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Effect of Seedrates and Nitrogen and Phosphorus Levels on Forage Maize (*Zea mays* L.) Varieties

J. R. Patel, K. R. Thaker, A. C. Sadhu, P. C. Patel and H. P. Parmar

Forage Research Project, Gujarat Agricultural University, Anand-388 110

ABSTRACT

A field experiment was conducted during *rabi* seasons of 1993-94 and 1994-95 on sandy loam soil to study the effect of seedrates, nitrogen and phosphorus levels on forage maize varieties. Maize variety African tall recorded significantly higher dry matter yield than Gujarat Maize-1, however both the varieties had no appreciable influence on green forage and crude protein yields. Gujarat Maize-1 was found superior in quality than African tall. Maize crop sown with 80 kg seed/ha was found advantageous in increasing net return and produced higher forage production with better quality than 40 and 80 kg seed/ha. Each successive increase in nitrogen level from 80 to 200 kg N/ha significantly increased the forage production of maize and increased the crude protein yield. Application of 200 kg N/ha also recorded the maximum values of crude protein content, leaf : stem ratio and net realization. Application of phosphorus had no influence on forage yield and quality of maize crop.

(Received on 1st Nov., 1995)

INTRODUCTION

Maize (*Zea mays*, L.) is an ideal cereal forage crop adapted to varying soil and climatic conditions. It can be successfully grown during *rabi* season, since hybrid Napier, sorghum and *bajra* produce low forage yields. Optimum seedrate determines the yield potentiality of any crop, while the chemical fertilizers play an important role in increasing forage production of maize with better nutritive value. Gujarat Maize-1 variety recently released by Gujarat Agricultural University, requires shorter period for forage production. Hence, a field experiment was conducted to study the forage production potential of Gujarat Maize-1 alongwith African tall under different

levels of seedrate and nitrogen and phosphorus fertilization under middle Gujarat conditions.

MATERIALS AND METHODS

A field experiment was conducted during *rabi* seasons of 1993-94 and 1994-95 on sandy loam soil, low in total nitrogen (0.03%), medium in available phosphorus (43.5 kg/ha) and high in available in potash (261.4 kg/ha). Thirty six treatments comprising combinations of two maize varieties (African tall and Gujarat Maize-1) and three seedrates (40, 60 and 80 kg/ha) in main plots and combinations of three levels of nitrogen (80, 140 and 200 kg N/ha)

and two levels of phosphorus (0 and 40 kg P_2O_5 /ha) in sub plots were tested in split plot design with four replications. Half of the nitrogen and entire quantity of phosphorus in the form of ammonium sulphate and single superphosphate, respectively were applied as per treatments at the time of sowing, whereas remaining half of nitrogen was topdressed one month after sowing. The harvesting of each treatment was done at milking stage. Nitrogen content of plant was estimated by modified Kjeldahl's method and crude protein content was worked out on dry weight basis (Jackson, 1973).

RESULTS AND DISCUSSION

Effect of varieties

The variety Gujarat Maize-1 produced significantly higher green forage yield than African tall during 1994-95, however the differences were not significant during 1993-94 and in pooled results (Table 1). African tall recorded significantly higher plant height and produced significantly higher dry matter yield than Gujarat Maize-1 during both the years as well as in pooled results. There was no appreciable influence on crude protein yield due to different varieties, however Gujarat Maize-1 recorded higher crude protein content than African tall during both the years (Table 2). The variety Gujarat Maize-1 also registered significantly lower Neutral Detergent Fibre (NDF) content, stem thickness and leaf : stem ratio than African tall during 1993-94 (Table 2). This might be due to varying genetic potentiality of two varieties. The results are in accordance with those reported by Desai and Deore (1980).

Effect of seedrates

During 1994-95 and in pooled results, the seedrates of 60 and 80 kg/ha produced equally

higher green forage and dry matter yields and were found significantly superior than the treatment of 40 kg seed/ha (Table 1). The seed rate of 80 kg/ha recorded the maximum crude protein yield during both the years (Table 1). Different seedrates did not influence appreciably the plant height and crude protein content of maize. However, the seedrate of 80 kg/ha recorded significantly lower NDF content than 60 kg seed/ha and gave significantly higher leaf stem ratio than 40 kg seed/ha during 1993-94, while each increment in seedrate from 40 to 80 kg seed/ha significantly decreased stem thickness of maize crop (Table 2). The crop sown with 80 kg seeds/ha also gave the highest net returns of Rs. 16300.50 (Table 4). The findings confirm the results of Nehra *et al.* (1981).

Effect of nitrogen

Each increment in nitrogen from 80 to 200 kg N/ha significantly increased the green forage and dry matter yields of maize crop during both the years as well as in pooled results (Table 1). The crude protein yield was also increased due to increase in nitrogen application upto the highest level of 200 kg N/ha during both the years. The higher forage production under higher levels of nitrogen was attributed to significant increase in plant height of maize during both the years, while higher crude protein yield was attributed to increase in dry matter yield and crude protein content of forage maize (Table 2). The increase in nitrogenous fertilization enhanced rapid expansion of dark green foliage and increased the growth as it has fulfilled the requirement of nitrogen at various stage of crop growth. Similar results were also reported by Desai and Deore (1983), while Singh *et al.* (1981) reported that increase in nitrogen application resulted in increased crude protein content only.

TABLE 1

Influence of seedrates, nitrogen and phosphorus levels on green forage, dry matter and crude protein yields of maize varieties.

Treatment	Green forage yield (q/ha)			Dry matter yield (q/ha)			Crude protein yield (q/ha)		
	1993-94	1994-95	Pooled	1993-94	1994-95	Pooled	1993-94	1994-95	Mean
Varities									
African tall	684	514	599	166.2	114.4	140.3	10.18	5.77	7.98
Gujarat Maize-1	640	587	613	137.5	103.3	120.4	9.45	6.30	7.88
S. Em. ±	15	14	13	3.3	2.9	2.8	—	—	—
C. D. at 5%	NS	41	NS	10.1	8.7	8.3	—	—	—
Seedrates (kg/ha)									
40	644	490	567	147.3	95.7	121.5	9.84	5.20	7.52
60	650	560	605	150.0	112.0	131.0	9.72	6.36	8.04
80	693	600	647	158.2	118.7	138.5	10.00	6.54	8.27
S. Em. ±	18	17	16	4.1	3.5	3.4	—	—	—
C. D. at 5%	NS	50	47	NS	10.7	10.2	—	—	—
CV %	18.94	20.87	25.20	18.64	22.56	25.46	—	—	—

J.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Nitrogen (kg/ha)									
80	595	469	532	136.8	93.9	115.3	7.67	4.49	6.08
140	675	573	624	152.5	111.8	132.2	10.56	6.20	8.38
200	717	608	663	166.1	120.8	143.5	11.33	7.41	9.37
S. Em. ±	8	7	5	2.4	1.4	1.4	—	—	—
C. D. at 5%	24	19	15	6.7	3.9	4.0	—	—	—
Phosphorus (kg/ha)									
0	659	546	602	150.5	108.7	129.6	9.91	6.05	7.98
40	666	555	610	153.1	108.9	131.0	9.80	6.01	7.91
S. Em. ±	7	5	4	1.9	1.1	1.1	—	—	—
C. D. at 5%	NS	NS	NS	NS	NS	NS	—	—	—
C. V. %	8.76	8.36	8.69	10.85	8.75	10.57	—	—	—

TABLE 2

Crude protein content and other ancillary observations of forage maize as influenced by different treatments.

Treatment	Av. plant height (cm)		Crude protein content (%)		NDF (%)	Stem thickness (cm)	Leaf : stem ratio 1993-94
	1993-94	1994-95	1993-94	1994-95			
Varieties							
African tall	313.7	206.2	5.83	4.98	68.7	2.02	0.39
Gujarat Maize-1	218.0	197.2	7.35	6.04	66.1	1.47	0.35
S. Em. ±	2.9	2.3	—	—	0.7	0.02	0.01
C. D. at 5%	8.8	7.0	—	—	2.2	0.07	0.03
Seedrates (kg/ha)							
40	271.0	197.8	6.77	5.39	65.6	1.90	0.33
60	261.4	201.7	6.55	5.65	70.1	1.70	0.40
80	265.1	205.5	6.46	5.49	66.5	1.62	0.39
S. Em. ±	3.6	2.8	—	—	0.9	0.03	0.01
C. D. at 5%	NS	NS	—	—	2.7	0.08	0.04
C. V %	9.31	9.77	—	—	9.2	10.73	24.55

1.	2.	3.	4.	5.	6.	7.	8.
Nitrogen (kg/ha)							
80	259.3	196.5	5.70	4.77	66.3	1.69	0.34
140	268.6	202.4	7.04	5.60	67.9	1.74	0.35
200	269.7	206.1	7.04	6.16	68.1	1.79	0.43
S. Em. ±	2.2	1.7	—	—	0.2	0.03	0.01
C. D. at 5%	6.1	4.8	—	—	0.6	0.07	0.03
Phosphorus (kg/ha)							
0	266.9	201.8	6.68	5.53	67.4	1.75	0.37
40	268.8	201.6	6.50	5.49	67.4	1.74	0.37
S. Em. ±	1.8	1.4	—	—	0.1	0.02	0.01
C. D. at 5%	NS	NS	—	—	NS	NS	NS
C. V. %	5.62	5.90	—	—	2.44	10.01	20.40

TABLE 3

Interaction effect of seedrates and nitrogen levels on green forage and dry matter yields (pooled data).

Treatment	Nitrogen (kg/ha)		
	80	140	200
Green forage yield (q/ha)			
Seedrates (kg/ha)			
40	498	564	639
60	526	635	655
80	573	672	694
S. Em. $\pm$		9.3	
C. D. at 5%		26.2	
Dry matter yield (q/ha)			
Seedrates (kg/ha)			
40	108.7	116.7	139.2
60	115.9	137.2	139.9
80	121.5	142.5	151.4
S. Em. $\pm$		2.4	
C. D. at 5%		6.9	

The highest level of 200 kg N/ha also recorded significantly higher values of stem thickness than 80 kg N/ha and leaf : stem ratio than 80 and 140 kg N/ha, while application of 80 kg N/ha registered significantly lower NDF content than 140 and 200 kg N/ha during 1993-94 (Table 2). The increase in NDF content with the application of higher doses of nitrogen might be due to the formation of more amount of complex carbohydrates. The economics of nitrogenous fertilization revealed that the application of 200 kg N/ha recorded the highest net realization of Rs. 15,914.50 on hectare basis (Table 4).

Effect of phosphorus

Application of phosphorus @ 40 kg P_2O_5 /ha did not exert significant influence on green forage and dry matter yields during both the years and also in pooled results (Table 1). Similar was the case with plant height, stem thickness and leaf : stem ratio of fodder maize and quality characters like crude protein yield, crude protein content and NDF content (Table 2). The findings confirm the results of Sharma *et al.* (1976).

TABLE 4

Economics of forage maize as influenced by seedrates and nitrogen levels.

Treatment	Pooled green forage yield (q/ha)	Gross realization (Rs./ha)	Cost of cultivation (Rs./ha)	Net realization (Rs/ha)
Seedrates (kg/ha)				
40	567	21262	7534	13728
60	605	22687	7748	14939
80	647	24262	7962	16300
Nitrogen (kg/ha)				
80	532	19950	6548	13402
140	624	23400	7748	15652
200	663	24862	8948	15914

Selling price of green forage = Rs. 37.50/q.

Cost of nitrogen (Ammonium sulphate) = Rs. 20/kg.

Cost of phosphorus (single superphosphate) = Rs. 13.75/kg.

Cost of seeds = Rs. 10.70/kg.

Labour charges = Rs. 25/day.

Interaction effects

Maize crop sown with 80 kg seeds/ha and fertilized with 200 kg N/ha gave the maximum green forage yield but at par with 140 kg/ha and produced significantly higher dry matter yield than rest of the treatment combinations (Table 3). Treatment combinations of 40 kg seed/ha and 80 kg N/ha produced significantly the lowest green forage

and dry matter yields indicating synergistic effects of both the inputs on forage production.

Conclusion

The results suggest that maize variety Gujarat Maize-1 be sown with 80 kg seeds/ha and fertilized with 200 kg N/ha for maximum dry matter and 140 kg N/ha for green forage production with better nutritive value.

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Productivity of Sunflower as Influenced by Phasic Water and Fertility Management Under South Gujarat Conditions*

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Gujarat Agricultural University, Navsari Campus, Navsari-396 450

ABSTRACT

A field experiment was conducted during *rabi* seasons of 1993-94 and 1994-95 to study the effect of irrigation, nitrogen and phosphorus each at three levels on the productivity of sunflower. Yield attributes as well as seed yield improved significantly with 0.8 IW/CPE ratio and 80 kg N/ha but phosphorus did not exert significant influence on any of the yield contributing characters and seed yield of sunflower.

(Received on 18th Sept., 1996)

INTRODUCTION

Sunflower, being a salt tolerant crop has been recently drawing the attention of farmers, particularly in salt affected belt of Gujarat and also in paddy follows with limited water resources. An area of 1.8 - 2.0 million hectare is available for intercropping with groundnut in Gujarat (Wasnic and Lal, 1984), which is almost equivalent to the area at present under sunflower cultivation throughout the country. The scope for sole crop is equally good. However, the information on its production technology is limited, particularly with respect to water and fertility management. Hence, the present study was undertaken to evaluate the performance of sunflower under various levels of water and fertility management.

MATERIALS AND METHODS

The field experiment was conducted with EC-68414 cultivar during the *rabi* seasons of

1993-94 and 1994-95 in slit plot design with three replications. The treatments comprised of irrigation levels (IW/CPE ratio of 0.6, 0.8 and 1.0 with 6 cm depth of irrigation water) as main plot treatment. Nitrogen (60, 80 and 100 kg/ha) and phosphorus (30, 40 and 50 kg/ha) levels were relegated to sub plots. Two common irrigations were given, one immediately after sowing and the other just after a week for better germination and establishment of crop. Half of the nitrogen was applied at the time of sowing along with full dose of phosphorus; and the remaining nitrogen was applied 30 days after sowing as per treatment.

The field capacity, permanent wilting point and bulk density were 32%, 18.2% and 1.39 g/cc, respectively. The soil was clayey in texture, having 0.53% organic carbon, 31.01 kg/ha available phosphorus and 360.12 kg/ha

*Based on Ph. D. thesis of the first author.

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TABLE 1

Yield attributing characters and yield of sunflower as influenced by varying levels of irrigation, nitrogen and phosphorus (Pooled data).

Treatment	Plant height (cm) (75 DAS)	Head diameter (cm)	Nu. of seeds/head	Filled seeds (%)	Seed weight/head (g)	Seed Index (g)	Seed yield (q/ha)
IW/CPE ratio							
0.6	173.73	12.77	664.10	71.33	23.73	53.26	17.72
0.8	185.26	14.66	730.99	76.95	30.26	58.02	21.29
1.0	187.93	14.74	735.43	77.13	30.52	58.56	21.41
S. Em. ±	1.83	0.18	7.36	0.84	0.34	0.61	0.29
C. D. at 5%	5.72	0.57	22.96	2.62	1.07	1.90	0.91
C. V. %	7.39	9.57	7.69	8.02	8.97	7.89	10.71
Nitrogen (kg/ha)							
60	171.64	12.63	653.55	70.16	24.26	54.60	18.68
80	183.39	14.70	721.34	77.35	29.84	57.32	20.70
100	191.89	14.85	735.64	77.90	30.41	57.92	21.04
S. Em. ±	2.23	0.19	7.10	0.87	0.35	0.71	0.23
C. D. at 5%	6.27	0.54	19.96	2.44	0.97	1.20	0.65
Phosphorus (kg/ha)							
30	181.04	14.03	699.66	75.05	27.95	56.49	19.93
40	182.34	14.05	702.76	75.15	28.23	56.78	20.16
50	183.54	14.09	708.09	75.22	28.33	56.57	20.33
S. Em. ±	2.23	0.19	7.10	0.87	0.35	0.71	0.23
C. D. at 5%	NS	NS	NS	NS	NS	NS	NS
C. V. %	8.99	10.13	7.41	8.51	9.05	9.22	8.56
Interactions	NS	NS	NS	NS	NS	NS	NS

NS = Not Significant.

available potash with pH 7.9. The quantity of water was measured with the help of 7.5 cm Parshal Flume installed across the irrigation channel. The crop was sown on 26th Nov., 1993 and 28th Nov., 1994 at 60 x 20 cm spacing.

RESULTS AND DISCUSSION

Irrigation scheduled at 0.8 and 1.0 IW/CPE ratio produced significantly higher seed yield with significant improvement in the yield contributing characters viz., head diameter, number of seeds, filled seeds (%), seed yield/head and seed index compared to the lower level of irrigation (0.6 ratio). The magnitude of increase in seed yield on pooled basis was to the tune of 20.1% at 0.8% and 20.8% at 1.0 IW/CPE over 0.6 IW/CPE ratio (Table 1). This might be due to adequate supply of water which has increased sink size. Seed size and seed filling were also improved with these treatments indicating better translocation of assimilates. The findings are in conformity

with Bhan and Khan (1980) and Somasundaram and Iruthayaraj (1981).

Similarly, significant improvement was noticed in yield attributes and seed yield with 80 kg/ha, and was also on par with apply of 100 kg N/ha. The percentage of increase in seed yield over N 60 was to the tune of 10.8 and 12.6% with 80 and 100 kg N/ha, respectively. The results are in conformity with Dhaka and Agarwal (1981).

Phosphorus fertilization did not exert and significant effect on either yield contributes or yield. This might be due to medium available phosphorus content of soil. The findings are substantiated with the reports of Deshmukh *et. al.*, (1987).

The results led to the conclusion that shedulling irriatation at 0.8 IW/CPE ratio (with 6 irrigations including the two common irrigations) and fertilizing the crop with the 80 kg N/ha were found optimum for sunflower under South Gujarat conditions.

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Integrated Nutrient Management in Wheat (*Triticum aestivum* L.)*

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ABSTRACT

Results of the experiment conducted at Gujarat Agricultural University, Junagadh (India) to study the effect of organic and inorganic fertilizer in wheat revealed that application of FYM @ 10 t/ha significantly increased grain and straw yield during both the years and total uptake of nitrogen during 1993-94. Application of NP (120:60 kg/ha) significantly improved grain and straw yield, protein content in grain and total uptake of N, P and K over their lower levels. The beneficial effect of potassium was not observed in any parameters except total uptake of potassium which was maximum under the application of 50 kg K/ha. Grain and straw yield, protein content in grain and total uptake of nitrogen and sulphur were significantly higher under application of 40 kg S/ha as compared to no sulphur. Treatment combination of 10 T FYM with 120 - 60 NP kg/ha was found the best in most of all the parameters.

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INTRODUCTION

Wheat occupies the prime position among the food crops in almost all the countries in the world. In India, it occupies an area of 23.99 m ha with a total production of 54.55 m t (Anon., 1993). The productivity of wheat crop in Gujarat is 2014 kg grain/ha. Still there is scope to increase the productivity by adopting integrated nutrient management approach. On account of sulphur deficiency, yield of the wheat crop can not be obtained upto the level. No work so far has been done on the effect of FYM, nitrogen, phosphorus, potassium, sulphur on the yield of wheat and nutrient uptake in this area. Taking note of the fact highlighted above an

experiment entitled 'Integrated nutrient management in wheat' was carried out.

MATERIALS AND METHODS

An investigation was carried out at Instructional Farm, Gujarat Agricultural University, Junagadh (India) during rabi season of the year 1992-93 and 1993-94 on vertisol. The soil was low in available nitrogen (232.5 kg/ha) and sulphur (8.15 ppm), medium in available phosphorus (32.4 kg/ha) and rich in available potassium (338.35 kg/ha). The experiment comprising of 24 treatment combinations was laid out in split plot design with four replications. The main plot treatments consisted of FYM (no FYM & 10 t FYM/ha).

*Part of Ph.D. thesis submitted by senior author to Gujarat Agricultural University, Sardar Krushi Nagar.

while sub plot treatments consisted of twelve combinations of three levels of nitrogen : phosphorus (60:30, 90:45 and 120:60 kg/ha), two levels each of potassium (0 and 50 kg/ha) and sulphur (0 and 400 kg/ha). The FYM and sulphur (as gypsum) were applied seven days before sowing whereas, half the quantity of nitrogen and full amount of phosphorus and potassium were applied at sowing. The remaining quantity of nitrogen was applied at crown root initiation stage of the crop. The crop was sown keeping the inter-row spacing of 22.5 cm with recommended seed rate of 120 kg seed/ha.

RESULTS AND DISCUSSION

Effect of farmyard manure

Data presented in Table 1 revealed that application of FYM @ 10 t/ha has tremendous effect on grain as well as straw yield of wheat during both the years and in pooled results. When compared with no FYM, application of 10 t FYM/ha has increased 17.85 and 16.12 per cent grain and straw yield respectively in pooled results. This may be due to increase in microbial activity in soil and improvement in physical and chemical properties of the soil which resulted in better utilization of the nutrients as compared to no FYM. These findings are in confirmation with the results of Maliwal *et al.* (1985) and Patel *et al.* (1993). Protein content in grain remain unaffected due to the application of FYM during both the years as well as in pooled analysis. The uptake of nutrients was also remain unaffected in individual years as well as in pooled results, except total N uptake during 1993-94 and in pooled results where in N uptake was significantly higher under application of FYM as compared to control (Table 2). The higher N uptake under FYM

application may be due to cumulative effect of higher nitrogen concentration in grain and straw and higher biological yield under FYM application. Similar significant effect was reported by Bhatiya *et al.* (1985) and Patel *et al.* (1993).

Effect of nitrogen : phosphorus

The yield of grain and straw was significantly increased with each increase in NP levels during both the years and in pooled results (Table 1). The application of NP at higher level (120:60 kg/ha) increase the grain and straw yields of wheat by 70.67 and 58.59 per cent over their respective lower level i.e. 60:30 kg/ha in pooled results. Maximum response under higher level of NP was might be due to higher growth and yield attributes of wheat and also increase the total uptake of N, P and K. Similar trend was also observed by Rana *et al.* (1982) and Singh *et al.* (1986). Protein content was also higher under NP. Fertilizing the crop (Table 2) with higher level of NP (120:60 kg/ha) significantly increased the total uptake of N, P and K over their respective lower levels. The maximum uptake of nitrogen (143.97 kg/ha), phosphorus (16.43 kg/ha) and potassium (99.88 kg/ha) were observed under the application of 120:60 kg/ha in pooled results which were higher by 108.56, 98.43 and 20.53 per cent over their respective lower level (60:30 kg/ha). Maximum uptake of N, P and K under higher level of NP was attributed to the cumulative effect of higher concentration in grain and straw and higher yield. Kalyan Singh *et al.* (1981) also observed the similar trend. The effect of application of NP was found non-significant on total uptake of sulphur eventhough the maximum total uptake of sulphur was recorded under higher level of NP fertilization.

TABLE 1
Effect of different treatments on yield of wheat and protein content in grain.

Treatments	Yield (q/ha)						Protein content (%)		
	Grain			Straw					
	1992-93	1993-94	Pooled	1992-93	1993-94	Pooled	1992-93	1993-94	Pooled
Levels of FYM (t/ha)									
F ₀ 0	39.84	36.36	38.10	53.43	48.72	51.06	9.97	10.44	10.21
F ₁ 10	46.82	42.98	44.90	61.72	56.31	59.29	10.99	12.18	11.58
C. D. at 5%	6.34	5.56	5.98	8.01	7.03	7.57	NS	NS	NS
Levels of N : P (kg/ha)									
NP ₁ 60:30	32.05	28.38	30.21	43.63	39.16	41.70	9.81	10.12	9.97
NP ₂ 90:45	44.39	41.13	42.76	59.73	55.51	57.73	10.00	10.75	10.38
NP ₃ 120:60	53.56	49.51	51.53	69.36	62.87	66.09	11.63	13.06	12.35
C. D. at 5%	2.59	2.10	2.36	2.63	1.88	2.25	1.02	1.08	1.04
Levels of Potassium (kg/ha)									
K ₀ 0	42.77	38.88	40.38	57.55	51.17	54.86	10.44	11.17	10.80
K ₁ 50	43.89	40.45	42.18	57.80	52.85	55.48	10.52	11.45	10.99
C. D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
Levels of Sulphur (kg/ha)									
S ₀ 0	41.33	38.18	39.75	55.60	51.33	53.47	10.06	10.83	10.44
S ₁ 40	45.33	41.16	43.25	59.60	53.69	56.82	10.90	11.79	11.34
C. D. at 5%	2.12	1.17	1.92	2.15	1.53	1.84	0.83	0.88	0.85

TABLE 2
Total uptake of N, P, K and S as affected by different treatments.

Treatments	Uptake of nutrients (kg/ha)											
	N			P			K			S		
	1992-93	1993-94	Pooled	1992-93	1993-94	Pooled	1992-93	1993-94	Pooled			
Levels of FYM (t/ha)												
F ₀ 0	115.17	85.99	100.58	12.23	11.12	11.68	96.04	85.45	90.74	8.94	8.06	8.50
F ₁ 10	120.45	99.35	109.90	13.20	12.56	12.88	98.04	88.01	93.03	9.20	8.35	8.79
C. D. at 5%	NS	10.60	8.00	NS	NS	NS	NS	NS	NS	NS	NS	NS
Levels of N : P (kg/ha)												
NP ₁ 60:30	80.72	57.34	69.03	8.80	7.76	8.28	89.75	75.59	82.87	8.58	7.96	8.27
NP ₂ 90:45	115.27	90.17	102.72	12.52	11.74	12.13	97.48	88.75	93.12	8.62	8.09	8.67
NP ₃ 120:60	157.44	130.50	143.97	16.84	16.02	16.43	103.89	95.87	99.88	9.38	8.58	8.98
C. D. at 5%	3.57	4.00	3.81	0.97	0.75	0.78	1.54	2.41	1.97	NS	NS	NS
Levels of Potassium (kg/ha)												
K ₀ 0	116.67	91.10	103.88	12.50	11.72	12.11	96.31	85.71	91.01	8.96	7.98	5.47
K ₁ 50	118.95	94.24	106.80	12.93	11.96	12.45	97.77	87.74	92.77	9.18	8.44	8.81
C. D. at 5%	NS	NS	NS	NS	NS	NS	1.25	1.97	1.61	NS	NS	NS
Levels of Sulphur (kg/ha)												
S ₀ 0	115.43	89.28	102.35	12.41	11.61	12.01	96.52	86.07	91.30	8.00	7.43	7.71
S ₁ 40	120.19	96.05	108.12	13.03	12.06	12.55	97.56	87.39	92.47	10.14	8.99	9.57
C. D. at 5%	2.92	3.27	3.11	NS	NS	NS	NS	NS	NS	0.80	0.60	0.70

TABLE 3
Effect of F x NP interaction on yield (q/ha) and uptake of nutrients (kg/ha).

NP (kg/ha)	1992-93			1993-94			Pooled		
	NP ₁	NP ₂	NP ₃	NP ₁	NP ₂	NP ₃	NP ₁	NP ₂	NP ₃
FYM (t/ha)									
Grain yield F ₀	26.64	42.53	50.36	23.19	38.03	47.87	24.92	40.28	49.11
F ₁	37.46	46.24	56.76	33.56	44.22	57.17	35.51	45.23	53.96
C. D. at 5%		3.68			2.97			3.33	
Straw yield F ₀	36.83	57.65	65.80	32.08	52.35	61.73	34.48	54.97	63.72
F ₁	50.43	61.81	72.93	46.25	58.67	64.01	48.91	60.49	68.45
C. D. at 5%		3.72			2.65			3.18	
N uptake F ₀	80.35	112.70	152.47	54.73	83.03	120.21	67.54	97.86	136.34
F ₁	81.09	117.84	162.41	59.95	97.31	140.79	70.52	107.56	151.61
C. D. at 5%		5.05			5.66			5.39	
P uptake F ₀	8.83	12.03	15.85	7.43	11.31	14.63	8.13	11.67	15.24
F ₁	8.77	13.08	17.83	8.09	17.41	17.41	8.43	12.59	17.62
C. D. at 5%		1.17			1.06			1.10	

Effect of potassium

Data presented in Table 1 and 2 clearly indicated that application of potassium (50 kg/ha) has no positive effect on grain yield, straw yield, protein content in grain and total uptake of N, P and S during both the years and in pooled results. However, the total uptake of potassium was significantly increased by the application of potassium. The non response of K on most of the parameters was due to higher K status in soil before sowing of the crop.

Effect of sulphur

A perusal of data (Table 1) revealed that in comparison to control (no sulphur), application of 40 kg S/ha significantly increased yield of grain and straw as well as protein content in grain during both the years. The per cent increase due to sulphur application in grain yield, straw yield and protein content in grain were 8.80, 6.26 and 8.62 over their respective control in pooled results. This might be due to the increased supply of sulphur to plant which in turn resulted into profused vegetative growth and ultimately more nutrient uptake. These results confirm the findings of Ishwari *et al.* (1987). Potassium and phosphorus uptake did not differ due to sulphur application. The results might be due to antagonistic effect between sulphur and phosphorus (Tondon, 1989).

Interaction effect

The interaction effect between FYM and NP fertilization was found significant in case of grain and straw yields and uptake of N and P during both the years as well as in pooled results.

It could be seen from the results (Table 3) that fertilizing the crop with NP from 60:30 to 120:60 kg/ha appeared to be advantageous in promoting grain and straw yields of wheat under both the levels of FYM. Whereas, it was more pronounced with application of FYM as compared to control. The maximum grain (53.96 q/ha) and straw (68.45 q/ha) yields of wheat was recorded with the treatment combination of F_1NP_3 in pooled results. Yaduvanshi *et al.* (1981) also reported similar increase in yield with FYM and NP fertilization.

The data presented in Table 3 further indicated that at lower level of NP, the response of FYM application was not observed in nutrient uptake. However, at higher level of NP the effect of FYM was more pronounced on uptake of N and P. The maximum uptake of N (151.61 kg/ha) and phosphorus (17.62 kg/ha) was recorded under the treatment combination F_1NP_3 in pooled results which were significantly higher by 9.87 and 7.42 per cent over respective lower levels (F_0NP_1).

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Crop Management Factor (C) for Runoff and Soil Loss Under Different Cropping Systems

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ABSTRACT

A study was conducted at College Agronomy Farm, Gujarat Agricultural University, Anand during 1992 and 1993 on runoff plots of size 25.2 m x 2.4 m on 0.75 per cent slope with loamy sand soil, to evaluate cropping management factor of the Universal Soil Loss Equation. Crop management factor (C) values for both runoff and soil losses were low under sole groundnut crop and was high under sole bidī-tobacco and pigeonpea crops but it declined considerably when groundnut crop incorporated as intercrop with both the crops.

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INTRODUCTION

The cropping management factor of the USLE combines the influence of many variables : kind of crop, residues, weeds, rotational practices, organic matter, fertilizer treatment, cultivation and tillage practices etc. Tejwani *et al.* (1975) evaluated erosion control effectiveness of some important crops at Soil Conservation Research Station, Dehradun. In view of above, the present study was undertaken to obtain information on cropping management factor (C) of important crops of the region.

MATERIALS AND METHODS

Runoff plots (25.2 m X 2.4 m at 0.75 per cent slope), located at College Agronomy Farm, GAU, Anand, were used in this

study. Anand is situated at 22°35' N latitude and 72°55' E longitude in the *Charotar* tract of middle Gujarat and is 45.1 metres above mean sea level. The average annual rainfall of the area is 864.0 mm received entirely from the South-West monsoon currents. July and August are the months of heavy precipitation. Taxonomically, the soil is classified as Typic Ustifluvents. The soil is loamy sand in texture, locally known as *Goradu* soil. Bidī-tobacco, pigeonpea, pearl millet and maize are main crops of this region.

Runoff and soil loss data were collected after the crops were sown. The runoff collected was recorded daily at 8.00 AM and representative runoff samples taken for estimation of soil loss. There were ten treatments consisted of sole crop of pearl millet

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(PM), pigeonpea (PP), bidi-tobacco (BT) and groundnut (GN) and their intercropping systems including cultivated (CF) and absolute fallow (AF) treatments.

The cropping management factor is the ratio which compares the soil loss or runoff from cropped land with that from cultivated baren fallow plot (Wischmeier, 1960). Erosion control effectiveness of each crop was approximated on the basis of four crop stage periods (Narain and Verma, 1982). Four crop stage periods selected were :

Period 1 : Seeding to one month after seeding,

Period 2 : From one to two months after seeding,

Period 3 : From two months after seeding to crop harvest and

Period 4 : From crop harvest onwards.

Per cent erosion index for each crop stage period was worked out by averaging two years data. Ratio of soil loss from respective cropped plot to soil loss from cultivated baren fallow was worked out period-wise and 'C' factors was then calculated as :

$$C = \frac{ET\% \times \text{Soil loss \%}}{100 \times 100}$$

Cropping management factor (C) for a crop is the total of 'C' values for four crop stage periods.

RESULTS AND DISCUSSION

Results of present study presented in Table 1 indicated that the highest C-values for both runoff (0.900) and soil loss (0.820) were recorded under sole crop of bidi-tobacco,

TABLE 1

Crop management factor (G) for runoff and soil loss under different cropping systems.

Cropping system	Runoff			Soil loss		
	1992	1993	Average	1992	1993	Average
AF	0.329	0.307	0.318	0.101	0.085	0.093
SPM	0.324	0.655	0.489	0.181	0.374	0.277
SPP	0.789	0.878	0.833	0.680	0.686	0.683
SBT	0.905	0.895	0.900	0.846	0.794	0.820
SGN	0.171	0.607	0.389	0.078	0.351	0.214
PM + GN	0.317	0.695	0.506	0.188	0.473	0.331
PP + GN	0.347	0.738	0.542	0.234	0.510	0.372
BT + GN	0.423	0.779	0.601	0.278	0.590	0.434
PM + PP	0.390	0.756	0.573	0.240	0.514	0.377
CD (0.05)	0.151	0.067	0.039	0.073	0.061	0.047

followed by sole pigeonpea, but it declined considerably when groundnut was taken as intercrop in both the crops. Since the optimum date of transplanting of bidi-tobacco is during the first fortnight of August, fields remain fallow during rainy months of June-July and also very slow growth after transplanting resulted in higher C-values under bidi-tobacco crop and that under pigeonpea was due to relatively slower growth rate during this period. Sutaria (1994) showed that July and August months, contributing 72.4 per cent of annual rainfall erosion index and thus these months are most critical for soil erosion under Anand conditions. The effectiveness of groundnut in reducing C-values could be attributed to the close growing habits and flat geometry of the

canopy and its favourable effect on soil properties. It is also evident from data that groundnut crop gave minimum values of C factor for runoff (0.389) and soil loss (0.214).

The C-value for runoff (0.489 and soil loss (0.277) under sole pearl millet was lower than that for pearl millet based intercropping systems (PM+GN, PM+PP). This could be attributed to better vegetative cover provided during rainy season.

Conclusion

Incorporation of groundnut with bidi-tobacco and widely spaced pigeonpea crops have great significance in reducing the runoff and soil loss.

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Heterosis for Yield and Yield Components in Castor (*Ricinus communis* L.) Over Environments

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ABSTRACT

Heterosis, for yield and yield components in castor (*Ricinus communis* L.) was studied in diallel set involving ten parents. Among the yield attributes, seed yield per plant, number of capsules per plant, number of effective branches per plant and oil content have manifested considerable amount of heterobeltiosis compared to shelling outturn, kernel content, 100 seed weight and effective length of main spike. Cross Aruna x SKI-6 recorded highest heterobeltiosis in summer (43.5%) and on average basis (41.08%) for seed yield. These cross combinations could be utilized to develop hybrid for tangible advancement in castor.

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INTRODUCTION

Exploitation of heterosis has become a common feature in castor breeding since the release of first castor hybrid GCH-3 in Gujarat during 1968. With a view to exploit the heterosis further and to assess the feasibility of developing hybrids for different seasons, the extent of heterosis was studied over two seasons. The heterosis measured in terms of superiority over the better parent is more suitable for selection of hybrids for further tests.

Considerably high heterobeltiosis in some hybrids and low in other shows the presence of gene moiety which interact with the environment for better productivity. Thus, the high heterobeltiosis in various cross

combinations is helpful in isolating superior cross combinations.

MATERIALS AND METHODS

The experimental material comprised of 10 parents viz., SH-41, SH-21, SH-16, SH-62, Aruna, J-1, 1379, SKI-6, VH-25, 48-1 and a half diallel set of 45 crosses developed during the *kharif* 1989. These ten parents alongwith their 45 hybrids were evaluated during *kharif* (August 1990 to January 1991) and summer (February 1991 to July 1991) at Motibaug and Instructional Farm, Agricultural College, GAU, Junagadh, respectively in randomized block design with four replications. Each plot consisted of one row of 4.5 m length. Inter and intra row spacing were 90 and 45 cm respectively. All recommended agronomic practices alongwith necessary plant protection

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TABLE 1

Pooled ANOVA showing mean squares of various characters.

Characters	Sources		Environ-ment		Genotypes		Genotypes x Environment		Parents		F ₁ S		Parent Vs F ₁ S		Pooled error
	I ^b	54 ^b	54 ^b	54 ^b	54 ^b	54 ^b	54 ^b	54 ^b	9 ^b	9 ^b	44 ^b	44 ^b	I ^b	I ^b	
Seed yield per plant	8162.220**	1892.893**	234.305**	2422.833**	1549.135**	12248.820**	54.666								
Number of capsules per plant	4227.808**	1209.053**	331.401**	1909.481**	962.864**	5737.510**	61.198								
Effective length of main spike	5456.627**	279.079**	41.555**	645.953**	209.645**	32.328**	4.078								
Number of effective branches per plant	71.688**	2.236**	0.447**	2.235**	2.030**	11.318**	0.151								
100 seed weight	10.017**	100.316**	7.509**	177.958**	85.887**	35.438**	1.043								
Oil content	1.262**	2.076**	1.406**	1.319**	1.938**	15.005**	0.139								
Shelling outturn	444.209**	18.197**	8.170**	12.624**	11.167**	107.676**	1.577								
Percent kernel per pod	1177.276**	18.918**	5.902**	24.553**	17.563**	27.833**	0.767								

*, ** = Significant at 5% and 1% level of significance, respectively.

22.27

measures were followed timely for successful raising of the crop. For recording observations five plants of each genotype were selected randomly from each plot and evaluated for seed yield per plant, number of capsules per plant, effective length of main spike and effective branches per plant. For shelling outturn 25 capsules were obtained from the bulk produce of each plant and percentage of seeds to capsules was worked out on weight basis. Kernel content was obtained by kernel to seed ratio on weight basis and expressed in percentage. Oil content was estimated by Nuclear magnetic resonance technique by taking a random sample of 6 gram seeds from bulk seeds of each genotype from each replication. Heterosis for various characters was calculated as per cent increase in F_1 over better parent.

RESULTS AND DISCUSSION

The pooled analysis of variance (Table 1) revealed the presence of significant variation amongst genotypes and significant interaction between genotypes and environments for yield and yield components, indicating the possibility of isolating the suitable genotypes for each environment. The mean squares due to hybrid Vs their parents were also significant for each trait indicating the possible presence of heterosis in all traits in the hybrids.

Range of heterobeltiosis with mean value of best five crosses for different characters are presented in Table 2. In the present study, among the yield attributes, seed yield per plant has been observed to be the most heterotic trait as out of 45 crosses 16, 11 and 18 crosses recorded significantly positive heterobeltiosis during *kharif*, summer and on average basis respectively. The cross Aruna x SKI-6 showed highest magnitude of

heterobeltiosis in *kharif* (53.88%), while cross SH-21 x 48-1 exhibited highest heterobeltiosis in summer (43.53%) as well as on average basis (41.08%). Among seasons the higher rate of heterosis was found in *kharif*, compared to summer. High value of heterosis for seed yield per plant in castor was also reported by Patel *et al.* (1986), Dangaria *et al.* (1987) and Pathak *et al.* (1988).

For capsules per plant, SH-41 x Aruna (30.97%), Aruna x 48-1 (29.77%) and Aruna x 48-1 (23.35%) depicted highest heterobeltiotic effects in *kharif*, summer and on average basis, respectively. Overall, 11 crosses recorded significantly higher number of capsules over better parents. The results are in conformity with Gujarat *et al.* (1973) and Pathak *et al.* (1988).

Heterotic response for effective length of main spike was marginal and varied in both directions. The frequencies of crosses which manifested negative heterobeltiosis were higher for this trait. The crosses SH-41 x Aruna and J-1 x VH/25 recorded highest heterobeltiosis in *kharif* and summer respectively.

An appreciable amount of heterosis was observed for number of effective branches per plant. More number of crosses turned out with positive heterosis in summer compared to *kharif*, which indicated the profound seasonal effect in the expression of this trait. Overall, cross SH-21 x SH-62 depicted highest heterosis to the tune of 50.28% over better parent.

Only few crosses registered heterobeltiosis for seed weight, and shelling percentage. The cross SH-62 x SKI-6 in *kharif* and SH-21 x SKI-6 in summer and on average basis revealed highest heterobeltiosis; 2.61%.

TABLE 2

Heterobeltiosis related parameters for different characters in castor.

Characters	Envt.	Mean of hetero-beltiosis	Range of heterobeltiosis	Number of crosses with		Best crosses with mean values of traits				
				S ⁻	S ⁺	First	Second	Third	Fourth	Fifth
1. Seed yield per plant	E ₁	10.46	-22.00 to 53.88	3	16	P ₅ x P ₈ (58.55)	F ₁ x P ₇ (63.55)	P ₂ x P ₁₀ (97.95)	P ₁ x P ₉ (61.05)	P ₁ x P ₅ (60.60)
	E ₂	3.97	-44.00 to 43.53	8	11	P ₂ x P ₁₀ (126.45)	P ₆ x P ₁₀ (93.50)	P ₄ x P ₁₀ (108.85)	P ₁ x P ₈ (67.65)	P ₈ x P ₉ (55.70)
	AV	2.28	-24.89 to 41.08	9	18	P ₂ x P ₁₀ (112.20)	P ₅ x P ₈ (56.46)	P ₆ x P ₁₀ (88.57)	P ₄ x P ₈ (90.45)	P ₁ x P ₁₀ (80.15)
	E ₁	5.86	-20.73 to 30.97	3	16	P ₁ x P ₅ (96.85)	P ₁ x P ₇ (80.40)	P ₁ x P ₈ (80.40)	P ₁ x P ₁₀ (95.55)	P ₁ x P ₆ (84.20)
2. Number of capsules per plant	E ₂	-3.42	-44.59 to 29.77	13	7	P ₅ x P ₁₀ (105.70)	P ₈ x P ₉ (65.15)	P ₄ x P ₁₀ (112.60)	P ₈ x P ₁₀ (89.40)	P ₂ x P ₁₀ (73.95)
	AV	1.22	-24.32 to 23.35	10	11	P ₅ x P ₁₀ (97.22)	P ₁ x P ₅ (94.55)	P ₁ x P ₁₀ (91.02)	P ₆ x P ₁₀ (98.00)	P ₈ x P ₉ (62.93)
	E ₁	-4.54	-43.81 to 53.26	18	9	P ₁ x P ₅ (27.05)	P ₅ x P ₇ (23.15)	P ₆ x P ₁₀ (35.40)	P ₅ x P ₈ (22.15)	P ₄ x P ₆ (29.00)
	E ₂	-35.24	-70.36 to 19.55	38	1	P ₆ x P ₉ (21.10)	P ₇ x P ₈ (08.55)	P ₆ x P ₈ (17.75)	—	—
3. Effective length of main spike	AV	-19.99	-55.42 to 21.26	29	4	P ₁ x P ₅ (20.17)	P ₆ x P ₉ (23.67)	P ₆ x P ₁₀ (30.05)	P ₇ x P ₈ (12.35)	P ₆ x P ₈ (22.25)
	E ₁	-0.71	-33.33 to 58.23	12	8	P ₂ x P ₄ (01.90)	P ₄ x P ₇ (02.00)	P ₄ x P ₅ (03.50)	P ₁ x P ₅ (02.70)	P ₅ x P ₈ (03.00)
	E ₂	7.05	-25.97 to 43.24	3	9	P ₂ x P ₄ (04.15)	P ₂ x P ₁₀ (04.05)	P ₅ x P ₈ (04.00)	P ₃ x P ₅ (04.00)	P ₄ x P ₅ (03.85)
	AV	3.80	-22.31 to 50.78	10	12	P ₂ x P ₄ (02.28)	P ₄ x P ₅ (03.67)	P ₃ x P ₈ (03.25)	P ₅ x P ₆ (03.60)	P ₅ x P ₉ (03.47)
4. Number of effective braches per plant	E ₁	-0.71	-33.33 to 58.23	12	8	P ₂ x P ₄ (01.90)	P ₄ x P ₇ (02.00)	P ₄ x P ₅ (03.50)	P ₁ x P ₅ (02.70)	P ₅ x P ₈ (03.00)
	E ₂	7.05	-25.97 to 43.24	3	9	P ₂ x P ₄ (04.15)	P ₂ x P ₁₀ (04.05)	P ₅ x P ₈ (04.00)	P ₃ x P ₅ (04.00)	P ₄ x P ₅ (03.85)
	AV	3.80	-22.31 to 50.78	10	12	P ₂ x P ₄ (02.28)	P ₄ x P ₅ (03.67)	P ₃ x P ₈ (03.25)	P ₅ x P ₆ (03.60)	P ₅ x P ₉ (03.47)
	E ₁	-0.71	-33.33 to 58.23	12	8	P ₂ x P ₄ (01.90)	P ₄ x P ₇ (02.00)	P ₄ x P ₅ (03.50)	P ₁ x P ₅ (02.70)	P ₅ x P ₈ (03.00)

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
5.	100-Seed weight	E ₁	-6.28	-26.56 to 10.05	24	4	P ₁ x P ₄ (31.49)	P ₄ x P ₉ (30.42)	P ₄ x P ₇ (30.36)	P ₂ x P ₈ (34.18)	P ₇ x P ₉ (29.28)
		E ₂	-5.91	-25.56 to 13.31	21	8	P ₂ x P ₈ (31.57)	P ₁ x P ₈ (30.27)	P ₂ x P ₁₀ (34.97)	P ₈ x P ₁₀ (31.67)	P ₃ x P ₈ (32.84)
		AV	-5.50	-26.06 to 06.62	24	5	P ₇ x P ₉ (29.61)	P ₂ x P ₁₀ (34.03)	P ₂ x P ₈ (34.01)	P ₁ x P ₇ (26.73)	P ₁ x P ₄ (30.85)
6.	Shelling outturn	E ₁	-0.76	-4.04 to 2.61	7	1	P ₄ x P ₈ (69.30)	P ₁ x P ₅ (70.46)	P ₂ x P ₆ (68.42)	P ₅ x P ₈ (68.76)	P ₃ x P ₉ (68.97)
		E ₂	+0.78	-4.85 to 6.23	4	9	P ₂ x P ₈ (69.98)	P ₂ x P ₇ (70.86)	P ₁ x P ₁₀ (75.02)	P ₄ x P ₇ (70.40)	P ₄ x P ₆ (70.15)
		AV	-0.15	-3.10 to 3.52	7	7	P ₂ x P ₈ (69.00)	P ₂ x P ₇ (68.95)	P ₂ x P ₆ (68.37)	P ₆ x P ₈ (68.38)	P ₃ x P ₉ (70.60)
7.	Kernel content	E ₁	-1.36	-5.07 to 3.43	13	2	P ₂ x P ₉ (73.04)	P ₁ x P ₂ (76.71)	P ₃ x P ₆ (74.24)	P ₃ x P ₇ (73.64)	P ₂ x P ₈ (74.47)
		E ₂	0.00	-6.68 to 5.58	11	10	P ₅ x P ₉ (77.32)	P ₅ x P ₆ (76.19)	P ₂ x P ₄ (80.26)	P ₅ x P ₁₀ (77.09)	P ₈ x P ₁₀ (77.06)
		AV	-0.58	-4.84 to 4.50	13	3	P ₅ x P ₉ (75.18)	P ₁ x P ₂ (77.64)	P ₂ x P ₄ (77.10)	P ₂ x P ₄ (77.10)	P ₅ x P ₆ (76.19)
8.	Oil content	E ₁	1.00	-4.38 to 4.14	4	19	P ₂ x P ₅ (50.05)	P ₂ x P ₄ (49.83)	P ₃ x P ₄ (49.26)	P ₃ x P ₅ (72.72)	P ₂ x P ₈ (74.47)
		E ₂	-0.28	-2.40 to 1.99	9	5	P ₂ x P ₈ (48.95)	P ₂ x P ₁₀ (48.85)	P ₈ x P ₁₀ (48.75)	P ₂ x P ₄ (80.26)	P ₂ x P ₃ (77.08)
		AV	0.40	-1.76 to 2.53	6	13	P ₂ x P ₈ (49.24)	P ₂ x P ₄ (49.45)	P ₂ x P ₅ (49.24)	P ₂ x P ₁₀ (76.12)	P ₃ x P ₄ (75.21)

E₁ = Kharif, E₂ = Summer, AV = Average, S⁺ = Positively significant, S⁻ = Negative significant.

6.33% and 3.52% respectively. Thus, there was no much heterosis for shelling outturn.

Heterotic response for kernel content was low and varied in both the directions. The top most cross Aruna x VH 25 depicted highest heterosis upto 4.5% and it resulted from the parents having low kernel content.

The magnitude of heterosis for oil content was moderate and the number of crosses which registered higher oil content were quite high. The number of crosses exceeded in oil content over better parent were 19 in *kharif*, 5 in summer and 13 on an average basis. Cross SH-21 x SKI-6 depicted highest heterosis over

better parent (1.99%) in summer and (2.53%) on an average basis. Ranking of five best crosses was in close agreement with *per se* performance indicating the real manifestation of heterosis for these crosses.

Among yield contributing characters, the number of capsules per plant was observed to be the most important yield attribute as it had shown positive heterotic effects in all the top crosses consistently whereas other yield attributes were not consistent and had shown different combinations for realization of heterosis for seed yield per plant. The results are in accordance with findings of Thakkar (1987) and Patel (1991).

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Combined Mutagenesis in Groundnut (*Arachis hypogaea* L.)

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ABSTRACT

To measure the degree and direction of genetic variation induced in five important quantitative characters viz. height of main axis, number of primary branches, number of secondary branches, number of matured pods and pod yield/plant due to gamma rays solo and in combination with EMS/Colchicine was studied in M_1 generation of groundnut (*Arachis hypogaea* L.). Higher variances were recorded for most of the characters. Shift in mean value was towards lower side for characters height of main axis, number of primary and secondary branches. The pod yield per plant had the shift towards higher side and towards both direction for character number of matured pods per plant. The increase in variance for character number of matured pods per plant due to mutagenesis was found to be 3.5 fold as compared to control. The combined mutagenic treatments were more effective to enlarge the variation in all the above quantitative characters.

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INTRODUCTION

Since groundnut has a relatively well developed embryo in the dormant kernel, direct effects of mutagenetic treatments in M_1 generation are readily observable. The central objective behind the use of mutagenesis is to increase in the magnitude and spectrum of genetic variation and appearance of novel mutants of positive values in the population. The degree and direction of variations induced are required to be investigated in M_1 generation itself as a prerogative to use of mutagenesis for induced genetic tailoring of crop plants.

MATERIALS AND METHODS

Freshly decorticated, dry, dormant, healthy, physically and practically uniform kernels of groundnut cultivar AK 12-24 were irradiated with five different doses 5, 10, 15, 20 and 25 Kr of gamma rays and 50 per cent of pre-irradiated kernels were soaked in freshly prepared 0.005 per cent solution of Colchicine and 0.20 per cent solution of EMS separately for 16 hours. On completion of these treatments kernels were thoroughly washed in distilled water for 30 minutes and air dried under shade for 8 hours. The treated samples were sown in RBD with four replications

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alongwith control. Variability induced in mutagenized population for five quantitative characters viz. height of main axis, number of primary branches, number of secondary branches, number of matured pods and pod yield per plant were studied.

RESULTS AND DISCUSSION

Height of main axis

In general, the mean value was relatively lower in treated population, except at treatment 20 Kr, where it was higher (39.7 cm). The lowest (30.6 cm) mean value amongst the treated population was recorded in treatment Colchicine 0.05 per cent and gamma rays 10 Kr + EMS 0.20 per cent (Table 1). The combined treatments have affected the plant height more than gamma rays solo. The shortening of plant height due to mutagenesis in M_1 may be mainly attributed due to disturbance or inhibition of physiological activities of plants. The present finding is amply corroborated by the similar results by Sinha (1991) in Urd bean.

Number of branches per plant

In the present experiment, treated population have registered highly significant variation in number of primary and secondary branches per plant. Amongst the treatments, higher variation for number of primary branches per plant was noticed in combined treatments of gamma rays + Colchicine. The mean value decreased in treated population as compared to that of control for the trait branches. The present finding of

decrease in mean value associated with significant variation is well supported by the findings of San and Srivastava (1991) in Pea and Vandana and Dubey (1988) in *Vicia faba*.

Number of matured pods per plant

Highly significant variation was observed in number of matured pods per plant. The mean value has shifted on both direction but towards lower side in majority of the treatments (Table 1). Significant variation associated with higher mean value was more pronounced in solo treatments of gamma rays when the dose did not exceed 15 Kr. Similar trend has been reported by Patil (1972) in groundnut and Sah and Srivastava (1991) in pea.

Pod yield per plant

In the treated population, the character fresh and dry pod yield was found to be affected one or the other way by mutagenesis. The mean value was lower in the most of the treatments. Amongst treatment the combination of gamma rays with EMS was found to be more effective in creating higher variability in the character dry pod yield, followed by the treatments gamma rays + Colchicine, and then gamma rays. Decrease in pod yield due to mutagenesis has been reported by Gregory (1968) in groundnut. Increase in pod yield as a result of mutagenic treatments was reported in groundnut by Pathirama et al. (1986), Patil (1978) which amply corroborated the present finding in groundnut.

TABLE 1
Effects of mutagenic treatments on five quantitative characters of groundnut.

Sr. No.	Treatments	Height of main axis (cm)		Branching / plant		No. of matured pod / plant		Pod yield / plant (In g)					
		axis (cm)		Primary		Secondary		Fresh		Dry			
		M	V	M	V	M	V	M	V	M	V		
1.	Control	37.4	3.77	8.83	0.59	22.24	5.88	29.2	4.14	35.25	29.85	19.7	8.95
2.	Gamma rays 5 kr	34.2	14.66	6.24	4.37	19.63	52.08	36.6	48.75	46.10	170.39	23.1	15.05
3.	10 kr	35.3	17.51	6.05	3.76	20.77	25.08	31.0	79.00	40.59	115.94	19.6	26.31
4.	15 kr	34.1	50.07	4.86	3.70	18.26	86.92	32.4	33.60	35.21	264.52	16.3	88.26
5.	20 kr	39.7	29.89	6.28	9.62	17.58	19.08	23.8	43.92	28.30	66.84	11.3	23.11
6.	25 kr	37.6	11.89	6.01	3.35	18.84	30.98	24.3	63.40	27.36	84.14	11.9	16.30
7.	0 kr + col. 0.05%	30.6	10.56	4.94	7.04	17.72	73.73	24.6	85.94	30.04	184.19	12.6	37.92
8.	5 kr + col. 0.05%	34.1	8.26	4.87	0.76	19.81	38.08	30.5	25.10	36.89	104.39	16.2	57.65
9.	10 kr + col. 0.05%	31.8	7.80	4.27	1.25	21.12	51.17	23.8	14.02	31.23	10.04	13.0	5.27
10.	15 kr + col. 0.05%	32.1	15.18	4.87	3.37	25.71	63.57	22.2	19.89	29.75	50.84	11.8	25.63
11.	20 kr + col. 0.05%	34.1	12.77	4.26	0.91	17.89	43.80	28.8	17.41	28.96	12.30	12.8	5.07
12.	25 kr + col. 0.05%	31.3	11.45	6.78	7.06	20.44	84.82	23.6	15.70	39.65	699.04	11.2	57.29
13.	0 kr + EMS 0.20%	33.9	13.14	6.06	4.99	19.51	80.32	31.7	58.70	38.53	114.89	17.4	14.16
14.	5 kr + EMS 0.20%	33.7	11.47	5.18	3.56	18.49	39.49	27.5	10.58	29.65	20.77	14.2	20.26
15.	10 kr + EMS 0.20%	30.6	16.06	5.16	1.95	18.10	35.56	27.6	27.42	31.91	44.57	14.3	23.17
16.	15 kr + EMS 0.20%	37.2	14.58	4.72	1.00	18.40	17.34	30.1	19.38	31.43	4.95	14.3	3.24
17.	20 kr + EMS 0.20%	32.1	14.44	4.43	0.96	16.42	12.23	22.9	34.28	24.60	44.89	8.7	21.82
18.	25 kr + EMS 0.20%	34.9	10.61	4.32	0.98	18.48	12.30	23.6	85.06	27.00	175.50	10.5	33.41

Where, M = Mean and V = Variance.

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Heterobeltiosis for Some Economic Characters Over Environments in Upland Cotton (*G. hirsutum* L.)

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ABSTRACT

Twenty-eight hybrids from an 8 x 8 diallel of *G. hirsutum* L. were tested with thier parents at Junagadh in three environments. The maximum heterobeltiosis over environments was recorded for seed cotton yield (74.16%). The cross, H. 777 x Surat Dwarf exhibited maximum heterobeltiosis for seed cotton yield. The same cross also displayed significant numerical estimates for ginning outturn and lint index. The hybrid LRK-516 x Surat Dwarf had maximum link index, ginning outturn and a high seed cotton yield.

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INTRODUCTION

Cotton, being the king of apparel fibre, has played a key role in the development of human civilization. Even today it occupies an outstanding position in the textile industry despite the pressure of man-made fibre and blended fabrics. Heterosis has been by far the most important and effective tool in the hands of crop breeders for effecting rapid improvement in yield and other ecomony attributes. Keeping these view in mind the present study was carried out.

MATERIALS AND METHODS

Eight parental lines, viz., G. Cot-10, H. 777, Sharda, DCI-108, G. 2360, LRK-516, Bikaneri Narma (B. N.) and Surat Dwarf (S.D.) and their 28 F₁'s, were evaluated during *kharif*, 1993 at the College Farm, Gujarat Agricultural

University, Junagadh in a randomized block design replicated thrice in three different environments (date of sowing : end of May, end of June and end of July). Each entry was represented by a single-row plot of ten plants, spaced at 90 x 60 cm. The normal agronomical and plant protection practices were followed from time to time for successful raising of the crop. Observations were recorded on five randomly tagged plants in each plot. Heterobeltiosis over environments was worked out using standard formula viz.

$$\text{Heterobeltiosis} = \frac{\overline{F_1} - \overline{BP}}{\overline{BP}} \times 100$$

RESULTS AND DISCUSSION

The pooled analysis of variance involving 36 genotypes (8 Parents + 28 F₁'s) for seed

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TABLE 1

Pooled mean squares for six characters in upland cotton (*G. hirsutum* L.).

Sources	d.f.	Character				
		Seed cotton yield/plant	Ginning outturn	Seed Index	Lint Index	2.5% span length fibre fineness
Environments (E)	2	74292.679**	115.419**	30.169**	2.428**	92.150**
Genotypes (G)	35	3948.863**	11.622**	4.459**	2.096**	7.600**
G x E	70	444.616**	0.627**	0.391**	0.173**	0.770
Error	210	58.136	0.331	0.055	0.036	1.109
						0.184

* Significant at 5% probability level.

** Significant at 1% probability level.

TABLE 2
Heterobeltiosis pooled over environments for six characters in upland cotton (*G. hirsutum* L.).

Crosses	Characters					
	Yield/ Plant	Ginning outturn	Seed index	Lint index	2.5% span length	Fibre fineness
G. Cot-10 x H 777	-14.27**	2.45**	1.15	5.03**	-2.61	11.35**
x Sharda	60.30**	-0.47	-3.78**	-4.48**	3.59	8.02
x DCI-108	24.42**	0.20	-0.77	3.26	-1.77	5.65
x G. 2360	-2.48	1.31	-3.58**	7.37**	2.44	-1.23
x LRK-516	24.32**	2.62**	5.81**	10.37**	0.83	-2.94
x B. N.	43.67**	-1.41**	2.03	-0.41	3.12	1.66
x S. D.		-2.20**	7.47**	3.49**	2.83	6.82
H 777	62.05**	-0.06	-3.01**	-1.30	0.42	11.75**
x Sharda	8.95**	-1.34	-2.43		-6.07**	19.00**
x DCI-108	25.59**	-1.01	-8.50**	7.93**	-1.63	0.26
x G. 2360	36.33**	-3.09**	2.89**	-7.05**	2.03	6.76
x LRK-516	33.08**	1.06**	-5.14**	-2.10	-4.16*	10.77*
x B. N.	74.16**	2.04**	1.38	-3.78	-3.04	2.11
x S. D.				6.40**		
Sharda	20.40**	-2.21**	-1.19	4.39*	-3.36	18.34**
x DCI-108	29.13**	2.31**	-8.16**	2.91	4.22	10.89*
x G. 2360	33.50**	-0.69	-0.14	-1.38	-1.20	2.94
x LRK-516	31.00**	0.80	-0.72	0.49	-2.88	8.31
x B. N.	43.00**	-0.92	0.84**	5.14*	-2.83	6.59
x S. D.						
DCI-108	1.16	-4.33**	-8.31**	-3.46	-0.34	10.10*
x G. 2360	-26.28**	0.01	-1.76	5.05**	-1.20	24.77**
x LRK-516	-00.23	-0.66	-0.33	3.90	0.15	17.96**
x B. N.	23.84**	-2.83**	5.83**	6.82**	1.18	12.34*
x S. D.						

1	2.	3.	4.	5.	6.	7.	
G. 2360	x LRK-516	-6.49	-0.08	1.96	7.99**	4.80*	13.53*
	x B. N.	29.63**	-1.75*	-12.45**	14.51**	1.60	-2.36
	x S. D.	35.50**	3.21**	8.86**	2.97	3.68	4.46
LRK-516	x B. N.	25.16**	-1.37	0.49	-1.82	-0.37	5.88
	x S. D.	52.92**	7.32**	0.00	12.27**	-0.42	9.71
B. N.	x S. D.	19.71**	3.16**	5.34**	10.83**	0.74	8.84

* Significant at 5% Probability level

** Significant at 1% Probability level

B. N. Bikaneri Narma

S. D. = Surat Dwarf

cotton yield, ginning outturn, seed index, link index, 2.5% span length and fibre fineness is presented in Table 1. The analysis of variance revealed that a larger portion of the total variance for all the characters studied was attributed to genotypes and environments when these were tested against G x E component. Both environmental and genotypic variances were found to be highly significant for all the characters. The magnitude of variance for G x E interaction was found to be highly significant for all the characters except 1.5% span length. The magnitude of G x E variance for different characters was lower than those due to genotypes.

The heterosis over better parent in all the 28 crosses for all the six character has been presented in Table 2.

Yield / plant

The extent of heterobeltiosis for seed cotton yield/plant ranged from -26.28 to 74.16 per cent. Out of 28 hybrids, 22 cross combinations exhibited significant positive heterobeltiosis. The cross, H. 777 x S. D. gave the highest heterosis (74.16 %) over the better parents. Singh and Singh (1981) and Bhatade and Rajewar (1994) also reported heterosis for seed cotton yield.

Ginning outturn

The heterobeltiosis varied from -4.33 to 7.32 per cent. In the present study, seven crosses manifested significant positive heterobeltiosis indicating importance of non-additive gene action. These results are in partial agreement with the results reported by Singh and Singh (1981) and Bhatade and Rajewar (1994).

Seed Index

In cotton, it has been reported that seed index had high positive association with boll weight (Kadapa, 1961, Singh *et al.* 1968). Six crosses exhibited highly significant positive heterobeltiosis. This may be ascribed to non-additive gene action for the inheritance of this trait. Among these, the cross G. Cot-10 x S. D. displayed highest heterobeltiosis (7.47%) and also recorded high seed cotton yield. Similar results have also been reported by Nagarajan *et al.*, (1994).

Link Index

The range of heterosis over better parent was from -14.51 (G. 2360 x LRK 516) to 12.27 (LRK-516 x S.D.) per cent. Only 13 out of 28 cross showed significant positive heterobeltiosis. Patil and Sheriff (1980) and Nagarajan *et al.* (1994) also observed heterosis for link index.

2.5% Span length

Throughout the world, fibre length is considered as the most important character amongst the fibre attributes (Sundaram, 1974). Heterobeltiosis for this trait was observed in only one cross, G.-2360 x LRK 516 (4.80%). This is in accordance with the results of Gururajan and Basu (1992).

Fibre fineness

In the present investigation a little improvement was recorded for this character. The results indicated that none of the hybrids under test recorded significant desired negative heterobeltiosis. The additive gene action with little dominance could have resulted in lower degree of heterosis for this character. These results are in partial agreement with the results reported by Prakash (1982).

The overall study of heterosis indicated that the cross combination LRK 516 x Surat Dwarf manifested highest link index, ginning percentage and high seed cotton yield. Thus it

become apparent that this hybrid could be successfully exploited for commercial cultivation after its sufficient testing over locations.

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Microbial Control of *Coccidohystrix insolita* (Green) on Pigeonpea*

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ABSTRACT

Microbial control of *Coccidohystrix insolita* (Green) infesting pigeonpea was studied in laboratory and field conditions at Junagadh. The entomogenous fungus, *cladosporium cladosporioides* tested at 3.6×10^6 and 2.7×10^6 spores/ml gave above 70 per cent mortality of *C. insolita*, whereas, *Fusarium pallidoroseum* at 6.1×10^5 spores/ml and *Alternaria alternata* at 5.6×10^4 spores/ml recorded above 60 per cent mortality in laboratory condition. Under field condition, *C. cladosporioides* at 3.6×10^6 spores/ml gave above 67 per cent mortality. Similarly, *F. pallidoroseum* at 6.1×10^5 spores/ml and *A. alternata* at 5.6×10^4 spores/ml gave more than 32 per cent mortality of *C. insolita*.

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INTRODUCTION

Pigeonpea *Cajanus cajan* (L.) Millsp. is an important legume crop and various insect-pests reduced the yield by 33.47 per cent in Saurashtra region of Gujarat State (Bhalani and Parsana, 1991). Among the 200 insect-pests (Lateef and Reed, 1990), the mealybug, *Coccidohystrix insolita* (Green) has been observed recently infesting pigeonpea in South Gujarat and Saurashtra regions (Patel *et al.*, 1985; Bhalani, 1990). Considering the importance of the pest, though *Fusarium* and *Alternaria* are the prudent pathogen for pigeonpea, but the species isolated in the present study worked as pest control agent rather than to cause disease in pigeonpea.

MATERIALS AND METHODS

Collection of the pathogen sample

The body of the mealybugs infected with fungi was dilated with pinkish colour and was mummified. The cadavar remained attached to the lower surface of the pigeonpea leaves by rhizoides under humid condition and turned brownish to blackish in colour. Such naturally diseased mealybug was collected and examined under compound binocular microscope for presence of pathogen. The isolation was carried out in potato dextrose agar medium and purified by single spore technique as described by Dhingra and Sinclair (1986). These cultures were got identified as *Alternaria alternata* (Fr.) Kessler agg, *Cladosporium cladosporioides* (Fres.) de

*Part of Ph.D. thesis submitted by senior author.

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Vries and *Fusarium pallidoroseum* (Cooke) Sacc. at International Mycological Institute, England.

Pathogenicity test of fungi

The pathogenicity test all three entomogenous fungi were carried out as described by Nayak and Srivastava (1978) and mortality was corrected by Abbott's formula before statistical analysis (Abbott, 1925).

Laboratory application

An isolated conidial suspension of *A. alternata* at a spore strength of 5.6×10^4 , 4.2×10^4 and 2.7×10^4 ; *C. cladosporioides* at 3.6×10^6 , 2.7×10^6 and 1.8×10^6

and *F. pallidoroseum* at 6.1×10^5 , 4.6×10^5 and 3.1×10^5 spores/ml was made by serial dilution method from the 15 days old culture grown in Richard's medium. Twenty-one days old potted pigeonpea plants were selected and tagged for the study. Before spraying, 25 third instar nymphs were released on each selected plants. The concentrated spore suspension of each entomogenous fungi was sprayed @ 3 ml per potted pigeonpea plant using atomizer. Each treatment replicated three times. In case of control only water was sprayed. Then, each plant was covered with glass chimney and top covered with muslin cloth. The mortality counts of mealybugs were recorded at 2, 3, 5, 7 and 10 days of treatments.

TABLE 1

Effect of different entomogenous fungi at different concentration against *C. insulita*, 7 days after spore application *in vitro*.

Sr. No.	Entomogenous fungi	Concentration (spore/ml)	Per cent mortality of mealybugs	
			Transformed	Retransformed
1.	<i>A. alternata</i>	5.6×10^4	50.91	60.24
2.	<i>A. alternata</i>	4.2×10^4	46.11	51.94
3.	<i>A. alternata</i>	2.8×10^4	42.26	45.23
4.	<i>C. cladosporioides</i>	3.6×10^6	73.70	92.12
5.	<i>C. cladosporioides</i>	2.7×10^6	57.69	71.43
6.	<i>C. cladosporioides</i>	1.8×10^6	49.33	57.53
7.	<i>F. pallidoroseum</i>	6.1×10^5	52.60	63.11
8.	<i>F. pallidoroseum</i>	4.6×10^5	46.90	53.31
9.	<i>F. pallidoroseum</i>	3.1×10^5	43.80	47.91
S. Em. $\pm$			2.12	
C. D. at 5%			6.31	
C. V. %			7.12	

Field application

The entomogenous fungi, *A. alternata*, *C. cladosporioides* and *F. pallidoroseum* were tested against mealybug with spore concentration of 5.6×10^4 , 3.6×10^6 and 6.1×10^5 spores per ml, respectively during the year 1991-92 and 1992-93 with six replication in a randomized block design. Twenty-four mealybugs infested pigeonpea (BDN 2) plants were selected. The suspension of respective entomogenous fungi applied in evening on tagged plants to the extent of slight run off. Water spray served as control. Subsequent spraying was done on 10th day of first application. The mealybug mortality was recorded before and after application at 2, 5, 7 and 10 days on five branches selected randomly from each plant of six randomly selected plants per replication. Three leaves (top, middle and basal) were selected randomly and tagged from each branch of the plant. Observation on mealybugs mortality due to infection by these fungi were recorded before and after application at 2, 5, 7 and 10 days. The data obtained were analysed after arcsin transformation.

RESULTS AND DISCUSSION

Pathogenicity test of fungi

The inoculated mealybugs were successfully infected by the entomogenous fungi, whereas in check they remained healthy. Infected mealybugs were inactive and sluggish, crawled slowly, ragging their legs and finally ceased to feed. The infected mealybugs turned orange to pink in colour within 2 days and died in 3 to 7 days after inoculation. The cadavar turned dry, shrunken, shapeless and lost holding with the leaves

in field, the body colour of the infected mealybugs changed to pinkish and mummified. The cadavar remained attached to the lower surface by rhizoids and under humid condition, the colour turned brownish to blackish. Such mummified mealybugs were blown off when dry climate prevailed. On the basis of radial growth, dry mycelial weight and sporulation of all three fungi viz., *A. alternata*, *C. cladosporioides* and *F. pallidoroseum* tested in 10 different media, Richard's medium was found to be the best for mass multiplication.

Laboratory application

All the entomogenous fungi at higher doses proved to be highly effective against *C. insolita* giving more than 60 per cent mortality 7 days after treatments (Table 1). However, *C. cladosporioides* with 3.6×10^6 spores per ml recorded significantly higher mortality (92.12%) than the rest of the fungi *in vitro*. *C. cladosporioides* at lower dose of 2.7×10^6 spores/ml gave more than 70 per cent mortality and it was followed by *F. pallidoroseum* at 6.1×10^5 spores/ml (63.11%) and *A. alternata* at 5.6×10^4 spores/ml (60.24%). In Kerala, Hareendranath *et al.*, (1987) have observed cent per cent mortality of *Aphis craccivora* Koch. with the application of *F. pallidoroseum*.

Field application

Pooled data on mortality of mealybugs population (Table 2) revealed that per cent mortality of *C. insolita* was highest with the application of *C. cladosporioides* (3.1×10^6 spores/ml) giving more than 67 per cent mortality 10 days after second spray in both the years. The application of remaining fungi viz., *F. pallidoroseum* (6.1×10^5 spores/ml) and *A. alternata* (5.6×10^4 spores/ml)

TABLE 2

Effect of different entomogenous fungi spray against *C. insolita* after 10 days of application in field.

Sr. No.	Treatment	Concentration (Spores/ml)	Mean no. of <i>C. insolita</i> per leaf before application			Per cent mortality of <i>C. insolita</i>						
						First Spray			Second Spray			
			1991-92	1992-93	Pooled	1991-92	1992-93	Pooled	1991-92	1992-93	Pooled	
1.	<i>A. alternata</i>	5.6 x 10 ⁴	6.38 ⁺ (40.70)	6.54 ⁺ (42.77)	6.46 ⁺ (41.73)	25.67 ⁺ (18.77)	23.42 ⁺ (15.80)	24.55 ⁺ (17.26)	36.42 ⁺ (35.25)	34.49 ⁺ (32.07)	35.47 ⁺ (33.66)	
2.	<i>C. cladosporioides</i>	3.6 x 10 ⁶	6.25 (39.06)	7.01 (49.14)	6.63 (43.96)	36.00 (34.55)	31.89 (27.91)	33.95 (31.19)	56.14 (68.96)	55.20 (67.43)	55.67 (68.20)	
3.	<i>F. pallidoroseum</i>	6.1 x 10 ⁵	6.76 (45.70)	6.92 (47.89)	6.84 (46.79)	29.11 (23.67)	25.25 (18.20)	27.18 (20.87)	43.05 (46.60)	39.14 (39.84)	41.09 (43.20)	
4.	Control (water spray)	—	6.86 (47.06)	7.11 (50.55)	6.98 (48.72)	10.05 (03.05)	10.73 (03.47)	10.39 (03.25)	12.04 (04.35)	13.88 (05.75)	12.96 (05.03)	
S. Em. ±												
			—	0.40	0.50	0.31	1.20	1.54	0.99	2.38	1.48	1.39
C. D. at 5%												
			—	N.S.	N.S.	N.S.	3.62	4.65	2.85	7.18	4.47	4.00
C. V. %												
			—	14.99	17.90	16.59	11.69	16.55	14.10	15.80	10.18	13.39

*transformed values.

+ Arcs in transformed values.

Figures in parentheses are retransformed values.

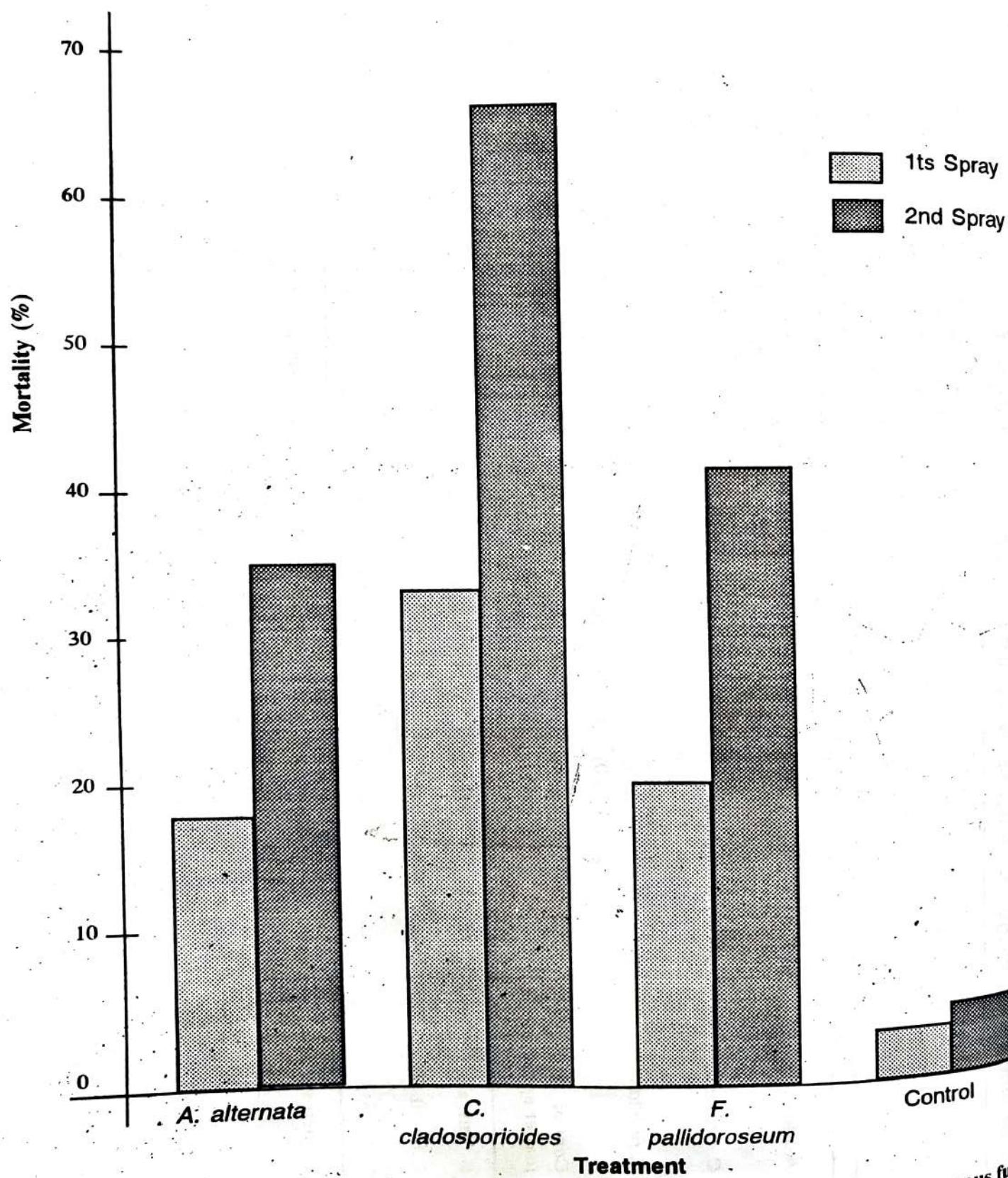


Fig. 1 : Pooled mean per cent mortality of *C. insolita* with field application of entomogenous fungi.

registered more than 32 per cent mortality 10 days after second sprays (Fig. 1). According to Samways and Grech (1986), the field application of *Cladosporium oxysporum* had resulted 82.8 per cent reduction of *Toxoptera citricidus* (Kirk.) in South Africa.

Thus, it can be concluded that entomogenous fungi, *C. cladosporioides* play

an important role in minimizing the population of *C. insolita* in pigeonpea followed by *F. pallidoroseum* and *A. alternata*.

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Sunnhemp - *Crotalaria juncea* Linn. A Reservoir for Entomophages at Anand (India)

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ABSTRACT

As many as 18 species of entomophages belonging to six orders and 14 families occurred on the *Crotalaria juncea* Linn. during 1994 and 1995 seasons. Out of these *Geocoris ochropterus* Fieber was the most abundant species.

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INTRODUCTION

Geocoris ochropterus Fieber is one of the important predators associated with different insect pests in several ecosystems. (Subha Rao *et al.*, 1965, Kumar and Ananthakrishnan, 1986, Sannigrahi and Mukhopadhyay, 1992, Kapadia and Puri, 1991, Kingeren *et al.*, 1968). During 1994 season its appearance in large number on green manuring crop *Crotalaria juncea* Linn. just before the start of cotton crop, where the predator played an important role in suppression of pests, tempted us to record the observation on its population dynamics. The observations on its population along with other entomophages encountered were recorded during 1994 and 1995 seasons. The results are presented in the paper.

MATERIALS AND METHODS

A 0.2 ha field of *C. juncea* was selected at university farm and observations on number

of *G. ochropterus* and other entomophages were recorded on 25 randomly selected plants at weekly intervals starting from the 12th July to 28th August in 1994 and from 21st June to 21st August in 1995. The results are presented in Table 1.

RESULTS AND DISCUSSION

The observations indicated that as many as 18 species of entomophages belonging to six orders and 14 families occurred during the season. Of these *Geocoris ochropterus* (Fieber) was the most abundant (34.28 and 38.1 per 25 plants during 1994 and 1995 respectively and occurred throughout the course of study. All the stages of the predator i.e. egg, nymph and adults were observed. This suggested that the predator had been reproducing. While predation by *G. ochropterus* was observed in the field, the other natural enemies were found hunting for

TABLE 1

Entomophages found on sunnhemp during July, August, 1994 and 1995.

Predator/Parasites Taxa	No./ 25 plants	Remarks	Reference
1.	2.	3.	4.
Hemiptera		Associated with cotton ecosystem	Schuster <i>et al.</i> , 1976
Lygaeidae			Yadav, 1994
<i>Geocoris ochropterus</i> (Fieber)	34.28 (38.1)	Potential predator of <i>Heliothis zea</i> boddie	Lingeren <i>et al.</i> , 1968.
		Reported as nymphal and pupal predator of <i>Bemisia tabasci</i> (Gemmadois)	Kapadia and Puri, 1991
Nabidae			
<i>Nabis</i> sp.	1.00 (0.2)		
Unidentified species	0.71 (0.00)		
Anthocoridae <i>Orius</i> Sp.	0.57	Feeds on thrips, nites, aphids and Lepidopteran eggs	Kiman and Yeargan, 1985
Reduviidae			
<i>Coranus spiniscutis</i> Reutr.	1.71 (0.2)	Feeds on larvae of <i>Helicoverpa</i> Hubner	Patel, 1985
<i>Rhinocoris fuscipes</i> Fa.	1.14 (0.1)	Feeds on larvae of <i>H. armigera</i> Hubner and <i>Spodoptera litura</i> Fab. green stink bug, <i>Nezara viridula</i> Linn. (in soybean)	Anon., 1993 Singh and Singh, 1987
Pentatomidae			
<i>Andrallus spinidens</i> Fb.	0.42 (0.2)	Feeds on larvae of <i>H. armigera</i> Hubner	Rajendra and Patel, 1971
Coleoptera			
Coccinellidae			
<i>Coccinella septumpunctata</i> Linn.	0.85 (0.30)	Potential predator of <i>Aphis craccivora</i> Kocha	Patel <i>et al.</i> , 1976
<i>Menochilus sexmaculatus</i> Fa.	2.72 (3.1)	Potential predator of <i>Craccivora</i> Kocha	Patel <i>et al.</i> , 1976
Carabidae			
Unidentified species	2.14 (0.2)		
Staphylinidae			
<i>Paederus</i> sp.	1.57 (3.1)	Abundant in groundnut and Cotton- Feeds on just hatched larvae of <i>Spodoptera litura</i> Fab. and Jassids on cotton	Anon., 1971

1.	2.	3.	4.
Diptera			
Tachinidae			
<i>Drino imberbis</i> wied	1.14 (0.50)	Parasitises late instar larva of <i>H. armigera</i>	Yadav, 1980
<i>Peribaea orbata</i>	0.57 (0.2)	Parasitises young larvae of <i>Earias vittella</i>	Bandhanja, 1982
Asilidae			
Unidentified species	1.57 (0.4)	Feeds on cotton jassids, <i>Enpoasca bigutulla bigutulla bigutulla</i>	Yadav, 1994
Hymenoptera			
Formicidae			
<i>Componotus</i> (F.)	7.21 (4.60)	Associated with cotton crop, Feeds on Young <i>H. armigera</i> larva	Manjunath, 1974
Dictyoptera			
Mantidae			
<i>Mantis</i> sp.	0.42 (0.57)		
Arachnida clubionidae	0.57 (3.3)	Feeds on larva of <i>H. armigera</i> Hubn. and <i>S. litura</i> Fa.	Dhulia and Yadav, 1991
<i>Clubiona</i> sp.			
Oxyopidae			
<i>Oxyopes ratnae</i> Tikadar	1.28 (1.50)	Feeds on soft bodied insects, larvae of <i>H. armigera</i> Hubn. and <i>Anomis flava</i> P.	Dhulia and Yadav, 1991

* Mean of 8(10) observations.

** Figures in paranthesis are of the year 1995.

their host/prey. These however, are known to parasitise/predate on several other insect pests on some other economical crops (Table 1). The nymphs and adults of *G. ochropterus* were often found preying upon young larvae of *Argina cribraria* Clerk, (Lepidoptera : Hypsidae), unidentified aphids, coleopterans, ants etc. The predator bugs seems to be quite sturdy as it was always observed in greater number despite continuous heavy rains (787.6 mm with 59 rainy days) during 1994. The population of *A. cribraria* remained low during both the years (1.57 larvae and 0.70 larvae per 25 plants.

during 1994 and 1995 respectively), probably due to the abundance of *G. ochropterus*. It appeared that a large number of *G. ochropterus* and other natural enemies were either perished or dispersed in search of new niches, when the crop was ploughed on 31st August in 1994 and on 21st August during 1995 for green manuring. The population of *G. ochropterus* at this time during both the years was quite high (34.28/25 plants in 1994 and 38.1/25 plants during 1995 whereas, other natural enemies viz. *Menochilus sexmaculatus* Fb., *Coccinella septumpunctata* Linn., *Nabis* sp., *Coranus*

spiniscutis Reutr, *Orius* sp., *Andrallus spinidens* Fb., *Camponotus* sp., *Paederus fuscipes* Fa., *Rhinocoris fuscipes* Fa. were found in small number (less than 7/25 plants). There are several reports where corn, maize mays and sorghum have been found to harbour a large number of entomophages (Fye, 1972; Javier and Altieri, 1990, Singh and Singh, 1987). Similarly, weeds such as wild parship, *Pastinaca sativa* L. (Wolcott, 1942), Starburr, *Acanthospermum hispidum* (Manjunath et al., 1976) and Sena, *Cassia occidentalis* Vahl. (Patel and Yadav, 1990) have been reported as reservoir for entomophages. In the present study the sunnhemp plants were found to harbour a large number of natural enemies perhaps due to insecticide free dense crop planting. *G.*

ochropterus in particular was observed in great number and its high population just before the ploughing of the crop for green manuring is of great interest. It however, remains to be seen whether a huge number of *G. ochropterus* and other natural enemies perish or disperse in serch of new niches; Nevertheless, information generated may help in designing the experiments on conservation utilization of enemies *G. ochropterus*.

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Population Build Up of Jassid *Empoasca kerri* Pruthi (Cicadellidae : Hemiptera) in Popular Varieties of Groundnut

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ABSTRACT

The field experiments were conducted during two consecutive *kharif* seasons of 1995 and 1996. Fifteen popular varieties grown in different parts of the country were sown for the study of incidence of jassid, *Empoasca kerri* Pruthi in the agroclimatic condition of Junagadh. Results indicated that GG 3 carried significantly lowest jassid population, whereas variety Somnath harboured maximum number of jassids among the tested varieties.

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INTRODUCTION

Groundnut is important cash crop of Saurashtra region of Gujarat State. Many insect pests cause damage to this crop, of which jassid, *Empoasca kerri* Pruthi is one of the most serious pest. The resistant or less susceptible variety plays an important role in formulating pest management programme. The present studies deal with population build up of jassid in popular varieties of groundnut.

MATERIALS AND METHODS

The field experiments were conducted during *kharif* seasons of 1995 and 1996 at Gujarat Agricultural University, Junagadh Campus, Junagadh. Fifteen popular varieties of different habit groups grown in different parts of the country were sown for the study of incidence of jassid in the agroclimatic condition prevailing at Junagadh. Each variety was grown in a plot size of 4.5 x 6.0 m. The details regarding varieties and their habit group are given below :

Sr. No.	Variety	Habit group	Botanical group
1.	GG 2	Erect (bunch)	Spanish
2.	GG 3	Erect (bunch)	Spanish
3.	GG 4	Erect (bunch)	Spanish
4.	JL 24	Erect (bunch)	Spanish

Sr. No.	Variety	Habit group	Botanical group
5.	J 11	Erect (bunch)	Spanish
6.	TG 26	Erect (bunch)	Spanish
7.	ICGS 37	Erect (bunch)	Spanish
8.	Gimar 1	Erect (bunch)	Spanish
9.	GG 20	Semi-spreading	Virginia
10.	TMV 10	Semi-spreading	Virginia
11.	Kadiri 3	Semi-spreading	Virginia
12.	GG 11	Spreading (runner)	Virginia
13.	GG 12	Spreading (runner)	Virginia
14.	GG 13	Spreading (runner)	Virginia
15.	Somnath	Spreading (runner)	Virginia

All the plots received an uniform basal fertilizer dose of 12.5 N + 25.0 P kg/ha. The experimental plots were kept free from weeds by weeding and hoeing as and when required. The plot was kept unsprayed throughout the seasons. Each plot was divided into four quadrates. Ten plants from each quadrate were selected for observing jassid population. The jassid nymphs per plant were recorded at weekly interval till harvest of the crop. Mean pest incidence was worked out and the data thus obtained were subjected to statistical analysis for assessing the relative incidence on groundnut varieties.

RESULTS AND DISCUSSION

The yearwise results (Table 1) indicated that the population build up of jassid, *E. keri* was higher in the year 1995 as compared to 1996 in different varieties. However, similar trend was observed in different varieties during both the year. Pooled results revealed that groundnut variety GG 3 carried significantly least jassid population (4.67 nymphs/plant) among fifteen varieties tested. Next in order was J 11, GG 2 and GG 4. The variety Somnath was found to be the most susceptible as it recorded 6.45 nymphs per plant and was at par with Kadiri 3 (6.45).

TABLE 1

Mean number of *E. kerri* nymphs per plant in different groundnut varieties.

Sr. No.	Variety	1995		1996		Pooled mean	
1.	GG 2	2.53*	(6.40)	2.01	(4.04)	2.27	(5.15)
2.	GG 3	2.42	(5.86)	1.90	(3.61)	2.16	(4.67)
3.	GG 4	2.57	(6.61)	2.04	(4.16)	2.30	(5.29)
4.	JL 24	2.67	(7.13)	2.18	(4.75)	2.42	(5.86)
5.	J 11	2.44	(5.95)	1.97	(3.88)	2.20	(4.84)
6.	TG 26	2.76	(7.62)	2.27	(5.15)	2.52	(6.35)
7.	ICGS 37	2.76	(7.62)	2.27	(5.15)	2.52	(6.35)
8.	Girnar 1	2.77	(7.67)	2.27	(5.15)	2.52	(6.35)
9.	GG 20	2.61	(6.81)	2.08	(4.33)	2.34	(5.48)
10.	TMV 10	2.77	(7.67)	2.30	(5.29)	2.53	(6.40)
11.	Kadiri 3	2.78	(7.73)	2.30	(5.29)	2.54	(6.45)
12.	GG 11	2.73	(7.45)	2.25	(5.06)	2.49	(6.20)
13.	GG 12	2.74	(7.51)	2.25	(5.06)	2.49	(6.20)
14.	GG 13	2.62	(6.86)	2.14	(4.58)	2.38	(5.66)
15.	Somnath	2.78	(7.73)	2.30	(5.29)	2.54	(6.45)
	S. Em. $\pm$	0.01		0.01		0.01	
	C. D. at 5%	0.02		0.03		0.03	
	C. V. %	4.22		9.25		6.74	

*√ Transformed values.

Figures in the parenthesis are retransformed values.

TMV 10 (6.40), Girnar 1 (6.35), ICGS 37 (6.35) and TG 26 (6.35). The varieties GG 12, GG 11, JL 24 and GG 13 showed moderate population of jassid as they registered 6.20, 6.20, 5.86 and 5.66 jassid nymphs per plant respectively. Therefore, GG 3 variety

may be recommended for cultivation in this region. According to Singh (1989) and Wheatley *et al.* (1989) the varieties, JL 24 and Kadiri 3 carried higher jassid population. Thus, present findings confirm the same.

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Activities of Mycophagous Beetle *Phalacrus immarginatus* Champ. on Whip Smut of Sugarcane*

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ABSTRACT

During the frequent surveys of Saurashtra region in Gujarat, an insect was observed constantly associated with smutted whips of sugarcane later identified as *Phalacrus immarginatus* Champ. beetle. The grub and adult stages of the beetle proved as heavy spore feeders. The mycophagous beetles were recorded throughout the crop season. The number of grubs and adults per whip recorded were 3 to 52 and 2 to 18 respectively, during the entire crop season in 1991. The highest insect population was recorded in the month of July and lowest in the month of September.

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INTRODUCTION

Sugarcane smut (*Ustilago scitaminea* Syd.) is an important disease in all sugarcane growing areas of the country. In Saurashtra region of Gujarat, it causes heavy quantitative and qualitative losses in most of the popular varieties like Co. 791, Co. 419 and Co. 7527. The smut affected plant produces apical whip consisting millions of smut teliospores which are disseminated by wind as well as insect and therefore act as potential source of secondary infection in nearby sugarcane plants (Antoine, 1961; Grillo and Saucedo, 1985). In Saurashtra region, the beetle, *Phalacrus immarginatus* were found constantly associated with smut whip throughout the crop season. They were seen

to damage smut whip and hence the study on the activities of this insect on smutted whip was undertaken.

MATERIALS AND METHODS

During the survey for sugarcane smut, some insects were invariably found on the sugarcane smut whip at the research farm, Gujarat Agricultural University, Junagadh and surrounding areas. The insects were collected and sent to the Director, International Institute for Entomology, London for confirmation of identifications.

The observations regarding marks of identification of eggs, grubs, pupa and adult of the insect were recorded.

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The feeding done by the insect on the smut whip was regularly monitored in the field and observations were recorded. The grubs were simultaneously dissected and observed under microscope to examine the presence of the smut spore in alimentary canal. These spores were cultured artificially to confirm the viability.

Monthly observations on grub and adult population were recorded from January, 1991 to December, 1991 in the heavily smut infected sugarcane fields at the research farm, Gujarat Agricultural University, Junagadh.

The grub and adult feeding on smut whips were collected separately and each were put in 2 ml. of water in a test tube. After shaking well, the spore count was done under microscopic field. The spores, thus observed were counted in 2 ml. of water. Such 25 observations were undertaken each for grub and adult.

RESULTS AND DISCUSSION

The adults of spore feeding insects collected from the smut infected sugarcane fields and sent to the Director, IIE, London and was identified as *Phalacrus immarginatus* Champ. (Coleoptera : Phalacrusidae).

The eggs of *P. immarginatus* were watery white and oblong measuring 0.48 to 0.78 mm in length and 0.15 to 0.30 mm in breadth. The eggs were laid in group of 4-6 inside the silvery membrane of smut whip in infected field. The newly hatched grub was more active, minute and transperant white. Later, it turned to whitish yellow with semi transperant abdominal segments. From the outward appearance, the grub looked blackish

due to feeding and ingestion of the smut spores. The grubs posses brown head with retractile mouth parts. The fully grown grub measures 4.80 to 5.60 mm in length and 1.30 to 1.60 mm in breadth. When nearing pupation, it ceases to feed and remain quescent for a time before pupating. The pupation takes place on base of the observed whip with leaf sheath. The pupa looks white in colour measuring 2.60 to 3.50 mm in length and 1.30 to 1.80 mm in breadth. The adult being convex, oval and shining black measuring 2.40 to 3.70 mm in length and 1.40 to 2.50 mm in breadth. The antennae were clavate and 11 - segmented. The elytra covers the abdomen entirely. This is more or less similar with the observations of Agarwal (1956).

The grub and adult stages of insect were found to feed smut spores. The grub forms a tunnel by feeding the spore mass on the basal part of whip which remains covered by the leaf sheath. The adult has always been found feeding spore mass by scraping on the open portion of the smut whip making irregular patches. The silvery membrane of infected smut whip was shredded-off due to insect feeding. Dissection of the grubs collected from the smut whip showed the presence of the spores in the alimentary system. The spores collected from the alimentary canal appeared to be normal but failed to germinate when cultured artificially as was earlier reported by Agarwal (1956).

The observations on the population of *P. immarginatus* were recorded during the crop season from smut infected sugarcane field. The results obtained on grub and adult population are presented in Table 1.

TABLE 1

Grub and adult population of *P. immarginatus* on smut whip of sugarcane.

Sr. No.	Month	No. of whip observed	No. of whip infested by <i>P. immarginatus</i>	Av. no of <i>P. immarginatus</i> /whip	
				Grub	Adult
1.	January	25	19	14	4
2.	February	38	22	16	3
3.	March	78	56	21	5
4.	April	100	92	12	5
5.	May	100	100	27	13
6.	June	100	100	39	16
7.	July	100	80	52	18
8.	August	88	51	5	2
9.	September	63	12	3	2
10.	October	56	20	21	4
11.	November	92	73	26	6
12.	December	83	62	18	4

The highest population of both the stages was recorded in the month of July, whereas, it was found the lowest in the month of September. The observations on the activities of this beetle while being in association of smutted whips revealed that they were heavy spore feeders and may act as potential biological control agent for sugarcane smut. These were earlier found effective in controlling the smut in Bolivia (Druett and Colque, 1984) and Cuba (Grillo and Saucedo, 1985).

The results presented clearly indicate that the mycophagous insects were observed throughout the crop season. The maximum number of whips with mycophagous insects were recorded in the months of May and June followed by April and July.

During the crop season, the population of the grub and adult was noted ranging from 3 to 52 (Av. 21.17) and 2 to 18 (Av. 6.87) per whip, respectively. The highest population of both

the stages was recorded in the month of July (52 grubs and 18 adults/whip) whereas it was found lowest in the month of September (3 grubs and 2 adults/whip). The observations on the activities of this beetle while being in association of smutted whips revealed that they were heavy spore feeders and may act as

potential biological control agent for sugarcane smut.

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Research Management Ability of the Heads of Research Departments in Gujarat Agricultural University

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ABSTRACT

To make a research organisation more productive, the proper research management practices should be adopted. Therefore, to measure extent and manner of research management ability of scientists who are working as head in Gujarat Agricultural University, the present investigation was undertaken. The results indicated that majority (71.67 per cent) of the heads exhibited medium level of research management ability. It also revealed that the span of control and research experiments to be conducted by heads had negative and highly significant relationship with their research management ability, while the age, interpersonal communication and departmental/station climate had positive and highly significant relationship with their research management ability.

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INTRODUCTION

Management is a universal process. Management of the organisation has attained paramount importance for the achievement of goals in modern time. The agricultural research management in India is relatively a new area. The head of departments/stations/projects/schemes of the agricultural university have to perform many research management functions. Thus, to make a research organisation more productive, the proper research management practices should be adopted by the research leaders. However, it is observed that the scientists who are working as the head have neither education nor experience in the field of management before they become head, even though, they have to

carry the responsibilities of management aspects too. Thus, to measure extent and manner of research management ability of scientists who are working as head in Gujarat Agricultural University the present investigation was undertaken.

MATERIALS AND METHODS

In the present study research management ability of the head has been operationalised as the ability of the head to apply the basic principles of management in running the department/station/project/scheme for agricultural research work. The standard scale to measure research management ability of the heads was developed for the purpose. All the independently working heads of the agricultural research department/station/

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project/scheme of the Gujarat Agricultural University were selected for the study purpose. For measuring research management ability of the selected heads two immediate subordinates of each head were randomly selected from respective department/stations/project/scheme. Thus in all 69 research heads

and 138 thier subordinates were selected. Two questionnaires were prepared for the study, one for the heads and the another for their subordinates. The respective questionnaire to the heads and subordinates were separately mailed to each person. Finally 86.95% responses were received.

$$RMAI = \frac{\text{Score obtained for the sub-component} \times \text{Weightage of the sub-component} \times \text{Scale value of main component}}{\text{Maximum score for the sub-component} \times \text{Weightage of the sub-component} \times \text{Scale value of main component}}$$

Measurement of dependent variable (RMAI)

To measure the research management ability of the research heads, the research management ability scale was applied to the two immediate subordinates of each head and RMAI from both the subordinates were calculated. The final RMAI of the head was determined by averaging the RMAI get from both the subordinates of respective head. Coefficient of correlation were computed to findout the relationship between each of the independent variable and dependent variable.

RESULTS AND DISCUSSION

Level of research management ability of heads

The data in Table 1 revealed that majority (71.67 per cent) of the respondents exhibited medium level of research management ability. Almost equal number of respondents were in low (15.00 per cent) and high (13.33 per cent) level of ability group.

It can be concluded that the majority (71.67 per cent) of the heads had medium level of research management ability. This might be due to the similar pattern of working situations in which they are working.

TABLE 1

Distribution of heads according to their research management ability index.

N = 60

Sr. No.	Category	Index range	Frequency	Per cent
1.	Low	Upto 55.73	9	15.00
2.	Medium	55.74 to 87.89	43	71.67
3.	High	Above 87.89	8	13.33

1. Relationship of research management ability of the heads with their selected characteristics

a. Personal characteristics

The five personal variables viz., age, academic qualification, family size, belonging state and health were studied in relation to research management ability index (RMAI) of the heads. The data are reported in Table 2.

TABLE 2

Correlation coefficient between personal characteristics of heads and their RMAI.

N = 60

Sr. No.	Name of variable	'r' value
1.	Age	0.2744*
2.	Academic qualification	-0.0070 NS
3.	Family size	-0.0331 NS
4.	Belonging State	0.0650 NS
5.	Health	-0.1950 NS

NS = Non Significant at 0.05 level.

* = Significant at 0.05 level.

The data presented in Table 2 revealed that age had positive and significant relationship with RMAI of the heads. It implies that as age increases the RMAI increases. It means older heads seemed to be better than the younger. This might be because of the tendency that the aged head would be more balanced and tactful than the younger ones. This finding was in conformity with those of Nair (1974), Nikhode and Kitey (1984), Kherde and Sahay (1972) and Sharma *et al.* (1988).

Academic qualification, Family size and Health had negative but non significant relationship with RMAI of the heads. These findings were in conformity with the findings of G. Rani (1985).

Regarding belonging State (i.e. Gujarat and other than Gujarat) had non-significant relationship with RMAI of the heads.

B. Organisational characteristics

Eight organizational variables i.e. (1) on campus/off campus situation (2) Span of control (3) research experiments to be conducted (4) interpersonal communications (5) departmental/station climate (6) staff facility (7) grant facility for research material and (8) office/research facility were studied in relation to RMAI. Data regarding the same are presented in Table 3.

TABLE 3

Correlation coefficient between organizational characteristics of heads and their RMAI.

Sr. No.	Name of variable	'r' value
1.	Off campus situation	-0.1810 NS
2.	Span of control	-0.3275**
3.	Research experiments to be conducted	-0.3850**
4.	Interpersonal communication	0.4676**
5.	Departmental/station climate	0.3884 **
6.	Staff facility	0.0368 NS
7.	Grant facility for research material	-0.0910 NS
8.	Office/research facility	-0.0853 NS

NS = Nonsignificant at 0.05 level.

** Significant at 0.01 level.

Among all organizational characteristics, span of control and research experiments to be conducted had negative significant relationship with RMAI of heads. This might be

due to the fact that, it is easy to control/coordinate the smaller group as compared to the bigger group, and more number of experiments increase the work load of the head, which directly affects on management. While interpersonal communication and departmental/station climate had positive significant relationship with RMAI of the heads. It implies that more the interpersonal communication higher will be the RMAI and the heads who perceived the climate of department/station as healthier had also higher RMAI.

This may be because interpersonal communication would promote the spread of ideas/instructions among the subordinates and other which would help heads to perform better management. The congenial climate for research activities as well as good cooperation and coordination at all the levels also might be resulted in higher RMAI.

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This findings were in line with findings of Murthy and Somasundram (1989), Laharia (1978) and Reddy and Jayaramaiah (1990).

It is also seen in Table 3 that off campus situation, staff facility, grant facility for research material and office/research facility had non significant relationship with RMAI of the heads.

Implication

Present investigation revealed that the majority of the heads were in the medium level of research management ability, and therefore, it is implied that there is urgent need to improve the research management ability of the heads, the efforts should be concentrated to strengthen the training facilities of management aspects. increasing the grant facility for research material and reducing the unproductive work load.

Influence of Socio-Psychological Correlates on Farm Women's Contribution in Mixed Farming

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ABSTRACT

The present study highlights the relationship that exists between the various socio-psychological characteristics of farm women and their contribution in mixed farming activities. The study was conducted in Kheda district of Gujarat State. The results indicated that all the socio-psychological factors i.e. social participation, achievement motivation, economic motivation, cosmopolite orientation, scientific orientation, agricultural beliefs and attitude towards mixed farming were having direct bearing on farm women's contribution in mixed farming.

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INTRODUCTION

It is an admitted fact that farm women play a significant and crucial role in managing the farm affairs and especially the home affairs. The daily work schedule of rural women is very demanding and arduous one. Her day starts in the early hours of the morning and she retires to bed at night. In India 79 per cent of the female working population as against 63 per cent of men is found actively engaged in agriculture and agricultural based enterprise i.e. mixed farming. Munjal *et al.* (1985), stated that about 60 per cent, 90 per cent and 95 per cent of women in farm families participated respectively in crops, dairy and home activities. However, their contribution in mixed farming production system varies with several factors such as personal, social, economic, psychological etc. which needs to be investigated. Keeping in view the above facts, an attempt has been made to

study the influence of socio-psychological factors on farm women's contribution in mixed farming.

MATERIALS AND METHODS

Sample population for this study was selected from four blocks of Kheda district of Gujarat State. Four villages were randomly selected from each of these blocks. The study was conducted in sixteen villages. A list of the farm families of each village was prepared. Sixteen farm women from each list were randomly selected and interviewed. Thus, the sample population for this study consisted of 256 farm women. Productivity score for each respondent was calculated by using two dimensions, crop yield and economic performance. The formula developed by Yang (1962) was used with little modifications to obtain the total score of contribution of farm women in mixed farming activities.

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In order to ascertain the existance or non existance of relationship, correlation of coefficient (r) was computed.

RESULTS AND DISCUSSION

The existance of relationship between independent and dependent variable, when tested for all respondents (Table 1) it was observed that all the variables under study i.e. social participation, achievement motivation, economic motivation, cosmopolite orientation scientific orientation, agricultural beliefs and attitude towards mixed farming were positively and significantly correlated with farm women's contribution in mixed farming. It meant that as the level of these characteristics increased, the contribution of farm women in mixed farming activities also increased.

It is quite obvious that active participation of women in various formal and informal organizations provide them an opportunity to meet other people, develop contacts with them through interpersonal communication and share day to day experiences with them. This might have

TABLE 1

Relationship between independent variables with contribution of farm women in mixed farming.

Socio-Psychological variables	Coefficient of Correlation 'r' value
Social participation	0.328*
Achievement motivation	0.374*
Economic motivation	0.337*
Cosmopolite orientation	0.311*
Scientific orientation	0.435*
Agricultural belief	0.141*
Attitude toward mixed farming	0.425*

*Significant at 0.05 per cent level of probability.

inspired them to know about improved practices and to adopt the same to increase production. This might be the reason of significant relationship of social participation and cosmopolite orientation with contribution of farm women in mixed farming. The finding is in concurence with the findings reputed by Candy (1990). With the idea of getting maximum profit from the resources available with them, farm women try to adopt improved technology at faster rate and evaluate them more objectively by following scientific criteria and adopt it with more accuracy which leads to higher production. This may be the possible reason for significant correlation of scientific orientation and achievement motivation with women's contribution in mixed farming.

Crop cultivation alone is subjected to higher degree of risk and uncertainty and provides seasonal, irregular and uncertain income. On the other hand dairy enterprise provides constant and regular flow of income from milk production all round the year. Under such circumstances, mixed farming is the only solution not only to augument income but also it provides gainful employment to the members of family throughout year. This may be the possible reason for significant relationship of attitude towards mixed farming and their contribution in mixed farming activities.

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Participation of Rural Farm Women in Sugarcane Production

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ABSTRACT

The study was conducted during 1992-93 in two districts of Uttar Pradesh i.e. Rae-Bareilly and Faizabad districts. Majority of the respondents were in medium age group, illiterate and having small size of family. Majority of (57 per cent) rural farm women were having medium level of decision making ability and 36 per cent of rural farm women were having high level of involvement in work during sugarcane cultivation operations. Most of rural farm women were also having medium level of participation in sugarcane cultivation.

The decision making ability and involvement in work by rural farm women were found highly significantly related with women's participation. Education was also found significantly correlated with women's participation in sugarcane production.

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INTRODUCTION

Farm women are backbone of Indian agriculture. No any agricultural field operation is beyond women. Women contribute in operations like seed selection, sowing, transplanting, weeding, manuring, harvesting, threshing, winnowing, storing, marketing, rearing of livestock and poultry keeping etc. In many of these operations, they are more efficient than men. In sugarcane production more than fifty per cent of work is done by rural farm women. Most of the activities are carried out by rural farm women in sugarcane cultivation, except ploughing, pata and marketing. Rural farm women are actively participating in all agricultural practices of

sugarcane cultivation but in decision making they are not actively participating due to illiteracy and male dominance in society (Tata & Bali, 1988).

The bulletin of all India coordinated research project on sugarcane (1991) reported that among major sugarcane growing countries in the world, India, the native of sugarcane, stands second in the cane production and contributes more than 20 per cent of the world's sugar output. Although considerably large area is under this crop (3.4 million hectares), the productivity in general is quite low i.e. 65.4 tonnes/ha, occupying ninth position in the

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world. The study was taken with the following objectives :-

- i) to assess the decision making and involvement in work by rural farm women in sugarcane production.
- ii) to measure the women's participation in sugarcane production.
- iii) to correlate socio-economic variables with women's participation.

MATERIALS AND METHODS

The study was conducted during 1992-93 in Rae-Bareilly and Faizabad districts of Uttar Pradesh purposively, because in these two districts most of the farmers were sugarcane growers. Two villages from each district were selected randomly making the total number of four villages. From Rae-Bareilly districts Khagipur Sadwa and Rajapur villages and from Faizabad district Biroli and Lilapur villages were selected with the help of simply random technique. The farm women from the each village were grouped into five categories on the basis of land holdings viz. marginal (less than 1 ha); small (1-2 ha); medium (2-4 ha); large (4-8 ha) and very large (above 8 ha) and five respondent women were selected randomly from each category. Therefore, twenty five respondent women were selected from each village. Thus, total hundred respondent women were included in the study from the four selected villages.

A detailed structured schedule was prepared to measure the different variables. To measure the socio-economic variables, the available scale of Trivedi and Pareek

(1963) was used and for decision making ability of rural farm women a schedule was prepared. The responses of the respondents towards particular inquiry were recorded on a three-point-continuum scale viz. 'individually' 'jointly' and 'occasionally' and weightages 3, 2 and 1 were assigned respectively. The decision making scores assigned to each respondents were sum totalled and mean ($\bar{X}$), standard deviation (SD) were computed by statistical methods. The decision making ability was categorised into three levels i.e. the respondents having scores below ($\bar{X} - S.D. \times 0.5$) were grouped under the category of 'low level decision' scores between ($\bar{X} - S.D. \times 0.5$) and ($\bar{X} + S.D. \times 0.5$) were grouped under the category of 'medium level decision' and scores above ($\bar{X} + S.D. \times 0.5$) were grouped under 'high level decision' category. To measure extent of involvement in work by rural farm women similar schedule was prepared. The responses of the respondents towards a particular inquiry were recorded on a three-point-continuum scale viz. 'regularly', 'sometime' and 'never' and weightages 3, 2 and 1 were assigned respectively. It was also categorised into three levels similarly as in case of decision making ability. To measure the interrelationship in between independent and dependent variables the regression analysis statistical technique was used.

RESULTS AND DISCUSSION

Decision making ability

The decision making ability of rural farm women towards sugarcane cultivation was categorised into three levels i.e. low level, medium level and high level.

TABLE 1

Decision making ability of rural farm women.

<i>Decision making</i>	<i>Frequency</i>	<i>Per cent</i>	<i>Mean</i>	<i>S.D.</i>
Low level (below 37.5 scores)	22	22%	39.61	4.21
Medium level (between 37.5 to 41.7 scores)	57	57%		
High level (above 41.7 scores)	21	21%		
Total	100	100%		

The data presented in the above table 1 revealed that majority of rural farm women were having medium level of decision making ability in sugarcane cultivation operations i.e. 57 per cent; followed by low level decision making ability by rural farm women i.e. 22 per cent and out of 100 women respondents only 21 women were having high level of decision making ability. Therefore, the majority of rural farm women were having medium level of

decision making ability and lowest in high level of decision making ability during sugarcane cultivation operations.

Involvement in work

The involvement in work during sugarcane cultivation by rural farm women was also categorised into three levels i.e. low level involvement, medium level involvement and high level involvement.

TABLE 2

Involvement in work by rural farm women.

<i>Involvement level</i>	<i>Frequency</i>	<i>Per cent</i>	<i>Mean</i>	<i>S.D.</i>
Low level (below 65.12 scores)	30	30%	67.32	4.40
Medium level (from 65.12 to 69.52 scores)	34	34%		
High level (above 69.52 scores)	36	36%		
Total	100	100%		

The data presented in table 2 revealed that the majority of rural farm women were found in the category of high level involvement

in work during sugarcane cultivation i.e. 36 per cent and 34 per cent women were found under category of medium level involvement and

followed by 30 per cent of rural farm women having low level of involvement. It indicates that majority of rural farm women were having high level of involvement in sugarcane production activities.

Women's participation in sugarcane cultivation

To find out the rural farm women's participation the following simple relationship was hypothesized :

$$WP = \sum_{i=1}^N (PD + PI)$$

Where,

WP = Women's participation.

PD = Total scores of participation in decision making obtained by rural farm women

PI = Total scores of participation in involvement in work obtained by rural farm women.

N = Total number of respondents

The women's participation in sugarcane cultivation was measured and categorised into three levels i.e. the respondents having scores below $(\bar{X} - S.D. \times 0.5)$ were grouped under the category of 'low level participation', scores in between $(\bar{X} - S.D. \times 0.5)$ and $(\bar{X} + S.D. \times 0.5)$ were grouped under the category of 'medium level participation' and scores above $(\bar{X} + S.D. \times 0.5)$ were grouped under 'high level participation'.

TABLE 3

Women's participation in sugarcane cultivation.

Participation level	Frequency	Per cent	Mean	S.D.
Low level (below 103.72 scores)	26	26%		
Medium level (from 103.72 to 109.53 scores))	47	47%	106.63	5.81
High level (above 109.53 scores)	27	27%		
Total	100	100%		

The table 3 revealed that the majority of rural farm women were under the category of medium level participation i.e. 47 per cent and 27 per cent farm women were under the category of high level participation and followed by low level participation i.e. 26 per cent. Out of 100 women respondents 47 women were having medium level of participation

followed by 27 women having high level of participation in sugarcane cultivation. The women's participation in sugarcane cultivation was slightly higher. Therefore, rural farm women were participating in both cultivation activities and decision making during sugarcane production.

Interrelationship of socio-economic variables with women's participation

The interrelationship between independent and dependent variables is presented in table 4. The regression analysis of the seven independent variables i.e. age; education; family size; land holding; farm assets possessed; decision making and involvement in work with the dependent variable i.e. women's participation was computed.

TABLE 4

Regression analysis of women's participation.

Variables	Regression coefficient	T value
Age	3.182	1.059
Education	0.29	2.517*
Family size	-2.07	-0.195
Land holding	-4.97	-1.958
Farm assets	0.46	1.590
Decision making	0.47	7.615**
Involvement in work	0.97	15.389**

*Significant at 5% level of probability.

**Significant at 1% level of probability.

The decision making ability and involvement in work by rural farm women were found highly significant at 1 per cent level of

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probability with women's participation. Simultaneously, education was also found significant at 5 per cent level of probability with women's participation in sugarcane cultivation. Whereas, age; family size; land holding and farm assets possessed were found to have non-significant relationship with women's participation.

Conclusion

Majority of rural farm women were highly participating in operations of sugarcane cultivation but their participation in decision making during sugarcane cultivation was of medium level. It may be due to illiteracy or lack of knowledge among women. The development of education level among rural farm women will be the most important component for increasing their participation in agricultural production.

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Frequency Distribution of Biological Measurements and Harvest Index of Chickpea

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ABSTRACT

The frequency distributions of grain yield (X), biomass yield (Y) and harvest index (Z) of chickpea have been investigated for the data set of a uniformity trial conducted during the *rabi* season of the year 1993 at the Agricultural Research Station, Gujarat Agricultural University, Derol, Gujarat, India. Three probability distributions, viz., erlang, logistic and normal have been graduated and tested for their goodness of fit. Normal distribution gave good fit for X and Y but for Z, no distribution gave good fit.

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INTRODUCTION

The individual measurements of the experimental units of grain yield (X) are denoted by x_i , and the individual values of the experimental units of total biomass weight (Y) are y_i ($i = 1, 2, \dots, N$). The harvest indices are calculated by $z_i = (x_i / y_i)$. It is of particular interest for application in agronomy and in plant breeding (Donald and Hamblin, 1976).

In many agricultural applications, e.g., selection procedures in plant breeding, analysis of yield and yield components etc., the experimenter is particularly interested in three aspects in handling the harvest indices, viz., calculation of mean harvest indices, variability of harvest indices and correlation among grain yield, biomass weight and harvest index. These aspects have been investigated

theoretically by Huan (1990) and Huan *et al.*, (1991) and applied to the data sets of winter oilseed rape. They reported that normal distribution gave a good fit.

The determination of frequency distribution of ratios, viz., coefficient of variation (CV), land equivalent ratio (LER), harvest indices etc. is of particular interest for the field experimenters [Oyejola and Mead (1989), Huan (1992) and Singh (1995)] due to its major role and importance for the development of statistical test vis-a-vis-test of significance.

In the field of theoretical statistics, the distribution of $Z = X/Y$ must not be necessarily known and normally distributed though X and Y are bivariate normally distributed. A general solution of this problem exists (Fieller, 1932) but it can not be simply applied to the

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biological measurements (harvest indices) because of its complex solution and some restricting conditions imposed on two variables X and Y : $X > 0$, $Y > 0$ and $X < Y$. A specification of general solution for application to harvest indices is calling attention of Agricultural Statisticians and yet to be established (Huan, 1992). Therefore, it is assumed distribution free assumptions for X and Y with a subsequent derivation for the distribution of Z, but to postulate distributional assumptions for Z directly and to prove their validity empirically by using experimental data set based on a uniformity trial on chickpea.

MATERIALS AND METHODS

Data collection

A uniformity trial on chickpea crop was conducted during the *rabi* season of the year

1993 at the Agricultural Research Station, Gujarat Agricultural University, Deroi with recommended package of practices. The crop was sown in rows along North-South direction at a spacing of 30 cm between rows. A block of 25 m wide and 30 m long, in a contiguous unit of 1 m² giving in all 750 units, was harvested to collect the data on grain yield (X) and biomass weight (Y) for each unit, separately. Thereafter, the harvest index (Z) was derived in per cent for each unit.

Fitting of probability distribution

The study variates (X, Y, Z) were used in preparing frequency distributions. The measures of skewness (β_1) and kurtosis (β_2) based on moments about mean were obtained by the following methods (Hastings and Peacock, 1975).

$$\beta_1 = (\mu_3)^2 / (\mu_2)^3$$

$$\text{and, } \beta_2 = (\mu_4) / (\mu_2)^2$$

$$\text{where, } \mu_r = \frac{1}{N} \sum_{j=1}^k f_j q(j - \bar{q})^r, \quad N = \sum_{j=1}^k f_j, \\ (r = 2, 3, 4)$$

where, q_j/f_j , ($j = 1, 2, \dots, k$), be the frequency distribution of the study variates, then its arithmetic mean $\bar{q}$ will be given by

$$\bar{q} = \left(\sum_{j=1}^k f_j q_j \right) / \sum_{j=1}^k f_j = \text{Arithmetic mean}$$

where, k = number of classes in the frequency distribution.

Assuming that the data from field experiments follow the continuous distribution, the continuous probability distributions which had no parametric relationship among themselves (i.e., no relationship between mean and variance) were considered to judge the

distribution of harvest indices. In this regard, three distributions, viz., normal, logistic and erlang distributions were examined (Hastings and Peacock, 1975). The corresponding probability density functions (p.d.f.) and distribution functions (D.F.) are given below :

(a) Normal distribution

$$\text{p.d.f.} = f(q) = \frac{1}{\sigma (2\pi)^{1/2}} \exp \left[-\frac{(q - \mu)^2}{2\sigma^2} \right]$$

$$\text{D.F.} = \Phi(m) = \frac{1}{(2\pi)^{1/2}} \int_{-\infty}^m \exp(-m^2/2) dm$$

where $|q| \leq \infty$, $|\mu| \leq \infty$, $\sigma > 0$ and m follows $N(0, 1)$.

(b) Logistic distribution

$$\text{p.d.f.} = f(q) = \frac{\exp\{(q-a)/k\}}{k[1 + \exp\{(q-a)/k\}]^2}$$

$$\text{D.F.} = \Phi(q) = 1 - [1 + \exp\{(q-a)/k\}]^{-1},$$

where $|q| \leq \infty$, $|a| \leq \infty$, and $k > 0$.

(c) Erlang distribution

$$\text{p.d.f.} = f(q) = \frac{(q/b)^{(c-1)} \exp(-q/b)}{b \{(c-1)!\}}$$

$$\text{D.F.} = \Phi(q) = 1 - [\exp(-q/b)] \left[\sum_{i=0}^{c-1} (q/b)^i / i! \right]$$

where, $q \geq 0$, $b > 0$ and $c > 0$ (c is a positive integer).

In order to fit a continuous distribution function to a given frequency distribution (q_i/f_i), mean and variance (second order moment about mean) from the data set were calculated. The estimates of the constant terms (parameters) of probability distribution functions were obtained through the empirical values of mean and variance of the frequency distribution of study variates. Now, at $q = q_i$ (say), the distribution function $\Phi(q_i)$ are computed. Finally, the successive intervals are obtained by

subtraction, viz., $\Phi(q_{i+1}) - \Phi(q_i)$, ($i = 1, 2, \dots, k$) and on multiplying these k subtracted

values by N , i.e., $(\sum_{i=1}^k f_i)$, we get the expected

frequencies of fitted probability distribution functions (Gomez and Gomez, 1984). The observed and fitted frequency distributions of study variates were tested for their goodness of fit by Karl Pearson's chi-square test (Finney, 1989).

RESULTS AND DISCUSSION

The estimates of mean, range, variance, CV (in per cent), β_1 and β_2 of chickpea data are presented in table 1.

The mean value of grain weight (X) and biomass weight (Y) were obtained 231.80 g and 519.67 g whereas it was 44.98 per cent for

harvest index (Z). The correlation coefficient (r) between X and Y was obtained 0.79 which showed a significant positive association between the variables. Scrutiny of raw data exhibited a considerable range of variation, causing a high value of CV which indicated a poor precision (Gomez and Gomez, 1984).

TABLE 1

Estimates of statistical parameters.

Variate	Mean	Range	Variance	CV	β_1	β_2
X	231.80	70-510	4868.63	30.102	0.172	3.176
Y	519.67	150-1200	19810.03	27.084	0.302	3.745
Z	44.98	16.17-92.00	79.28	19.795	0.828	7.074

For the normality of the data, β_1 and β_2 should be 0 and 3 but in the present study the values obtained crossed these limits, i.e., $\beta_1 > 0$ and $\beta_2 > 3$. Generally, with field experiment, several workers reported that it is not always possible to get such values of β_1 and β_2 (Bose *et al.*; 1936, Huan; 1992 and Singh; 1995). In a theoretical investigation, Srivastva (1959) reported that test of significance for F and t test were hardly affected if β_1 was between -0.5 and 0.5 and β_2 was between 2 and 4. Therefore, findings summarized in Table 1 for β_1 and β_2 would not affect the test of significance for the variables X and Y except for Z causing a serious problem of non-normality.

All the variables were graduated for goodness of fit for the erlang, logistic and normal probability distributions to get an exact idea about the distributional properties of the frequency distributions of X, Y and Z. The results are being presented in Table 2 for grain weight (X), biomass weight (Y) and harvest index (Z).

Table 2 showed that the grain weight (X) gave best fit for the normal distribution. It gave lowest chi-square value in comparison to other two distributions. This was also supported by the lowest values of β_1 and β_2 (Table 1). In addition to it, if a variable was tested for its goodness of fit by chi-square test for two theoretical probability distributions and both revealed a non-significant chi-square simultaneously, vis-a-vis, a good fit to both probability distributions. Then, the best fit would be one with which chi-square value would be least among these distributions. In view to it, the erlang distribution gave best fit out of all three probability distributions for the biomass weight (Y). But at the same place, biomass weight had also a good fit (non-significant chi-square) for the normal distribution. Hence, the frequency distribution of biomass weight can be considered to follow the normal distribution. The harvest index (Z) was found highly significant at 5 per cent probability level for goodness of fit revealing that no distribution was giving a good fit to it

TABLE 2

Frequency distribution and chi-square values for goodness of fit.

<i>Grain weight (X)</i>		<i>Biomass</i>	<i>Weight (Y)</i>	<i>Harvest index (Z)</i>	
<i>Class</i>	<i>Observed Frequency</i>	<i>Class</i>	<i>Observed Frequency</i>	<i>Class</i>	<i>Observed Frequency</i>
< 20	0	< 300	32	> 15	0
20-60	0	300-340	35	15-20	2
60-100	2	340-380	45	20-25	10
100-140	62	380-420	70	25-30	14
140-180	96	420-460	79	30-35	44
180-220	152	460-500	85	35-40	103
220-260	169	500-540	87	40-45	208
260-300	127	540-580	75	45-50	193
300-340	87	580-620	61	50-55	107
340-380	38	620-660	57	55-60	32
380-420	9	660-700	31	60-65	15
420-460	4	700-740	39	65-70	9
460-500	3	740-780	23	70-75	5
≥ 500	1	≥ 780	31	≥ 75	8
Total	750		750		750
Chi-Square values					
Erlang	23.29*		12.85		66.95*
Logistic	15.50		29.48*		30.92*
Normal	4.58		17.25		74.10*

*Significant at 5% probability level.

(Table 2). The results also supported that the ratio of two normal variates would not be necessarily normal in every case as envisaged by Steel and Torrie (1960).

Conclusion

From the foregoing data analysis and discussion, the present study concluded that

the frequency distributions of grain yield and biomass yield gave a good fit to the normal distribution whereas harvest index did not give a good fit to it. Hence, to have a statistically valid inference from the harvest index based on the ratio of biological measurements in field experimentation, the test of significance should be attempted very carefully.

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Prediction of Brinjal (*Solanum melongena*, L.) Yield From Partial Harvest

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ABSTRACT

The analysis of picking-wise fruit weight (yield) data of 1200 brinjal plants (Cv. Doli 5) collected separately from uniformity trial revealed that a plot of 20 plants (2 rows each of 10 plants) spaced 0.75 m x 0.75 m is of optimum size for field experimentation. The data were further utilized to predict total production of crop well in advance from first few pickings. The yield data of 1200 basic units were grouped into 60 experimental plots (samples) each of 20 plants. The following linear models were derived to predict total brinjal yield (Y) on the basis of partial harvest upto 3rd picking.

$$\hat{Y} = (2.746 + 0.0026 X_{23}) \quad x \quad 888.89 \quad \dots (R^2 = 0.83)$$

$$\hat{Y} = (4.108 + 0.0016 X_{123}) \quad x \quad 888.89 \quad \dots \dots (R^2 = 0.86)$$

Where: $\hat{Y}$ = Predicted yield of brinjal (kg/ha)

X_{23} = Sum of the yields of 2nd and 3rd picking 9kg/2 plants)

X_{123} = Sum of the yields of 1st, 2nd and 3rd picking (kg/20 plants)

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INTRODUCTION

The approaches followed to predict the yield of crops like cereals, pulses etc. may not be useful for predicting total yield of brinjal crop which is the sum of the yields obtained from individual pickings. To record pickingwise data is time consuming and costlier procedure. In survey work, collection of crop production data still becomes more difficult because of transport and supervision difficulties. It is therefore, worthwhile to examine the feasibility of prediction of the vegetable production by observing only the partial harvest data. For

accurate prediction it is necessary to adopt optimum sample size for brinjal crop so as to get maximum information from experimental material.

Several experiments have been conducted with annual crops to determine the most suitable size and shape of plots (sample) necessary to minimise the effect of soil variability on error component associated with experimental plots. However, very scanty work has been done with regards to vegetable crops. The present investigation was therefore taken up on brinjal crop to find out optimum size and shape of the plot and predict yield of the crop from partial harvest data.

TABLE 1

The picking-wise average coefficient of variability per unit area for plots of different sizes for fruit weight of brinjal.

Units	Pickings							Total yield
	1.	2.	3.	4.	5.	6.	7.	
1.	82.3	64.4	59.4	61.4	65.7	74.1	76.9	39.1
2	61.3	49.0	52.0	49.1	49.5	58.1	54.8	30.1
3	52.6	40.7	44.0	42.8	44.0	48.2	45.3	25.7
4	46.8	37.4	39.3	40.6	38.6	46.4	39.3	24.0
5	44.2	34.0	36.5	38.7	36.6	42.7	36.6	22.7
6	40.6	32.0	34.3	37.8	35.3	40.5	33.5	21.3
8	35.5	27.9	28.9	33.3	29.5	37.6	29.9	18.9
10	35.0	26.3	27.7	34.2	23.5	35.7	27.1	18.6
12	32.0	23.9	26.8	33.9	19.4	34.3	25.2	17.7
15	30.6	22.3	25.4	32.5	27.8	32.9	23.8	16.5
16	28.6	21.4	21.0	28.7	23.1	31.5	22.6	15.2
20	27.4	20.1	12.2	31.0	25.2	30.5	20.9	15.5
24	26.0	18.1	19.6	29.5	23.6	30.3	20.5	14.6
25	27.2	18.5	20.5	30.3	23.4	31.1	21.1	14.4
30	25.6	17.8	19.9	30.3	23.8	29.4	19.2	14.3
40	21.3	14.5	15.3	23.6	18.7	23.0	16.1	11.9
48	22.6	14.3	13.9	26.6	19.1	28.4	17.8	12.4
50	23.0	15.2	14.6	28.7	21.0	27.9	16.1	12.5
60	21.1	14.1	15.7	28.7	21.3	26.9	15.2	12.6
75	21.3	14.0	16.1	29.0	20.1	28.0	13.4	12.1
80	16.1	9.8	11.2	16.2	11.7	15.6	11.8	8.4
100	18.3	12.1	10.7	27.3	19.2	25.7	13.0	11.2

MATERIALS AND METHODS

Uniformity trial of brinjal crop (variety Doli 5) was conducted during the year 1989 at the College Agronomy Farm, Gujarat Agricultural University, Anand. The plant-wise fruits weight was recorded for 1200 plants. Each plant formed basic unit. Therefore there were 1200 basic units under study. In all nine pickings were obtained in a period of five weeks. The data on fruit weight recorded in each pickings were subjected to statistical analysis.

The 'maximum curvature method' was used to determine optimum plot size (Federer, 1955). The plots of size 2, 3, 4, 5, 6, 8, 10 80 and 100 units were formed by combining fruits weight of adjacent units both length wise as well as width wise. A curve of C.V. % against plot size was prepared. The optimum plot size was taken as the point on the curve just beyond the point of the maximum curvature.

For predicting total fruits yield optimum plot size of 20 units was utilized. Whole field of 1200 units was divided into 60 plots each of 20 units (2 rows x 10 plants). Picking-wise fruits yield data for these 60 plots were also generated from original record of 1200 plants. The total yield of brinjal was worked out by summing the yields obtained in individual pickings. Simple linear regression equation was worked out for predicting total fruits yield on the basis of yield obtained in the first picking as well as total yield of first two pickings, total yield of first three pickings and so on.

RESULTS AND DISCUSSION

The C.V. % per unit area (Table 1) decreased with the increase in the plot size,

either by increasing the length of plot or by increasing the number of rows upto 80 units and thereafter there was little increase in variability for 100 units plot size. The decrease in C.V. per cent beyond 16 units plot size was not proportional to the amount of land used. So 16 units size was considered as the point of maximum curvature. The optimum plot size is one just beyond the point of maximum curvature. Therefore 20 units was considered as optimum plot size (2 rows x 10 plants).

The regression analysis (Table 2) indicated the best fit when partial harvest of first three pickings were considered. The sum

TABLE 2

Regression coefficient of total yield on different pickings.

Pickings	<i>b</i>	<i>R</i> ²
1	0.0032 (0.0003)	0.65
2	0.055 (0.0051)	0.66
3	0.0031 (0.00032)	0.61
4	0.0022 (0.0003)	0.73
1 + 2	0.0024 (0.00017)	0.78
2 + 3	0.0026 (0.00016)	0.83
3 + 4	0.0018 (0.00011)	0.81
1 + 2 + 3	0.0016 (0.00009)	0.86
2 + 3 + 4	0.00014 (0.00006)	0.91
1 + 2 + 3 + 4	0.0011 (0.00004)	0.94

Figures in parenthesis are standard error.

of yields of second and third pickings also gave better fit. The equation fitted was :

$$(1) \quad \hat{Y} = (2.746 + 0.0026 X_{23}) \times 888.89 \dots (R^2 = 0.83)$$

$$(2) \quad \hat{Y} = (4.108 + 0.0016 X_{123}) \times 888.89 \dots (R^2 = 0.86)$$

Where,

$\hat{Y}$ = Predicted total yield, kg/ha

X_{23} = Total yield of second and third pickings, kg/20 plants

X_{123} = Total yield of first three pickings, kg/20 plants

It can be concluded from the present investigation that (1) the optimum plot size of 11.25 sq.m. should be used for field experimentation on brinjal Doli 5 and (2) total brinjal production could be forecasted using partial harvest data of first three pickings precisely.

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Seed Germination in Pearl Millet Hybrids and Parents Under Extreme Temperature Conditions

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ABSTRACT

Germination behaviour and seedling growth of two pearl millet (*Pennisetum glaucum* (L) R, Br, emend, stuntz) F1 hybrids - GHB-15 and GHB-235 and two parents MS 5054-A and J-108 (parents of GHB-15) were studied in a range of temperatures from 10 to 50°C under laboratory conditions. The optimum temperature for germination was found to be 30-35°C, while there was no germination at 10°C and 50°C. The seeds kept at 10°C for a week, when transferred to the optimum temperature resumed normal germination, thus exhibiting the chilling resistance. The hybrids performed better than the parents with respect to per cent germination, germination index and seedling growth in terms of length and dry weight at most of the temperatures studied. The hybrid GHB-15 exhibited better parental heterosis at all the temperatures and the magnitude of mid parental heterosis was more adverse temperatures than that at the optimum.

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INTRODUCTION

Heterosis in seedling growth and vigour in pearl millet has already been established (Joshi et al. 1986 a, b). The study of heterotic behaviour under extreme environmental conditions is a matter of interest and utility. A relationship of base germination temperature and germination parameters with adaptability and yield in sorghum has been shown (Mann and Miller 1983, Mann et al. 1983). Seed germination and seedling establishment in pearl millet under extremely low temperature conditions have been studied (see Pearson 1984). The high soil temperatures have also been found to be one of the principle causes of poor

seedling emergence and establishment (see Rai and Anandkumar 1994). The present paper deals with the study and comparison of germination behaviour and seedling growth of pearl millet hybrids and parents in a range of temperatures under laboratory conditions.

MATERIALS AND METHODS

The seeds of two F1 hybrids GHB-15 and GHB-235, and two parents of the hybrid GHB-15 viz., MS 5054-A and J-108, harvested at Millet Research Station, Gujarat Agricultural University, Jamnagar, India in summer 1993 and stored for two months in paper bags kept at room temperature (mean daily temperature : 30°C; mean R.H.: 72%)

were surface sterilized with 0.1% solution of mercuric chloride for 10 min. and thoroughly washed. The petri dishes, each containing 50 seeds on Whatman No. 1 filter paper moistened with DW were transferred to the incubators maintained at 10, 15, 20, 25, 30, 35, 40, 42, 45 and 50 ($\pm 2^\circ\text{C}$) in continuous dark. Each treatment had three replicates.

The germination percentage was recorded at suitable intervals till the plateau was achieved. Further, the petri dishes kept for germination under the extreme temperatures viz., $10 \pm 2^\circ\text{C}$ and $50 \pm 2^\circ\text{C}$ were transferred after a week to $35 \pm 2^\circ\text{C}$ and the observations on the per cent germination were recorded. The germination index for each treatment was calculated using following formula-

$$GI = \frac{GP(t_1) - GP(t_0)}{t_1} + \frac{GP(t_2) - GP(t_1)}{t_2} + \frac{GP(t_n) - GP(t_{n-1})}{t_n}$$

where,

GI = Germination index

GP (t_0), GP (t_1) GP (t_n) = Germination percentage after the time periods

$t_0, t_1, \dots, t_n$

$t_0, t_1, \dots, t_n$ = Time in days.

Seedling dry weight, root and shoot lengths after 48 hours of germination were recorded. Ten seedlings were used for the measurement and mean values are presented for each replicate. As there was no germination at 10°C and 50°C and very slow germination at 15, 42 and 45°C , the length and dry weight measurements could not be taken at these temperatures.

Per cent germination over time was subjected to standard deviation analysis and seedling growth parameters to ANOVA as per

factorial CRD and critical differences were indicated in the graphical representations. Mid parental heterosis was calculated for the hybrid GHB-15 using

Turner's (1953) formula -

F1-MP

per cent heterosis over mid parent = $\frac{\text{F1-MP}}{\text{MP}} \times 100$

and is represented in the graphical form.

RESULTS AND DISCUSSION

The first count of germination percentage, germination index and seedling growth in terms of root length, shoot length and seedling dry weight (Figs. 1 & 2) indicated that the optimum temperature for germination in pearl millet was $30-35^\circ\text{C}$, the minimum $10 \pm 2^\circ\text{C}$ and the maximum $50 \pm 2^\circ\text{C}$. This observation is in agreement with the earlier data (Garcia-Huidobro *et al.* (1982) indicating that the base temperature for germination in pearl millet (under constant temperature condition on a thermal gradient plate) is around 12°C , the optimum $33-35^\circ\text{C}$ and the maximum for germination 48°C . The temperature below $30-35^\circ\text{C}$ delayed the germination, while that above $30-35^\circ\text{C}$ not only delayed the germination but resulted in a marked decline in the germination percentage due to high temperature injury. High temperature effects on seedling emergence and stand establishment have been indicated (Soman and Peacock 1985, Ougham *et al.* 1988, Lynch 1993 and Rai and Anand Kumar 1994).

The seeds kept for a week at 10 and 50°C when transferred to $35 \pm 2^\circ\text{C}$, the former resumed the normal germination showing chilling resistance and no low

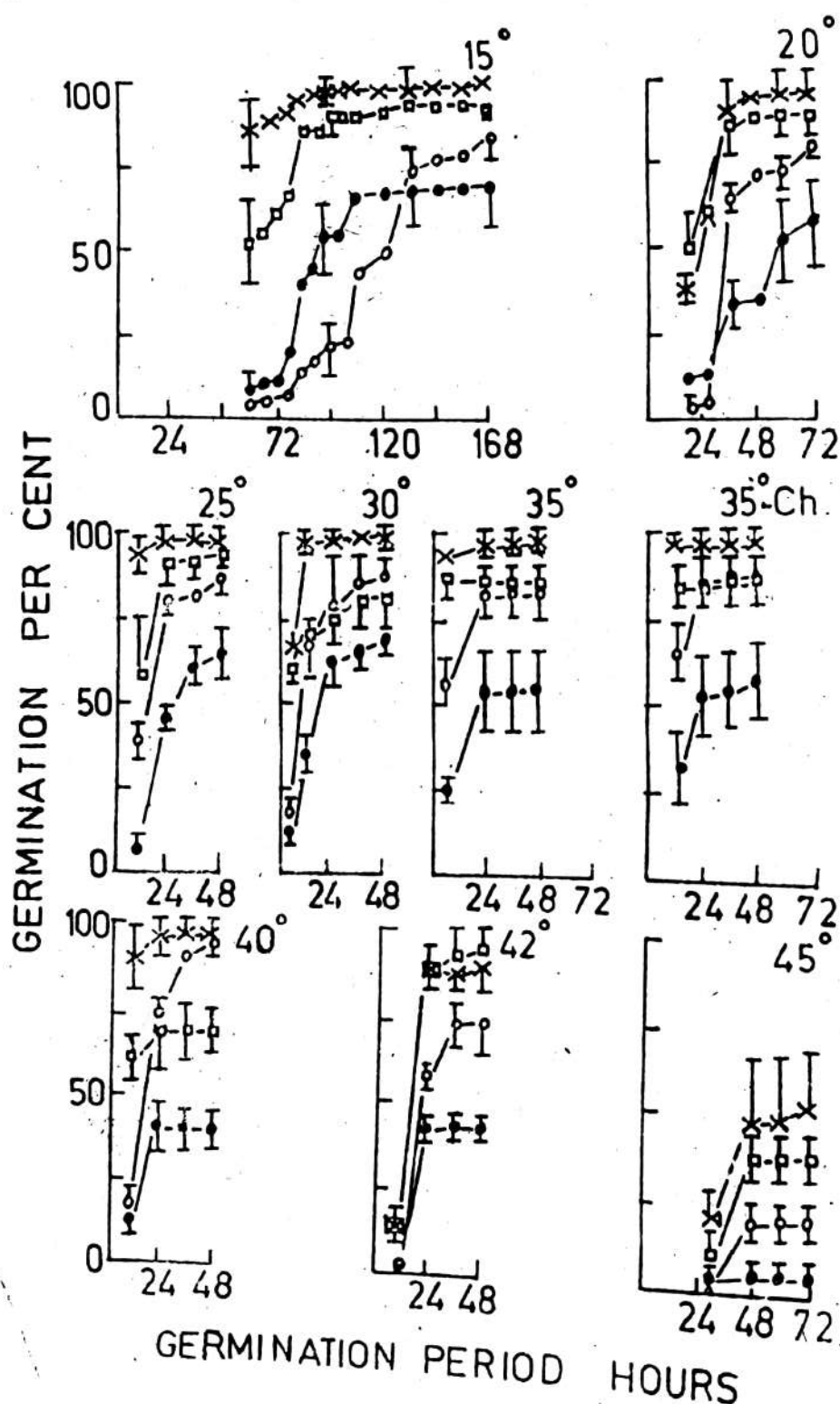


Fig.1. : Effect of temperature on seed germination per cent in pearl millet hybrids GHB-235 (□ — □) and GHB-15 (x — x), and female parent MS 5054-A (○ — ○) and male parent J-108 (● — ●) of the hybrid GHB-15. The vertical bars represent the standard deviation. 35°-Ch indicates germination percentage at 35°C after chilling ($10 \pm 2^\circ\text{C}$) the seeds for a week.

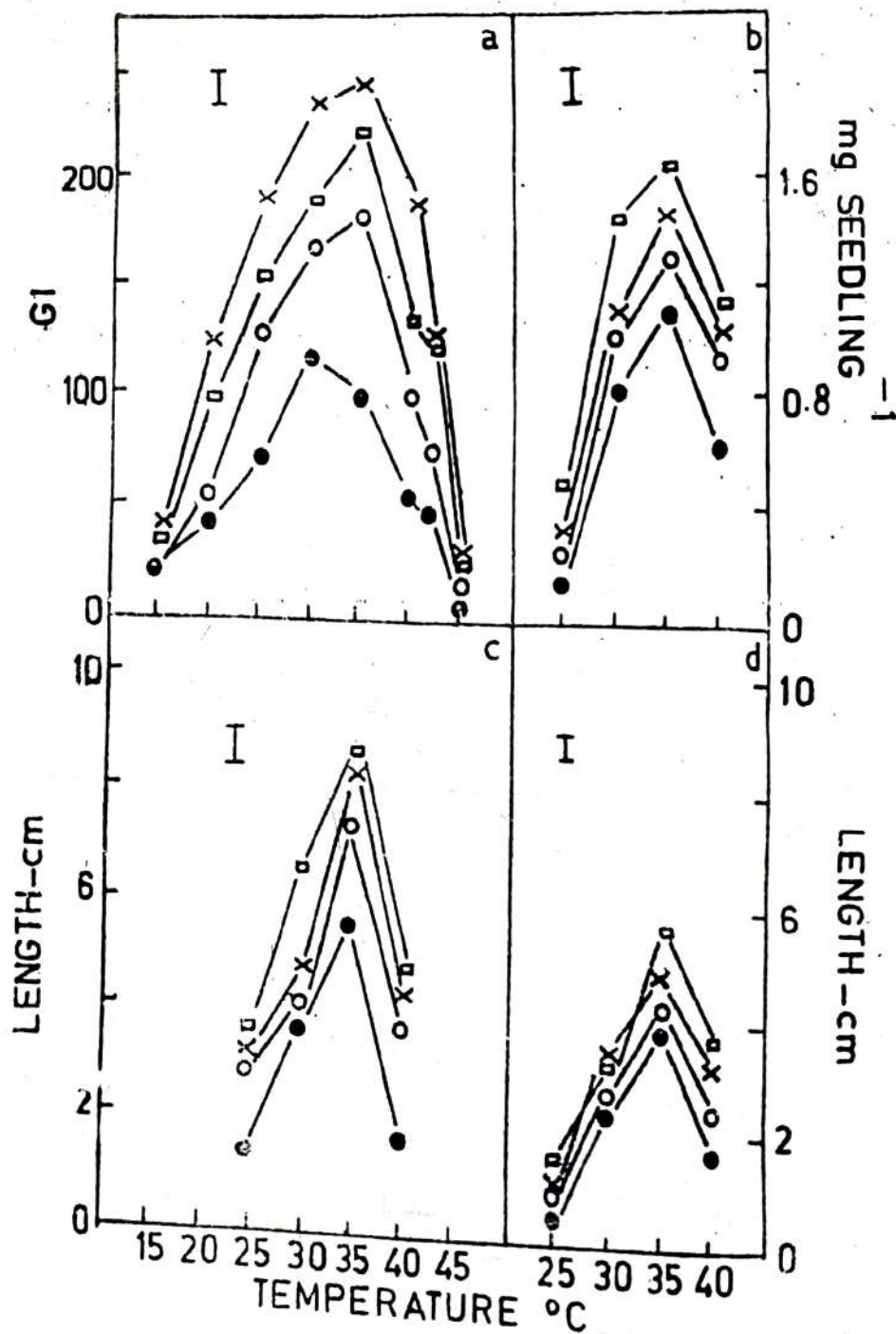


Fig. 2.: Effect of temperature on a) G1, b) dry weight, c) root length and d) shoot length after 48 hours of incubation in pearl millet hybrids and parents. The vertical bar (I) represents LSD. Other details as in Fig. 1.

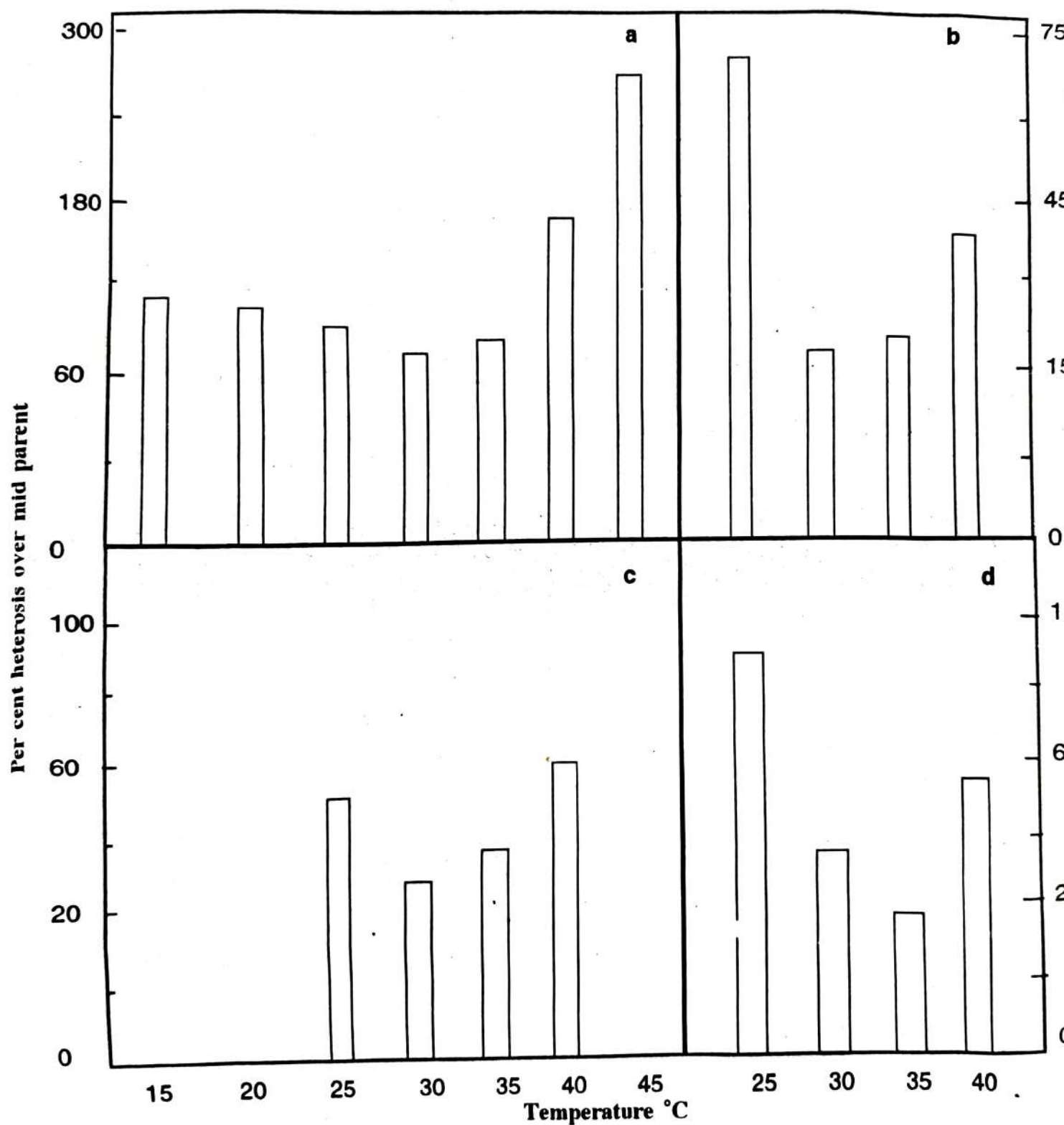


Fig. 3. : Effect of temperature on mid parental heterosis for a) GI, b) seedling dry weight, c) root length and d) shoot length in the pearl millet hybrid GHB-15 (MS 5054-A x J-108).

temperature injury was observed (Fig. 1, 35°-Ch.) while the later could not germinate at all due to high temperature injury. The high temperature effects on germination have also been reported by Garcia-Huidobro *et al.* (1985).

The hybrid GHB-15, which was superior in germination index as compared to the hybrid GHB-235, was trailing behind it with respect to seedling growth characters (root length, shoot length and seedling dry weight). Hence, besides germination rate, the influence of mean shoot length on vigour index has also been stressed (Parvathamma *et al.* 1988).

The hybrids performed better than the parents with respect to GI and seedling growth at almost all the temperatures especially the adverse ones. Hybrid vigour in pearl millet

seedling growth under normal conditions (Joshi *et al.* 1986 a, b) and heterosis effects on cold tolerance in sorghum (Matthews 1983) have already been reported. Evidently the magnitude of mid parental heterosis in GHB-15 for GI and seedling growth was much higher at adverse temperatures than the optimum (Fig. 3). According to Pearson (1975) an unfavourable climate has a progressive and cumulative effect on seedling performance where as all genotypes may germinate, differences become apparent at emergence and get progressively larger.

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List of abbreviations used :

ANOVA = Analysis of variance

DW = Distilled water

GP = Germination percentage

CRD = Complete randomised design

GI = Germination Index

LSD = Least Significant Difference

MP = Mid parent

Short Communications

Character Association and Path Analysis for Seedling Vigour Index in Stored Wheat Seed

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The vigour index is a multiplicative end product of many complex components like germination (%), root and shoot length of seedling. These parameters play an important role for high planting value of seed lot and early establishment of crop (Mahajan and Nayeem, 1989). Hence, only one character as such would not be more effective for establishing the real quality of seeds, but several characters often have to be handled together.

Cleaned seeds of four wheat varieties (Sonalika, Lok-1, Kalyan Sona and GW 496) having about 100 per cent moisture were stored from May 1992 to April 1993 in 4000 gauge polythene bags under ambient conditions and tested for seed moisture (%), seed index (100 seed weight), seed density (g cm^{-3}), imbibitional rate (cc g^{-1}), electrical conductivity (dS m^{-1}) of seed leachate, germination (%) (Anon, 1985), germination rate and seedling growth in terms of root length, shoot length and fresh weight of 10

days old seedlings. Vigour index was determined by multiplying the germination (%) with the sum of root and shoot length (cm). Correlation coefficient among all the components was computed separately. The components having significant correlation with the dependent variable vigour index were subjected to path coefficient analysis (Dewey and Lu, 1959).

The correlation study (Table 1) indicated that the vigour index was found to be significant and positively associated with seedling shoot and root length and fresh dry weight of seedling, germination rate and germination per cent. This indicated that functionally related traits tend to be highly integrated morphologically and their correlation structure confirms to the functional relationship structure. Such association helps in reducing the complexities of testing procedures for seed quality. The present results are in agreement with the findings of Mahajan and Nayeem (1989). Strong and positively significant correlation was observed between seed moisture and electrical conductivity. Both the parameters have antagonistic relationship with the vigour index suggesting that an increase in seed moisture and electrical conductivity would reduce the vigour index. Consequently, both the traits had negative correlation with seed density, imbibitional rate, germination per cent.

TABLE 1

Correlation coefficient among vigour index and different components during storage.

Components	seed moisture (%)	Seed index (g)	Seed density (g/cm ³)	Imbibition rate (cc/g)	Electrical conductivity (ds/m)	Germi- nation rate (%)	Germi- nation rate	Seedling fresh weight (mg)	Seedling root length (cm)	Seedling shoot length (cm)	Dry weight of seedling (mg)
Vigour index	-0.565**	-0.115	0.028	0.263	-0.682**	0.738**	0.777**	0.894**	0.947**	0.974**	0.913**
Seed moisture		0.518*	-0.511*	-0.341	0.864**	-0.821**	-0.869**	-0.423	-0.371	-0.532*	-0.458*
Seed index			-0.995**	0.246	0.619**	-0.426	-0.447*	0.119	0.118	-0.031	0.030
Seed density				-0.287	-0.629**	0.427	0.473*	-0.130	-0.140	0.015	-0.046*
Imbibition rate					-0.031	0.184	0.143	0.212	0.299	0.215	0.219
Electrical conductivity						-0.906**	-0.962**	-0.505*	-0.485*	-0.646**	-0.533*
Germination							0.952**	0.613**	0.512*	0.691**	0.619**
Germination rate								0.648**	0.581**	0.745**	0.673**
Fresh weight of seedling									0.813**	0.948**	0.980**
Root length of seedling										0.901**	0.846**
Shoot length of seedling											0.952**

** Significant at 1 per cent level of probability.

* Significant at 5 per cent level of probability.

TABLE 2

Direct and indirect effects of various components on vigour Index.

Components	Seed moisture (%) X1	Imbibitional rate (cc/g) X2	Electrical conductivity (ds/m) X3	Germi- nation (%) X4	Germi- nation rate X5	Shoot length of seedling (cm) X6	Root length of seedling (cm) X7	Fresh weight of seedling (mg) X8	Dry weight of seedling (mg) X9	'r' value
X1	-0.021	0.001	0.020	-0.234	0.149	-0.195	-0.191	0.001	0.001	-0.565**
X2	0.005	-0.018	-0.001	0.052	-0.008	0.079	0.154	-0.001	0.000	0.263
X3	-0.018	-0.001	0.024	-0.258	0.055	-0.237	-0.250	0.001	0.001	-0.682**
X4	0.017	-0.003	-0.021	0.285	-0.054	0.254	0.264	-0.002	-0.001	0.738**
X5	0.018	-0.003	0.023	-0.271	0.057	0.299	0.299	-0.002	-0.001	0.777**
X6	0.011	-0.004	-0.015	0.197	-0.042	0.367	0.465	-0.002	-0.01	0.974**
X7	0.008	-0.005	-0.011	0.146	-0.033	0.331	0.516	-0.002	-0.001	0.947**
X8	0.009	-0.004	-0.012	0.175	-0.036	0.348	0.319	-0.002	-0.001	0.894**
X9	0.010	-0.004	-0.013	0.176	-0.038	0.349	0.436	-0.002	-0.001	0.913**

Residual effect = 0.027

** Significant at 1% level of significance.

germination rate, fresh weight and dry weight of seedling and root and shoot length of seedling indicating their adverse effect of these characters. Singh (1987) made similar observation in sorghum.

Among the nine characters involved for path analysis (Dewey and Lu, 1959), root and shoot length of seedling and germination (%) appeared to govern the vigour index directly with high positive values. These traits also had positive influence all characters, except seed moisture and electrical conductivity. Therefore, it indicated that the correlation among these traits and with vigour index explain ture relationship between them. Germination rate, fresh and dry weight of seedling had negative direct effect on vigour index though their correlation with vigour index were strong and

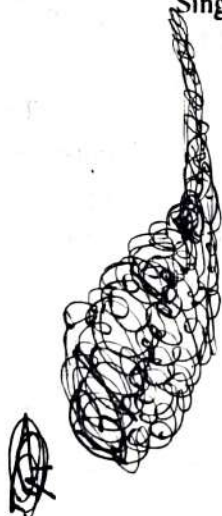
significantly positive. This revealed that the indirect effects played major role. Under such situations, the indirect causal factors viz., shoot and root length of seedling and germination per cent are to be considered important. These findings are in agreement with the findings of Singh (1987) for sorghum and Mahajan and Nayeem (1989) for wheat.

Thus, from the correlation and path coefficient analysis it emerged that root and shoot length of seedling and germination per cent appear to be important components contributing to the vigour index directly and indirectly and thereby, help in estimating the planting value of seed lot and establishment of wheat crop.

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Effect of Harvesting Stages and Levels of Nitrogen and Phosphorus on Yield of Fodder Maize (*Zea mays* L.)

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A field experiment was conducted at the Instructional Farm, Gujarat Agricultural University, Junagadh during *rabi* season of 1992-93. The soil was clay loam in texture, low in total nitrogen (0.07%), medium in available phosphorus (33.89 kg/ha), high in available potassium (302.75 kg/ha) and slightly alkaline in reaction (7.8 pH) with normal E.C. (0.29 dS/m). Twenty four treatment combinations consisting two stages of harvesting (silking and milking), four levels of nitrogen (0, 40, 80 and 120 kg N/ha) and three levels of phosphorus (0, 40 and 80 kg P₂O₅/ha) were tried in a split plot design and replicated three times. Half dose of N and full dose of P as urea and SSP, respectively were applied at sowing and remaining half dose of N in the form of urea was top-dressed at 25 days after sowing. The crop variety was sown on October 22, 1992 at inter-row spacing of 30 cm with 60 kg seeds/ha.

Plant height at harvest, length of internode and leaf area/plant recorded at

milking stage were significantly higher than those recorded at silking stage. While plant height at 40 DAS, leaves/plant, internodes/plant and stem thickness did not differ between the two stages of harvesting. Green and dry fodder yields recorded at milking stages were significantly higher than silking stage. At milking stage, 13.87 and 22.77% higher green and dry fodder yields were recorded over at silking stage, respectively. The higher yield at milking stage could be because of the fact that vegetative growth in maize normally take place upto milking stage and thereafter the nutrients absorbed by plants get utilized for maturity and grain formation. The findings corroborates the reports of Tiwana *et al.* (1983).

The growth attributes were significantly improved with each incremental level of N and application of 120 kg N/ha recorded maximum values of plant height at 40 DAS and at harvest, leaves/plant, internodes/plant, length of internode, stem thickness and leaf area/plant. At this level, 98.5, 29.2 and 14.2% higher green fodder and 102.5, 31.3 and 16.3% higher dry fodder yield were recorded over 0, 40 and 80 kg N/ha, respectively. The results are in conformity with those of Singh *et al.* (1981) and Hunshal *et al.* (1989).

Application of phosphorus above 40 kg/ha failed to show significant influence on growth attributes. Application of 40 kg P₂O₅/ha while

TABLE 1

Effect of different treatments on growth and yield of fodder maize.

Treatment	Plant height (cm) at		Leaves/plant at		Internodes/ plant	Length of internode (cm)	Stem thickness (cm)	Leaf area/ plant (cm ²)	Fodder yield (q/ha)	
	40 DAS	Harvest	40 DAS	Harvest					Green	Dry
Harvesting stages										
Silking	105.6	155.6	13.1	15.7	13.1	13.6	1.16	14.60	280.6	66.9
Milking	108.3	164.4	13.4	16.0	13.4	15.4	1.24	15.74	319.5	82.1
C. D. at 5%	NS	8.4	NS	NS	NS	1.0	NS	0.93	23.1	7.9
Nitrogen (kg/ha)										
0	91.7	141.0	10.4	15.1	11.7	13.3	0.96	14.37	191.7	47.2
40	102.8	158.8	12.8	15.6	13.1	14.2	1.12	14.97	294.6	72.8
80	111.1	166.7	13.9	16.1	13.7	14.7	1.28	15.58	333.3	82.2
120	122.2	173.5	15.8	16.6	14.6	15.8	1.44	16.19	380.6	95.6
C. D. at 5%	3.8	5.0	0.7	0.4	0.4	0.5	0.09	0.60	14.8	4.2
Phosphorus (kg/ha)										
0	99.4	149.8	11.4	15.0	12.9	13.6	0.75	14.74	266.7	66.3
40	109.6	165.3	13.8	16.2	13.4	14.9	1.39	15.37	314.2	78.0
80	111.8	165.5	14.3	16.4	13.4	15.0	1.46	15.80	319.2	79.2
C. D at 5%	3.3	4.3	0.6	0.4	0.4	0.5	0.08	0.52	12.8	3.6

producing statistically similar green and dry fodder yields to that of 80 kg P_2O_5 /ha gave 17.8% higher green fodder yield and 17.6% higher dry fodder yield over control. The results are in ac-

cordance with those reported by Hunshal *et al.* (1989) and Dodia (1991).

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Screening of Some Wheat Varieties for Salinity Tolerance

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In the coastal areas of South Gujarat, paddy-wheat seems to be a economically viable cropping sequence. However, wheat as such is not much popular crop in this area owing to its low productivity under salt affected soil conditions. The differential behaviour of wheat varieties under varying salinity levels has been reported by some workers (Kumar *et al.*, 1981 and Sen Gupta, 1981). For making wheat cultivation more popular and profitable in costal areas, appropriate tolerant variety is to be idnetified and the present experiment was a step towards this direction.

A pot experiment was conducted with six wheat varieties ($V_1 = J24$, $V_2 = J18$, $V_3 = Lok1$, $V_4 = NP\ 824$, $V_5 = Sonalika$ and $V_6 = 206$) and for EC_e levels ($S_1 =$ non saline soil 2.1 , $S_2 = 4$, $S_3 = 8$ and $S_4 = 12$ dSm^{-1}) in CRD. The treatments were repeated thrice. The experimental soil was clayey in texture, alkaline in reaction ($pH = 7.40$), non saline ($EC_e = 2.1$ dSm^{-1}), low in organic carbon (0.5%), medium in available

P (19 kg P_2O_5/ha) and high in available K (400 kg K_2O/ha). The desired salinity levels were achieved by adding $CaCl_2$ and $NaCl$ in such a proportion to maintain constant SAR value. For attaining equilibrium, treated soil was subjected to wetting and drying cycles and this equiliberated soil was filled in alkathene lined earthen pots @ 2.5 kg/pot. In each pot, 30 healthy wheat seeds were sown and thinned to 15 plant/pot, 8 days after sowing. The pots were maintained at field capacity till the harvest of crop i.e. 60 days after sowing. In addition to per cent reduction in germination and dry matter yield, mean salinity index (Kumar, 1983) and salinity elasticity coefficient (Dravid *et al.*, 1976) were also worked out.

Germination : The individual and interactive effects of variety and salinity levels were significant on the germination of wheat (Table 1). Among the varieties tested, Sonalika recorded significantly higher germination per cent (87.5%) which was closely followed by J 24 (86.6%) and J 18 (85.8%) varieties. The lower value of germination with A 206 (77.5%) and NP 824 (80.3%) varieties indicate their suceptability to the salinity. A gradual reduction in the germination count was observed with increase in salinity level (EC_e). The differential behaviour of wheat varieties at varying levels of salinity was evident from the minimum of 19.5 per cent reduction in

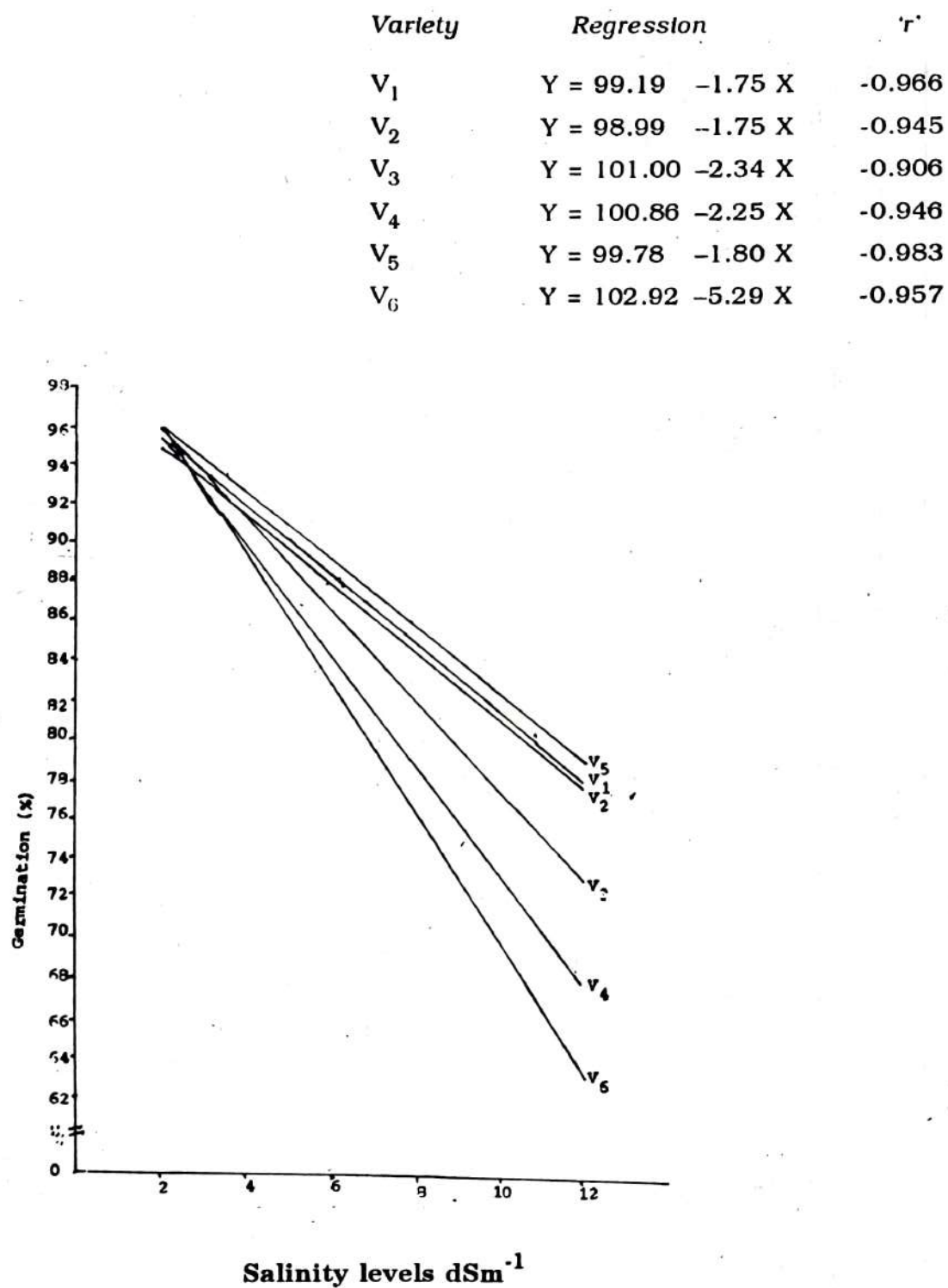


Fig. 1 : Relationship between salinity levels and germination percentage of different wheat varieties.

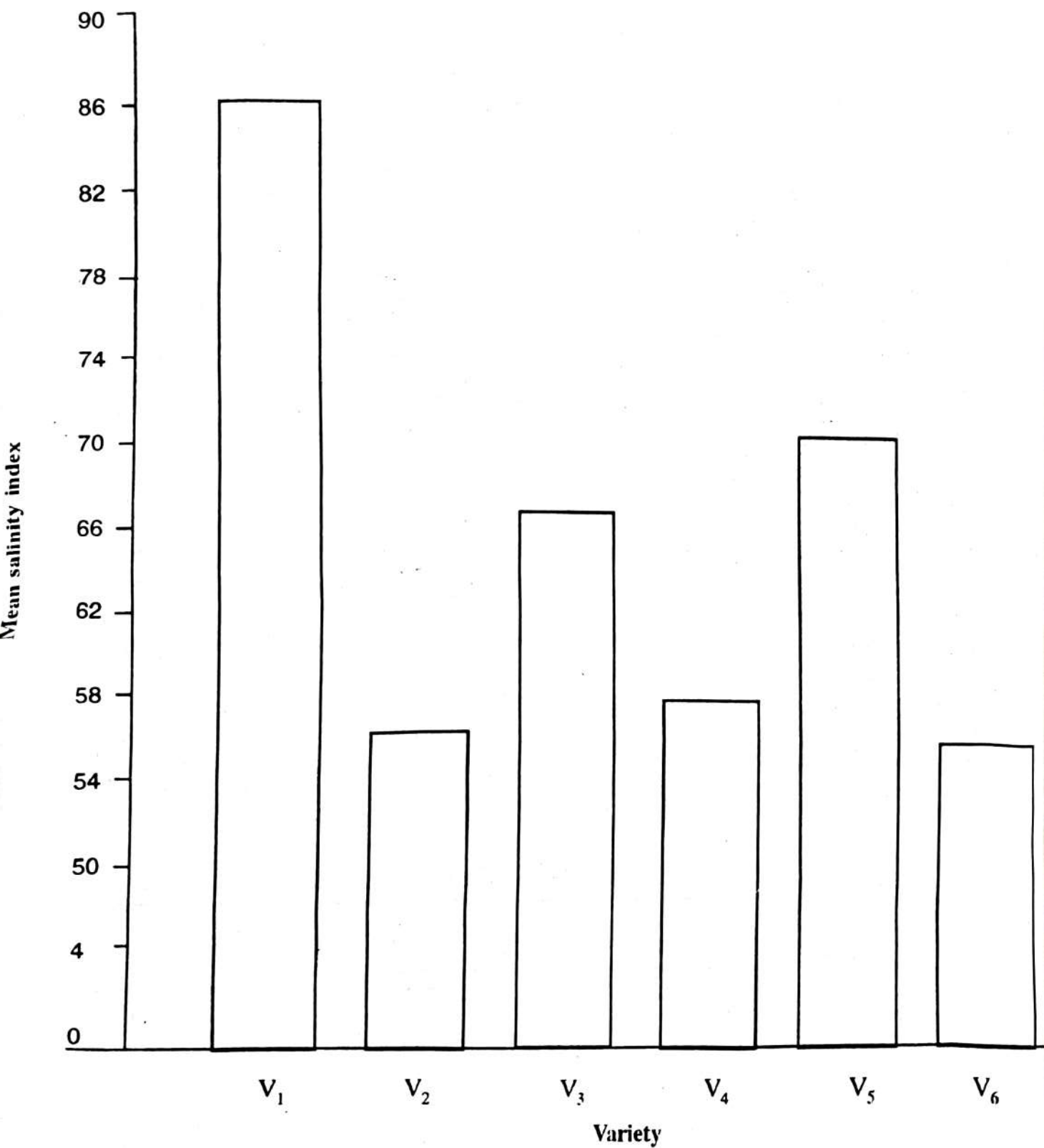


Fig. 2 : Mean salinity index of different wheat varieties

germination recorded with Sonalika and that of maximum with variety A 206 (35.3%). This was further substantiated from the regression equation (Fig. 1) in which Sonalika had lower 'b' value (-1.697) than A 206 (-3.291). The correlation between salinity and germination count was invariably negative and it was varying between -0.906 with Lok 1 to -0.966 with J 24. Earlier workers have also reported silimar effect of salinity on germination of wheat varieties (Singh and Dastane, 1970 and Sharma *et al.* 1971).

Dry matter production : The dry matter yield significantly differed due to different varieties of weat (Table 2). Sonalika recorded significantly higher dry matter yield of 4.37 g/pot than A 206 (2.49 g/pot) but it was at par with rest of the varieties. With increase in each level of salinity, considerable decline in dry matter yield was observed. However, the interaction effect (V X S) was found to be absent. In order to mask the yield potential effect on salinity tolerance of wheat varieties, per cent yield reductuin over contol, (S_1) was computed. The yield reduction was of the order of 50 per cent in the case of J 18 and A 206 varieties even at EC_e 8 dSm^{-1} , while similar

magnitude of reduction was noticed only at EC_e 12 dSm^{-1} (S_4) in Sonalika. The behaviour of variety Lok-1 was rather ambiguous i.e. instead of decrease in dry matter yield at S_2 over S_1 , it was found to increase by 4.3 per cent and further increase in salinity also could not depress the yield to an extent that was observed with other varieties at equal salinity level, Panda *et al.* (1979) and Kumar (1983) have also observed silimar behaviour of different wheat varieties under varying salinity levels.

In present study 'Mean Salinity Index' (MSI) was also computed as described by Kumar (1983). The higher MSI value of 86.75 for J 24 amply substantiate its better performance under saline condition in comparison to other varieties (Fig. 2). Apart from this, for further testing of performance of wheat varieties in saline conditions, yardstick 'Salinity Elasticity Coefficient' (SEC) as suggested by Dravid *et al.* (1976) was also employed. Here too, variety J 24 maintained its superiority over other varieties which is evident from the lowest SEC values of -0.563 which was recorded with this variety at 12 dSm^{-1} salinity level (Table 3). The next in

TABLE 3

Salinity elastically co-efficient (SEC) of different wheat varieties at varying salinity levels.

Variety	'r' value	Salinity elasticity co-efficient		
		X=4	X=8	X=12
J 24	-0.709	-0.136	-0.316	-0.563
J 18	-0.915	-0.282	-0.788	-1.954
Lok 1	-0.966	-0.223	-0.576	-1.215
NP 824	-00.873	-0.264	-0.718	-1.681
Sonalika	-0.726	-0.216	-0.552	-1.144
Arnej 206	-0.863	-0.305	-0.881	-2.362

order at the same salinity level was variety Sonalika (-1,144). The SEC values of more than -1 recorded with other varieties suggest that the reduction in yield of these varieties will be at much faster rate at corresponding increase in salinity level.

The results of present study clearly brought out the fact that wheat varieties viz., J 24 and Sonalika are better performers under saline soil conditions.

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Variability Heritability and Expected Genetic Advance in F₂ Generation of Four Cowpea Crosses

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Cowpea (*Vigna unguiculata* (L.) Walp) is one of the most important early, multiseason, multipurpose, annual leguminous crops in the tropics and subtropics. Selection is basically most important tool in the hand of plant breeders for developing high yielding genotypes and its efficiency depends upon nature and amount of genetic variability present in breeding materials. With this view, four F₂ populations viz., (1) Pusa Falguni x V 269, (2) GC 1 x RC 8, (3) GC 2 x V 16 and (4) GC 2 x V 240 were planted on 6th March 1991 at the College Instructional Farm, Gujarat Agricultural University, Sardar Krushinagar alongwith its parents. Each F₂ was grown in 9.0 m long block accommodating 14 rows with a spacing of 45 x 15 cm. The population size of F₂ was 794, 792, 791 and 785 plants for cross 1 to cross 4, respectively. Two rows each of the seven parents were grown next to F₂ populations in 9.0 m row length plots. Observations were recorded for pods per plant and seed yield per plant on 250 plants in each of the F₂ populations and 10 plants in

each of the parents. Measurements on days to 50 per cent flowering and days to maturity were noted on plot basis. Genotypic variance was calculated by substrating square root of product of variance of parents from variance of F₂. The genotypic and phenotypic coefficients of variation (GCV and PCV), heritability in broad sense and expected genetic advance were computed according to Burton (1952), Mahmud and Kramer (1951) and Allard (1960), respectively.

Variability parameters, heritability and expected genetic advance were estimated for pods per plant and seed yield per plant in original unselected F₂ population of four cowpea crosses and days to 50 per cent flowering and days to maturity in F₂ and parents (Table 1). The maximum and minimum phenotypic range were observed in cross 2 and cross 3, respectively for number of pods per plant and seed yield per plant. Among the crosses, the highest number of pods per plant were observed in cross 4 (17.8) which was significantly higher than rest of the crosses. The highest seed yield per plant was also recorded in cross 4 (16.5 g) which was statistically at par with cross 2 (16.1 g) but significantly higher than cross 1 and cross 3. Phenotypic and genotypic variance for both the traits were highest in cross 2 and lowest in cross 3. The maximum phenotypic and genotypic coefficient of variation of both the

TABLE 1

(a) Variability parameters for number of pods per plant and seed yield per plant in F₂ generation of four cowpea crosses.

Parameters	Pusa Falguni x V 269 (cross 1)		GC 1 x RC 8 (cross 2)		GC 2 x V 16 (cross 3)		GC 2 x V 240 (cross 4)	
	Pods per plant	Seed yield per plant	Pods per plant	Seed yield per plant	Pods per plant	Seed yield per plant	Pods per plant	Seed yield per plant
Range %	4.0 - 36.0	3.5 - 31.5	7.0 - 42.0	4.5 - 44.5	7.0 - 36.0	5.0 - 31.5	7.0 - 41.0	6.0 - 36.5
Mean $\pm$ S. E.	16.1 ^{ab} $\pm$ 0.4	15.0 ^b $\pm$ 0.4	16.6 ^a $\pm$ 0.5	16.1 ^{ab} $\pm$ 0.5	15.2 ^b $\pm$ 0.4	13.5 $\pm$ 0.3	17.8 $\pm$ 0.4	16.5 ^a $\pm$ 0.4
σ_p^2	36.4	32.8	49.7	51.8	30.5	26.7	39.2	35.0
σ_g^2	25.3	25.2	39.5	45.7	21.9	14.6	28.4	25.1
σ_c^2	11.1	7.6	10.2	6.1	8.6	12.1	10.7	9.9
PCV (%)	37.5	38.3	42.5	44.8	36.2	38.2	35.2	35.9
GCV (%)	31.2	33.5	37.8	42.1	30.7	28.3	30.0	30.4
h ² (%)	69.4	76.8	79.5	88.3	71.9	54.7	72.6	71.2
GA	7.4	7.7	9.8	11.2	6.9	4.9	8.0	7.4
GA (% mean)	45.8	51.6	59.2	69.4	45.7	36.7	44.8	44.8
P ₁ ⁺⁺ Mean	12.4 $\pm$ 1.2	11.3 $\pm$ 0.5	12.0 $\pm$ 1.1	10.3 $\pm$ 0.6	19.8 $\pm$ 1.2	18.1 $\pm$ 1.1	19.8 $\pm$ 1.2	18.1 $\pm$ 1.1
P ₂ ⁺⁺ Mean	16.4 $\pm$ 0.9	21.7 $\pm$ 1.4	14.9 $\pm$ 0.9	12.9 $\pm$ 1.0	13.1 $\pm$ 0.7	21.4 $\pm$ 1.1	16.9 $\pm$ 0.9	20.4 $\pm$ 0.9

(b) Mean days to 50% flowering (DF) and days to maturity (DM) for F_2 and parents, summer season, 1991

	Days to 50% flowering	Days to maturity	Days to 50% flowering	Days to maturity	Days to flowering	Days to maturity	Days to 50% flowering	Days to maturity
$\bar{F}_2$	49	70	47	67	51	80	54	82
$\bar{P}_1$	46	63	47	61	45	62	45	62
$\bar{P}_2$	55	72	43	60	57	76	54	70

§ For each character, values with common superscript do not differ significantly from each other at $P = 0.05$ as determined by Z-test.

* The population size of F_2 generation was 794, 792, 791 and 785 plants in cross 1 to 4, respectively.

** The first parent is P_1 and second is P_2 in all the four crosses.

characters were observed in cross 2. The estimates of PCV were lowest for both the traits in GC 2 x V 240.

The estimates of heritability in broad sense was high and ranged from 69.4% (cross 1) to 79.5% (cross 2) for pods per plant and from 54.7% (cross 3) to 88.3% (cross 2) for seed yield per plant. Similarly, the expected genetic advance as per cent of mean was found to be maximum in cross 2 and minimum in cross 3 for both these traits. High heritability coupled with high expected genetic advance as per cent of mean observed for both the traits in F_2 populations of all the four crosses indicated presence of good variability and possibilities of genetic gain through selection in these populations.

The reservoir of genotypic variation is basic requirement of breeding crop plants. For any kind of selection scheme to be effective, presence of adequate genetic variability in the population is a pre-requisite. Wider the genetic variability, more the chances of improvement through selection. In autogamous crops, additive genetic variance is apparently more important than non-additive type of variance (Matzinger, 1963). In the present study, high mean performance, wider range of variation, along with higher values of genotypic and phenotypic variances as well as its coefficient of variation displayed relatively higher amount of genetic variability for pods per plant and seed yield per plant in all the four crosses (Table 1). The extent to

which the genetic segregation is expected in later generation of cross is largely a reflection of the heritability of the characters in question (Mahmud and Kramer, 1951). The heritability was calculated by utilizing the variability among spaced F_2 plants in relation to the variability among spaced plants of the non-segregating parents. High heritability coupled with high expected genetic advance as per cent of mean was observed for pods per plant and seed yield per plant for all the four crosses which indicated the predominant role of additive gene action in the expression of both the traits. The present findings are akin to the results reported by Chauhan and Joshi (1981), Patil and Bhapkar (1986), Patil and Shete (1986), Patel (1988) and Patel (1991) in cowpea.

The parents involved in the four crosses showed a considerable range of variation for all the characters studied. It is worth mentioning here that the parents Pusa Falguni, GC 1 and RC 8 were low yielder but were earlier in flowering and maturity. Whereas the parents V 16, V 240 and V 269 were high yielder with delayed flowering and maturity. GC 2, earlier in flowering and maturity coupled with high seed yield, is a best cultivated variety available in this part of the country. It was also observed that except for days to maturity in cross 2, 3 and 4, the F_2 had intermediate values to their parents for days to 50 per cent flowering and days to maturity.

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Persistent and Relative Toxicity of Different Insecticides Against *Coccidohystrix insolita* (Green) Infesting Pigeonpea*

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The mealybug, *Coccidohystrix insolita* (Green) (Homoptera : Pseudococcidae) has been found seriously infesting pigeonpea crop in isolated patches in the Saurashtra region of Gujarat State. The pest commonly known as brinjal mealybug and has been reported by Chaudhuri (1976) and Nair and Nair (1977) attacking brinjal. It has also been reported feeding on pigeonpea in Gujarat (Patel *et al.*, 1985; Bhalani, 1990). Since no information is available regarding residual persistence and relative toxicity of insecticides against *C. insolita*, an attempt was made to investigate the same.

A field-cum-laboratory experiment was conducted to evaluate residual persistent toxicity of 12 insecticides for this pest on pigeonpea crop. Three rows of pigeonpea crop (5 m long) were sprayed with different insecticides (Table 1). The spraying was done @ 800 l/ha with the help of knapsack sprayer. The leaves from respective treatments were brought to the laboratory 1 hour after spraying and at 1, 3, 7, 9, 11 and 13 days intervals. They were placed in-

dividually in Petri dish (9.0 cm x 9.0 cm) having moist germination paper. Twenty-five third instar nymphs of mealybug were released into each Petri dish containing the treated leaves of pigeonpea and each set was repeated thrice. Observations on the mortality were recorded 48 hr after the release. The per cent mortality was corrected by using Abbott's formula (Abbott, 1925). The zero and cent per cent values were removed by using the formula $1/4 n \times 100$ and $(1-1/4 n) 100$, respectively (Bartlett, 1947). The data thus obtained were angularly transformed and subjected to statistical analysis. Persistent toxicity (PT) and residual persistent toxicity (RPT) for each insecticide was worked out as suggested by Sarup *et al.* (1970).

For finding out relative toxicity if different insecticides against third instar nymphs of *C. insolita*, six graded concentrations viz., 0.03, 0.015, 0.0075, 0.00375, 0.00188 and 0.00094 per cent for dichlorvos, malathion, methyl parathion, triazophos and quinalphos; 0.4, 0.2, 0.1, 0.05, 0.025 and 0.0125 per cent for mint oil, neemmark and neemgaurdi 0.02, 0.01, 0.005, 0.0025, 0.00125 and 0.00063 per cent for phosphamidon; 0.04, 0.02, 0.01, 0.005, 0.0025 and 0.00125 per cent for nicotine sulphate and 0.07, 0.035, 0.0175, 0.0088 0.0044 and 0.0022 per cent for endosulfan were prepared from commercial formulations of the insecticides except mint oil and were used for this investigation. Each concentration was applied @3 ml per potted pigeonpea plant of 21 days

*Part of Ph.D. thesis submitted by senior author to Gujarat Agricultural University.

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TABLE 1

Toxicity of some insecticides against *C. insolita* on pigeonpea.

Treatment	Concen- tration (%)	Corrected per cent mortality of <i>C. insolita</i> at different days after spray			P	T	PT	RPT	LC 50	Fiducial limits	Relative toxicity
		1hr	7 days	13 days							
Dichlorvos	0.04	84.23 (98.99)	27.48 (21.29)	5.74 (1.00)	9	44.28	398.54	0.4972	0.013646	+0.020835 -0.008935	0.7171
Malathion	0.05	84.23 (98.99)	31.90 (27.92)	5.74 (1.00)	11	41.93	461.25	0.5755	0.013155	+0.020107 -0.008607	0.7438
Methyl parathion	0.05	84.23 (98.99)	29.32 (23.98)	5.74 (1.00)	11	37.80	415.85	0.5188	0.013394	+0.020667 -0.008681	0.7306
Monocrotophos	0.04	64.40 (81.33)	39.99 (41.30)	9.60 (2.78)	13	49.33	641.21	0.8000	0.016568	+0.026604 -0.010319	0.5906
Phosphamidon	0.03	49.20 (57.30)	38.43 (38.63)	11.53 (3.99)	13	43.13	560.72	0.6995	0.028421	+0.038489 -0.020987	0.3443
Triazophos	0.04	84.23 (98.99)	50.75 (59.97)	13.16 (5.18)	13	61.65	801.50	1.0000	0.011501	+0.016873 -0.007840	0.8508
Quinalphos	0.05	84.23 (98.99)	39.99 (41.30)	7.67 (1.78)	13	52.05	675.65	0.8442	0.009785	+0.014525 -0.006592	1.0000
Endosulfan	0.07	39.99 (41.30)	20.08 (11.79)	5.74 (1.00)	9	25.56	230.01	0.2869	0.082761	+0.100847 -0.067919	0.1182
Mint oil	0.50	64.40 (81.33)	18.98 (10.58)	5.74 (1.00)	9	40.26	362.37	0.4521	0.337397	+0.546031 -0.208481	0.0290
Neemark	0.50	69.88 (88.17)	20.08 (11.79)	5.74 (1.00)	11	36.44	400.86	0.50010	0.201113	+0.296179 -0.136561	0.0487
Neemguard	0.50	58.90 (73.32)	23.57 (15.99)	5.74 (1.00)	11	35.60	391.60	0.4885	0.266255	+0.414590 -0.170993	0.0368
Nicotine sulphate	0.05	57.19 (70.64)	11.53 (3.99)	5.74 (1.00)	7	31.16	218.15	0.2722	0.026359	+0.039051 -0.017793	0.3712
S. Em. %		0.89	0.99	0.86							
C. D. at 5%		2.62	2.91	2.53							
C. V. %		2.25	5.86	20.40							

Figures in parentheses are retransformed values.

old with the help of Potter's spraying tower at a constant pressure of 1.76 kg/cm². The treated plants were dried. The nymphs were then released from the laboratory culture. The plants were covered with glass chimney having top end covered with muslin cloth. Each treatment was replicated thrice. The mortality counts were recorded 48 hr after the spray. Data were corrected by using Abbott's formula (Abbott, 1925). The mortality data were subjected to probit analysis (Busvine, 1971). Toxicity ratio of an insecticide was computed according to Jotwani *et al.* (1971).

Triazophos (0.04%) was the only insecticide which was found toxic upto 7 days, recorded 60 per cent nymphal mortality. On the basis of RPT values, the order of persistence toxicity was triazophos > quinalphos > monocrotophos > phosphamidon. Looking to the consistency of the results

triazophos, quinalphos, monocrotophos and phosphamidon were found most effective both in respect of mortality of the pest as well as prolonged persistence. Basu and Pramanik (1968) reported phosphamidon (0.01%) as effective insecticide against *C. insolita* on brinjal which persisted for 15 days.

Quinalphos (LC 50 = 0.009785) was found to be the most toxic insecticide against this pest (Table 1). Triazophos (LC 50 = 0.011501) was found slightly less toxic than quinalphos (LC 50 = 0.009785). The dichlorvos, monocrotophos were less toxic than the quinalphos and they gave relative toxicity values 0.7171, 0.7306, 0.7438 and 0.5906, respectively. Endosulfan in synthetic insecticides and mint oil in botanical materials were found to be the least toxic.

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First Record of *Diplazon laetatoris* Fab. (Ichneumonidae : Hymenoptera) As a Pupal Parasite of Syrphid Fly, *Xanthogramma scutellarge* Fab. (Syrphidae : Diptera) in Gujarat State

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Mustard aphid, *Lipaphis erysimi* L. is one of the major pests in mustard growing areas of Gujarat State. The yield losses due to aphid has estimated and ranged between 35.4 to 72.3 per cent in different agroclimatic condition in the country (Bakhetia, 1986). In nature this pest is regulated by several arthropod natural enemies viz., Lady bird beetle *Menochilus sexmaculatus*, *Coccinella septumpunctata*, *Chrysopa* spp, Braconid parasite, *Diaretiella rapae* and syrphid fly, *Xanthogramma scutellarae*. Seven species of aphidophagous syrphids have been recorded on mustard in Punjab (Kumar *et al.* 1989), while in Gujarat, four species have been found feeding on aphids (Patel and Patel, 1989). Hence, attempts were made at castor-mustard research project S. K. Nagar during 1994-95 to see the beneficial role of syrphid fly for the

ecological management of mustard aphid under confined-cage condition.

With a view to have a more number of adults, pupal stages of syrphid fly were collected and released (n=100) in mustard plot covered with muslin cloth measuring 2 x 2 meter area. After a week, it was noted that most of the pupae failed to develop into adult. Another lot of field collected pupa was brought to laboratory to see its natural enemies, if any. Such pupae reared in individual plastic tube and parasitic fly emerged out from them, were kept separately and preserved in 80 per cent alcohol. These specimens were sent to Taxonomy Section, Division of Entomology, I.A.R.I., New Delhi for identification. Later on it was identified as *Diplazon laetatoris* F. which is hitherto unreported pupal parasite of syrphid fly from Gujarat State. Patel and Patel (1969) have however reported *D. orientalis* as a pupal parasite of syrphid fly from Anand. Thus, this is quite first time reported from Gujarat State.

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Host Range of *Drechslera hawaiiensis* Bough. Causing Leaf Blight of Papaya

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Preliminary survey carried out for the diseases of papaya in papaya growing areas of Surat and Valsad districts, papaya crop was found severely affected by leaf spot and leaf blight diseases in certain pockets. Isolation

and subsequent identification of pathogens revealed to be *Alternaria alternata* (Fr.) Keissler and *Drechslera hawaiiensis* Bough. Pathogenicity test carried out on cv. Madhubindu showed that *A. alternata* caused leaf spot while *D. hawaiiensis* caused leaf blight of papaya.

In order to study host range of *D. hawaiiensis*, twelve plant species commonly found in South Gujarat (Table 1) were tested for host range under glasshouse condition. The plants were raised in pots filled with autoclaved soil and inoculated by spraying the spore suspension (125-150 conida/100 x micro field)

TABLE 1

Infection test of *Drechslera hawaiiensis* on different plant species.

Sr. No.	Plant species	Family	<i>D.hawaiiensis</i>		Per cent Infection
			No. of plant inoculation	No. of plant infected	
1.	Okra (<i>Hibiscus esculantus</i> L.)	Malvaceae	2	0	0
2.	Cabbage (<i>Brassica oleracea</i> var. capitata)	Cruciferae	2	0	0
3.	Cauliflower (<i>Brassica oleracea</i> var. cauliflora L.)	Cruciferae	2	0	0
4.	Bottle gourd (<i>Lagenaria siseraria</i> (Mol.) Stanli.	Cucurbitaceae	2	2	100

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1.	2.	3.	4.	5.	6.
5.	Cotton (<i>Gossypium herbaceum</i> L.)	Malvaceae	2	2	100
6.	Brinjal (<i>Solanum melongena</i> L.)	Solanaceae	2	0	0
7.	Tomato (<i>Lycopersicon lycopersicum</i> L. (Karst.))	Solanaceae	2	0	0
8.	Cluster bean or Guar (<i>Cyamopsis tetragonaloba</i> L.)	Papilionaceae	2	0	0
9.	Potato (<i>Solanum tuberosum</i> L.)	Solanaceae	2	0	0
10.	Pegionpea (<i>Cajanus cajan</i> L.)	Papilionaceae	2	0	0
11.	Banana (<i>Musa cavendish</i> L.)	Musaceae	2	0	0
12.	Elephant's foot (<i>Amorphophalus campanulatus</i> Blume).	Araceae	2	0	0

of *D. hawaiiensis* cultured on PDA for ten days. Suitable checks for each plant species were kept uninoculated. Plants were watered regularly.

Final observation on development of symptoms recorded after 15 days of inoculation revealed that *D. hawaiiensis* infected only 2 plant species i.e. bottle gourd (*Lagenaria siseraria*) and cotton (*Gossypium herbaceum*) belonging to family cucurbitaceae and malvaceae producing the characteristic leaf blight lesions similar to papaya (Table 1). No

symptoms developed on rest of the plant species tested.

Though *D. hawaiiensis* has been reported to infect many plant species including bermuda grass (Mishra *et al.* 1971), pineapple (Cheeran and Sasikumaran, 1972). Commelina (Narendra and Rao, 1973) rhodesgrass (Sonoda, 1974), pearl millet (Misra and Singh, 1975), maize (Shukla and Shukla, 1974) and Sorghum (Pandey and Shukla, 1979), bottle gourd for this fungus.

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Effect of Paclobutrazol on Fruiting Behaviour of Mango

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Paclobutrazol, a broad-spectrum gibberelline and strobilino-synthesis retardant a thousand times more potent than chlomequat chloride, ensure regular, early and heavy fruiting in mango. Paclobutrazol was used @2.3 g PBZ per metre tree canopy spread radius in soil drip for the control of alternate bearing. It not only induced early flowering but increased number of fruit on each tree, yield, specific gravity and decreased fruit weight, fruit volume and fruit size.

The productivity of mango orchards throughout the country is low and stagnant, around 8 tonnes per hectare, even though 65 per cent of the world mango harvests are reaped in India. This is mainly because of alternate and shy-bearing in most commercial varieties like Dashehari, Langra, Chausa and Bombay Green of North India. Some growth regulators viz. Cycocel, Alar, KNO_3 and Ethrel, have induced flowering in mango at certain locations (Maiti *et al.*, 1972 and Chacko *et al.*, 1972 a) but application of these compounds at other locations have failed to be of any practical importance (Ram *et al.*, 1976).

Hence, an experiment was conducted to induce flowering and fruiting in mango by early application of PBZ in soil drip.

The experiment was carried out during 1994-95 on uniformly bearing mango trees (16-17 years) on Dashehari, Langra, Chausa and Bombay Green to find out the effect of early application PBZ on vegetative growth and flowering. Paclobutrazol was applied on 25 August 1994 @2.3 g PBZ per metre tree canopy spread radius in soil drip followed by spraying of 1.5% KNO_3 , on 25 October, 1994. The aqueous suspension of PBZ for treatment were prepared by adding desired quantity of 23% cultar in 7 litre of water. Each treatment was applied on one tree and replicated thrice.

The observations recorded were subjected to statistical analysis by using Randomized Block Design. Valid conclusions were drawn only on significant difference between the treatment mean at 0.05 level of probability (Cochran and Cox, 1959). In order to compare treatment means, critical difference were calculated.

Flowering

Data on per cent flowering in (Fig. 1 A, B, C, D) show that PBZ treatment in 25 August induced early flowering. In cultivar Dashehari 20 days early flowering occurred. However, in Langra not only 20 days flowering occurred

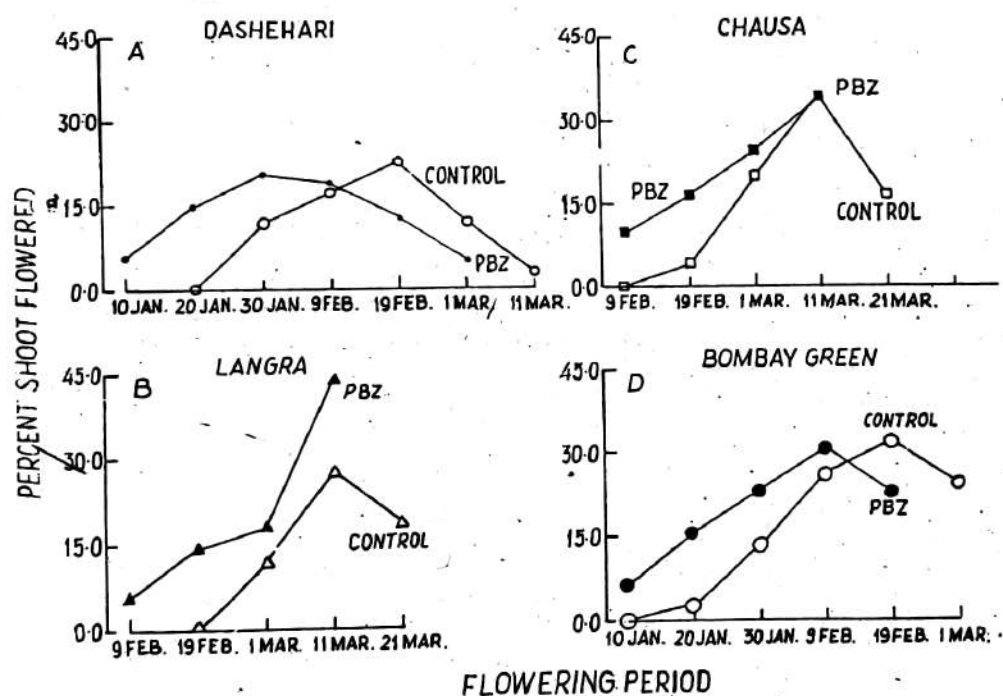


Fig. 1 : Response of PBZ on flowering of mango cvs. Dashehari (A) Langra (B) Chausa (C) and Bombay Green (D) when 16-17 year old trees were treated with 2.3 g PBZ per meter tree canopy spread radius followed by spraying of 1.5% KNO₃.

TABLE 1

Effect of paclobutrazol treatment on fruit set, fruit growth and yield.

Treatment	Initial fruit set (1st week of April)	Fruit set at pea stage (2nd week of April)	Mature fruit/panicle	No. of fruit/tree	Yield (kg/tree)	Fruit weight (g)	Fruit volume	Specific gravity	Length of fruit (cm)	Width of fruit (cm)
Dashehari - Control	43.00	13.66	1.33	145.00	56.66	275.33	269.33	1.01	11.26	7.03
Dashehari - 2.3 g PBZ/m tree canopy spread radius	48.00	16.00	2.33	191.66	74.00	259.00	253.66	1.01	9.93	6.30
Langra - Control	38.00	14.33	1.33	181.66	66.00	286.33	280.00	1.01	9.37	8.20
Langra - 2.3 g PBZ/m tree canopy spread radius	43.33	16.33	2.00	219.00	87.66	250.66	244.00	1.02	8.93	7.30
Chausa - Control	41.33	13.33	1.66	120.66	38.66	277.66	262.00	1.01	11.98	6.90
Chausa - 2.3 g PBZ/m tree canopy spread radius	44.66	15.33	2.33	155.00	56.00	249.66	246.66	1.01	11.17	6.13
Bombay green - Control	42.00	11.66	1.33	190.33	33.66	271.66	267.66	1.01	7.05	7.43
Bombay Green - 2.3 g PBZ/m tree canopy spread radius	47.00	14.33	2.00	280.66	49.33	288.00	282.66	1.01	8.18	8.00
Treatment	3.544	1.694	NS	9.875	7.382	12.683	12.411	0.0047	0.621	0.338
C. D. at 5% cultivar	NS	NS	NS	23.510	NS	NS	17.552	NS	0.879	0.478
Interaction	NS	NS	NS	NS	NS	25.367	24.823	NS	NS	0.677

due to PBZ application but per cent flowering was also increased and flowering completed about 20 days earlier. Similarly in cvs. Chausa and Bombay Green induction and completion of 10 days earlier flowering was accomplished by paclobutrazol. Similar results were earlier reported by (Galila and El-Masry, 1991; Vuillaume, 1991).

Fruit set and yield

Data on fruit set and yield are reported in Table 1 show that PBZ increased fruit set in all the cultivars without much of cultivar difference. Interaction between cultivar and

cultivars were not significant. Paclobutrazol increased number of fruits on each tree, yield, specific gravity and decreased fruit weight, fruit volume and fruit size without any effect on number of mature fruits per panicle. Difference between cultivars occurred due to paclobutrazol application on fruit number per tree, yield fruit volume and size of fruit. Kulkarni (1988) reported that soil drench of 10 g paclobutrazol per tree increased 1.6% fruit yield and similar increased in yield were also reported (Kurian and Iyer 1993).

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Abstracts of Ph. D. Thesis

Studies on Characterization and Amelioration of Salt Affected Soils of North West Agroclimatic Zone of Gujarat

Submitted to Gujarat Agricultural University

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In present study, an attempt was made to characterize the salt affected soils of North-West agroclimatic arid zone by collecting 440 surface soil samples from the salt affected but cultivated fields of the zone. In addition to this, a pot experiment was conducted on saline-sodic soil (EC_e : 11.9 dSm^{-1} , ESP : 28.0) with 30 treatment combinations comprising three levels of leaching (L_1 : 50 to 100% WHC, L_2 : 50 to 150% WHC and L_3 : 50 to 200% WHC), two levels of FYM (F_0 : 0 and F_1 : 25 t/ha) and five levels of gypsum application (G_0 : no gypsum G_1 : 25% GR, G_2 : 50% GR, G_3 : 75% GR and G_4 : 100% GR) in a factorial completely randomized design with three

replication by growing wheat (Rabi, 1992-93) and fodder sorghum (summer, 1993) in sequence as test crop.

The results of characterization study showed that out of 308 samples analysed, 49.1, 31.2 and 19.1 per cent samples were of saline, saline-sodic and sodic soils, respectively. Thus, saline and saline-sodic soils were extensive.

The results of the pot experiment are showed that the germination percentage, plant height, grain and straw yields of both crops as well as nutrient uptake were found to increase significantly with increase in levels of leaching (L), FYM (F) and gypsum (G). The content of N, P, K, Ca, Mg, S, Fe, Mn, Zn and Cu was increased and that of Na decreased in wheat grain and fodder of both the crops due to main effect of L, F and G. Interaction effects of L x G and F x G was significant on growth, yields and nutrient uptake by both the crop.

In general, EC, pH and ESP of the soil were found to decrease considerably with the increase in the levels of leaching, FYM and gypsum at all the sampling during both the crop growth periods. The periodical analysis of soils and leachate substantiated the effects of leaching, FYM and gypsum.

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Construction of Scale to Measure the Entrepreneurial Behaviour of Rural Women in Dairy Farming

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The present research study is an exploratory work in the virgin area of entrepreneurial behaviour (EB) of rural women in dairy farming. The EB is an indispensable and crucial factor for development of dairy farming occupations are indeed inherently interwoven. The term entrepreneur can be defined as creative and innovative response to the environment, person who organises and manages commercial undertaking. The entrepreneur is an economic woman, who strives to maximise her profits by adopting innovations. Entrepreneurship as a variable in dairy farming is not yet recognised only a few researches have been conducted in agricultural entrepreneurship, but not particularly in dairy farming entrepreneurs.

In all, one dependent variable i.e. entrepreneurial behaviour (EB) and 10 scale indicators and 13 independent variables were studied. The salient finding of the study were : (1) The scale was constructed by using the

normalised rank order method. The relative importance of all the scale indicators were significant and established positive and significant relationship with EB of dairy women. (2) Most (72.00 per cent) of the respondents have medium level of EB and almost equal number of respondents were in low and high level of group. (3) It was found that innovativeness and leadership ability were crucial indicators affecting directly and positively on EB of dairy women. (4) Most (71.56 per cent) of the dairy women were in medium group of milk yield, infrastructural experience was medium and medium dairy income category. Further, more than half of medium herd size and family size were also medium. (5) The variables namely education, type of family, size of family, land holding, herd size, social participation, infrastructural experience, dairy income, dairy experience and milk yield were positive and significantly correlated with EB of dairy women (6) About 90.56 per cent ($R^2 = 0.9056$) contribution to the variation in dependent variable (EB) was accounted by dairy income and dairy experience jointly. (7) The variables dairy farming income and milk yield were crucial independent variables affecting directly and positively on EB of dairy women. (8) There were certain main problems in dairy farming namely low milk price, costly management and high cost of milch animals. (9) Important suggestions were milk price should be increased, cattle feed should be available at reasonable price by dairy and loan should be provided for the purchase of milch animals.

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Quantitative Genetic Study in Treated and Untreated Diallel Populations of Cowpea (*Vigna unguiculata* (L.) Walp)

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The present investigation was carried-out with a view to estimate and compare the genetic parameters heterosis over mid and better parents, general and specific combining ability and nature of gene action in treated and untreated populations for eleven traits. Seven diverse genotypes of cowpea were crossed in half diallel fashion. Simultaneously, the seven parents and 21 F_1 's were irradiated with 30 KR X-rays.

The mean range and variances were higher in F_1M_1 as compared to F_1 except seeds per pod. The irradiation treatment to F_1 's resulted in to increased variation in both F_1M_1 and F_2M_2 generations as compared to the corresponding F_1 and F_2 generations therefore increasing

the scope for selection. Such an approach could prove beneficial in terms of labour and time to isolate desired genotypes.

Under treated conditions, promising hybrids were, GC 8926 x 8968, Pusa Phalguni x GC 8930, GC 8930 x GC 8968, Pusa Phalguni x GC 8963 and GC 8926 x GC 8963. Whereas, under untreated conditions, Pusa Phalguni x GC 8968 and GC 8930 x GC 8968 were promising ones. These all heterotic hybrids had high sca effects for yield and its components. For yield heterosis the component traits were, branches per plant, pods per plant and cluster per plant in treated and seeds per pod in untreated condition.

The gca effects was altered due to irradiation for days to 50 per cent flowering in parent GC-2. In Pusa Phalguni protein content turned out to be poor combiner due to irradiation treatment. By and large the X-ray treatment to F_1 's had an enhancing effect on gca effects of parents.

In fact the two modes of inducing polygenic variability, hybridization and mutation could be combined profitably for generating more variability for better scope of selection.