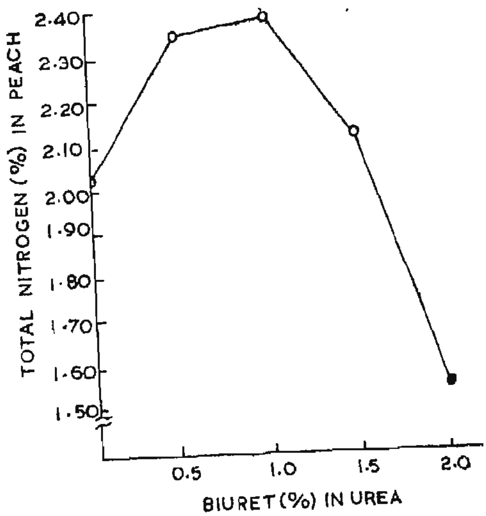

FIG. 3

Fig. 3. Response curve of total nitrogen in peach in relation to biuret concentrations.

Thereafter, the nitrogen content showed a decline and biuret added at the two highest concentrations, i.e., 1.5 and 2.0 per cent, nitrogen content in the leaves was even lower than 1.5 per cent urea alone. At these two concentrations, foliage injury was also the highest. These observations are supported by the findings of Carles (1960) who, while studying the response of a number of vegetable crops to the application of urea containing biuret, observed that biuret up to its safe limits, added to urea, had a beneficial effect on growth and yield. Wlodkowa (1969) observed that nitrogen content of black current was higher in treatments of urea+biuret than urea alone. This may be due to the fact that basically biuret is only a degradation product of urea and essentially it contains nitrogen in the amide form, so with its application an increase in nitrogen content of leaves is understandable. However, when the concentration of biuret reaches toxic

TABLE 2

Effect of various concentrations of biuret on nitrogen content of leaves in peach and grape

Concentration of biuret in 1.5 per cent solution of urea	Per cent Nitrogen	
	Peach leaves	Grape petioles
Control (no biuret)	1.99 a	2.45 a
0.5	2.39 b	2.56 a
1.0	2.52 c	2.12 b
1.5	1.91 a	2.09 b
2.0	1.64 d	1.96 b
C.D. at 5% level of significance	0.10	0.33

TABLE 3

Effect of various concentrations of biuret on true protein nitrogen content of peach and grape leaves

Concentration of biuret in 1.5 per cent concentration of urea solution	Protein nitrogen content per cent	
	Peach leaves	Grape petioles
Control (no biuret)	1.41 a	1.93 a
0.5	1.34 a	1.79 ab
1.0	1.42 a	1.79 ab
1.5	1.40 a	1.65 bc
2.0	1.22 a	1.60 c
C.D. at 5% level of significance	N.S.	0.16

Values in each column not followed by the same letter are significantly different from each other at 5% level as judged by Duncan's new multiple range test.

levels it disturbs the normal metabolism of leaves and as a result their nitrogen content comes down

These observations get further support from the data on protein nitrogen content, given in Table 3, which, though non-significant in peach, showed that at the highest concentration of biuret in urea, the protein content was lowest of all the treatments; whereas, in grape with 1.5 and 2.0 per cent biuret there was a significant decrease in protein nitrogen. Several workers, viz., Webster *et al.* (1957), Carles (1960) and Impey and Jones (1960) also observed that presence of biuret in urea caused a decrease in leaf protein content. As leaf proteins constantly undergo break-down and resynthesis, the decrease in protein level could either be due to an inhibition of protein synthesis or to a promotion of protein decomposition.

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EFFECT OF LEVELS OF PHOSPHORUS AND NITROGEN ON SOYBEAN VARIETIES

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ABSTRACT

Studies were conducted to find out the response of soybean (Glycine max (L) Merr) varieties to different levels of phosphorus and nitrogen application during *Kharif* season of 1969 and 1970. Maximum grain yield was obtained from Bragg variety by the application of 80 Kg P_2O_5 and 20 Kg N per hectare, followed by Pb. No. 1 and Clark-63. The response curve revealed that Bragg and Pb. No. 1 showed linear response to phosphorus application while Clark-63 showed quadratic response. The application of phosphorus and nitrogen increased the protein and oil content in grain *appreciably. Among varieties,* Bragg recorded 41.18 and 24.04 per cent protein and oil, respectively.

Soybean yields are usually enhanced by the application of fertilizers, particularly phosphorus, on soils that test low to medium phosphorus content; on high fertility soils fertilizer additions do not give spectacular increase in yield (Caviness and Hardy, 1970). The beneficial effect of phosphorus on nodulation, yield and general behaviour of leguminous crops have been established. Application of phosphatic fertilizer results in better vigour of plant and ultimately reflects on the final grain yield (Weber and Caldwell, 1962; Kamprath and Millar, 1958). It has also been stated by some workers that phosphate fertilization increased the protein and oil content in soybean grains (Jones and Lutz, 1971, Singh and Singh, 1968). Legumes are generally known not to require any additional dose of nitrogen. However, effects of initial application of small nitrogen doses in stimulating nodulation, nitrogen fixation and finally grain yield of legumes have been found beneficial (Calland, 1960; Singh and Saxena, 1973). Carter and Hartwig (1962) reported that nitrogen application enhances the protein content in soybean grains. Keeping above considerations in view an experiment comprising levels of phosphorus and nitrogen was conducted to find out the yield potentiality of soybean varieties.

MATERIAL AND METHODS

A field experiment was conducted on sandly loam soil during *kharif* season of 1969 and 1970 at the Haryana Agricultural University Farm, Hissar to determine the response of three levels of phosphorus P_0, P_1 and P_2 (0, 40 and 80 Kg P_2O_5/ha) and two levels of nitrogen N_0 and N_1 (0 and 20 Kg N/ha) to three soybean varieties, namely, V_1 –Pb. No. 1, V_2 –Bragg and V_3–Clark-63. The experiment was laid out in Split Plot design with varieties and levels of phosphorus as main plot and nitrogen levels as sub plot with three replications. The mechanical and chemical (mean of two years) analysis of the soil showed 62.2, 19.5 and 18.8 per cent of sand, silt and clay in sandy loam soil, 8 2 pH, and available N, P_2O_5 and K_2O were 265.2, 18.5 and 462.5 Kg per hectare, respectively. The seed was treated with soybean culture before sowing to facilitate germination and to develop adequate rhizobium in the plant. The weather data prevailing during the experimental period revealed that the minimum and maximum temperature did not vary significantly in both the years, but the humidity percentage and rainfall during 1969 was higher than during 1970.

In order to see the significance of the results, the grain yield data were subjected to statistical analysis.

RESULTS AND DISCUSSION

The grain yield of soybean varieties as influenced by different fertility levels of phosphorus is presented in Table 1.

The mean grain yield was higher in 1969 than 1970. This may be because of more favourable weather during the first year. However, the mean temperature and humidity were almost the same during both the years. The rainfall was also well distributed, but in 1969 the amount of rainfall was higher than in 1970.

Table 2 reveals that phosphorus application had significant effect on grain yield of soybean varieties in both the years. Pb. No. 1 and Bragg showed linear response to phosphorus application, whereas Clark-63 showed a response only up to 40 Kg P_2O_5/ha. Weber and Caldwell (1962) at Minnesota and Singh and Singh (1968) at Kanpur also recorded increase in grain yield due to phosphorus application.

Among the varieties, Bragg out-yielded Pb. No. 1 and Clark-63 significantly.

TABLE 1

Response of grain yield of soybean varieties to the levels of phosphorus (q/ha)

Levels of phosphorus (Kg/ha)	1969				1970				Average			
	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean
P_0	10.35	11.54	7.65	9.65	9.60	11.62	7.24	9.50	9.98	11.60	7.45	9.67
P_{40}	13.64	13.33	13.13	13.36	12.40	14.39	11.90	12.89	13.02	13.86	12.51	13.13
P_{80}	15.00	19.76	13.07	15.94	14.32	18.45	11.14	14.63	14.66	19.10	12.10	15.29
Mean	12.99	14.87	11.28		12 10	14.83	10.09		12.55	14.85	10.68	
C. D. at 5%												
V and P		1.00				1.46				1.26		
		1.80				N.S.				2.19		

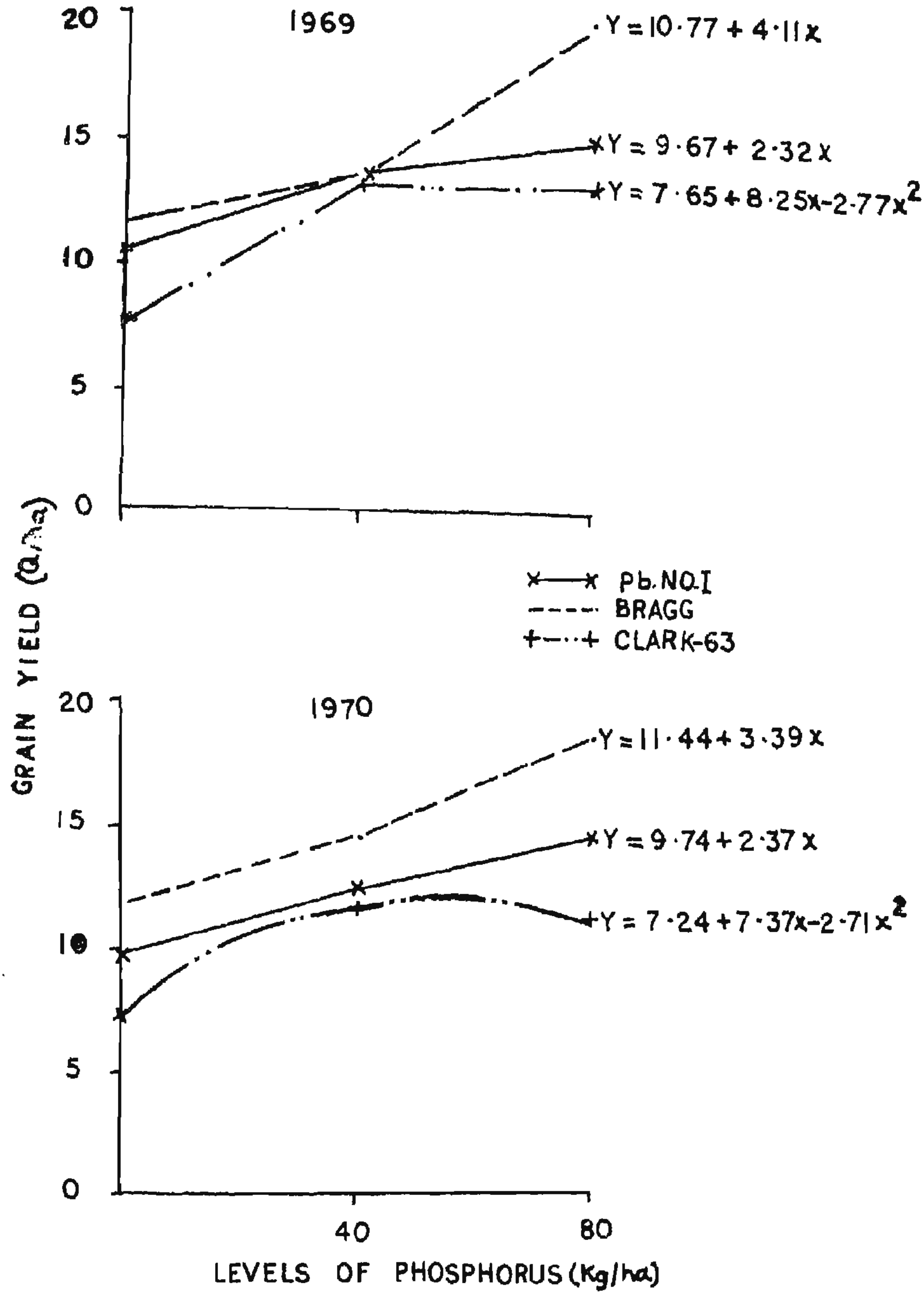

FIG. I. RESPONSE OF THREE SOYBEAN VARIETIES TO PHOSPHORUS

Singh (1968) and Leng (1968) also reported similar observations. Bragg gave 18.3 and 39.0 per cent higher yield than Pb. No. 1 and Clark-63, whereas Pb. No. 1 gave 17.5 per cent higher yield than Clark-63. The interaction of varieties and phosphorus was found significant during 1969 as well as on the basis of pooled analysis. The grain yield of Pb. No. 1 increased up to 80 Kg P_2O_5/ha application, however, the differences between the two higher levels were non-significant. In Bragg, each level of phosphorus application enhanced the yield significantly over its lower doses, but in Clark-63 the yields increased significantly only up to 40 Kg P_2O_5/ha application and further addition of phosphorus had an adverse effect.

The nature of response curves of soybean varieties to phosphorus application (Fig. 1) was also investigated for each year. The curve came out to be linear in Pb. No. 1 and Bragg varieties, whereas in Clark-63 it was quadratic. The optimum dose of phosphorus (x) was also calculated for Clark-63 variety by the following equation.

$$X = \frac{q/P - b}{2C}$$

Where

q = Price per unit of fertilizer

p = Price per unit of produce

b & C = Constants in response curve

Optimum dose of phosphorus for Clark-63 was found to be 48 Kg P_2O_5/ha as the average of two years.

The effect of nitrogen and its interaction with phosphorus and varieties are presented in Table 2.

It is evident from Table 2 that the application of 20 Kg nitrogen/ha had significant effect in increasing the grain yield of Soybean varieties. During 1969 and 1970, nitrogen application produced 20.1 and 21.7 per cent more grain yield than control, respectively. This might be due to the fact that nitrogen application

TABLE 2

Effect of nitrogen and its interaction with phosphorus and varieties on grain yield (q/ha)

Levels of nitrogen (Kg/ha)	Phosphorus levels (Kg/ha)				Varieties			
	1969				1970			
	P_0	P_{40}	P_{80}	Mean	V_1	V_2	V_3	Mean
N_0	9.25	11.71	14.61	11.85	11.10	12.74	9.56	11.13
N_{20}	10.44	15.02	17.27	14.24	13.12	16.92	10.63	13 55
Mean	9.84	13.36	15.94	—	12.11	14.83	10.09	—
C. D. at 5%								
Nitrogen (N)		0.38			Varieties (V)		1.00	
Phosphorus (P)		1.00			Nitrogen (N)		0.80	
N×P		0.80			N×V		1.40	

TABLE 3

Protein and oil content of soybean varieties as influenced by levels of phosphorus and nitrogen

Treatments	Protein (per cent)	Oil (per cent)
Varieties		
Pb. No. 1	39.81	21.27
Bragg	41.18	24.04
Clark-63	38.22	24.30
Levels of P_2O_5 (Kg/ha)		
P_0	36.68	22.50
P_{40}	41.14	23.76
P_{80}	41.39	23.33
Levels of N (Kg/ha)		
N_0	39.25	22.91
N_{20}	40.23	23.50

delays senescence of leaves and is believed to increase the leaf area. Therefore, increased photosynthetic capacity for longer duration might have resulted in higher production of photosynthate in the plants treated with additional nitrogen as compared to control. Similar results have also been reported by Calland (1960), Kamprath and Millar (1958) and Singh and Saxena (1973). The interaction of nitrogen and phosphorus was also found to be significant during 1969, i.e., maximum grain yield was recorded when nitrogen was applied with 80 Kg P_2O_5/ha. In 1970, the interaction of varieties and nitrogen was also found to be significant. Variety Bragg out-yielded, followed by Pb. No. 1 and Clark-63 with nitrogen application.

Effect on quality

The composite samples of grain from the various treatments were analysed chemically and the results are summarised in Table 3.

A perusal of Table 3 reveals that nitrogen application enhanced the protein percentage. It seems that grain yield of soybean and protein content is interdependent because the increase in the protein content is associated with an increase in the yield due to nitrogen application. Singh and Singh (1968) and Carter and Hartwig (1962) have also obtained higher protein content due to nitrogen application. Oil percentage is not much affected by nitrogen application, however, only a slight increase was obtained.

Phosphorus application showed a remarkable response in increasing the protein percentage. Application of 40 Kg P_2O_5/ha increased the protein percentage over control, whereas its higher dose did not respond well over 40 Kg P_2O_5/ha. The highest protein and oil percentage was obtained in Bragg variety. Oil percentage was also increased by the addition of 40 Kg P_2O_5/ha. Similar results have been reported by Jones and Lutz (1971).

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PATH-COEFFICIENT ANALYSIS FOR FODDER CHARACTERS IN CLUSTERBEAN *(CYAMOPSIS TETRAGONOLOBA* (L) TAUB)

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ABSTRACT

The genotypic and phenotypic correlations and path-coefficients were studied in two different environments using 18 fodder genotypes of clusterbean (*Cyamopsis tetragonoloba* (L) Taub). Considerable amount of genetic variation was present for green fodder yield and its component characters. Heritability and genetic advance were high and consistant for the two characters, i.e., the number of leaves per plant and the number of branches per plant. Plant height, the number of leaves per plant and the number of branches per plant were highly correlated with green as well as dry matter yield both at the genotypic and phenotypic levels. Based on path-coefficient analysis, the number of leaves per plant was found to be the most important component character. Selection based on the number of leaves per plant and number of branches per plant is likely to be useful for simultaneous improvement in both yield and quality of fodder in clusterbean.

In order to initiate any effective selection programme for further advancement in yield, it is necessary to have an understanding about the mutual relationships among the yield and its component characters. This would improve the chances of achieving correlated response in the desired direction. Obviously, therefore, information regarding the direct and indirect effects of the various components on yield, as obtained from path-coefficient analysis, is essential. Use of path-coefficient analysis, as proposed by Wright (1921) and discussed by Dewey and Lu (1959), has been made in some forage crops (Dangi and Paroda, 1974 in cowpeas; Saini, 1974 and Paroda *et al.*, 1975 in Sorghum; Solanki *et al.*, 1973 in oats and Paroda *et al.*, 1973 in *Pennisetum pedicellatum*). However, such information appears to be lacking in case of clusterbean (*Cyamopsis tetragonoloba* (L) Taub), particularly on forage yield and its component traits. Accordingly, the present work was undertaken to study the genotypic and phenotypic correlations and path-coefficients, using 18 forage genotypes, in clusterbean.

MATERIAL AND METHODS

The experimental material comprised 18 genetically diverse lines of clusterbean, selected from the genetic stock based on the existing variation for the fodder characteristics. Varieties FS 277 and No. 2 were used as checks. All the 18 genotypes were grown in *kharif* 1972 (E_1) and *kharif* 1973 (E_2) in a randomised block design comprising three replications. The seeds were sown by dibbling at 10 cm apart in three metre long rows spaced 30 cm apart. Each genotype was accommodated in a three-row plot and observations on individual plant basis were recorded from the five competitive plants from the central row. Six quantitative characters, namely, days to 50 per cent flowering, number of branches per plant, number of leaves per plant, plant height (cm), dry matter yield per plant (g) and green fodder yield per plant (g) were recorded

Genotypic and phenotypic correlation coefficients were studied and path-coefficient analysis was carried out at the genotypic level, as discussed by Dewey and Lu (1959).

RESULTS AND DISCUSSION

The data on mean performance of the 18 genotypes for green fodder yield and other characters, for the two years, are given in Table 1. It was found that in environment I, genotype 281 gave highest green fodder yield per plant, whereas in environment II, genotypes 128, 313, 227 and 119 gave significantly higher green fodder yield per plant. Similar trend was obtained for dry matter yield in both the years. Over both the environments, genotypes 119, 128 and 227 gave highest green as well as dry matter yield per plant. The tallest genotype was 277-I, whereas genotypes 53, 128 and 227 had maximum number of leaves per plant and the earliest genotypes were 314 and 277-I. It is apparent from Table 1 that there was considerable amount of variability present for all the characters studied and that in environment II the mean performance of all the genotypes was higher for all the characters.

The analysis of variance revealed significant variances due to genotypes for all the six characters studied in both the environments (Table 2). Estimates of heritability (in broad sense), expected genetic advance and coefficient of variability (C. V.) are also presented in Table 2. Dry matter yield, height, number of leaves per plant and number of branches per plant showed high heritability, whereas the green fodder yield, and days to 50 per cent flowering were found to be less heritable. The trend was similar in both the environments for all the characters. Expected genetic advance was high in case of the number of leaves per plant and the number of branches per plant in both the environments. For the remaining characters the expected genetic advance was low and the estimates were inconsistent over the environments. Thus, both the number of leaves per plant and the number of branches per plant could be used in selection work in clusterbean. Sohoo *et al.*, (1971) have also reported high heritability and genetic advance for the number of branches per plant in clusterbean. The coefficient of variation was relatively high for the number of leaves per plant in environment I, for the number of branches per plant in environment II, and for green fodder yield per plant in both the environments.

The correlation coefficients between pairs of different quantitative characters were studied at the genotypic and phenotypic levels in both the environments

TABLE 1

Mean performance of the 18 genotypes for green fodder yield and other component characters in the two years

S. No.	Genotype	Green fodder yield/ plant (g)		Dry matter yield/ plant (g)		Plant height (cm)		No. of leaves plant		No. of branches/ plant		Days to 50% flower	
		E_1	E_2	E_1	E_2	E_1	E_2	E_1	E_2	E_1	E_2	E_1	E_2
1.	53	32.3	163.0	22.3	3t.7	97.9	137.6	67.5	94 7	12.5	12.7	61.3	78.7
2.	119	111.0	170.0	28.7	44.0	119.7	169.3	44.9	68.9	8.6	11.4	64.7	71.3
3.	128	121.0	182.3	31.7	47.7	119.6	153.2	62.7	94.3	12.8	14.9	64.0	71.3
4.	156	96.3	148.7	21.3	32.7	113.4	158.0	39.7	52.3	6 9	9.4	64.3	68.7
5.	182	87.3	166.3	19.3	36.7	98.4	143.7	46.4	80.5	9.7	13.2	63.0	75.3
6.	197	91.7	132.0	22.0	31.7	121.3	139.0	45.8	78.4	8.6	12.5	63.7	69.0
7.	227	104.7	173.0	22.7	34.7	125.1	144.1	66.7	97.7	12.2	13.7	59.7	67.0
8.	236	107.3	161.0	20.0	28.7	111.0	148.1	54.4	75.1	11.9	12.5	59.7	73.3
9.	244	87.7	163.7	17.3	32.7	105.1	138.5	38.5	74.2	9.2	14.0	64.3	74.3
10.	256	105.7	114.0	23.0	28.0	124.9	158.7	22.0	29.5	0 8	1.6	59.0	61.3
11.	281	145.0	123.7	; 9.0	24.7	130.4	162.5	22.3	42.7	0.6	3.2	56.7	63.0
12.	313	95.7	173.7	20.7	38.0	123.9	155.0	21.6	42.6	0.1	2.0	61.7	59.3
13.	314	98.7	140.7	21.3	31.0	122.9	158.7	29.1	30.2	0.8	0 7	57.3	54.7
14.	315	110.0	133.7	24.0	29.0	114.7	150.5	28.5	59.0	5.3	10.1	63.0	64.0
15.	320	82.0	163.0	14.3	29.7	107.2	148.3	30.7	69.2	6.7	10 7	65 0	71.0
16.	277-I	122.3	140.3	31.3	34.3	162.5	160.8	43.1	42.6	2.1	1.6	56.7	59.3
17.	2	83.0	149.3	20.0	36.0	116.1	154.7	52.4	67.9	11.9	10.7	58.0	70.0
18.	FS 277	108.7	151.7	27.7	39.3	140.5	165.3	27.3	30.5	0.5	0.8	60.3	58.3
	Mean	110.2	153.0	24.81	34.48	119 7	152.55	41.3	62.96	6.7	2.161	61.3	67.2
	SE (m)	± 11.43	± 13.39	± 0.64	± 1.53	± 1.94	± 2.65	± 4.35	± 2.43	± 1.18	± 1.95	± 0.13	± 2.94

TABLE 2

The analysis of variance of the six characters alongwith the estimates of heritability, genetic advance and coefficient of variability.

	d. f.	Green fodder yield/ plant		Dry matter yield/ plant		Plant height		No. of leaves/ plant		No of branches/ plant		Days to 50% flower	
		MEAN SQUARES											
		E_1	E_2	E_1	E_2	E_1	E_2	E_1	E_2	E_1	E_2	E_1	E_2
Replications	2	1820.05*	681.77*	98.25*	287.90*	681.21*	267.25*	264.72*	265 41*	6.53*	74.26*	0.370*	21.15*
Varieties	17	3009.77*	3868.0*	221.30*	149.23*	669.40*	183.48*	686.57*	150.24*	67.59*	83.04*	0.256*	196.60*
Errors	34	392.26	537.4	1.24	10.46	14.53	21.12	62 29	17.66	4.25	11.44	0.056	25.90
Heritability (broadsense)		68.92	67.30	98.[illegible]3	81.60	93.84	71.92	76.96	71.44	72.32	67.79	54.47	68.70
Gain from selection		27.71	36.77	37.29	36.60	24.65	8.39	63.04	38.37	65 88	38.40	0.63	28.70
C. V. %		17.97	15.15	4.47	9.33	3.15	3.00	19.09	6.67	3.06	15.64	0 38	7.5

*Significant the 1 per cent level.

TABLE 3

Phenotypic and genotypic correlations between all pairs of traits measured in Environment I (Upper right) and Environment II (lower left)

		Plant height	No. of leaves/ per plant	No. of branches per plant	Days to 50% flower	Dry matter yield per plant	Green fodder yield per plant
Plant	G	—	0.561*	0.238	0.176	0.584*	0.634**
height	P	—	0.538*	0.214	0.141	0.532*	0.601**
No. of leaves	G	0.624**	—	0.434	0. 48	0.732**	0.768**
per plant	P	0.563*	—	0.401	0 012	0.674**	0.731**
No. of branches	G	0.110	0.521*	—	−0.101	0.631**	0.371
per plant	P	0.040	0.431	—	−0.101	0.621**	0.321
Days to 50%	G	0.141	−0.211	−0.041	—	−0.401	−0.501*
flower	P	0.011	−0.141	−0.021	—	−0.368	−0.561*
Dry matter yield	G	0.712**	0.781**	0.561*	−0.020	—	0.998**
per plant	P	0.584*	0.632**	0.432	−0.001	—	0.976**
Green fodder	G	0.561*	0.674**	0.231	−0.131	0.954**	—
yield per plant	P	0.504*	0.632**	0.154	−0.101	0.867**	—

*Significant at 5% level **Significant at 1% level

(Table 3). In most of the cases, the magnitude of genotypic correlation coefficient was higher than the phenotypic correlation coefficient. Mostly, characters showing negative correlation at the genotypic level also showed negative association at the phenotypic level. However, the magnitude of these negative associations was not significant except for the days to 50 per cent flowering. Plant height and dry matter yield were significantly correlated with green fodder yield at both the genotypic and phenotypic levels in environment I, whereas the number of leaves per plant, plant height and dry matter yield showed significant association with green fodder yield in environment II. Plant height, number of leaves per plant and the number of branches per plant showed significant and positive association with dry matter yield at genotypic as well as it phenotypic level in both the environments. Dangi and Paroda (1974) observed on the basis of correlation studies that the characters like leaves per plant, branches per plant and stem girth were the most important component characters of both green and dry matter yield in fodder cowpeas. Days to 50 per cent flowering showed significant negative association with both green and dry matter yield in environment I, reflecting the fact that the early flowering plants were, in general, high yielding. In environment II, this association did not persist and, thus, flowering behaviour of the genotypes appeared to be affected due to environmental variation.

Mostly the component characters did not have high correlation among themselves, except in case of plant height and the number of leaves per plant which showed significant positive correlation at the genotypic and phenotypic levels in both the environments. In environment II, the number of branches per plant showed high significant and positive correlation with the number of leaves per plant, but no such trend was noticed in environment I. In general, it appeared that plant height, number of leaves per plant and number of branches per plant were the important components of green and dry matter yield in the present material of clusterbean.

In order to present a clear picture of the interrelationship between different characters, the direct and indirect effects of the important quantitative characters on dry matter yield per plant, as it has high correlation with green fodder yield and it is also most important character as far as utilization aspect by animal is concerned, were worked out in both the environments, using path-coefficient analysis at the genotypic level (Table 4). All the characters recorded were included in this analysis. All the characters, except days to 50 per cent flowering, showed positive and high direct effect on dry matter yield per plant on both the environments. However, the magnitude of the direct effects varied with the change in environment. The number of leaves per plant showed highest direct effect (0.6774) on dry matter yield and it was followed by that of the number of branches per plant (0,2596) in environment I, whereas plant height showed highest direct effect (0.5050) in environment II. Although the positive direct effect of plant height contributed to a certain extent to its positive correlation with dry matter yield per plant, the number of leaves per plant seemed to have contributed indirectly to the high association of the number of branches per plant in both the environments. Both plant height and

TABLE 4

Path-coefficient analysis of dry matter yield *vs* other component characters.

Characters	Path-coefficient	
	Environment I	Environment II
Dry matter yield *vs* plant height		
Direct effect	+ 0.2162	+ 0.5050
Indirect effect via no. of leaves per plant	+ 0.3698	+ 0.1905
,, branches per plant	+ 0.0556	+ 0.0161
,, days to 50% flower	− 0.0576	+ 0.0004
Total	+ 0.5840	+ 0.7120
Dry matter yield *vs* no. of leaves/plant		
Direct effect	+ 0.6774	+ 0.3283
Indirect effect via plant height.	+ 0.0464	+ 0.2845
,, no. of branches/plant	+ 0.0140	+ 0.1732
,, days to 50% flower	− 0.0058	− 0.0050
Total	+ 0.7320	+ 0.7810
Dry matter yield *vs* no. of branches per plant		
Direct effect	+ 0.2596	+ 0.4001
Indirect effect via plant height	+ 0.0464	+ 0.0202
,, no. of leaves/plant	+ 0.2756	+ 0.1414
,, days to 50% flower	+ 0.0494	− 0.0007
Total	+ 0.6310	+ 0.5610
Dry matter yield *vs* days to 50% flower		
Direct effect	− 0.4084	+ 0.0303
Indirect effect via plant height	+ 0.0306	+ 0.0055
,, no. of leaves per plant	+ 0.0082	− 0.0474
,, no. of branches per plant	− 0.0314	− 0.0084
Total	− 0.4100	− 0.0200

number of leaves showed significant positive correlation. This clearly established that the characters, like plant height, number of leaves per plant and also the number of branches per plant could effectively be utilized in a selection programme aiming at the genetic improvement of both green and dry matter yield. Particularly, the number of leaves per plant and the number of branches per plant seemed to be the reliable components owing to the fact that these two characters were highly heritable and had positive association with green and dry matter yield. Dangi and Paroda (1974) suggested that selection based on leaves per plant was likely to be useful for further genetic improvement in yield and quality of fodder in cowpeas. Similarly, Saini (1974) and Paroda *et al.*, (1975) reported in forage sorghum that the leaf area per plant was the most important component character which could reliably be used as a selection criterion for improvement in not only the dry matter yield but also in the quality of forage.

In recent years, the importance of correlation and path-analysis have been realised in forage crops, like, sarghum (Saini, 1974; Paroda *et al.*, 1975), *bajra* (Gupta and Athwal, 1966; Gupta and Nanda, 1971), *Pennisetum pedicellatum* (Paroda *et al.*, 1973) fodder cowpeas (Dangi and Paroda, 1974) and oats (Mehra *et al.*, 1971; Solanki *et al.*, 1973). However, the effectiveness of component approach has not been emphasised on the basis of observed gain in practice as has been done in cereal, like, barley (Rasmusson and Cannell, 1970; Borthakur and Poeh-lman, 1970) and wheat (Borojevic and Cupina, 1969). Thus, it would be most desireable to initiate a selection programme on the basis of important component characters, like, plant height, number of leaves per plant and number of branches per plant for achieving desired correlated response in clusterbean.

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HAEMATOLOGICAL CHANGES IN SHEEP EXPOSED TO SUB-LETHAL DOSES OF LEAD DURING GESTATION

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ABSTRACT

Haematological changes, produced in 12 sheep exposed to sub-lethal dose of lead throughout their gestation, were investigated. The changes (anisocytosis, poikilocytosis, immature red cells and basophilic stippling) were highest between 6th and 7th week of exposure and varied with the dosage; they disappeared during the later part of the experiment. Increased number of monocytes and neutrophils (bands) and decreased number of eosinophils were highly significant in the exposed sheep. The mean percentage of eosinophils in the exposed group was significantly less than the control group ($P<.01$), whereas the mean percentage of monocytes and neutrophils (bands) was significantly higher ($P<.01$) than that of the control group.

The erythrocytic morphology of anaemia, associated with lead poisoning in man and animals, usually consists of macrocytosis, hypochromasia and basophilic stippling, accompanied by a variable number of reticulocytes (Leikin and Eng, 1963; Chisolm, 1971; Zook *et al.*, 1970; Christian and Tryphonas, 1971). Lead poisoning also causes decreased haeme synthesis, which may at first be due to a decrease in the life span of the red blood cells and later to a decrease in the number of red blood cells and in the amount of haemoglobin per cell. As a result, the blood forming tissues step up their production of red cells and, consequently, immature red cells, reticytes and basophilic stippled cells appear in the circulation of the organism.

MATERIAL AND METHODS

Twenty-one aged Columbia-Rambouillet cross bred sheep were acclimatized to their surroundings in a farm house in Iowa (USA) for one month. During this period, they were fed alfalfa and brome-grass hay and one fourth pound of pelleted grain mixture consisting of 600 parts corn, 300 parts soyabean meal and 100 parts binder material. After acclimatization, the sheep were divided into two groups, viz., exposed and control group, consisting of 12 and 9 sheep,

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respectively. Pairing was done on the basis of their body weight and packed cell volume.

The exposed sheep were fed pellets containing 7050 ppm of fine powdered metallic lead at a rate of one fourth pound per sheep per day. Levels of lead fed to the sheep varied between 24 mg and 800 mg per sheep per day (Fig. 1). Daily dosage was adjusted so as to maintain a blood lead level of at least 0.4 ppm without producing death. The control sheep were also fed pellets at the same rate but without any lead. Sheep in both the groups were fed chopped alfalfa hay, twice a day, *ad libitum*.

Samples from the control group were obtained once a week for the first two weeks and once a month afterwards. Blood was drawn directly from the right or left external jugular vein, using 15 gauge stainless steel needle, and collected into heparinized test tubes.

The following analyses were made on the blood :

Blood lead. It was estimated by standard method (Hessel, 1968).

Other blood constituents. Red blood cell and white blood cell counts were made using a Coultar-counter*. On some occasions, this instrument was not functioning, consequently, determinations could not be made for those weeks. Packed cell volume determinations were done using microhematocrit technique. Haemoglobin values were determined using cyanmethemoglobin technique. Blood smears were stained with routine Wright's stain and washed with phosphate buffer.

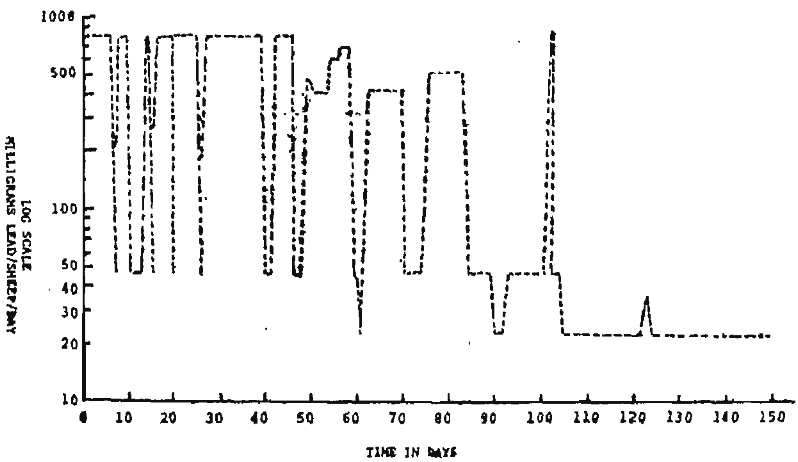

Fig. 1

The levels of lead fed to the exposed sheep varied between 24 mg and 800 mg per sheep per day for 164 days. Daily dosage of lead was varied to maintain a blood lead level of approximately 0.40 ppm without producing death. Blood and urine samples were collected from the exposed sheep every other day during the first week, twice weekly during the second week and once weekly thereafter.

*Coulter Electronics, Inc., Hialeah, Florida.

RESULTS AND DISCUSSION

Microscopic examination of blood smears from the exposed sheep revealed anisocytosis, piokilocytosis, hypochromasia, many immature red blood cells and numerous basophilic stippled cells (Fig. 2). The blood haemogram was normal in the unexposed sheep. Similar changes in erythrocytic morphology have been reported in cattle, dogs and human beings, chronically exposed to lead (Christian and Tryphonas, 1971; Zook *et al.*, 1969, 1972; Chisolm, 1971).

rapidly removed from the circulation by spleen (Aub *et al.*, 1925; McFadzean and Davis, 1949). However, Pirrie (1952) reported that lead produced haemotological changes primarily upon the red cell precursors in the bone narrow and that the resultant defective erythrocytes were removed from the circulation by the spleen and reticuloendothelal system in general. Consequently, both dyshaemopoisis and haemolysis appear to play a part in the production of anaemia in chronic lead poisoning.

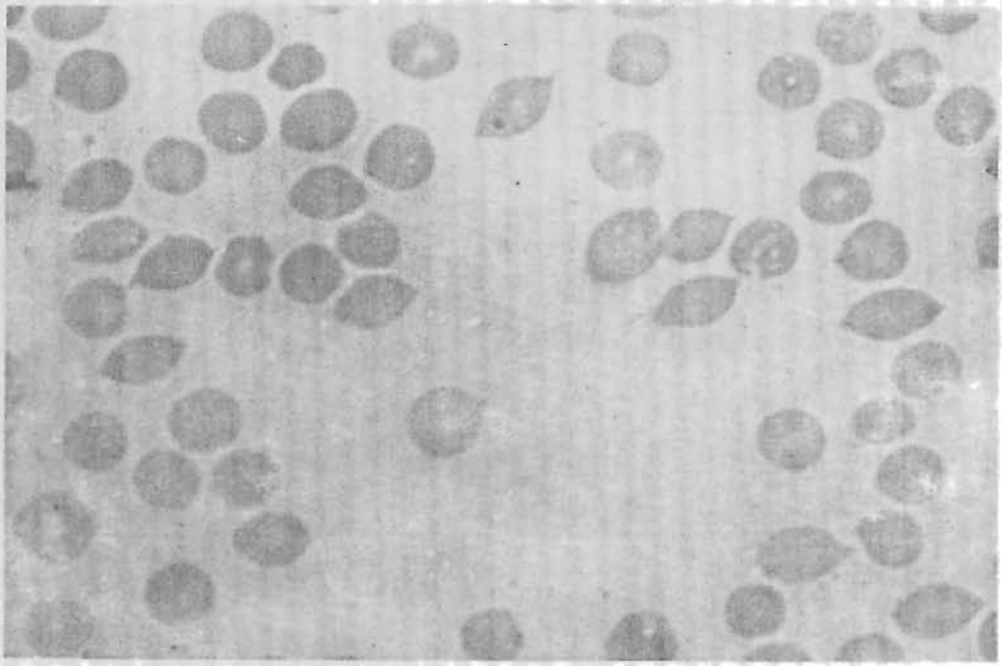

Fig. 2

Leikin and Eng (1963) reported that several mechanisms existed for the production of anaemia of lead poisoning and it also depended on the duration of intoxication. They further stated that lead appeared to affect blood and bone marrow.

In the early stages of lead poisoning, the erythrocytes are more fragile and are

A summary of changes in the morphology of red blood cells of exposed sheep is given in Table 1. Data summarized in this Table indicate that anisocytosis, poikilocytosis, immature red blood cells, and basophilic stippling reached highest between the 6th and 7th week of exposure, decreased with the reduction of dosage of lead in feed and disappeared during the later part of the experiment.

TABLE 1

Summary of changes in red blood cells of sheep exposed to lead

Days of exposure	Number of sheep with RBC changes			
	Anisocytosis	Poikilocytosis	Immature RBC	Basophilic stippling
1	0/12	0/12	0/12	0/12
3	1/12	0/12	0/12	0/12
5	1/12	0/12	0/12	0/12
8	2/12	0/12	0/12	0/12
11	4/12	0/12	3/12	0/12
16	6/12	4/12	3/12	1/12
23	7/12	5/12	4/12	4/12
31	11/12	8/12	6/12	6/12
38	11/12	8/12	6/12	6/12
45	10/12	9/12	7/12	6/12
52	9/12	6/12	6/12	6/12
59	10/12	8/12	4/12	7/12
66	9/11	9/12	6/12	4/12
73	9/11	8/11	6/11	6/12
80	9/10	8/11	5/11	6/11
87	7/10	7/11	5/11	6/11
94	5/9	5/10	3/11	7/11
101	5/9	3/9	0/9	4/9
108	3/8	3/8	0/8	2/8
115	3/8	2/8	0/8	0/8
122	0/8	0/8	0/8	0/8
129	0/8	0/8	0/8	0/8
136	0/8	0/8	0/8	0/8
143	0/8	0/8	0/8	0/8
150	0/8	0/8	0/8	0/8
157	0/8	0/8	0/8	0/8
164	0/8	0/8	0/8	0/8

This might either be due to reduced lead dosage or the development of resistance in the animals. However, very little information is available in the literature.

No significant differences were observed between the exposed and unexposed sheep for haemoglobin, packed cell volume, white blood cells and red blood cells (Table 2). Analysis of variance for differential leukocyte count revealed that the increased number of monocytes and neutrophils (bands) and decreased number of eosinophils were highly significant in the exposed sheep (Table 3). However, no significant differences were observed

TABLE 2

Analysis of variance for the studied parameters

	d.f.	MSB[a]	MSW[b]	$F=\frac{MSB^{c}}{MSW}$
Hemoglobin	1	0.0054	0.5040	0.0107
Packed cell volume	1	0.0430	2.7801	0.0155
White blood cells	1	512	295,974	0.0017
Red blood cells	1	0.1453	0.3873	0.3750
Blood lead	1	0.3929	0.0222	17.7042**
Urine lead	1	0.3823	0.0598	6.3906*
ALA	1	0.6703	0.0768	8.7251

[a]MSB = Mean square between groups.

[b]MSW = Mean square within, error term.

[c]Degrees of freedom for F are 1,20.

Table values for F are 4.35 at 5% and 8.10 at 1%.

**Significant at $P<0.01$.

*Significant at $P<0.05$.

TABLE 3

Analysis of variance table for differential white blood cell counts of control and exposed groups

Variable	d.f.	MSB[a]	MSW[b]	$F=\frac{MSB}{MSW}$
Eosinophils	1	526.20	17.4	30.24**
Monocytes	1	259.67	28.87	8.99**
Neutrophils-Band	1	261.92	18.66	14.04**
Neutrophils-Segs	1	183.88	213.01	0.86
Lymphocytes	1	67.94	183.48	0.37

[a]MSB = Mean square between groups.

[b]MSW = Mean square within, error term.

** = Significant at $P<.01$.

TABLE 4

Means, standard deviations, and variance of white blood cells of control and exposed groups

Variable	Number of observations	Mean (%)	Standard deviations	Variance	Published normal values
Eosinophils					
Control	56	7.98	5.22	27.19	4.5%(1-10)
Exposed	189	4.49	3.78	14.31	
Monocytes					
Control	56	1.13	1.58	2.50	2.5%(1-6)
Exposed	189	3.58	6.03	36.37	
Neutrophils-Bands					
Control	56	0.13	0.47	0.22	0.5%(0-2)
Exposed	189	2.59	4.90	23.92	
Neutrophils-Segs					
Control	56	35.42	13.88	192.53	30%(10-50)
Exposed	189	37.49	14.72	216.82	
Lymphocytes					
Control	56	52.86	14.83	220.05	62%(40-75)
Exposed	189	51.60	13.07	170.07	

in the number of neutrophils (segs) and lymphocytes. The mean percentage of eosinophils in the exposed group was significantly less than the control group ($<.01$), while the mean percentage of monocytes and neutrophils (bands) was significantly higher than that of the control group (Table 4). The importance of a slight but statistically significant decrease in eosinophils and a little but statistically significant increase in monocytes and neutrophils (bands) in lead poisoning is not understood at present. It can not be explained on the basis of the present study because of the large standard deviation and overlap between the two groups. Further studies are needed to clarify these findings.

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CYTOGENETIC STUDIES OF SOME LINUM SPECIES AND THEIR HYBRIDS

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ABSTRACT

Twelve species of *Linum*, each with a diploid chromosome number of 30, were used primarily with the object of assessing the possibility of transferring some desirable characters into the cultivated type. Meiotic behaviour of the hybrids was also studied. From *L. strictum*, *L. palliscence* and *L. perenne*, the genes for tillering, capsule number and dwarfing, respectively, could be transferred to the cultivated type. *L. hirsutum* was found to be the best of all the 12 species on the basis of index score analysis.

The hybrids were generally intermediate in performance, except that a few of them showed heterotic effect for tiller number and capsule number. Meiosis in the hybrids was normal and no chromosomal abnormalities were observed.

Linum usitatissimum L., commonly known as linseed or flax, is grown for oil as well as fibre. About 110 species have been listed under the genus *Linum*. At present, several improved varieties of linseed are available, mostly produced through selection and intervarietal hybridization. Many of the wild species of *Linum* possess several agronomically valuable attributes, such as, resistance to diseases and drought, winter hardiness and tillering etc. These may be very well exploited in breeding programmes.

The present study was undertaken to assess the possibility of transferring desirable characters from wild species of *Linum* into the cultivated type. Meiotic behaviour of the hybrids was also observed.

MATERIAL AND METHODS

The material for the present study consisted of 12 species and 13 interspecific hybrids mostly with the cultivated species, i. e., *L. usitatissimum*. The hybrids and the species were raised in the field, following a randomized block design with two replications. Each genotype was accommodated in 3 metre long single row plots spaced 45 cm apart. Observations on 10 randomly taken plants from each plot were recorded for days to flowering, plant height, tiller

TABLE 1

Analysis of variance of some characters in *Linum*.

Sources of variation	Degree of freedom	*Mean sum of squares*							
		Plant height	Days to flowering	Tiller number	Capsule number	Seeds per capsule	Capsule size	Seed yield	Pollen size
Replication	1	11.52	0.98	7.15	21120.84	0.50	0.29*	43.06*	0.01*
Treatment	24	281.99**	9.12**	5.43**	5358.03	0.89**	0.708**	23.11**	51.44**
Error	24	35.92	3.02	1.53	5854.82	0.45	0.05	6.30	0.002

* Significant at 5%

** Significant at 1%

TABLE 2

Average performance of some *Linum* species and their hybrids for different agronomic characters

S. No.	Genotype	Days to flowering	Plant height (cm)	Tiller No.	Capsule No.	Capsule size (mm)	Seed yield (g)	Seeds per cap.
1.	*L. usitatissimum*	98.0	54.5	5.4	266.8	7.0	16.6	8.4
2.	*L. anquatifolium*	99.9	70.9	8.2	241.3	7.5	10.6	8.3
3.	*L. cathorticum*	97.5	73.4	8.1	218.5	6.8	8.8	8.6
4.	*L. crepetans*	99.0	74.5	6.9	205.2	6.3	7.3	7.6
5.	*L. floccosum*	101.0	70.5	9.9	187.3	6.3	3.7	8.2
6.	*L. gallicum*	97.0	56.6	8.2	219.3	7.8	10.4	7.7
7.	*L. hirsutum*	97.5	51.2	6.7	283.9	7.8	12.5	7.8
8.	*L. lewissi*	98.0	47.1	8.4	265.0	7.0	11.3	8.2
9.	*L. pallescence*	97.5	57.4	6.3	293.1	7.6	13.8	7.4
10.	*L. perenne*	98.0	39.6	7.1	244.4	7.1	9.3	8.5
11.	*L. strictum*	102.5	47.4	11.5	282.9	5.8	5.9	7.8
12.	*L. tenue*	98.0	77.9	6.7	222.9	6.1	6.7	9.0
13.	*L. anqustifolium* × *L. usitatissimum*	100.0	73.7	6.5	154.6	7.3	7.3	8.2
14.	*L. cathorticum* × *L. usitatissimum*	99.9	77.7	7.4	205.4	7.2	8.1	7.5
15.	*L. crepetans* × *L. usitatissimum*	100.5	78.2	7.8	229.1	6.3	7.9	8.6
16.	*L. floccosum* × *L. usitatissimum*	104.0	71.7	10.0	264 6	6.3	7.8	7.8
17.	*L. gallicum* × *L. usitatissimum*	100.0	52.6	6.5	277.4	7.5	12.6	9.4
18.	*L. hirsutum* × *L. usitatissimum*	99.9	58.4	6.4	246.3	6.9	9.8	8.4
19.	*L. lewissi* × *L. usitatissimum*	100.5	61.0	6.0	225.8	7.0	10.9	8.5
20.	*L. pallescence* × *L. usitatissimum*	99.0	66.9	5.2	221.2	7.1	7.8	7.4
21.	*L. perenne* × *L. usitatissimum*	98.0	42.9	7.0	309.9	6.8	13.8	8.6
22.	*L. strictum* × *L. usitatissimum*	98.0	42.2	9.4	349.4	6.4	12.9	7.4
23.	*L. tennue* × *L. usitatissimum*	96.0	64.0	7.3	145.2	7.0	6.3	7.3
24.	*L. cathorticum* × *L. hirsutum*	101.5	59.0	9.5	176.6	6.7	4.8	6.2
25.	*L. strictum* × *L. lewissi*	105.0	58.3	10.2	136.2	6.2	2.7	7.7
	C. D. at 5% level	3.58	12.37	2.55	1.96	0.4615	5.18	1.38
	C. D. at 1% level	4.86	16.16	3.46	2.65	0.62	7.02	1.87

number, capsule number, capsule size, seed yield and seeds per capsule. Analysis of variance was done to test the significance between treatment means. The species and the hybrids were evaluated by index score analysis (Anderson, 1957). Cytology of the hybrids was studied by smearing technique.

RESULTS AND DISCUSSION

Significant genotypic differences were observed among the species and the hybrids for all the characters under study (Table 1). Mean performance (Table 2) revealed considerable diversity among the species for different characters, like, plant height, number of primary tillers, number of capsules and capsule size etc. None of the wild species was superior to the cultivated one with respect to capsule size, seed yield and, to certain extent, days to flowering. However, for the characters, like, plant height, tiller number and capsule number, many wild species performed better than the cultivated species. For example, all the species had more primary tillers, *L. hirsutum, L. palliscence* and *L. strictum* had more capsules and *L. hirsutum, L. lewissi, L. perenne* and *L. strictum* were shorter than the cultivated species. *L. hirsutum* was found to be the best performing species on the basis of index score analysis. Superiority of *L. strictum* over *L. usitatissimum* from the view point of number of tillers has also been indicated by Seetharam (1972). These species should, therefore, be given major emphasis in interspecific crossing programme aimed at improving the above mentioned characters.

Most hybrids were either intermediate between their respective parents or inferior to the better parent for majority of the characters. A few hybrids, however, performed even better than the best species for capsule number. These were *L. perenne* × *L. usitatissimum* and *L. strictum* × *L. usitatissimum*. Seetharam (1972) also reported intermediate performance of most interspecific hybrids with a few of them exhibiting hybrid vigour for characters, like, plant height and tiller number.

Microsporogenesis of the hybrids was fairly regular, showing 15 bivalents at diakinesis and their normal separation at anaphase I. No chromosomal abnormalities of any kind were noticed in any case. However, pollen sterility was of higher magnitude in the hybrids than in the species. This suggests that the sterility in the hybrids in genic rather than chromosomal. Obervations from this study further suggested that differentiation in these species, if any, occured at the genic level. Pachytene analysis which is very difficult in *Linum* due to very small chromosomes, perhaps, can supply more information on the similarities and differences among the genomes of the various species. Seetharam and Srinivasachar (1972) also reported similar results, though Gill and Yermanos (1967) found that speciation within n=15 group of *Linum* species proceeded through the mechanism of chromosomal reorganization.

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SHORT TERM CAPITAL AND CREDIT REQUIREMENTS OF THE SMALL FARMERS IN GURGAON DISTRICT

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ABSTRACT

With the introduction of high yielding varieties and due to continuously rising prices of farm products, the possibilities for farmers to improve the farm productivity and income have increased manifold. The resources owned by the farmers are meagre and inadequate to adopt improved agricultural practices and this problem is more serious in case of small farmers. They would not be able to adopt the new farm technology without borrowing additional funds. The study revealed that the supply of adequate working capital would increase income of the small farmers at existing technology. It would generate still more income with improved level of technology. The amount of credit advanced to small farmers was less as compared to their demand. Therefore, credit availability needs to be increased so as to enable the farmers to adopt optimum farm plan at improved level of technology.

With the introduction of high yielding varieties and intensive use of growth promoting farm inputs, the possibilities for farmers to improve the farm productivity and income has increased manifold. However, farmers owned resources are meagre and inadequate to adopt improved agricultural practices and other innovations. This problem is more serious in case of the small farmers who have been caught up in a vicious circle of low investment, low productivity and ultimately low farm incomes. It is, therefore, essential to supplement the capital needs of such farmers with credit which helps in acquiring modern inputs necessary for technological transformation. In fact, credit has become *sine-qua-non* in the strategy of agricultural development, specially for the small farmers. The present study was, therefore, undertaken with the following objectives :— (i) to study the capital and credit needs of the small farmers at the existing and improved levels of production technology, (ii) to find out the gap between the potential demand and existing supply of credit, and (iii) to analyse the impact of loan in promoting farm incomes in case of small farmers of Gurgaon district.

MATERIAL AND METHODS

Gurgaon district was purposively selected for this study because of the

SFDA project which is operating in this district. The district was divided into two groups, one group consisting of tehsils (Rewari[1], Gurgaon and Ballabgarh) in which the amount of credit taken by the small farmers was more than the average of the total credit (Rs. 44,32 lakhs) distributed during July 1971 to March 1973 in the district. The second group includes these tehsils (Palwal, Ferozepur-Jhirka and Nuh) where farmers had taken less credit than the district average. The three tehsils consisting of eight blocks were included in Group I, whereas the remaining three tehsils consisting of six blocks were included in Group II. From each of these groups one block was randomly selected for data collection. From these two selected blocks (Gurgaon from Group 1 and Palwal from Group II), four villages, two from each block (Daultabad and Jharra from Gurgaon and Ghori and Pirthala from Palwal) were again randomly selected. The list of the small farmers[2] in the selected villages was prepared and thirty per cent of small farmers from each village were selected with probability proportion to the size of the farm by Lahiri's method. Thus, for this study, 104 farmers were selected (49 from Group I and 55 from Group II) for the collection of primary data regarding farm inventory, cropping pattern, financial situation, farm assets and farm expenditure with the main emphasis on capital and credit requirements and their supply etc., pertaining to agriculture year 1972-73. Two synthetic farm situations were developed (one for each block) by pooling and averaging the data on existing resource use pattern and cropping pattern. These synthetic farm organizations were considered as representative farm for the respective groups.

Variable resource programming technique was used for developing the optimum farm plans at existing and improved level of technology[3].

Mathematical Model

The Programming Models used in this study for estimating the credit needs of the farmers can be stated symbolically. The predetermined data include the technical input-output coefficients a_{ij}, return over variable cost G_j, real activities x_j and resource levels b_i. The problem is to determine activity levels x_j such that;

$$\text{Maximize } Z = \sum_{j=1}^{n} Cj\, Xj$$

Subject to :

$$\sum_{i=1}^{m} \sum_{j=1}^{n} aij\ xij \gtreqless bi$$

$$xj \geqslant 0$$

Based on this model, normative production plans were worked out for each synthetic farm situation at existing and improved level of technology. All major crop enterprises of the zones followed under different rotations of one year du-

[1]Rewari tehsil has now been merged with the Mahendergarh district. However at the time of field investigations it was a part of Gurgaon district.

[2]A small farmer for this study was the one who has land between 2.5 to 7.5 acres. This criterian for defining the small farmers was also used by the SFDA.

[3]The existing technology means the production practices being adopted by the farmers, whereas improved technology means production practices recommended to the farmers by the District Extension Specialists on scientific basis to be adopted by the farmers.

ration and dairy were included in the matrices as real activities. For improved technology the input-output coefficients were obtained from the Package of Practices prepared by the Directorate of Extension Education, Haryana Agricultural University, Hissar. These recommendations were marginally modified in consultation with the District Extension Specialist (Farm Management) of the region. Resource restrictions were confined to land available (irrigated and unirrigated) irrigation water available during peak load periods of October-November, June-July and January-February, minimum green fodder and *bhusa* requirements.

RESULTS AND DISCUSSION

The results are discussed in the context of working capital requirement, capital available and short term credit requirement, their impact on farm income and the gap between potential demand and existing supply of credit.

Working capital requirements :

The working capital requirement for the whole farm as well as on per acre basis for different levels of technology are shown in Table 1. The working capital requirement at existing level of technology was more in Palwal block due to the higher average size of holding as compared to Gurgaon block. Further, the optimum crop plan with variable capital was also different in cropping pattern for Gurgaon and Palwal blocks. The drastic change in working capital requirement at improved level of technology was due to change in optimum crop plan dominated by the vegetable crops which were relatively more capital intensive in nature. The percentage increase in working capital requirement over existing capital use was 70.98 and 115.64 per cent at existing level of technology, whereas the increase at improved level of technology was 215.97 and 295.28 per cent in Gurgaon and Palwal blocks, respectively. The average increase with existing and improved level of technology was 92.45 and 260.03 per cent, respectively. These results will help the lending agencies in assessing the amount of working capital which the farmer would require to make the optimum utilization of the resources at existing and improved level of technology for obtaining the maximum profit.

The percentage increase over the owned working capital was 170.33 and 237.74 per cent at existing level of technology and with the improved technology it was 399.54 and 519.11 per cent in Gurgaon and Palwal blocks, respectively. This indicates the amount of additional capital which a farmer would require to adopt optimum plan at existing and improved levels of technology over his owned working capital.

Capital available

The foregoing analysis indicates that the capital requirements increased considerably in the optimal plans. How far these requirements could be met from owned funds is examined in Table 2 which shows that the quantity of short term capital available on the farm as a whole and on per acre basis at existing as well as at improved level of technology was more in Gurgaon block as compared to Palwal block. The share of owned working capital at existing level of technology was 36.99 per cent and 29.60 per cent in Gurgaon and Palwal blocks, respectively,

TABLE 1

Working capital requirements at different level of technology

Name of block	Total working capital requirements (Rs.)							
	Existing technology				Improved technology			
	Per farm	Per acre	Percentage increase over		Per farm	Per acre	Percentage increase over	
			Existing* working capital	Owned working capital			Existing working capital	Owned working capital
Gurgaon	1462.08	332.29	70.98	170.33	2701.80	614.04	215.97	399.54
Palwal	1520.56	332.00	115.64	237.74	2787.30	608.58	295.28	519.11
Average	1493.00	332.14	92.45	202.89	2747.01	611.25	260.03	457.30

* Existing working capital means capital being used for production purpose, i.e., owned working capital plus borrowed capital used for agriculture production.

TABLE 2

Availability of working capital

Name of block	Total working capital available (Rs.)							
	Owned working capital				Existing working capital used by the farmers (borrowed plus owned working capital)			
	Per farm	Per acre	Percentage of the total requirement at		Per farm	Per acre	Percentage of the total requirement at	
			Existing technology	Improved technology			Existing technology	Improved technology
Gurgaon	540.85	122.92	36.99	20.07	855.07	194.33	58.48	31.64
Palwal	450.21	98.29	29.60	16.15	705.13	153.93	46.37	25.29
Average	492.91	110.40	33.01	17.94	775.77	173.74	51.96	28.24

TABLE 3

Short term credit requirements at different levels of technology

Name of block	Short term credit requirements (Rs.)					
	Existing technology			Improved technology		
	Per farm	Per acre	Percentage of the owned working capital	Per farm	Per acre	Percentage of the owned working capital
Gurgaon	9 2.23	209.37	67.00	2160.95	491.12	79.98
Palwal	1070.35	233.71	70.39	2337.09	510.29	83.84
Average	1000.09	221.74	68.72	2254.10	500.85	82.05

TABLE 4

Effect of technology on income

Name of block	Income with existing technology and without borrowing (Rs.)		Income with improved technology and without borrowing (Rs.)		Increase in income due to improvement in technology (Rs.)		Percentage increase in income due to improvement in technology
	Per farm	Per acre	Per farm	Per acre	Per farm	Per acre	
Gurgaon	1014.47	230.56	1172.66	266.51	158.19	35.95	15.59
Palwal	755.43	164.94	975.65	213.02	220.23	48.08	29.15
Average	877.46	178.95	1068.47	217.21	191.01	38.26	21.76

TABLE

Effect of credit

Name of block	Income at existing technology without borrowing		Income at existing technology with borrowing		Increase in income due to borrowing at existing technology		Percentage increase in income due to borrowing of credit at existing technology
	Per farm	Per acre	Per farm	Per acre	Per farm	Per acre	
1	2	3	4	5	6	7	8
Gurgaon	1014.47	230.56	2585.50	587.61	1517.03	357.05	154.86
Palwal	755.43	164.94	2511.35	548.32	1755.92	383.38	230.43
Average	877.46	178.95	2546.28	567.57	1668.85	370.47	190.19

whereas at improved level of technology, the respective percentages were 20.07 and 16.15. Overall availability of the owned working capital was Rs. 492.91 per farm and Rs. 110.40 per acre. Thus the small farmers in the study area owned only 33.01 per cent of the total requirement at the existing level of technology. The situation further detriorated with the improved level of technology when the share of owned capital shrank down to 17.94 per cent of the total working capital requirements. This reflects that on the small farms there exists a huge gap between the owned working capital and requirements.

The situation slightly improved when owned and already borrowed working capital were considered together to adopt optimum farm plans at existing technology, the availability was 58.48 per cent and 46.37 per cent in Gurgaon and Palwal blocks, respectively. Whereas to adopt the optimum plans with the improved level of technology, the respective availability were 31.64 and 25.29 per cent in the Gurgaon and Palwal block. This was due to the reason that the farmers in Gurgaon block were already using more capital for agriculture as compared to Palwal block. The average working capital used by these small farmers of both the blocks was 51.96 per cent at the existing level of technology and 28.24 per cent with the improved level of technology, indicating a sizeable gap between the requirements and availability of the working capital. Thus the study revealed that the supply of the credit by the Small Farmers Development Agency to the small farmers was inadequate to meet the optimum working capital requirements.

Credit requirement

The percentage share of owned funds to total working capital was considerably inadequate in both the blocks at existing as well as improved level of technology. The magnitude of credit requirements in different blocks at different levels of technology are presented in Table 3. The percentage of credit requirement in proportion to the owned working capital at existing level of technology was 67.00

5

on income (Rs.)

Income at improved technology without borrowing		Income at improved technology with borrowing		Increase in income due to borrowing at improved technology		Percentage increase in income due to borrowing at improved technolo y
Per farm	Per acre	Per farm	Per acre	Per farm	Per acre	
9	10	11	12	13	14	15
1172.66	266.51	6958.84	1581.55	5786.18	1315.04	493.42
975.65	213.02	7186.82	1569.17	6211.17	1356.15	636.61
1068.47	217.21	7079.40	1576.23	6010.93	1358.02	562.57

and 70.39 per cent in Gurgaon and Palwal blocks, respectively, whereas at improved level of technology, the respective percentage was 79.98 and 83.84. This indicates that a farmer of the Gurgaon block requires 79.98 per cent more credit over his owned working capital to adopt improved technology as compared to 83.84 per cent in Palwal block. The overall credit requirements with the improved level of technology was 82.05 per cent.

Increase in farm income

The adoption of improved technology and the requirements of additional credit needs cannot be justified till its impact on the income of the farm is shown.

(a) **Effect of technology on income**

It has been estimated (Table 4) that the income from the optimum plan with the existing level of technology and without borrowing was Rs. 1014.47 at Gurgaon block as compared to Rs. 755.43 at Palwal block. The overall estimated income from the optimum plan was Rs. 877.46. With improved level of technology, the in come would be Rs. 1172.66 in Gurgaon block as against Rs. 1014.47 at existing technology per farm, thereby making an increase of Rs. 158.19 per farm. In Palwal block, the income with improved technology came out to be Rs. 975.65 as against Rs. 755.43 at existing level of technology making an increase in income by Rs. 220.23 per farm. The increase in income was 15.59 per cent in Gurgaon as compared to 29.15 per cent in Palwal. The study indicated that even without borrowing, farmers can increase income to the extent of 15 to 29 per cent by adopting the improved technology.

(b) **Effect of credit on income**

With the borrowing of working capital up to the optimum level, the income of the small farmers can further be increased. Table 5 shows the effect of credit on income at improved as well as at existing level of technology. At existing level of technology with borrowing per farm, the income would be Rs. 2585.50 in Gurgaon block, thereby making an increase in income by Rs. 1571.03 (154.86 per cent). In Palwal, the small farmers can increase income up to Rs. 1755.92 (230.43 per cent). The overall income of the small farmers without borrowing could be enhanced up to Rs. 1668.85 per farm or Rs. 370.47 per acre (190 per cent).

In case of adoption of improved technology and with borrowing the income would be Rs. 6958.84, thereby making an increase in income by Rs. 5786.18 (493.42 per cent) in Gurgaon block. In Palwal,the income can be increased up to Rs. 6211.17(636.61 per cent) by borrowing an additional amount. The percentage increase in income was more in Palwal as compared to Gurgaon at existing as well as with the improved level of technology. In aggregate the income of the small farmers can be increased up to Rs. 6010.93 per farm or Rs. 1358.02 per acre. This indicates that with the adoption of the improved technology alongwith the availability of the additional funds by the Small Farmers Development Agency, the financial position of these farmers could be improved significantly.

The study revealed that the farmers would need additional working capital for adoption of optimum plans at existing as well as improved level of technology. The income of the farmers could be increased with the adoption of improved technology, even without the borrowing of additional working capital. However, adequate supply of working capital would add to farm income considerably.

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STUDIES ON THE UTILIZATION OF SUGAR BEET LEAVES IN THE RATIONS OF SHEEP

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ABSTRACT

Nutritive value of three silages, namely, wilted sugar beet leaves (T_1), sugar beet leaves and lucerne (T_2) and sugar beet leaves, oat forage and urea (T_3) was compared with lucerne hay (control) by conducting a four-week feeding trial with adult sheep. The average voluntary dry matter consumption per 100 kg body weight was 3.61, 3.84, 2.38 and 4.10 kg for T_1, T_2, T_3 and control rations, respectively. The DCP and TDN contents in respect of above treatments were 6.00 and 58.23; 7.83 and 63.07; 5.99 and 61.88; and 8.79 and 61.25 per 100 kg dry matter, respectively. The animals were in positive nitrogen balance in all the four treatments. While the calcium balance was in the negative for control only, the calcium and phosphorus balances were positive in other treatments. The animals of all the groups except those in T_3 maintained their body weight.

There is an acute shortage of feeds and fodders for the large livestock population in this country. In view of such a difficult situation it is being realised that an improvement in the supply position could be brought about by greater and judicious utilization of agro-industrial waste and byproducts. A good quantity of sugar beet leaves is now available as a result of increased sugar beet production in various parts of the country. These leaves have no economic use. Preliminary studies at this university on feeding fresh sugar beet leaves did not show encouraging results due to their high moisture content and low palatability. Increasing the dry matter content and palatability by various treatments, such as wilting, mixing with good quality forages and then ensiling could lead to better utilization of these leaves as reported earlier in other cases by Lal and Mudgal (1967), Narang and Pradhan (1973, 1974) and Gupta (1974).

A trial was, therefore, planned to study the feeding value of silages prepared from sugar beet leaves either alone or in combination with good quality forages.

MATERIAL AND METHODS

Three different silages were prepared by making use of sugar beet leaves. The silages comprised wilted sugar beet leaves (T_1); sugar beet leaves and lucerne in equal parts (T_2) and sugar beet leaves and oat forage in equal parts in which urea was added @ 1 kg/q of the mixture. The lucerne, oat and sugar beet leaves were harvested and wilted for one day. Later on, these were chaffed and filled in kacha pits. Plastic sheets were spread on the bottom and the walls in order to prevent seepage and air contact. The top of the silo pit was properly sealed. The silos were opened after 75 days and the pH was recorded. The nutritive value of these silages was compared with lucerne hay (control) by conducting a four-week feeding trial with sheep.

Sixteen adult sheep were divided in four groups of four animals each, on the basis of their body weights. These groups were then randomly alloted to one of the four experimental rations. A metabolic study with five days of collection period was also conducted after a feeding trial of 25 days. Metabolic cages were used for the collection of urine and faeces separately. The chemical composition of feed, faeces and urine samples was determined according to the procedure recommended by A.O.A.C. (1970). The energy value of feed and faeces samples was determined by using adiabatic bomb calorimeter. The procedure for determining *in vitro* dry matter digestibility was the same as reported by Gupta and Pradhan (1973). The experimental data were statistically analysed (Snedecor, 1967).

RESULTS AND DISCUSSION

The proximate composition in per cent of dry matter with respect to lucerne, oat and sugar beet leaves, respectively, for CP was 13.56, 7.40 and 10.06; CF 28.45, 29.74 and 7.10; EE 7.60, 4.06 and 10.85; NFE 39.75, 49.30 and 31.79; ash 10.60, 9.50 and 20.00. The chemical composition of different rarions is presented in Table 1. The crude protein content of

TABLE 1

Chemical composition of different experimental rations

Treatments	Dry matter	Crude protein	Ether extract	Crude fiber	Nitrogen free extract	Total ash	Insoluble ash	Ca	P
		Kg/100 kg DM							
T_1	29.70	8.97	8.00	22.30	27.23	33.00	18.10	2.18	0.49
T_2	26.40	11.81	7.40	26.80	32.89	21.10	8.61	2.54	0.41
T_3	33.40	10.06	9.00	27.80	33.04	20.10	11.74	1.58	0.29
Control	90.40	13.56	7.60	28.45	39.75	10.60	1.80	1.22	0.17

TABLE 2

Body weight gain and feed consumption of sheep

Treatment	Body weight gain kg/wk	Dry matter intake kg/day/animal	% of body wt.	g/kg W 0.75
T_1	+0.27	1.01	3.61±0.37	84.16
T_2	+0.43	1.12	3.84±0.36	87.36
T_3	−0.07	0.66	2.38±0.41	55.00
Control	+1.03	1.06	4.10±0.26	94.81

TABLE 3

Average digestibility coefficients of mutrients in different treatments

Treatments	Digestion coefficients							
	Dry matter	Crude protein	Ether extract	Crude fibre	Nitrogen free extract	Organic matter	ENERGY	IVDMD
T_1	75.25±3.36	66.94±3.38	80.6 ±4.39	78.86±3.36	72.96±4.00	77.50±3.55	74.61±1.20	81.10±2.19
T_2	70.32±1.28	66.29±5.73	61.92±1.22	74.55±2.50	75.89±0.76	72.66±1 41	72.16±1.61	77.40±1.72
T_3	62.55±2.36	59.57±4.44	71.65±3.70	78.69±2.87	59.02±6.15	68.45±0.81	74 30±1.75	70.14±1.10
Control	59.99±2.32	64.77±4.16	55.95±3.50	66.63±4.71	60.21±4.57	62.82±2.58	57.50±2.10	69.24±0.84

different rations varied from 8.97 (T_1) to 13,56 per cent (control). The total ash content varied from 10.60 (control) to 33.00 per cent (T_1). The higher ash content in T_1, i.e. 33.00 per cent may be due to higher amount of insoluble ash of sugar beet leaves contaminated with soil. The pH was 4.4, 4.9 and 5.2 in T_1, T_2 and T_3 silage samples, respectively. The average dry matter consumption (kg) per 100 kg body weight was 3.61, 3 84, 2.38 and 4.10 in T_1, T_2, T_3 and control, respectively (Table 2). The dry matter consumption was significantly different ($P \angle 0.05$) and was highest in control, followed by T_2, T_1 and T_3. The average gain in body weight was 0.8, 1.3 and 3.1 kg in T_1, T_2 and control rations, while the animals receiving ration T_3 lost 0.2 kg of body weight during the experimental period. The lower dry matter consumption of T_3 ration may perhaps be due to the poor palatability, which also resulted in the body weight losses in the group.

The digestibility coefficient of dry matter, crude protein, ether extract, crude fibre, nitrogen free extract, organic matter, energy and *in vitro* dry matter digestibility (IVDMD) are given in Table 3. The dry matter digestibility coefficients in treatment T_1, T_2, T_3 and control were 75.25, 70.32, 62.55 and 59.99 per cent, respectively. The corresponding *in vitro* values were 81.10, 77.40, 70.14 and 69.24 per cent, respectively. The trend of dry matter digestibility conducted by *in vitro* and *in vivo* methods was the same. It is interesting to note that in spite of higher amounts of insoluble ash in all the three sugar beet silages (T_1, T_2 and T_3), the dry matter digestibility was higher than the control, (lucerne hay). This clearly indicates that silica content of the ration was not phytolithic and was from external contamination which did not interfere with silage digestibility. The dry matter digestibility was significantly different among the different treatments.

TABLE 4

Average balances of nitrogen, calcium and phosphorus

Treatments	Average daily intake (g)	Average daily outgo (g)	Balance (g)
		Nitrogen	
T_1	17.0	8.6	+ 8.4
T_2	17.7	15.3	+ 2.4
T_3	12.0	9.0	+ 3.0
Control	25.3	14.8	+10.5
		Calcium	
T_1	28.9	6.9	+22.0
T_2	25.4	11.1	+14.3
T_3	14.9	9.9	+ 5.0
Control	10.4	16.6	− 6.2
		Phosphorus	
T_1	6.6	1.1	+ 5.5
T_2	4.3	2.0	+ 2.3
T_3	2.1	1.6	+ 0.5
Control	1.4	1.4	+ 0.0

The average percentage of DCP and TDN contents with respect to T_1, T_2, T_3 and control were 6.00, 7.83, 5.99 and 8.79; and 58.23, 63.07, 61.88 and 61.25, respectively. The DCP content was found significantly different ($P \angle 0.05$) due to treatments, whereas the TDN values were not statistically significant.

The balances of nitrogen, calcium and phosphorus have been presented in Table 4. The animals showed positive balance for nitrogen in all the treatments, the highest being in the control. The balance for phosphorus was positive in treatments T_1, T_2 and T_3, while it was at equilibrium in case of control ration. The balance for calcium was positive in treatments T_1, T_2 and T_3, while the control showed negative calcium balance.

It was thus found that the wilted sugar beet leaves alone and in combination with lucerne formed a good silage for the maintenance of sheep. The nutritive value of these silages was comparable to that of lucerne hay.

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FACTORS AFFECTING MILK YIELD AND PEAK YIELD IN THARPARKAR HERD

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ABSTRACT

Three hundred and thirty nine records on Tharparkar cows, maintained at Government Cattle Breeding Farm Chandenwell, Rajasthan, for the period 1967-74, were used for the present study. The average milk yield and peak yield obtained were as 1456.80 ± 55.83 kg and 7.85 ± 0.24 kg, respectively. The parity and period effects were found to be significant ($P \angle 0.01$) for peak yield, whereas the season had no effect. Milk yield was found to be influenced significantly ($P \angle 0.01$) by parity only. Hence, the order of lactation and peak yield should be given due weightage in selection for higher milk yield.

The milk yield and peak yield are complex biological processes influenced both by genetic and nongenetic factors. But once the genotype of an animal is established its expression depends upon the influence of several nongenetic factors. Accordingly, in the present study an attempt has been made to investigate the influence of some nongenetic factors affecting peak yield and milk yield in Tharparkar cattle. The scope of the study was further extended to establish what kind of association existed between these traits.

MATERIAL AND METHODS

The data on 339 records of milk yield and peak yield of Tharparkar cows, maintained at Government cattle Breeding Farm, Chandenwell, Rajasthan, for the period 1967-74, were classified into four periods, each comprising two consecutive years, and each year was further subdivided into three seasons, namely, winter (November to February), summer (March to June) and monsoon (July to October) and up to eight calving according to the parity order. The first parity was not included because the herd was purchased one. The data were analysed by the method described by Snedecor (1968). Milk yield in a lactation was taken as the total yield in 305 days. Necessary adjustment was made for lactation length extending more than this and falling shorter than this by using following formula, practised at Military Farm and used by Shri Ram (1974) :

$$SLP = LY - \left(\frac{LD - 305 \times A.V.}{LD} + \frac{A.V.}{3}\right)$$

LD−305

TABLE 1

Means with standard errors and coefficients of variation of the milk yield and peak yield of Tharparkar cattle

Classification	Milk Yield Obs.	Mean		SE	CV	Peak Yield Obs.	Mean		SE	CV
P_2	29	1374.16^b	±	104.97	41.10	25	7.34^a	±	0.32	22.07
P_3	55	1500.51^a	±	77.28	37.85	49	7.81^a	±	0.22	19.97
P_4	72	1571.64^a	±	59.95	32.36	76	8.15^a	±	0.17	18.65
P_5	64	1575.91^a	±	62.45	31.73	65	8.32^a	±	0.53	51.08
P_6	61	1375.30^b	±	79.63	48.77	59	8.14^a	±	0.33	30.71
P_7	38	1395.96^b	±	73.76	32.57	36	7.96^a	±	0.41	30.77
P_8	20	1208.25^c	±	11.35	6.45	29	5.73^b	±	0.67	63.00
Seasons										
S_1	115	1476.88^a	±	44.40	30.16	113	7.46^a	±	0.36	51.74
S_2	126	1435.69^a	±	72.04	56.32	127	8.00^a	±	0.21	29.50
S_3	98	1457.82^a	±	51.04	34.88	99	8.10^a	±	0.16	20.00
Periods										
a_1	108	1423.14^a	±	81.39	59.44	99	7.57^a	±	0.18	23.64
a_2	121	1546.34^a	±	53.71	38.20	126	7.97^a	±	0.14	19.82
a_3	94	1465.75^a	±	40.71	26.96	94	8.68^a	±	0.17	45.50
a_4	16	1154.75^b	±	103.50	32.31	20	4.55^b	±	0.80	78.46
Overall										
	339	1456.80		55.83	32.96	339	7.85	±	0.24	69.00

The observations superscripted by different letters differed significantly from each other ($P \angle 0.05$).

where, SLP=standard lactation production for 305 days

LY=total lactation yield

LD=Lactation period in days

A.V.=Average daily yield during lactation

Peak yield was taken as maximum yield of a day in a lactation.

RESULTS AND DISCUSSION

The means of milk yield and peak yield with their coefficient of variation are presented parity-wise, season-wise and period-wise in Table 1 and the results of analysis of variance are given in Table 2.

Effect of parity

Parity had significant ($P \angle 0.01$) effect on both milk yield and peak yield. The relative contributions of parity to total variability in these traits were 5.10 and 6.25 per cent, respectively. This means that the order of lactation should be given due weightage while selecting the animal for milk production. A linear rising trend in milk yield and peak yield up to 5th parity and after that a declining trend was noticed (Table 1). Nagpaul and Bhatnagar (1972) also reported significant effects of parity on milk yield.

The milk yield and peak yield were of the highest order in 5th lactation and lowest in 8th lactation and they differed significantly from each other.

No significant differences were observed between milk yield of 3rd, 4th and 5th lactation and similar was the case with 2nd, 6th and 7th, while the former group differed significantly from the latter. It may be infered that the Tharparkar cows attained their physiological maturity during 3rd to 5th sequence of calving. This is also supported by the results of Chhikara (1974) who reported that the maximum milk yield occurred during the 4th lactation in this breed. Significant differences were noted between the peak yield of 8th parity and the remaining ones.

Seasons

Season had no significant effect on milk yield and peak yield suggesting that feeding and management conditions re-

TABLE 2

Analysis of variance for milk yield and peak yield of Tharparkar cows

Source	d. f.	Milk yield		Peak yield	
		M. S. (kg)	R^2 (%)	M. S. (kg)	R^2 (%)
Among periods	3	745181.00	1.70	40.05**	4.56
Among seasons	2	372360.50	0.56	13.19	1.01
Among parity	6	1113185051**	5.10	27.38**	6.25
Error	327	371725.40		7.08	

**$P \angle 0.01$

mained practically the same throughout the year. The coefficient of determinations were 0.56 and 1.01 per cent in the same order. Singh and Dutt (1963) obtained similar results in Sahiwal cattle.

Periods

Highly significant effect ($P < 0.01$) of period was observed in peak yield only, and this source contributed 1.7 and 4.56 per cent to total variability in milk yield and peak yield, respectively. The means pertaining to different periods revealed that only the fourth period differed significantly from other periods for the two traits. Gill and Balaine (1971) and Shri Ram (1974) reported significant effects of periods on milk yield and peak yield in Haryana and Friesian Sahiwal crosses, respectively.

The overall means for milk yield and peak yield were 1456.30 ± 55.83 kg and 7.85 ± 0.24 kg, respectively. The results are in agreement with the results obtained by Singh and Choudhary (1961). But Sundaresan *et al.* (1965) and Bhatnagar *et al.* (1966), however, reported higher values for this breed.

Correlation and regression coefficients

The correlation between milk yield and peak yield was observed to be 0.49 ± 0.06, indicating a positive association between these traits. It means that earlier selection for higher milk yield may be possible on the basis of peak yield. The regression of milk yield on peak yield was found to be 82.01 kg. This indicated that the per unit increase in peak yield could result in increase in milk yield by 82.01 kg, which seems to be a substantial improvement. These findings are in close conformity with those reported by Singh and Desai (1961) in Haryana cows.

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THE EFFECT OF FEEDING LUCERNE MEAL IN THE DIET ON THE PERFORMANCE AND CARCASS QUALITY OF GROWING PIGS

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ABSTRACT

An experiment was conducted with 18 growing middle White Yorkshire pigs to determine the effect of including lucerne meal in the diet on their growth, feed efficiency and carcass quality. Two levels of lucerne meal (5 and 10 per cent of the diet) were used. The average daily gain of pigs fed 5 and 10 per cent lucerne meal in the diet increased by 20 and 30 per cent, respectively, as compared to those fed the control diet.

The carcass characteristics indicating muscling (lean cut per cent, *longissimus dorsi* area, ham+loin per cent and quality scores of marbling and firmness) increased and those indicating fat in the carcass (average back fat thickness) decreased when 10 per cent lucerne meal was incorporated in the diet. The carcasses of these pigs were, thus, of a better quality than of those fed the control diet. 5 per cent lucerne meal in the diet did not produce a marked effect on carcass traits, except on average back fat thickness and firmness score.

Selected parts of the carcasses of lucerne groups showed a significant increase in the protein content of muscles and a decrease in the fat content. The effect of inclusion of lucerne meal in the diet on the development of the digestive tract and the organs is also reported.

Lucerne meal is a good source of protein and vitamins (Crampton and Harris, 1969). The beneficial effect of lucerne meal on the productivity of pigs are already established (Cunha, 1957). Tusanova and Bavan (1968) also carried out work on the effect of lucerne meal on the productivity of pigs and poultry. The influence of lucerne meal on growth and carcass quality, however, needs further investigation. The present study was, therefore, undertaken to find the effect of feeding lucerne meal in the diet on the performance and carcass quality of growing pigs.

MATERIAL AND METHODS

Eighteen middle White Yorkshire pigs, each about 14 kg in body weight, were used in the study. The pigs were allotted to the teatments at random using a completely randomized design and were kept in groups in 2.70 × 2.35 m pens with cemented floors. Each pen provided 6.88 m^2 of floor space and housed six pigs. All pigs were fed *ad lib* in mangers. The feed was offered at 8 A. M. and 4 P. M. daily. A watering trough was provided in each pen.

The per cent composition of the diets is presented in Table 1. The treatments consisted of the following diets :

A=is 16 per cent C.P. maize-GNC-FM diet (control)

B=Control with 5 per cent lucerne meal in the diet.

C=Control with 10 per cent lucerne meal in the diet.

Information regarding amino acid, calcium and phosphorus contents of feeds was obtained from the reports of NAS-NRC (1968) and Aykroyd (1966). The green lucerne used for preparing the meal was cut at the pre-bloom stage in the second cutting. Each diet was mixed in adequate amounts prior to the start of the experiment. Feed consumption and body weight gains were recorded every 7 days.

The pigs were slaughtered after being kept on the experimental diets for 77 days when they reached about 50 kg in body weight. The slaughtering and cutting procedure was the same as recommended by U. S. Department of

TABLE 1

Percentage composition of experimental diets

Ingredient[a]	Diet identification		
	A	B	C
Ground yellow maize	71.75	68.90	65.80
Groundnut cake	16.75	14.70	12.90
Fish meal	10.00	10.00	10.00
Lucerne meal	—	5.00	10.00
Ground limestone	0.40	0.40	0.40
Mindiff 'Boots'[b]	0.50	0.50	0.50
Common salt	0.50	0.50	0.50
Vit. mixture[c]	0.10	0.10	0.10
C. P. (%)	16.06	16.02	16.02
C. F. (%)	3.90	4.90	5.91

a Maize, groundnut cake, fish meal and lucerne meal contained 9.8, 31.1, 38 2 and 17.5 per cent, C. P., respectively.

b Mindiff contained 25 per cent calcium, 9 per cent phosphorus, 30 per cent sodium chloride, 0.5 per cent iron, 0.05 per cent potassium iodide, 0.08 per cent copper, 0.10 per cent manganese, 0.15 per cent cobalt and 0.15 per cent sulphur.

c Each 100 g of vitamin mixture contained 30 g Rovibe (Vit. B_1 4 mg; B_6 8 mg; B_{12} 40 mcg; niacine 60 mg; calcium pantothionate 40 mg and vit. E 40 mg per supplement; 30 g Rovimix (Vit. A 40,000 I. U., vit B_2 25 mg and vit D_3 6000 I. U. per g of supplement) and 40 g APF vit B_{12} supplement.

Agriculture (1970). Lean cut per cent was obtained from the weights of lean cuts (ham, shoulder and loin). Dressing percentage was calculated from the hot carcass weight. The quality scores of 1 through 5 were obtained for colour, firmness and marbling of the *longissimus dorsi* muscle cut at the 10th rib as reported by Sharda *et al.* (1972).

Immediately after slaughter, portions of *longissimus dorsi* and ham muscles were wrapped in plastic bags and placed in a freezer. The frozen samples were analysed for moisture, ether extract and protein according to the procedures outlined by the AOAC (1970). Ash was determined by substraction.

Data were analysed statistically by analysis of covariance. The critical difference as described by Steel and Torrie (1960) was used for mean separation.

RESULTS AND DISCUSSION

The performance of pigs fed lucerne meal in the diets is shown in Table 2. The average daily gain of pigs (ADG) fed 5 and 10 per cent lucerne meal in the diet was better than of those fed the control diet. The increase in ADG by 24 and 30 per cent, by the pigs fed 5 and 10 per cent lucerne meal in the diet, respectively, over those fed the control diet was significant ($P \angle 0.01$). The efficiency of gain as represented by gain/feed and feed/gain ratios, however, was not different for the pigs fed the different diets. There was no difference for these traits between the pigs fed 5 and 10 per cent lucerne meal in the diet. These results do not agree with those reported by Delic and Zdvavkovic (1964), Delic *et al.* (1964) and Syrinek (1970) who reported a depression of growth during early stages. Cunha (1957), however, reported that level could be raised to 10 per cent without affecting the rate of gain or efficiency of fed utilization. The better performance of pigs fed lucerne meal in terms of average daily gain in the present study might be due to better quality of protein provided by lucerne meal prepared at the prebloom stage in the second cutting.

The effect of inclusion of lucerne meal in the diet on the carcass characteristics in shown in Table 3.

The inclusion of lucerne meal in the diet proved beneficial in terms of reducing

TABLE 2

Performance of pigs fed diets containing lucerne meal

Item	Diet identification			
	A	B	C	SE
Av. initial weight (kg)	14.4	15.0	14.1	
Av. final weight (kg)	42.7	50.0	50.8	
Av. daily gain (g)	367^{a}	454^{b}	477^{b}	28
Av. daily feed consumed (kg)	1.32	1.51	1.64	
Gain/Feed	0.278^{a}	0.361^{a}	0.290^{a}	0.02
Feed/Gain	3.63^{a}	3.52	3.53	0.21

a, b Means with the same letters do not differ significantly ($P \angle 0.01$)

TABLE 3

Effect of inclusion of lucerne meal in the diet on the carcass characteristics of pigs

Item	Diet identification			SE
	A	B	C	
No. of carcasses	5	6	6	
Dressing percentage	66.5^{a}	66.7^{a}	69.0^{b}	0.49
Av. back fat thickness (cm)	2.77^{a}	2.29^{b}	2.03^{c}	0.07
Av. length (cm)	58.6^{a}	61.2^{a}	63.9^{b}	1.36
L. D. Area (cm^2)	20.5^{a}	21.8^{a}	24.1^{b}	0.55
Lean cut per cent	61.0^{a}	61.5^{a}	63.5^{b}	0.46
Ham+Loin per cent	44.8^{a}	45.2^{a}	46.7^{b}	0.47
Colour Score	2.33_{a}	2.41^{a}	2.50^{a}	0.09
Marbling score	2.83^{a}	2.67^{a}	2.59^{b}	0.06
Firmness score	3.00^{a}	2.59^{b}	2.50^{b}	0.08

a, b, c Means with the same letters do not differ significantly ($P \angle 0.01$)

fat and increasing the total muscle in the carcass as indicated by the traits studied. The average back fat thickness decreased by 17.3 and 26.7 per cent in the pigs fed 5 and 10 per cent lucerne meal diets, respectively, as compared to those fed the control diet. Further it was observed that the trait decreased by 11.3 per cent in the pigs fed 10 per cent lucerne meal as compared to those fed 5 per cent. The differences among the treatment means were found to be statistically significant ($P \angle 0.01$). The carcass length and dressing percentage were larger for the pigs fed 10 per cent lucerne meal in the diet as compared to those fed the control diet and diet containing 5 per cent lucerne meal. The *longissimus dorsi* area, the lean cut per cent, the ham+loin per cent and the quality scores of marbling and firmness were significantly larger for the pigs fed 10 per cent lucerne meal in the diet as compared to those fed the control diet ($P \angle 0.01$). The inclusion of 5 per cent lucerne meal in the diet had no affect on these traits.

The composition of *longissimus dorsi* and ham muscles from the pigs fed the experimental diets are presented in Table 4. The *longissimus dorsi* and ham muscles of the pigs fed 5 and 10 per cent lucerne meal in the diet contained higher amount of protein than of those fed the control diet ($P \angle 0.01$). The ether extract content of lucerne fed pigs was smaller than of those fed the control diet ($P \angle 0.01$). The water and ash content were not affected by the different treatments.

These findings about the improvement in the carcass quality of pigs fed lucerne meal agree with those reported by Cunha (1957). Syrinek (1970) reported no deleterious effect on the carcass quality as a result of feeding lucerne meal.

The pigs fed 10 per cent lucerne meal in the diet showed a larger weight (ex-

TABLE 4

Effect of inclusion of lucerne meal in the diet on the proximate composition of selected parts of the carcass

Item	Diet identification			
	A	B	C	SE
L. D. Muscle				
Moisture (%)	73.3^{a}	72.4^{a}	72.2^{a}	0.45
Protein (%)	18.6^{a}	20.5^{b}	20.7^{b}	0.28
Ether extract (%)	6.1^{a}	5.1^{b}	5.0^{b}	0.19
Ash (%)	2.0_{1}	$2,0^{a}$	2.1^{a}	0.05
Ham Muscle				
Moisture (%)	71.7^{a}	71.4^{a}	71.4^{a}	0.27
Protein (%)	18.6^{a}	20.7^{b}	20.9^{b}	0.15
Ether estract (%)	8.1^{a}	6.1^{b}	6.1^{b}	0.11
Ash (%)	$1,6^{a}$	1.8^{a}	1.6^{a}	0.05

a, b Means with the same letters do not differ significantly (P∠0.01)

TABLE 5

Effect of lucerne meal in the diet on the growth of gastro-intestinal tract and organs in growing pigs

Item*	Diet identification			
	A	B	C	SE
G. I. Tract	13.62^{a}	13.63^{a}	14.94^{b}	.450
Heart	0.286^{a}	0.296^{a}	0.293^{a}	.005
Liver	2.160^{a}	2.500^{b}	2.180^{a}	.050
Spleen	0.183^{a}	0.164^{a}	0.148^{b}	.008
Kidneys	0.351^{a}	$0,296^{b}$	0.321^{b}	.006
Lungs+bronchii	1.036^{a}	0.887^{b}	0.845^{b}	.042

* Expressed as a per cent of the kill weight.

a,b *Means with the same letters do not differ significantly* (P∠0.01)

pressed as a per cent of the kill weight) of the gastrointestinal tract as compared to those fed the control diet (P∠0.01). This indicated an adjustability of the tract to an increase in the fibre content of the diet. 5 per cent lucerne meal in the diet had no effect on this trait. This finding agrees with the observations of Krasnoscekij (1969) that the development of large intestine and stomach with different treatments was different. The liver was larger in the pigs fed 5 per cent lucerne meal than in those fed the control and 10 per cent lucerne meal diets. The pigs fed 10 per cent lucerne meal had smaller spleen than those subjected to the other two treatments. The lung+bronchii were smaller in pigs fed 5 and 10 per cent lucerne meal than in those fed the control diet ($P \angle 0.05$). To explain these results, further investigations on the effect of lucerne meal feeding on the development of organs are needed.

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PITCHER FARMING OF VEGETABLES UNDER DRYLANDS A NEW DIMENSION IN WATER HARVESTING

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Run off water is potentially an important water resource in arid region. Special techniques of collection and utilization of runoff are required in order to make the best possible use of it. Two practical problems associated with successful runoff utilization are (i) methods of run off inducement in order to increase water yield, and (ii) methods of collection, conveyance, and agricultural utilization of the water. The best technique to tide over these situations and to utilize the land properly would be to collect the run off water of a small plot in a pitcher and raise those vegetables which require some area for spreading around the pitcher. The pitcher acts as a storage tank and water conveyance channels. With this idea, the experiment was conducted under dry farming situation at the Haryana Agricultural University, Hissar.

The land was divided into 2 m×2 m plots. Each side of the plot was given 3 per cent slope towards its centre. A pit, 40 cm wide and 45 cm deep, was dug at its centre and a pitcher of a capacity of about 24 litres and with a mouth diameter of 15 cm was embedded in the pit with its mouth just touching the surface. The remaining area of the pit was filled with the soil mixed with 2 Kg of FYM (farm yard manure) and 50 gm of *Kisan Khad*. The remaining area of the plot was compacted. The mouth of pitcher was kept covered with polythene to check evaporation of water. The vegetables were sown (6-8 seeds) at equal distance along a circle of redius 15 cm from the pitcher.

For this system, every mm of effective rain added 3 litres of water to the pitcher and it took about 10-12 mm rain to fill it completely. Once it was filled, it took 12-15 days to leak all of its water. The moisture content of the soil profile around the pitcher at a distance of 30 and 60 cm at different days after complete filling of the pitcher is reported in Table 1.

It is evident from Table 1 that even after 14 days of filling the pitcher it maintained 12.8 per cent of moisture (on volume basis) at a distance of 30 cm and 10.0 per cent of moisture at a distance of 60 cm from the pitcher This moisture was sufficient to maintain a favourable water balance for vegetables

TABLE 1

Moisture profile around the pitcher after 3 and 14 days of filling the pitcher*

Depth cm	Moisture (mm) at a distance of 30 cm from the centre		Moisture (mm) at a distance of 60 cm from the centre	
	After 3 days	After 14 days	After 3 days	After 14 days
0-15	27.2	15.7	21.8	13.3
15-30	28.3	18.4	20.0	14.4
30-60	54.0	42.7	41.8	32.4
Total	109.5	76.8	83.6	60.1

*There was no rain during this period.

for a period of 15-20 days. Dry spells of this period are commonly observed under dryland situation. This technique thus helps in overcoming adverse effect of such dry spells.

The yield of different vegetables grown during *kharif*, 1975, is reported in Table 2.

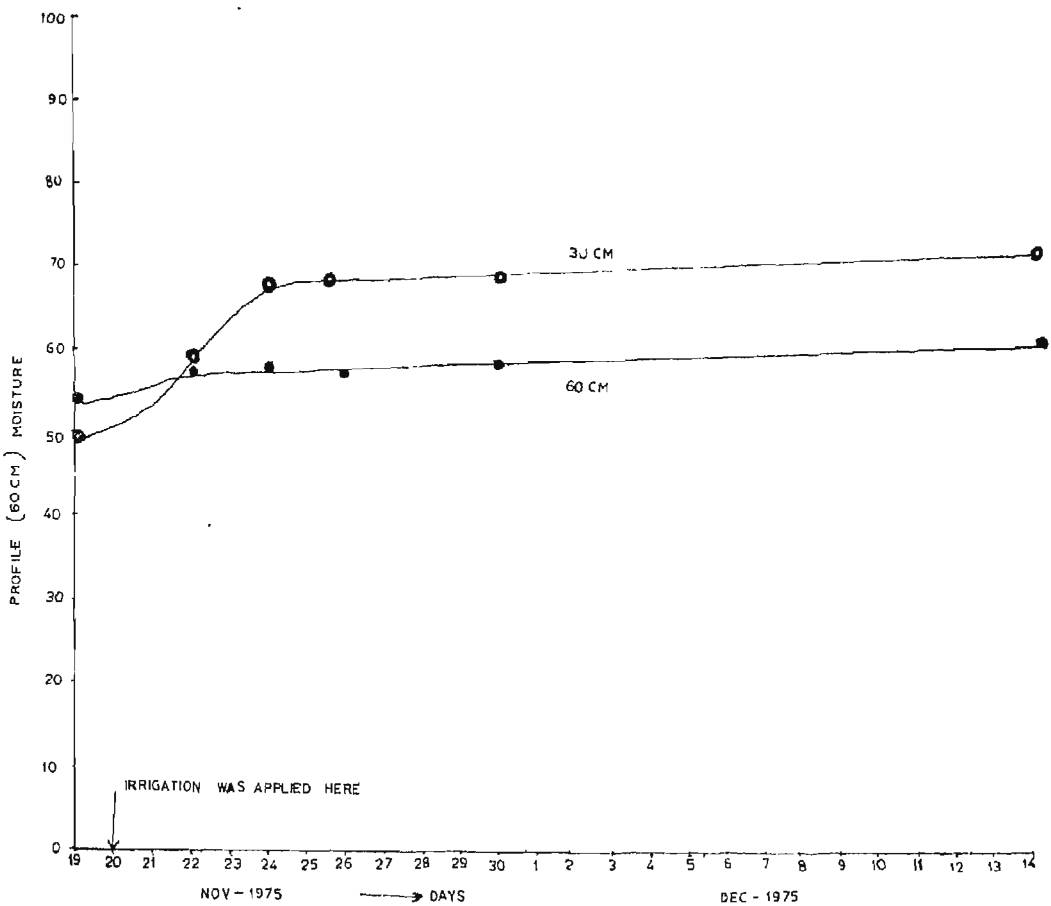
Ghiya-round yielded maximum, followed by *Ghiya*-long, *Tori*-ridge, *Tori*-smooth and *Bhindi*. *Tarbooj* and *Kakri* got spoiled due to excess of rains at early stage of their growth. *Karela* did not yield marketable produce due to disease. The low yield of *Bhindi* is also attributed to disease.

TABLE 2

Yield of vegetables during *kharif*, 1975

S. No.	Vegetable	Yield (q/ha)
1.	*Tori*-ridge (*Luffa acutangula* Roxb)	28.1
2.	*Tori*-smooth (*Luffa cylindrica* Roxb)	26.5
3.	*Ghiya*-long (*Legeneria Siceraria* Standl.)	91.4
4.	*Ghiya*-round —do—	93.4
5.	*Kakri*-phoot (*Cucumis melo*)	0.0
6.	*Tarbooj* (*Citrullus vulgaris*)	0.0
7.	*Karela* (*Momordica charantia* Linn.)	0.0
8.	*Bhindi* (*Abelmoschus esculentus* Moenchus)	3.1

FIG. 1 MOISTURE RELEASE PATTERN OF PITCHER



In case of drought spell of longer duration than that of 15-20 days, the pitcher can be filled with just two buckets of water. The moisture release pattern of such pitcher is given in Fig. 1. The pitcher will also maintain a very favourable water balance for vegetables for 15-20 days. This will provide life saving treatment to vegetables.

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EFFECT OF HARVESTING TIME ON THE GRAIN AND OIL YIELD OF *RAYA (BRASSICA JUNCEA* (L) CZERN AND COSS)

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Raya (Brassica juncea (L) Czern & Coss) is a cash crop of Haryana. It is harvested earlier than wheat and barley, and hence it avoids competition of labour at the peak hours. Because of its early maturity, sugarcane crop can be sown on the fields vacated by it. The sowing of zaid crop to fetch high yields is also possible after *raya*. It is, therefore, essential to know the right stage of crop harvest for obtaining maximum grain and oil yield. Farmers, generally, harvest the crop when it is fully matured and pods are completely dry. Delay in the harvesting causes shattering of pods and also delays the sowing of the succeeding crop.

Mohammad and Ahmad (1940) observed most rapid development of oil when the *Brassica* seed was about 20 day old and continued for another 20 days. Singh (1958) reported that the formation of oil in *Brassica* began with the seed formation, i.e., after the ovary was fertilized. The oil in the seed goes on forming with the development of seed towards maturity. The present investigations were, therefore, undertaken to find out the optimum time of harvesting for *raya* crop.

The experiment was conducted at the Research Farm of the Haryana Agricultural University, Hissar, for two years (1970-72). The recommended variety RL-18 was sown on 8th October during both the crop seasons.

The crop was harvested at (i) 130 days just after completion of siliqua formation, (ii) 135 days, (iii) 140 days, (iv) 145 days, (v) 150 days, (vi) 155 days, and (vii) 160 days after sowing. The different crop duration treatments were arranged in randomized block design. There were four replications and the net plot size was 1/463 ha. A basal dose of 80 Kg N/ha was applied at the time of sowing. Two irrigations, one at flowering and another at siliqua formation stage, were applied. To remove weeds, one hoeing was done after first irrigation. The seed yield, test weight and oil content in the seed were recorded. The oil content was determined by Soxhlet extraction method.

The *raya* harvested at 130 days after sowing gave significantly low seed yield of 741 Kg and 403 Kg per ha during 1970-71 and 1971-72, respectively (Table 2). During both the crop seasons the *raya* harvested at 145, 150, 155 and 160 days stages gave significantly higher seed yield over thc harvestings of *raya*

TABLE 1

Meteorological parameters

Months	Year	Temperature °C		Relative humidity (%)		Rainfall
		Maximum	Minimum	Morning	Evening	(mm.)
October	1970	34.2	16.0	78	23	42.4
October	1971	33.6	15.5	72	26	36.2
November	1970	28.2	7.2	80	18	Nil
November	1971	28.3	7.8	75	23	Nil
December	1970	23.5	N.A.	93	30	Nil
December	1971	23.1	N.A.	84	28	Nil
January	1971	19.8	3.0	97	43	18.8
January	1972	22.3	7.2	79	32	7.8
February	1971	24.5	7.4	92	39	13.1
February	1972	20.6	4.5	80	29	14.0
March	1971	29.5	10.5	91	44	9.5
March	1972	30.0	11.6	79	25	6.6
April	1971	37.6	11.8	63	24	3.0
April	1972	34.4	16.8	63	23	8.9

N. A. stands for not available.

at 130, 135 and 140 days stages. During both the crop seasons the highest seed yield of 3252 Kg/ha and 1606 Kg/ha were recorded from the crop harvested at 155 days after sowing. Year variations in the seed yield were recorded. These can be explained in the light of meteorological parameters (Table 1). During 1971-72, the temperature (both maximum and minimum) was unfavourable to the crop growth, particularly the minimum temperature was extremely low (4.5°C) in comparison with that of previous year (7.4° C) at seed filling stage. Similarly, relative humidity in March (1972) was comparatively low and rainfall during crop growth (1971-72) was also less which adversely affected the seed yield. These findings are in confirmity with those of Singh *et al.* (1974) who recorded increased seed yield towards maturity of *Brassica campestris* var. *toria* Duthie and Full. Thus, to fetch greater seed yield, *raya* should be harvested at maturity before it reaches shattering stage.

Delayed harvestings increased the seed weight whereas earlier harvestings resulted in decreased seed weight. Crop harvested at 130 days stage resulted in lowest oil content of 25.75 per cent and 33.30 per cent with the oil yield of 191 Kg and 134 Kg/ha in the first and second year of the investigations, respectively. Oil content was found to increase up to the last date of harvesting of *Raya* giving 34.30 per cent in 1970-71 and 39.25 per cent in 1971-72. Year variations recorded in the oil per cent were due to temperature fluctuations (Table 1). Singh *et al.* (1974) also opined that abrupt change in temperature affected the oil content adversely at seed filling stage of siliqua.

TABLE 2

Effect of harvesting time on grain yield, oil content, oil yield and test weight of *Raya* (1970-72)

Crop duration	1970-71				1971-72				Mean yield (Kg/ha)
	Seed yield (Kg/ha)	Oil (%)	Oil yield (Kg/ha)	1000-seed weight (g)	Seed yield (Kg/ha)	Oil (%)	Oil yield (Kg/ha)	1000-seed weight (g)	
130 days	741	25.75	191	1.035	403	33.30	134	1.029	572
135 days	1042	26.17	273	1.705	509	35.60	181	1.656	775
140 days	1840	32.05	590	2.100	551	36.00	198	2.050	1195
145 days	2315	33.25	770	2.355	859	36.80	318	2.346	1587
150 days	2830	34.07	964	2.610	940	37.00	348	2.569	1885
155 days	3252	34.28	1115	2.785	1606	38.10	612	2.698	2429
160 days	3252	34.30	1115	2.798	1545	39.25	601	2.709	2398
C.D. at 5%	361				299				

The results discussed above clearly reveal that the harvesting of *raya* at 130 days after sowing gave significantly low seed yield as well as low oil content in seeds during 1970-71 and 1971-72. The highest seed yield, oil content in seeds and oil yield were obtained when the crop was harvested 155 days after sowing during both years of investigation.

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EFFECT OF SUPPLEMENTATION OF ASCORBIC ACID ON EGG PRODUCTION AND EGG QUALITY IN WHITE LEGHORN PULLETS DURING SUMMER

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It is a common observation that egg production and egg quality deteriorate during the summer months. Thornton (1962), Perek and Kendler (1962, 1963) and Hunt and Aitkin (1962) observed beneficial effect of ascorbic acid supplementation on egg production, whereas Herrick and Neckless (1969) failed to observe any increase in egg production or shell quality due to high or low levels of supplementation of ascorbic acid under normal environmental conditions. The amount of ascorbic acid synthesized for physiological needs is believed to be significant under optimum climatic conditions, while the level synthesized is not sufficient to meet the body requirements when the temperature is high (Nester *et al.*, 1972). According to Freeman (1971) ascorbic acid has properties that can suppress stress effects. This vitamin was supplemented in the ration of pullets and the physiological responses in relation to egg production and egg quality were studied during high ambient temperatures of summer. Thirty-six pullets of the same batch, belonging to the White Leghorn breed were used in this study. The pullets were randomly allotted to two groups : (i) control and (ii) experimental and were maintained in an *ad lib* feeding schedule. Layer ration obtained from the Haryana Agro-Industries was used for feeding. The experimental ration was prepared by thoroughly mixing 50 mg of ascorbic acid per kg of feed. After three days normal feeding for both groups for adjustment, the experimental feed was offered to the experimental group from 12th June and continued for 10 weeks. Individual records of feed intake, body weight gain and egg production were maintained. Eggs collectec every week were subjected to egg quality measurements, like, egg weight, shell thickness, albumin and yolk index (Table 1).

None of the parameters studied in the control and experimental groups were found to differ significantly. However, the values for egg production, egg weight, shell thickness, yolk and albumin indices and body weight gain, were all found to be slightly more in the experimental group than in control. On a slightly lower feed intake, the experimental group had better body weight gain and egg production than in the control group. Such marginal increase in the ascorbic acid treated group is unlikely to

TABLE 1

Mean values and test of significance for egg production and egg quality in control and experimental groups of White Leghorn Pullets

Parameters		Control group	Experimental group (50 mg ascorbic acid/kg feed).	't'
1.	Average increase in body weight (g).	128.10 +38.63	169.40 +49.38	0.66
2.	Egg production per bird per week.	2.76 +0.66	2.96 +0.68	0.18
3.	Per cent egg production	39.40	42.28	—
4.	Average egg weight (g)	43.14 +1.72	43.24 +1.64	0.32
5.	Feed intake per bird per week (g)	641.87 +40.80	639.62 +41.30	0.66
6.	Feed conversion ratio	5.38	4.99	—
7.	Average shell thickness (mm)	0.37 +0.05	0.38 +0.04	0.44
8.	Average albumin index	14.90 +4.02	15.40 +4.13	0.24
9.	Average yolk index	47.20 +11.78	48.40 +12.56	0.06

make the supplementation of ascorbic acid profitable for egg production. The results compared favourably with the findings of Harms and Waldroup (1961), Ahmad *et al.* (1967) and Nester *et al.* (1972) on egg production, and of Perek and Kendler (1962, 1963), Hunt and Aitkin (1962), Heywang *et al.* (1964) and Nester *et al.* (1972) on shell quality.

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OCCURRENCE OF SOME SAP-TRANSMISSIBLE VIRUSES OF TOMATO IN HARYANA*

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A number of viruses have been reported to occur on tomato in India, causing various types of symptoms. In Haryana the tomato cultivation is largely suppressed due to virus diseases. Tomato leaf curl is of common occurrence, which is not sap-tranmissible. An attempt was made to isolate and identify the sap-tranmissible viruses from plants showing symptoms other than those caused by tomato leaf curl.

Diseased leaves, collected from field grown plants, were crushed in pestle and mortar and the sap extracted was mechanically inoculated into the test plants using 400 mesh carborundum powder as an abrasive. Physical properties, i.e., dilution end point (DEP), thermal inactivation point (TIP) and longevity *in vitro* of the virus isolates were determined using the standard methods.

Two samples, i.e., sample 'A' showing symptoms of reduced leaf size with some curling and rolling, occasional top necrosis and stunted growth of the plants and sample 'B' showing malformed, bronzed necrotic leaves and fruits (Figs. 1 and 2) were collected. Leaf sap from sample A and B was separately extracted and mechanically inoculated into *Datura metel* L., *Nicotiana tabacum* L. var. *Xanthi* and *N. debneii* Domin. Sample 'A' caused big necrotic ringspots followed by systemic mosaic and distortion of leaves in *D. metel*, but did not show any symptoms on tobacco species. Sample 'B' produced only local necrotic lesions on *D. metel* and faint mottling on tobacco species. Leaf samples were then taken from all these plants and mechanically inoculated again into *D. metel* which constantly exhibited 2 different types of lesions. Samples producing these different types of lesions on *D. metel* were treated as isolates 1 and 2.

Host range

Host range and host reactions of the two virus isolates have been summarised in Table 1. The following plants were not susceptible to any isolate which was confirmed by back inoculation :

Cucumis melo L., *Luffa acutangula* Roxb., *L. cylindrica* L., *Citrullus lanatus* Thunb, Manaf., *C. vulgaris* Schrad.,

*Part of the M.Sc. Thesis of the first author.

TABLE 1

Host range and host reactions of virus isolates 1 and 2

Host Plant species	Host reactions	
	Virus isolate 1	*Virus isolate* 2
Nicotiana tabacum L. var. *Xanthi*	Systemic mottling	Faint mottling
N. tabacum L. var. White Burley.	Systemic mosaic mottling	Systemic mosaic mottling
N. rustica L.	Mosaic followed by mild necrosis	Big necrotic local lesions. New leaves distorted with necrosis (Fig. 3)
N debneii Domin.	Faint mottling	Mosaic mottling, slight leaf rolling and distortion (Fig. 4)
N. glutinosa L.	Local lesions on leaves which later dried	Necrotic lesions which increased in size drying whole leaf
Capsicum frutescens L.	Mosaic mottling, leaf size reduced	Faint mottling
Datura metel L.	Small necrotic lesions coalescing and drying the leaves	Medium-sized necrotic lesions ultimately coalesced leading to absicion of leaves
Solanum nigrum L.	Faint mottling	Drastic stunting and smalling of the leaves showing mosaic mottling
Lycopersicon esculentum Mill.	Reduction, rolling and faint mosaic of leaves	Prominent mosaic, slight leaf rolling, and vein banding
Celocia argentia L.	Large number of local lesions on leaves coalesced. New leaves curled	No symptoms
Chenopodium amaranticolor Coste et Reyn.	Small purple coloured local lesions on leaves	Numerous small purplish lesions on leaves
Spinacia oleracea L.	Not infected	Faint chlorotic local lesions
Trianthema monogyna L.	Small necrotic local lesions	No symptoms

Note : Necrotic streak symptoms were not reproduced on tomato possibly because some other viruses got eliminated during isolation through *D. metal.*

Fig. 1. *Lycopersicon esculentum* Mill. showing malformed, bronzed necrotic leaves with prominent veinal and leaf necrosis and necrotic streaks on stem.

Fig. 2. Disfigured and badly necrotic fruits of tomato (upper) as compared to healthy tomato fruit (lower).

Fig. 3. *Nicotiana rustica* L. Plant infected with virus isolate 2, showing necrotic lesion and systemic necrosis.

Fig. 4. *Nicotiana debneii* Domin. plant infected with virus isolate 2, showing mosaic mottling and distortion of leaves.

Trichosenthes anguina L., *Glycine max* (L) Merr., *Vicia faba* L., *Phaseolus mungo* L., *P. aureus* Roxb., *Pisum sativum* L., *Trigonella Foenum-graecum* L., *Brassica caulorapa* L., *B. olearacea* L., *Raphanus sativus* L , *Eruca sativa* Mill., *Chenopodium album* L., *C. murale.* L and *P. vulgaris* L. var. *Runner bean.*

Physical properties

Dilution end point (DEP). Virus isolate 1, 1 : 10000 to 1 : 100000 and virus isolate 2, 1 : 1000 to 1 : 10000.

Thermal inactivation point (TIP). The virus isolate 1, 95°C and virus isolate 2, 90°C.

Longevity *In vitro*. Virus isolates 1 and 2 could withstand the ageing up to 9 and 13 days at room temperature (30° and 35°C) and up to 15 and 39 days at freezing temperature (—20°C), respectively.

The virus isolates 1 and 2, isolated from the field grown tomato plants, showed reaction on some hosts quite similar to the common strain of TMV. Reactions of TMV on *T. monogyna* and *C. argentia* are not known and, therefore, cannot be compared. However, isolates 1 and 2 slightly differed from each other in host reactions and physical properties. Majority of the strains of TMV possess a high dilution end point but there were certain strains of TMV which failed to reach high concentration in tomato leaves (Jones, 1940; Das and Raychaudhuri, 1953; Azad and Sehgal, 1958). Recently, Rao and Reddy (1971) have reported a serologically related necrotic strain of TMV on tomato having a dilution end point of 10^{-3} which is identical with that of the virus isolate 2 and quite similar to that (10^{-4}) of virus isolate 1, as described here. Further, most of the strains of TMV possess a very high thermal inactivation point of 90-95°C as was found for isolate 1 and 2 in the present work. However, the *in vitro* longevity of the two virus isolates reported here is rather too short as compared to other strains of TMV. *In vitro* longevity of necrotic lesion strain reported by Rao and Reddy (1971) from India is also short, i.e., 138 days at room temperature (25-30°C)

Based on similarities of symptoms on important hosts and some physical properties the two virus isolates, isolated from field grown tomatoes in Haryana, may be considered as Indian strains of TMV, slightly differing from common or wild type strains of TMV.

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