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uptake (t/ha)

Factorial Randomised Block Design with four replications. Full dose of phosphorus from single super phosphate and potash as muriate of potash were applied at the time of transplanting as basal dose, while nitrogen applied in form of ammonium sulphate in equal splits viz., at transplanting, tiller panicle initiation and boot stage. The crop was transplanted maintaining 20 cm x 15 cm spacing in last and third week of July and August, during 1983 and 1984 respectively.

Straw yield was not influenced significantly by various NP levels. Yield components viz., plant height, number of productive tillers/m², panicle length and panicle weight were remarkably improved as levels of

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RESULTS AND DISCUSSION

Effect of NP Fertilizer

The results presented in Table 1 reveal that the highest mean grain yield of 53.5 and 51.71 q/ha recorded at N₁₅₀ P₇₅ and N₁₀₀ P₅₀ respectively was statistically at par but significantly higher over lower levels of NP fertilizers (N₀ P₀ and N₅₀ P₂₅). Increasing dose of fertilizers beyond N₁₀₀ P₅₀ did not increase the yield significantly. Increase in yield at higher NP levels was evidently resulted from beneficial effects of these levels on yield attributes viz., plant height, number of productive tillers/M², panicle length and panicle weight. This increase in grain yield may also be attributed to higher uptake of plant nutrients especially nitrogen, phosphorus and potash by rice plant (Table 2) which favourably enhanced yield attributes for better grain yield of rice.

This level (N₁₀₀ P₅₀) also gave higher net profit of Rs. 8376/-ha with net ICBR of 1:5.07, closely followed to N₁₅₀ P₇₅. Thus, application of N₁₀₀ P₅₀ was optimum and profitable dose. The findings corroborate the reports of Deo (1979), Patel (1982), Balasubramaniyan (1983) and Nayak (1984).

While... significantly... et al. (1982)

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Alexander *et al.* (1974) and Vinaysingh and Jaiprakash (1979).

Protein content in grain was not significantly influenced by various NP levels. Whereas its content in straw was significantly increased as levels of NP fertilizer increased.

Effect of potash levels

The results reveal that straw yields of rice were not influenced with varying levels of potash. The probable reason for the lack of response of potash on rice may be due to the availability of available potash in the soil.

Interaction
C.V. %

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Yields of rice (GR 11) and economics as affected by potash under various NP levels.

	Yield (q/ha)		Economics (Rs/ha) on pooled basis			Plant height (cm)	No. of productive tillers/m ²	No. of filled spikelets/panicle	Length of panicle (cm)	Panicle weight (g)
	Grain	Straw	Net profit	Per cent increase	Net ICBR					
NP levels (kg/ha)										
N ₀ P ₀	25.16	32.93	29.40	—	—	84.2	130.8	182.9	20.9	2.66
N ₅₀ P ₂₅	41.79	57.80	6335	115.47	1:6.39	95.8	202.7	186.8	22.0	2.96
N ₁₀₀ P ₅₀	51.71	86.76	8376	185.30	1:5.07	105.1	252.9	197.2	22.7	3.22
N ₁₅₀ P ₇₅	53.51	89.94	8380	185.40	1:3.31	110.6	268.6	188.3	23.0	3.07
S. Em.	2.86	9.7	—	—	—	1.4	8.9	8.2	0.10	0.057
C. D. 0.05	8.11	NS	—	—	—	6.36	39.8	NS	0.29	0.159
K ₂ O levels (kg/ha)										
0	42.64	66.27	6594	—	—	98.4	209.7	194.2	21.9	3.03
25	42.31	66.65	6474	—1.82	1:3.83	99.0	215.8	180.7	21.8	2.86
50	43.68	69.92	6752	—2.39	1:4.59	97.9	213.3	191.1	22.3	3.02
75	42.32	68.13	6384	—3.18	1:1.05	100.0	220.2	183.5	22.4	2.44
100	42.39	68.33	6342	—3.82	1:0.39	99.5	209.7	193.8	22.4	3.04
S. Em.	00.85	01.11	—	—	—	0.48	4.3	4.7	0.20	0.063
C. D. 0.05	NS	NS	—	—	—	1.35	NS	NS	NS	NS
Interaction	NS	Sig.	—	—	—	NS	NS	—	NS	NS
C. V. %	11.4	09.3	—	—	—	2.8	11.5	—	3.0	—

TABLE 2

Content and uptake of N, P, K nutrients by GR 11 rice as affected by potash under various NP levels.

Treatments	Protein content(%)		N content (%)		N Uptake by rice crop (kg/ha)	P content (%)		P Uptake (kg/ha)	K content (%)		K uptake (kg/ha)
	Grain	Straw	Grain	Straw		Grain	Straw		Grain	Straw	
NP levels (kg/ha)											
N ₀ P ₀	6.94	3.07	1.111	0.492	45.18	0.722	0.256	26.41	1.881	1.890	109.5
N ₅₀ P ₂₅	7.40	2.99	1.185	0.478	76.58	0.673	0.252	43.15	1.776	1.830	178.3
N ₁₀₀ P ₅₀	7.90	3.73	1.265	0.597	114.43	0.654	0.324	61.44	1.795	1.985	259.8
N ₁₅₀ P ₇₅	9.04	4.47	1.445	0.714	147.84	0.698	0.353	72.10	2.018	1.980	299.2
S. Em. ±	0.40	0.10	0.555	0.016	15.52	0.024	0.020	05.27	0.076	0.101	28.2
C D. 0.05	NS	0.29	NS	0.045	NS	NS	NS	23.7	NS	NS	NS
K ₂ O levels (kg/ha)											
0	7.73	3.49	1.237	0.558	93.32	0.663	0.291	47.94	1.925	1.764	202.1
25	7.99	3.53	1.278	0.565	92.26	0.734	0.292	52.86	1.799	1.892	196.5
50	7.68	3.68	1.226	0.590	98.50	0.694	0.300	52.16	1.778	1.862	211.0
75	7.90	3.49	1.264	0.559	95.99	0.664	0.287	49.15	1.768	1.974	218.6
100	7.81	3.62	1.251	0.580	95.01	0.677	0.311	51.73	1.954	2.117	230.5
S. Em. ±	0.13	0.23	0.021	0.018	2.30	0.019	0.019	00.98	0.094	0.100	8.3
C. D. 0.05	NS	NS	NS	NS	NS	NS	NS	2.78	NS	NS	NS
Interaction	NS	NS	NS	NS	NS	NS	Sig.	NS	NS	NS	NS
C. V. %	9.1	17.9	9.4	8.7	13.5	5.3	8.3	10.9	7.0	6.6	12.1

(1976) reported that except for black soil of South Gujarat, in general, there was hardly any response of potash application because available K_2O status are fairly high. According to Ponnamperna (1972), flooding the soil causes an increase in the concentration of ions in the soil solution. These ions are chiefly Ca^{++} , Mg^{++} , K^+ , Na^+ , NH_4^+ , Fe^{++} , Mn^{++} etc. Gorantiwar *et al.* (1973) reported that the availability and uptake of K_2O significantly increased in submerged conditions. Similar trend was also observed by Kadrekar and Kibe (1973). Thus, it is clear that under wet conditions of the soil, the availability of native potash is increased which is responsible for failure of response to the applied potash on grain yield of rice in the soil when it is adequately supplied with available K_2O and potentially rich in reserve potash.

Different levels of potash did not alter significantly various yield components viz., no. of productive tillers/m², no. of filled spikelets/panicle, length of panicle and panicle weight, except plant height which was maximum at 75 kg K_2O /ha but was at par with 10 kg K_2O /ha and 25 kg K_2O /ha.

The N, P and K content in grain and straw as well as their uptake were not appreciably influenced due to various levels of potash. Uptake (52.86 kg/ha) by rice crop increased remarkably upto 25 kg K_2O /ha. The significant increase in P uptake due to application of 25 kg K_2O /ha over control could be due to the formation of KH_2PO_4 complex, which has, though non-significant, gave high P content of grain and thereby affected the P uptake. This lends support to the findings of Vinaysing and Jaiprakash (1979).

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Differential Gynotypic Salt Tolerance of Wheat in Simulated Saline Soils

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ABSTRACT

A green house experiment was conducted during *rabu* 1986 in a big galvanized pot (75 cm x 60 cm x 25 cm) to evaluate 16 varieties of wheat with four salinity levels (S_0 -2.0, S_1 -4.0, S_2 -8.0 and S_3 -12.0 ECe $dS^{m^{-1}}$) in a medium black calcareous soil. The results showed that germination percentage, plant height, straw and grain yield as well as Na & K content and Na/K ratio were severely affected by salinity levels.

Among the varieties, the highest germination percentage, plant height and straw and grain yield were recorded with Kharchia, J-24 and Popatia, which were at par with each other but significantly superior to the rest cultivars. The highest mean salinity index (87.9) was noted with genotype Kharchia, followed by J-24 (86.6) and that of lowest (65.4) was recorded by GW-1 and GW-2. In addition to this a minimum Na content and Na/K ratio in straw were also observed in these varieties.

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INTRODUCTION

Fortunately agricultural crops show marked differences in their ability to grow under saline conditions and a great variability exists among varieties (Epstein, 1972, Maas and Haffman, 1977). Salinity brings physiological, biochemical and morphological changes in plants which reflect on the overall performance of the plant. The significant varietal differences in salt tolerance have been reported in wheat by Giriraj *et al.* (1980) and Kumar (1983). However, the high yielding varieties of wheat grown in Saurashtra region have not been evaluated for their salt tolerance.

In Saurashtra region of Gujarat, the main source for irrigation is well water (80%) and majority of these water are either saline or sodic or bath (Patel *et al.* 1982). However, the farmers of this region grow wheat with these poor quality well water to meet their food and fodder requirement. The present study was, therefore, undertaken to study the relative salt tolerance of different varieties of wheat grow in this region.

MATERIALS AND METHODS

A green house study in big galvanized iron pots (75 cm x 60 cm x 30 cm) containing 120 kg calcareous medium black clay soil

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(Vertisol) was conducted during *rabi* 1986 to evaluate the relative salt tolerance of sixteen wheat varieties (viz., V₁-J-405, V₂-Lok-1, V₃-J-24, V₄-Kalyan Sona, V₅-WH-147, V₆-GW-120, V₇-HD-2236, V₈-HI-1077, V₉-GW-89, V₁₀-Kharchia, V₁₁-Raj-1555, V₁₂-HD-4560, V₁₃-GW-1, V₁₄-GW-2, V₁₅-A-206 and V₁₆-Popatia (Local) using four levels of salinity (viz., S₀-2.0, S₁-4.0, S₂-8.0 and S₃-12.0 ECe dSm⁻¹) in a completely randomized design with two replications. The soil was clay in texture having pH-8.0, EC-1.05 dSm⁻¹, CaCO₃-19.5%, organic carbon-0.75% Olson's available P 12.4 kg/ha and available K 323 kg/ha. The saline waters of 4.0, 8.0 & 12.0 EC dSm⁻¹ were prepared by dissolving sulphates and chlorides of Na, Mg and Ca at 15:2:1 and of Cl : SO₄ at 2:1 ratio. The calculated amount of N & P as urea and diammonium phosphate was applied in furrow per pot as basal @ 60 kg N & 60 kg P₂O₅/ha and remaining N was supplied in two equal splits, each of 30 kg N/ha as urea at 20 and 40 days after sowing. Following this, 50 seeds of each variety were sown in line (22.5 cm spacing) in each pot and they were covered with the soil. Forty two litres of solution of different salts concentration as per the treatments were applied uniformly in each pot in order to attain slightly higher moisture (35%) than that of field capacity. The soil was allowed to attain equilibrium for 48 hrs and then it was checked whether the desired salinity (ECe) in the soil was attained or not. The water content in the pots was maintained within 80-100% available water throughout the growth period by adding distilled water. However, salinity levels (2, 4, 8 & 12 EC dSm⁻¹) of the pots as per respective treatments were maintained constant through out the crop growth by irrigating them with respective saline waters, whenever required. The fourth day after sowing, the daily germination count was

recorded periodically but the final counts were considered on eleventh day after sowing. Finally 10 seedlings for each variety were allowed to grow up to maturity. The mean plant height and grain and straw yield at harvest were recorded. The soil analysis was carried out by the standard methods as described by Richards (1954), whereas plant analysis for Na & K as per the method described by Jackson (1973).

RESULTS AND DISCUSSION

Effect on Germination

Salinity : The periodic germination counts showed (Fig. 1) that the germination was almost 94 per cent after eleventh day of sowing with control (2.0 ECe dSm⁻¹) followed (88%) by

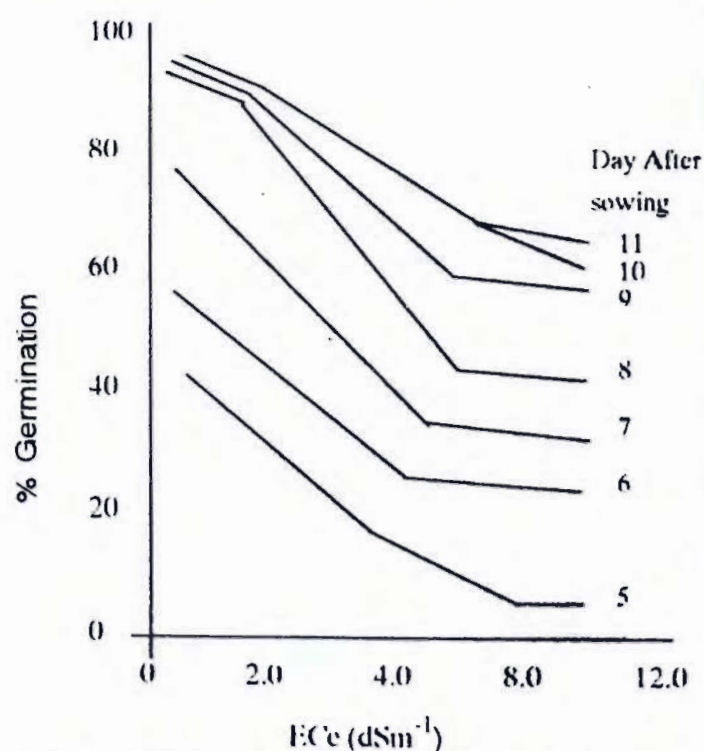


Fig.1 : Periodic germination of wheat as influence by salinity levels.

ECe level of 4.0 dSm⁻¹. The higher salt concentration levels at 8.0 dSm⁻¹ and above showed the inhibitory effect and markedly decreased the total germination. Only 56 per cent of total germination was observed at ECe

12 dSm⁻¹. The final germination count was significantly affected by salinity levels and it was decreased with salinity level increased. The linear relationship between salinity level and germination could be expressed by the regression equation $y = 101.2 - 3.93 x$ ($r = 0.981$). The results are in accordance to Kumar (1983) who reported that germination percentage of wheat varieties were decreased with an increased in salinity levels.

Variety : The result in table 1 showed that the highest mean germination percentage (80.5%) was recorded with variety Popatia, followed by Kharchia (79.0%), J 24 (78.5%), Lok 1 (78.3%), G.W.-2 (77.7) and A 207 (77.5%) in that order which were at par with each other.

Interaction : The interaction effect showed that the highest germination percentage (64%) was noted with variety J 24 followed by G.W.1 and Lok 1 (63.0%) and Kharchia and Popatia (62.0%) at highest salinity level (ECe 12 dSm⁻¹). Nevertheless, the results indicated that most of the varieties have less harmful effect on germination up to 8.0 ECe dSm⁻¹ salinity level.

Effect on plant height

Salinity : As salinity level increased the mean plant height significantly from 52.6 to 32.1 cm (Table 1). The linear relationship between salinity levels and average plant height (Table 4) could be expressed by the regression equation $y = 57.4 - 2.21 X$ ($r=0.992$). The results are in agreement with those reported by Kumar (1983).

Variety : The plant height was also affected significantly by the varieties (Table 1). The maximum mean plant height (52.4 cm) was

recorded with variety G.W-2. While the minimum plant height was noted with variety W.H. 147 (34.7 cm), followed by H.D. 2236 (38.9 cm).

Interaction : The significant depression in plant height under the highest saline condition (ECe 12 dSm⁻¹) was minimum with variety Popatia (28.6%), followed by J 24 (29.0%), whereas the highest with G.W-2 (51.3) followed by H.D. 2236 (50.9%). The height of plant was more adversely affected in case of low salt tolerant varieties than those of high salt tolerant once. The depression effect of salinity on plant height might be due to the inhibition effect of presence of soluble salts (Bernstein and Hayward. 1958).

Effect on yields

Salinity : The straw and grain yield were severely affected by salinity (Table 2). The reduction in straw (7.2, 27.7 and 46.1%) and grain (9.4, 27.2 and 38.4%) yield were found at low (S₁), medium (S₂) and high (S₃) salinity level, respectively. The results are in accordance with Sharma *et al.* (1981), who observed that 50% reduction in yield of wheat at EC of 16 dSm⁻¹ of water in black soil. Such decreases in the yield of wheat were reported by Kumar and Singh (1980) and Kumar *et al.* (1981). In present investigation, a considerable reduction in grain ($b = 0.112$, $r = 0.997^{***}$) and straw ($b = -0.175$, $r = 0.998^{***}$) of wheat were noticed when the soil salinity levels increased from 8 to 12 dSm⁻¹. Our results are in agreement with Balakrishnarao *et al.* (1981) Magar *et al.* (1982) and Kadum *et al.* (1983). The reduction of yield might be due to lower photosynthesis and hence, disturbed carbohydrates and nitrogen metabolism in salt stress condition leading to poor yield (Strognov. 1964).

TABLE 1
Effect of salinity levels on germination percentage and plant height of different varieties of wheat.

Varieties	Salinity level (dSm ⁻¹)					Salinity level (dSm ⁻¹)					Per cent height decline at 12 EC level
	Control	Germination percentage				Control	Plant height (cm)				
		4.0	8.0	12.0	Mean		4.0	8.0	12.0	Mean height	
J - 405	92.0	80.0	70.0	60.0	75.5	51.6	50.0	35.4	30.5	41.8	41.0
Lok - 1	94.0	87.0	69.0	63.0	78.3	49.6	45.6	36.4	32.3	40.9	35.0
J - 24	94.0	87.0	69.0	64.0	78.5	50.0	49.5	38.8	35.5	43.5	29.0
K.Sona	93.0	89.0	65.0	60.0	76.8	51.8	50.0	37.4	32.9	43.0	36.5
W.H.147	93.0	86.0	58.0	45.0	70.5	44.8	40.0	29.0	25.0	34.7	44.2
G.W.120	96.0	95.0	59.0	54.0	76.0	56.0	49.0	39.0	31.2	43.5	44.3
H.D.2236	92.0	92.0	65.0	54.0	75.7	49.5	45.7	36.3	24.3	38.9	50.9
H.L.1077	96.0	87.0	62.0	46.0	72.7	52.5	51.2	38.0	29.6	42.8	43.6
G.W.89	93.0	87.0	58.0	53.0	72.7	53.8	50.8	39.0	30.8	43.6	42.8
Kharchia	96.0	89.0	69.0	62.0	79.0	50.5	48.8	40.1	34.2	43.4	32.3
Raj-1555	86.0	82.0	71.0	54.0	73.2	53.5	52.2	39.0	30.6	43.8	42.7
H.D.4560	90.0	90.0	60.0	46.0	71.5	52.8	52.0	40.0	30.2	43.8	42.8
G.W.1	91.0	86.0	63.0	63.0	75.8	55.0	51.1	38.6	29.0	43.4	47.2
G.W.2	95.0	92.0	64.0	60.0	77.7	63.6	62.2	52.0	31.8	52.4	51.3
A - 206	96.0	90.0	64.0	60.0	77.5	52.1	51.2	36.1	35.5	43.7	31.8
Popatia	96.0	94.0	70.0	62.0	80.5	53.8	45.3	41.2	38.4	44.7	28.6
Mean	93.3	88.3	64.8	56.6		52.6	49.7	38.5	32.1		
CD (0.05)	S=1.6	V=3.0	S x V = 6.2			S=0.8	V=1.6	S x V = 3.1			

TABLE 2

Effect of salinity levels on grain and straw yield of different varieties of wheat.

Varieties	Salinity level (dSm ⁻¹)					Salinity level (dSm ⁻¹)				
	Control	4.0	8.0	12.0	Mean	Control	4.0	8.0	12.0	Mean
	Grain yield g plant ⁻¹					Straw yield g plant ⁻¹				
J-405	3.25	2.90	2.40	2.00	2.64	3.80	3.60	2.65	2.00	3.01
Lok-1	3.05	2.85	2.55	1.95	2.60	3.95	3.75	2.85	2.15	3.18
J-24	3.10	2.95	2.70	2.40	2.78	3.80	3.75	3.15	2.50	3.30
K. Sona	3.05	2.90	2.65	2.15	2.70	3.65	3.50	2.75	2.10	3.00
W.H.147	3.00	2.65	2.05	1.55	2.31	3.40	3.10	2.40	1.60	2.63
G.W.120	3.09	2.85	2.50	1.85	2.56	3.75	3.55	2.90	1.80	3.00
H.D.2236	3.10	2.80	2.45	1.75	2.53	3.45	3.05	2.55	1.65	2.68
H.L.1077	3.15	2.55	2.00	1.65	2.34	3.75	3.45	2.35	1.85	2.85
G.W.89	2.80	2.40	2.05	1.30	2.14	3.65	3.25	2.55	1.65	2.78
Kharchia	3.10	3.00	2.70	2.48	2.81	3.55	3.45	3.15	2.63	3.20
Raj-1555	3.13	2.85	2.15	1.70	2.46	3.95	3.65	2.35	1.90	2.96
H.D.4560	3.05	2.85	2.35	1.80	2.51	4.18	3.80	2.95	2.00	3.23
G.W. 1	2.55	2.05	1.75	1.20	1.89	3.55	3.15	2.20	1.70	2.65
G.W. 2	2.55	2.10	1.65	1.25	1.89	3.75	3.55	2.45	1.95	2.93
A-206	2.65	2.55	2.45	1.75	2.35	3.40	3.05	2.75	1.90	2.78
Popatia	3.05	2.85	2.55	2.33	2.70	4.40	4.05	3.55	3.00	3.75
Mean	2.97	2.69	2.31	1.83		3.75	3.48	2.71	2.02	
		(9.4)	(22.2)	(38.4)			(7.2)	(27.7)	(46.1)	
C D (0.05)	S = 0.08	V = 0.16	S x V = 0.31			S = 0.070	V = 0.14	S x V = 0.28		

Note : Figures in parantheses are showed the percentage over control.

Variety : Irrespective of salinity levels, the highest mean grain yield were recorded with Kharchia ($2.31 \text{ g plant}^{-1}$), followed by J 24 ($2.78 \text{ g plant}^{-1}$), Kalyansona and Popatia ($2.70 \text{ g plant}^{-1}$) which were at par with each other but they were significantly superior to the rest cultivars. The local variety Popatia, significantly out yielded the rest in case of straw yield ($3.75 \text{ g plant}^{-1}$). The next varieties in decreasing order were J 24 (3.30), Raj 1555 (3.23) and G.W. 89 ($3.20 \text{ g plant}^{-1}$) which were at par but significantly superior to the rest of the cultivars (Table 2).

The mean grain yield for salinity levels followed the similar trend recording the highest mean salinity index (89.9) with variety Kharchia followed by J 24 (86.6) and Popatia and Kalyansona (84.4). The results (Table 3) further revealed that for 50% yield decline was expected with the highest EC (26.2 dSm^{-1}) for Kharchia, of 24.4 dSm^{-1} for J 24 and that of 22.7 dSm^{-1} for Popatia. Whereas that of the lowest value 11.4 dSm^{-1} for GW 1 and GW 2 indicating comparatively less salt tolerance. The rest of cultivars were expect the 50 per cent yield decline even below 20 dSm^{-1} salinity. Considering the reduction in grain yield at the highest salinity level ($\text{EC } 12 \text{ dSm}^{-1}$), the minimum reduction (20.3%) was noted with Kharchia, followed by J 24 (22.5%) and Popatia (23.9%) on the other hand, cultivar GW 89 recorded the highest reduction (53.6%). The lowest negative regression co-efficient (b) -0.064 with variety Kharchia indicate the less sensitive to decline the yield with increasing the salinity. The high yielding variety J 24 has also the almost the same regression co-efficient (b) -0.069 indicating equivalent to Kharchia in salt tolerance. The following varieties were Popatia (b = -0.071), A 206 (b = -0.084) and Kalyan-

sona (b = -0.088) also possessed lower regression co-efficient. Contrary to this, variety Raj 1555 recorded the highest regression slope (b = -0.146) indicating more sensitive to salinity. On same line, Giriraj *et al.* (1980) reported that the varieties Kharchia and A 206 showed higher tolerance to salinity.

Interaction : The data given in table 2 showed that though the variety J 405 noted highest grain yield ($3.25 \text{ g plant}^{-1}$) at normal condition but at highest salinity level (12 EC dSm^{-1}) variety Kharchia has recorded the highest grain yield (2.48) followed by J 24 (2.40) and Popatia ($2.33 \text{ g plant}^{-1}$) which were at par with each other but were significantly superior to J 405. Whereas, significantly lower grain yield was recorded with variety G.W-1 and G.W-2 and G.W. 89 at almost all salinity levels. In case of straw yield, variety Popatia out yielded at almost all salinity levels. However, variety Kharchia and J 24 also recorded the significantly higher straw yield (2.63 and $2.50 \text{ g plant}^{-1}$, respectively) over the rest of the cultivars. Thus it can be concluded that at medium salinity level (8.0 EC dSm^{-1}) the different wheat varieties follow the order Kharchia J 24 > Kalyansona > Popatia = A 206, while at higher salinity level (12.0 EC dSm^{-1}) that was Kharchia = J 24 > Popatia > Kalyansona.

Sodium, potassium content and its ratio

Effect of salinity : Salinity had significant effect on Na, K content and Na/K ratio in straw (Table 4). As soil salinity levels increased Na content and Na/K ratio in straw gradually increased from 35.2 to 84.5 (me%) and 1.47 to 5.86, respectively. The reverse was true in case of K content (23.9 to 14.8 me%).

TABLE 3

Relative salt tolerance of wheat varieties based on grain (yield).

Varieties	Mean** grain yield (g)	Reduction at ECe 12 dSm ⁻¹ over control (%)	Mean** salinity index (%)	Salinity level for 50 % yield decline (dSm ⁻¹)	Regression of yield on salinity
J-405	2.43	38.5	74.9	14.7	$Y = 3.43 - 0.123 X$ ($r = -0.983$)
Lok-1	2.45	36.1	80.3	16.5	$Y = 3.29 - 0.107 X$ ($r = -0.966$)
J-24	2.68	22.5	86.6	24.4	$Y = 3.23 - 0.069 X$ ($r = -0.946$)
K.Sona	2.58	28.5	84.4	19.6	$Y = 3.25 - 0.088 X$ ($r = -0.949$)
W.H.147	2.08	48.3	69.4	12.2	$Y = 3.25 - 0.144 X$ ($r = -0.994$)
G.W.120	2.40	39.3	78.7	15.4	$Y = 3.32 - 0.117 X$ ($r = -0.990$)
H.D.2236	2.33	43.5	75.3	14.0	$Y = 3.36 - 0.129 X$ ($r = -0.982$)
H.I.1077	2.06	47.6	65.6	11.9	$Y = 3.27 - 0.143 X$ ($r = -0.919$)
G.W.89	1.91	53.6	68.5	11.7	$Y = 3.06 - 0.142 X$ ($r = -0.971$)
Kharchia	2.72	20.3	87.9	26.2	$Y = 3.23 - 0.064 X$ ($r = -0.976$)
Raj-1555	2.23	45.7	71.3	12.6	$Y = 3.40 - 0.146 X$ ($r = -0.972$)
H.D.4530	2.33	41.0	76.6	14.3	$Y = 3.33 - 0.126 X$ ($r = -0.964$)
G.W.1	1.66	52.9	65.4	11.4	$Y = 2.70 - 0.125 X$ ($r = -0.959$)
G.W.2	1.66	50.9	65.4	11.4	$Y = 2.70 - 0.125 X$ ($r = -0.948$)
A-206	2.25	33.9	84.0	18.8	$Y = 2.90 - 0.084 X$ ($r = -0.862$)
Popatia	2.58	23.9	84.4	22.7	$Y = 3.16 - 0.071 X$ ($r = -0.948$)

* Grain yield across salinity levels

** Mean salinity index = $\frac{\text{Mean of 4, 8 and 12 EC}}{\text{Control yield}} \times 100$

TABLE 4

Effect of salinity levels and varieties on sodium, potassium content and Na/K ratio in wheat straw.

Varieties	Salinity levels (dSm ⁻¹)					Salinity levels (dSm ⁻¹)					Salinity levels (dSm ⁻¹)				
	Control	4.0	8.0	12.0	Mean	Control	4.0	8.0	12.0	Mean	Control	4.0	8.0	12.0	Mean
	Na me (%)					K me (%)					Na/K ratio				
J-405	33.5	40.7	60.4	86.1	55.2	22.4	21.3	17.5	14.2	18.8	1.50	1.91	3.45	6.06	3.23
Lok-1	32.0	37.5	56.2	84.0	52.4	22.2	21.3	17.7	14.8	19.0	1.45	1.77	3.16	5.68	3.02
J-24	33.0	35.8	50.1	61.5	45.1	23.9	22.0	19.7	17.5	20.9	1.38	1.63	2.39	3.51	2.23
K.Sona	32.3	37.7	54.3	66.5	47.8	22.5	20.5	17.7	15.2	19.0	1.44	1.84	3.06	4.36	2.68
W.H.147	34.3	43.0	70.8	91.2	59.8	22.5	21.7	18.0	13.5	18.9	1.53	1.98	3.92	6.76	3.55
G.W.120	32.5	38.7	68.6	87.0	57.2	23.5	21.3	18.2	13.7	19.2	1.39	1.82	3.76	6.48	3.37
H.D.2236	37.0	46.5	74.0	91.2	62.4	25.5	24.0	19.5	14.7	20.9	1.45	1.94	3.79	6.20	3.34
H.L.1077	36.0	41.3	67.7	91.0	59.0	25.2	24.0	18.7	14.5	20.6	1.43	1.72	3.61	6.27	3.26
G.W.89	36.2	43.5	70.8	85.5	59.0	23.1	20.0	18.5	12.7	18.6	1.56	2.17	3.84	6.72	3.58
Kharchia	33.5	38.0	49.0	57.0	44.4	23.9	22.5	20.7	18.5	21.4	1.39	1.69	2.36	3.08	2.13
Raj.1555	36.8	46.0	74.0	99.0	63.9	25.9	23.2	19.1	13.6	20.4	1.42	1.99	3.87	7.25	3.63
H.D.4530	36.7	46.0	75.0	101.0	64.7	25.3	22.0	16.7	13.6	19.4	1.45	2.10	4.58	7.40	3.86
G.W.1	37.5	47.2	67.7	99.0	62.9	25.1	22.0	18.0	13.0	19.7	1.49	2.15	3.78	7.34	3.69
G.W.2	36.0	45.7	68.0	100.0	62.4	25.6	24.0	17.5	14.5	20.4	1.39	1.91	3.88	6.90	3.52
A-206	38.0	43.0	62.3	79.0	55.5	22.5	21.7	18.5	16.0	19.7	1.68	1.98	3.37	4.95	2.99
Popatia	38.5	45.0	62.4	78.0	55.9	24.3	23.7	19.7	16.0	20.9	1.59	1.98	3.24	4.87	2.90
Mean	35.2	37.8	64.5	84.5		23.9	22.2	18.5	14.8		1.47	1.91	3.50	5.86	
C D (0.05)	S = 0.22 V = 0.43 S x V = 0.61					S = 0.25 V = 0.52 S x V = 0.72					S = 0.10 V = 0.21 S x V = 0.42				

Effect of variety : The varietal differences in sodium and potassium absorption were significant in straw. The highest Na content in straw was recorded with variety H.D. 4560 (64.7 me%) followed by Raj. 1555 (63.9), G.W-1 (62.9) and G.W-2 and H.D. 2236 (62.4 me %). Variety G.W 1, G.W 2 and H.D. 2236 were at par with each other. Contrary to this, Kharchia has noted the lowest Na content (44.4 me%) followed by J 24 (45.1 me %). On the other hand, significantly highest K content in straw was noted by variety Kharchia (21.4 me 100 g⁻¹) followed by J 24, Popatia and H.D. 2236 (20.9) and H.I. 1077 (20.6 me%). These varieties were at par with each other. This results are inconformity with Gill and Dutt (1987). Absorption of Na was minimum in Kharchia, J 24, Kalyansona, Popatia and A 206 varieties with comparison to all salinity levels, which showed less reduction in yield as

well as higher tolerance limit as compared to Raj. 1555, H.D. 2236 and H.D.4560. Reverse was true in case of K content.

Sodium, potassium content in straw and Na/K ratio has been found to be suitable parameter to adjust relative salt tolerance. Variety Kharchia (2.13), J 24 (2.33), Kalyansona (2.68) and Popatia (2.90) have been found low Na/K ratio as compared to other cultivars in all salinity levels. Variety Kharchia, J 24, Popatia and Kalyansona gave higher yield with low Na/K ratio, while Raj. 1555, H.D. 2236 and H.D. 4560 were sensitive giving lower yield with higher Na/K ratio. The present finding confirmed the earlier work of Rana *et al.* (1976).

Besides variety Kharchia, variety J 24 could be considered tolerant among the 16 cultivars under test, as this variety has least yield decline under increasing salinity level.

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Effect of Surface Drainage on Water Table and Performance of Soybean

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ABSTRACT

The experiment on the effect of surface drainage on water table and performance of soybean crop were conducted during *kharif* season of 1985-1991 at adopted villages of ICAR Drainage Project, JNKVV Centre-Bari (Raisen) at Barna Command region of Madhya Pradesh. The JS 72-44/JS 72-280 were taken as test varieties. The yield reduction due to 1-4 days excess soil moisture regimes were varied from 1.77 to 32.42% at crop emergence stage, 3.04 to 24.18% at branching stage and 1.49 to 15.09% at flowering stage. The surface drainage system have been found effective in controlling the surface stagnation as well as sub surface water by 17 cm at Bari, 96 cm at Patni and 18 cm at Babai village after 5 years construction of drainage system. The impact of surface drainage system on average yield increment of soybean was observed 3.41 q/ha at Bari 2.54 q/ha at Babai and 2.45 q/ha at Patni village. The yield of soybean was increased by 22.7% at Patni, 27.4% at Babai and 31.8% at Bari village after 5 years of construction of surface drainage system.

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INTRODUCTION

Soybean *Glycine max* (L) Merrill is a major crop of Barna Command occupying more than 30% of total culturable command in *kharif*. The problem of water-logging and drainage are ever growing in irrigated command. The presence of excess surface and sub-surface water leads to water logging which needs drainage. The yield reduction or complete crop failure is generally being observed due to excess soil water which impedes soil aeration by adversely affecting the root and shoot development. Rising trends of ground water table in Barna command has adversely affected the soybean cultivation,

which inhibits the growth specially at early stage. It may be due to heavy and frequent rains, application of irrigation water during rainy season, low infiltration rates, lack of natural outlets for safe disposal of excess water and finally, the presence of impervious layer below 1 metre of soil depth (Singh *et al.* 1982). Generally 2-4 days surface stagnation is being observed under field condition and yield reduction is varied from 2.38 to 35% (Anonymous 1991). The rising trends of ground water table inhibit the production of soybean by 25 to 33% reported by Kool and Maurya (1988). The surface drainage system have been found effective to control the rising water table

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trends by 11 cm to 127 cm and surface stagnation effectively in *kharif* and yield has been increased by 25 to 50% (Mal *et al.* 1985). Hence present studies were conducted to see the effect of surface drainage on rising trends of shallow ground water table and performance of soybean crop.

MATERIALS AND METHODS

The study was conducted on clayey soil of Barna Command at farmers field during *kharif* season of 1984 to 1991. The fields were low in

available nitrogen, phosphorus and medium to high in potash with the neutral soil reaction (pH 6.8 to 7.2), low in infiltration rates 0.9 to 1.2 cm/hour and bulk density of 1.51 g/cc. The soybean JS 72-44/JS 72-280 were taken as test variety and were planted in first week of July from 1984 to 1991. The average annual rainfall was recorded 1240 mm which is distributed from June to September. The 1-4 days maximum rainfall for the return period of 2, 5, 10 and 20 years have been estimated presented in Table 1.

TABLE 1

Maximum depth of rainfall (mm.) at Barna Command area of Madhya Pradesh.

Particulars	Return period (years)			
	2	5	10	20
Maximum 1 day rainfall (mm.)	72	110	132	158
Maximum 2 days rainfall (mm.)	118	175	205	238
Maximum 3 days rainfall (mm.)	130	188	235	258
Maximum 4 days rainfall (mm.)	157	232	255	265

The surface drainage @ 6 lit/sec./ha. were constructed at Bari, Patni and Babai village during 1986 to 1988 where water table was within the effective root zone depth. The water table fluctuation were recorded in auger hole and in open wells.

RESULTS AND DISCUSSION

Effect of excess moisture on soybean

The data pertaining to yield reduction of soybean under 1-4 days excess moisture condition has been depicted in Fig 1. It is evident from the data that yield reduction due to 1-4 days submergence varied from 1.77 to 32.42%

at sowing to crop emergence, 3.04 to 24.18% at branching and 1.49 to 15.05% at flowering stage. The maximum yield reduction of soybean 12.06 to 32.42% have been observed under 3-4 days submergence. It may be due to adverse effect of excess moisture on soil aeration which caused more mortality of plants. The greater mortality due to excess soil moisture were noted at sowing to crop emergence stage. Soybean crop tolerated 1 day submergence effectively at early stage and 1-2 days submergence at later stage of the growth. The same findings were also reported by Anonymous 1991 and Mal *et al.* 1985.

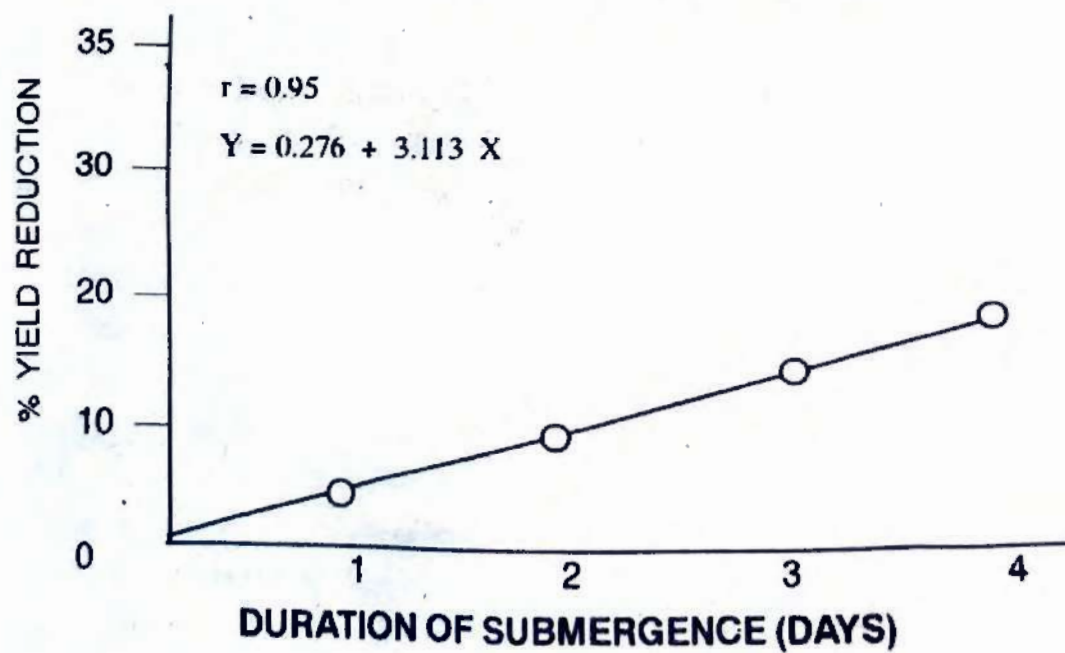
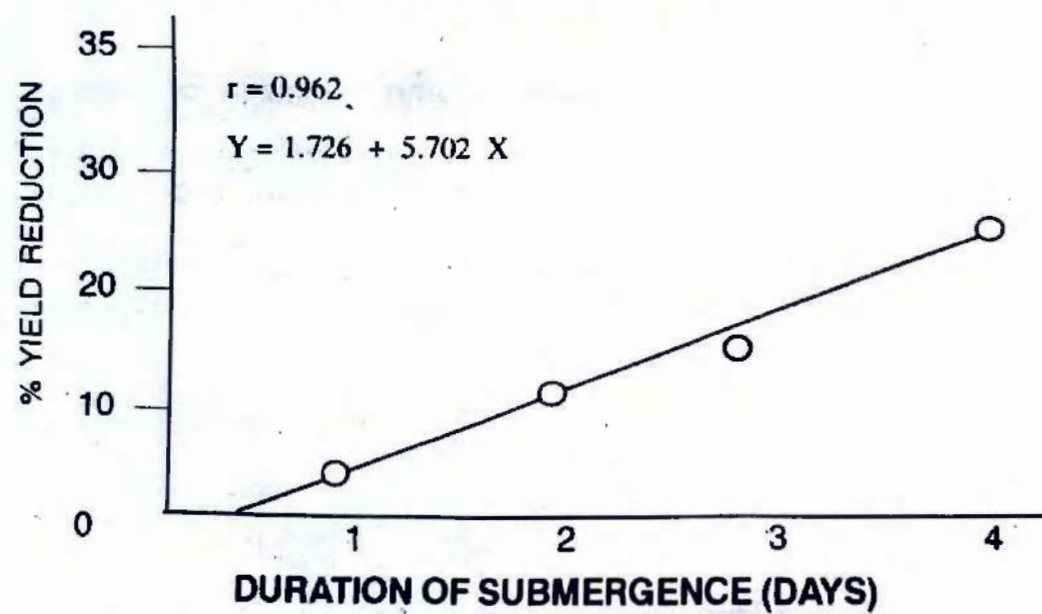
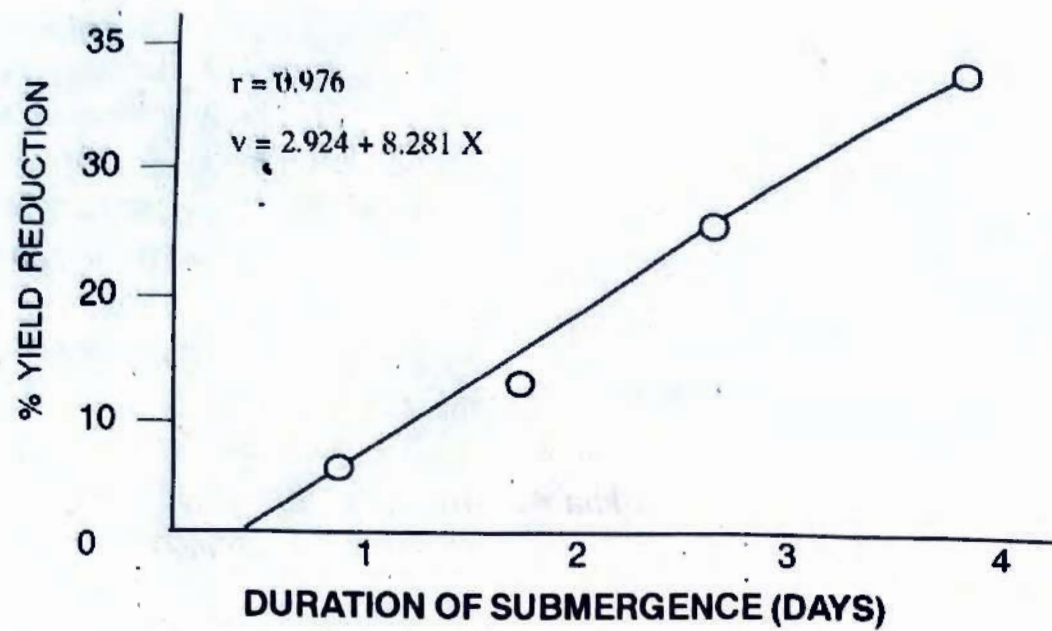


Fig. 1 : Linear relationship in different duration of submergence and yield reduction of soybean

The 1-4 days submergence and yield reduction of soybean were significantly correlated and yielded a correlation coefficient of 0.976 at sowing to crop emergence stage, 0.962 at branching and 0.953 at flowering stage and depicted in Fig. 1 along with the linear relationship. Finally it has been concluded that soybean crop tolerated 1 day submergence effectively and surface drainage should be designed by considering 1 day effective tolerance period.

Effect of surface drainage

Water Table : The monthly ground water table fluctuation from the ground surface before and after construction of surface drainage have been presented in Table 2. It is evident from the

data that water table depth varied from 54-170 cm at Bari, 15-130 cm at Babai and 18-87 cm at Patni village before construction of surface drainage system during entire crop season from June to October. The ground water table depth was within the effective root zone depth prior to construction of field drainage system. It may be due to concentration of more than 90% of total rainfall from July to September month, lack of natural outlets for safe disposal of excess rain water, low infiltration rates 0.9 to 1.2 cm/hour and presence of impervious layer below 2 metre of soil depth. The existing ground water table depth was lowered by 0 to 41 cm at Bari, 11 to 23 cm at Babai and 76 to 127 cm at Patni village after 5 years construction of drainage system @ 6 lit/sec/ha.

TABLE 2

Impact of surface drainage on ground water table fluctuation from ground surface (cm).

Village	Month					Seasonal mean
	June	July	August	Sept.	Oct.	
I. Before construction of surface drainage						
Bari	170.00	64.00	54.00	66.00	75.00	86.00
Babai	130.00	58.00	15.00	39.00	62.00	61.00
Patni	87.00	40.00	20.00	18.00	23.00	37.00
Mean	129.00	54.33	29.66	41.00	53.33	61.30
II. After 5 years construction of surface drainage						
Bari	183.00	105.00	66.00	66.00	96.00	103.00
Babai	153.00	81.00	26.00	52.00	82.00	79.00
Patni	214.00	148.00	96.00	95.00	115.00	135.00
Mean	183.33	111.33	62.66	71.00	96.66	105.00
III. Impact of surface drainage on lowering of existing ground water table depth						
Bari	-13.00	-41.00	-12.00	-0.00	-21.00	-17.00
Babai	-23.00	-23.00	-11.00	-13.00	-20.00	-18.00
Patni	-127.00	-108.00	-76.00	-77.00	-92.00	-96.00
Mean	-54.33	-57.33	-33.00	-30.00	-44.33	-43.66

The seasonal mean water table depth varied from 66 to 183 cm at Bari, 26 to 153 cm at Babai and 95 to 214 cm at Patni village. It has been observed that water table depth was comparatively deeper after construction of surface drainage. The impact of surface drainage on lowering of mean ground water table depth were observed by 96 cm at Patni, 18 cm at Babai and 17 cm at Bari village after 5 years construction of surface drainage system. The same findings were reported by Kool and

Maurya 1988, Sharma *et al.* 1990 and Anonymous 1991.

Yield attributes : The data pertaining to yield attributing characters have been presented in Table 3. It is clear from the data that the superior yield attributing characters were observed under drainage condition and the yield of soybean crop was comparatively higher by 33.30% at Bari, 20.17% at Babai and 18.70% at Patni village.

TABLE 3

Yield attributing characters and yield of soybean in drained and undrained conditions.

(Pooled data)

Particulars	Undrained condition			Drained condition		
	Bari	Babai	Patni	Bari	Babai	Patni
Plant height (cm)	54.00	58.30	59.30	37.50	63.80	65.00
No. of branches/plant	1.50	2.00	2.00	3.50	3.00	3.00
No. of nodes/plant	12.50	8.60	12.10	13.00	14.00	12.60
No. of pod bearing nodes/plant	9.80	6.00	10.60	12.30	10.20	10.85
No. of pods/plant	32.50	28.00	37.00	43.00	36.80	47.00
Pod yield/plant (g)	18.50	16.00	17.30	24.00	20.00	18.00
Biomass/plant (g)	21.80	20.30	21.30	34.00	29.00	27.80
No. of seeds/plant	75.00	63.00	61.00	90.00	82.00	63.00
Seed yield/plant (g)	8.10	7.20	7.15	10.60	9.60	7.35
Seed yield q/ha	13.20	11.90	12.30	17.50	14.30	14.60
	(0.00)*	(0.00)*	(0.00)*	(33.30)*	(20.17)*	(18.70)*

*% Increase in yield.

Yield and yield increment : The data pertaining to yield and yield increment have been presented in Table 4. It is evident from the data that the yield of soybean crop was increased by 22.7% at Patni, 27.4% at Babai and 31.8% at Bari village. It may be due to partial improvement of drainage in soybean crop. The

same findings were also reported by Anonymous 1989, Kool and Maurya 1988 and Sharma *et al.* 1990. The impact of surface drainage on yield increment of soybean crop was observed 3.41 q/ha at Bari, 2.54 q/ha at Babai and 2.45 q/ha at Patni village after 5 years construction of surface drainage system.

TABLE 4

Average yield and yield increment of soybean (JS 72-44) q/ha.

Particulars	Bari	Babai	Patni	Mean
Before construction of drainage system	10.70	9.25	10.80	10.25
After 5 years construction of drainage system	14.11 (31.8)*	11.79 (27.4)*	13.25 (22.7)*	13.05 (27.3)*
Impact of drainage on yield increment	3.41	2.54	2.45	2.80

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Effect of P and Zn on Wheat Crop Grown on Calcareous Soils

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ABSTRACT

A pot experiment was conducted to study the mean and interaction effect of applied phosphorus and zinc on the yield attributes, yield concentration and uptake of nutrients (P, Zn and Ca) by wheat CV GW 120. Application of P (P_3) increased the grain and straw yield by 51 and 30 per cent, respectively, so also the Zn (Zn_3) upto 7 per cent in the both grain and straw through its positive effects on the yield attributes and their respective concentrations and uptake of P and Zn in the grain and straw. The P X Zn interaction became antagonistic at P_2/Zn_3 resulting in a 21 per cent reduction in the grain yield over that in P_2/Zn_0 and also a considerable reduction in the concentration and uptake of P and/or Zn in the plant when compared with that in the respective controls. (key words : Phosphorus, Zinc, Phosphorus x Zinc and Wheat)

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INTRODUCTION

The phosphorus (P) x zinc (Zn) have formed a subject for many workers (Loneragan, 1951; Burleson *et al.*, 1961; Boawn and Brown, 1968; Safaya, 1976). This P X Zn interaction assumes special importance in the calcareous soils. Since P fixation capacity of these soils went up to 92 per cent an extra large amount of phosphatic fertilizer is added to the soils to harvest a better crop which in turn aggravates Zn deficiency as a result of P x Zn antagonism. The above contention has been tested in the present investigation with a view to establish a magnitude of the interaction effects.

MATERIALS AND METHODS

A pot experiment was conducted on a vertisol (medium black calcareous soil) during

winter 1986 with four levels each of phosphorus ($0-P_0$, $25-P_1$, $50-P_2$ and $100-P_3$ mg kg⁻¹) and zinc ($0-Zn_0$, $5-Zn_1$, $10-Zn_2$ and $20-Zn_3$ mg kg⁻¹) with two replications in a completely randomised factorial design. Monocalcium phosphate ($Ca (H_2PO_4)_2 \cdot H_2O$) and zinc sulphate ($ZnSO_4 \cdot 7H_2O$) were used as source of phosphorus and zinc, respectively. Some of the soil characteristics are : sand 13.0%, silt 30.3%, clay 56.7%, pH 7.8 EC 0.18 dSm⁻¹, $CaCO_3$ 3.3%, CEC 55.0 m.e. 100 g⁻¹, exchangeable Ca 44.5 and Mg 6.4 m.e. 100 g⁻¹, organic carbon 0.84%, Olsen's P 5.73 ppm P_2O_5 , available K 172.5 ppm K_2O and DTPA extractable Zn 0.62, Fe 6.53, Cu 3.22 and Mn 11.50 ppm. The polyethylene lined earthen pots (12 litre volume) were filled with 12 kg of the treated soil. Wheat CV GW 120 was sown, which was thinned to nine plants per pot a week after

germination. The plant samples were digested in a di-acid mixture as described by Jackson and Ulrich (1969). The acid extract was used for analysis of different nutrients viz. P, Zn and Ca. Phosphorus in the acid extract was determined by vanadomolybdophosphoric yellow colour method, Ca by Versenate method (Jackson, 1958) and Zn by Atomic absorption spectrophotometry (Shimadzu Model AA-640-13).

RESULTS AND DISCUSSION

Mean effect of phosphorus and zinc

Phosphorus application at P_3 level increased the effective tillers earhead length, test weight and grain and straw yield by 17, 46, 79, 8 and 51 and 30 per cent, respectively, over the values of the respective parameters under P_0 , while zinc fertilization and Zn_3 increased the earhead length and test weight

TABLE 1

Mean and interaction effect of phosphorus and zinc on yield attributes and yield of wheat CV GW 120.

Treatment combination	Earhead length (cm)	Test weight (g)	Grain yield ($g\ pot^{-1}$)	Straw yield ($g\ pot^{-1}$)
P_0	4.08	38.02	10.81	24.29
P_1	5.01	39.12	11.70	28.48
P_2	6.61	39.91	13.54	31.28
P_3	7.29	41.11	15.05	31.65
CD (0.05)	0.66	0.57	1.03	0.67
Zn_0	5.69	39.44	10.63	27.75
Zn_1	5.72	39.63	12.89	29.27
Zn_2	5.78	39.68	13.32	29.03
Zn_3	5.80	40.41	13.45	29.63
CD (0.05)	0.66	0.57	1.3	0.67
P_0Zn_0	4.02	37.82	8.61	21.98
P_0Zn_1	4.06	37.98	9.00	23.72
P_0Zn_2	4.10	38.05	12.56	24.88
P_0Zn_3	4.15	38.22	13.10	26.56
P_1Zn_0	4.90	38.81	12.00	25.95
P_1Zn_1	4.92	39.10	12.16	28.53
P_1Zn_2	5.07	39.22	11.12	29.23
P_1Zn_3	5.16	39.35	12.10	30.21

1.	2.	3.	4	5.
P_2Zn_0	6.49	39.58	14.82	30.28
P_2Zn_1	6.59	39.80	14.78	31.63
P_2Zn_2	6.73	39.33	12.87	31.73
P_2Zn_3	6.64	39.24	11.68	31.49
P_3Zn_0	7.34	41.55	16.81	32.81
P_3Zn_1	7.33	41.63	16.78	23.23
P_3Zn_2	7.24	39.43	11.75	30.29
P_3Zn_3	7.25	39.83	14.84	30.27
CD (0.05)	1.12	1.04	1.62	1.34

and consequently increased the grain and straw yield by 7 per cent over the values of the respective parameters at Zn_0 (Table 1). Many workers reported phenomenal increase in the yield of wheat due to P fertilization (Randhawa and Tandon, 1982) mostly brought about by positive effects on the yield attributes (Rajput *et al.*, 1987).

Many early workers (Brar and Sekhon, 1978) reported positive effect of Zn on the yield attributes and yield of wheat under varying soil conditions. From the number of field trials, Takkar and Randhawa (1978), Sakal *et al.*

(1980), Khamparia *et al.* (1984) reported significant increase in the yield of wheat grains due to Zn application @20 to 25 kg ha⁻¹ of $ZnSO_4$.

Fertilization with P increased the concentration of this nutrient by 21 and 20 per cent and its uptake upto 82 and 30 per cent by grain and straw, respectively at P_3 level over that under P_0 . However, the Zn concentration under P_3 was reduced by 17 and 16 per cent but its uptake was increased to 25 and 10 per cent by the grain and straw, respectively, over that of control. Similarly, the Ca concentration

TABLE 2

Mean and interaction effect of phosphorus and zinc on the concentration and uptake of phosphorus by wheat CV GW 120.

Treatment combinations	P concentration (mg g ⁻¹)		P uptake (mg pot ⁻¹)	
	Grain	Straw	Grain	Straw
P_0	4.11	0.84	44.04	24.70
P_1	4.82	0.83	56.39	23.63
P_2	4.99	0.96	67.55	30.02
P_3	4.99	1.07	76.94	31.96
CD (0.05)	0.40	0.06	7.46	5.09

1.	2.	3.	4.	5.
Zn ₀	4.97	1.11	30.80	24.14
Zn ₁	4.79	1.15	33.66	27.80
Zn ₂	4.64	0.94	27.28	23.51
Zn ₃	4.53	0.86	25.48	27.55
CD (0.05)	0.40	0.06	7.46	5.09
P ₀ Zn ₀	4.16	0.75	35.81	22.77
P ₀ Zn ₁	4.18	0.96	37.62	25.85
P ₀ Zn ₂	4.11	0.78	51.62	19.40
P ₀ Zn ₃	4.00	0.73	52.40	27.35
P ₁ Zn ₀	5.02	0.87	60.24	21.01
P ₁ Zn ₁	4.84	0.87	58.85	24.82
P ₁ Zn ₂	4.79	0.85	53.15	24.84
P ₁ Zn ₃	4.63	0.77	56.02	23.26
P ₂ Zn ₀	5.28	1.08	76.24	32.70
P ₂ Zn ₁	5.05	0.97	74.63	30.66
P ₂ Zn ₂	4.83	0.82	62.16	26.02
P ₂ Zn ₃	4.82	0.95	56.29	29.91
P ₃ Zn ₀	5.40	1.16	90.61	38.10
P ₃ Zn ₁	5.09	1.07	85.66	35.55
P ₃ Zn ₂	4.81	0.98	56.60	29.68
P ₃ Zn ₃	4.67	0.82	69.30	24.81
CD (0.05)	0.12	0.23	12.92	NS

and its uptake by the grain was also curtailed, while in the straw these parameters remained unaffected (Table 2 and 3). Our results supports the findings of previous workers who also reported positive effect of applied P on its concentration and uptake (Marok and Dev, 1980). Similarly, the observed adverse effect of P application on the Zn concentration is also in the affirmation with that reported by others (Burleson *et al.*, 1961; Safaya, 1976).

Zinc application at Zn₃ level increased its concentration by 77 and 64 per cent and its uptake upto 88 and 75 per cent by the grain and straw, respectively over that in Zn₀, while the concentration and uptake of P by grain were reduced by 32 and 17 per cent, respectively, over the respective values of these parameters under Zn₀. Though the concentration of P in the straw was diminished with progressive Zn levels, its uptake was increased upto 15 per cent under Zn₃ over that in Zn₀. These

TABLE 3

Mean and interaction effect of phosphorus and zinc on the concentration uptake of zinc wheat CV GW 120.

Treatment	Zn concentration (mg g ⁻¹)		Zn uptake (mg pot ⁻¹)		Ca concentration (mg g ⁻¹)		Ca uptake (mg pot ⁻¹)	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
P ₀	76.47	60.34	826	1465	1.12	3.22	12.05	78.21
P ₁	71.70	59.34	834	1690	1.08	3.21	12.63	91.42
P ₂	63.28	53.71	855	1680	1.07	3.19	12.48	99.78
P ₃	63.29	50.71	975	1604	1.02	3.22	15.73	111.91
CD (0.05)	3.30	6.20	24	25	0.03	NS	0.56	NS
Zn ₀	49.27	44.69	622	1240	1.05	3.13	1.26	86.85
Zn ₁	63.32	53.54	816	1567	1.13	3.23	14.56	94.54
Zn ₂	75.04	60.69	999	1761	1.04	3.26	13.85	94.63
Zn ₃	87.11	73.17	1171	2168	1.06	3.21	14.25	95.11
CD (0.05)	3.30	6.20	24	25	0.03	0.03	0.56	NS
P ₀ Zn ₀	58.79	54.00	506	1186	1.03	3.20	9.21	70.33
P ₀ Zn ₁	74.17	61.25	667	1452	1.24	3.47	11.16	82.31
P ₀ Zn ₂	82.45	70.51	1035	1754	1.06	3.16	13.31	78.62
P ₀ Zn ₃	90.47	77.62	1185	2327	1.10	3.05	14.41	81.00
P ₁ Zn ₀	51.70	42.31	620	1097	0.97	3.15	11.64	81.73

1	2	3	4	5	6	7	8	9
$P_1 Zn_1$	66.06	55.37	803	1579	1.15	3.05	13.98	87.01
$P_1 Zn_2$	80.95	62.41	900	1825	1.12	3.35	12.45	97.92
$P_1 Zn_3$	88.09	77.21	1062	2332	1.07	3.27	12.95	98.78
$P_2 Zn_0$	47.82	43.90	708	1329	1.07	2.88	15.85	87.20
$P_2 Zn_1$	56.22	51.15	830	1616	1.15	3.39	16.99	107.16
$P_2 Zn_2$	65.11	58.24	837	1847	1.04	3.37	13.55	106.93
$P_2 Zn_3$	83.98	63.93	380	2013	1.03	3.11	12.03	97.93
$P_3 Zn_0$	38.78	38.55	650	1264	1.08	3.28	18.12	107.61
$P_3 Zn_1$	46.84	46.37	737	1540	1.00	3.01	16.81	100.02
$P_3 Zn_2$	71.65	53.57	844	1622	0.95	3.16	11.19	95.71
$P_3 Zn_3$	85.89	64.34	1284	1947	1.05	3.43	15.58	108.82
CD (0.05)	2.66	1.40	48	58	0.06	0.06	1.12	2.86

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 Observations are in direct line with those reported elsewhere (Brar and Sekhon, 1978). Sakal *et al.* (1981) reported 61 and 9 per cent increased in Zn concentration due to Zn application @ 10 kg Zn ha⁻¹ in the grain and straw of wheat, respectively. Similar results were also reported by other workers (Khamparia *et al.*, 1984). Negative effect of Zn fertilization on the concentration and uptake of P by the field crops was also reported by (Safaya, 1976).

Interaction effect of phosphorus and zinc

The P x Zn interaction was significant in case of the earhead length, test weight and grain and straw yield (Table 1). At a particular level of P, the earhead length was increased with the advancing levels of Zn upto P₂Zn₂ beyond which it was decreased. Similarly, test weight was found to be curtailed under P₂Zn₂, P₂Zn₃, P₃Zn₂ over that in their respective preceeding levels. Grain yield showed somewhat ambiguous trend. It was increased with Zn levels under P₀ and P₁ except P₁Zn₂. Contrary to expectation, it was decreased with progressive levels of Zn under P₃, the reduction being 21 per cent in P₂Zn₃ over P₂Zn₀. Similarly, the grain yield was further reduced by P₃Zn₂ but it was raised slightly under P₃Zn₃. While it increased with Zn levels except P₂Zn₃, P₃Zn₂ and P₃Zn₃ whereby it was curtailed when compared with the preceeding Zn level. Safaya (1976) also reported antagonistic effect of P x Zn on the yield attributes and yield.

Phosphorus % zinc interaction was significant in case of the concentration of P, Zn and Ca and their respective uptake by the grain

and straw except the P uptake by the straw (Table 2 and 3). The concentration and uptake of P by the grain and straw were gradually diminished with increasing levels of Zn under each level of P except the P uptake by straw which was erratic. Effect of Zn was more severe on the P concentration in the straw, particularly under P₂ and P₃.

The interaction of P x Zn significantly affected the concentration and uptake of Zn and Ca by the grain and straw. Though the Zn concentration and uptake were raised with increasing level of Zn, its magnitude was found to decreased with progressive levels of P and this was more so in case of the Zn concentration in the straw. The calcium concentration varied inconsistently with the levels of P and Zn, so also its uptake by the grain and straw.

Negative interaction between P and Zn has been widely reported (Takkar and Randhawa, 1978). The common observation is that one reduces the other's concentration and uptake in the plant (Loneragan, 1951; Burleson *et al.*, 1961). In most case, P induced Zn deficiency results from the dilution effect when the rate of plant growth exceeds that of uptake of Zn as also reported by Loneragan (1951). There are cases where P decreased the Zn concentration but its uptake remained same (Boawn and Brown, 1968). The reason of this P induced Zn deficiency has been suggested to be due to interference by P with the uptake, uneven distribution of Zn in the plant (Burleson *et al.*, 1961) and physiological immobilization of Zn by P (Boawn and Brown 1968).

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Scheduling Irrigation for Bidi Tobacco Var. GT 5

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ABSTRACT

An experiment was conducted to schedule irrigation for bidi tobacco Var. GT 5 at Bidi Tobacco Research Station, Anand from 1986-87 to 1988-89 based on IW/CPE ratios. The results revealed that to accrue maximum monetary returns under middle Gujarat soil conditions, bidi tobacco Var. GT 5 should be irrigated at 0.5 IW/CPE ratio, which requires 4 to 5 irrigations with a depth of 5 cm each at an interval of 15-20 days after cessation of monsoon.

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INTRODUCTION

Among various types of tobacco grown in Gujarat, bidi tobacco accounts for about 85% of the total tobacco area of the state. The newly released bidi tobacco variety GT 5 has high yield potential by 27 per cent over Anand 119. With the introduction of high yielding varieties and owing to inadequate rainfall before planting and at the time of planting and ill distribution of rains during growth period, it is necessary to irrigate the crop in most of the years. A substantial improvement in water use efficiency is possible by timing the irrigation based on open pan evaporation (Ravindranath and Subrahmanyam, 1978 and Ramchandran *et al.*, 1984). Gopalachari and Gopinath (1965) also reported progressive increase in yield of FCV tobacco with irrigation. Khot (1974) reported 55 per cent increase in yield of bidi tobacco when crop was irrigated once in 15 days. Hence, present study

was undertaken to workout optimum and economic level of irrigation for bidi tobacco variety GT 5 under middle Gujarat condition.

MATERIALS AND METHODS

The experiment was conducted at the Bidi Tobacco Research Station, Gujarat Agricultural University, Anand Campus, Anand during 1986-87 to 1988-89 in a randomised block design with four replications. The treatments comprised seven levels of irrigation viz., no irrigation (I_0), irrigation upto crop establishment (I_1), irrigation at 0.3 IW/CPE ratio (I_2), irrigation at 0.4 IW/CPE ratio (I_3), irrigation at 0.5 IW/CPE ratio (I_4), irrigation at 0.6 IW/CPE ratio (I_5) and irrigation at 0.7 IW/CPE ratio (I_6). The gross and net plot sizes were 5.4 m x 8.4 m and 1.8 m x 6.0 m, respectively. The crop was transplanted at 90 cm x 60 cm spacing in the second fortnight of August. The irrigation treatments were imposed from 15th September.

TABLE 1

Response of GT 5 to levels of irrigation.

Treatment		Cured leaf yield (kg/ha)				Economics on the basis of pooled data (Rs./ha)			
		1986-87	1987-88	1988-89	Pooled	Gross reali- zation	Treat- ment cost	Net reali- zation	C.B.R.
No irrigation	(I ₀)	1128 (-)	1328 (-)	1820 (-)	1426 (-)	10053	6131	3922	1 : 0.63
Irr. upto esta.	(I ₁)	2361 (1)	1172 (1)	1976 (-)	1836 (1)	12944	6345	6599	1 : 1.04
Irr. at 0.3 IW/CPE ratio	(I ₂)	3150 (3)	1719 (3)	1962 (2)	2277 (3)	16053	6666	9387	1 : 1.41
" 0.4 "	(I ₃)	3513 (4)	2014 (4)	2407 (3)	2645 (4)	18647	6773	11844	1 : 1.75
" 0.5 "	(I ₄)	3533 (5)	2208 (5)	2468 (4)	2736 (5)	19289	6856	12433	1 : 1.81
" 0.6 "	(I ₅)	3709 (6)	2089 (6)	2477 (4)	2758 (5)	19444	6963	<u>12481</u>	1 : 1.79
" 0.7 "	(I ₆)	3727 (6)	1970 (7)	2254 (5)	2650 (6)	18682	7058	11624	1 : 1.65
S. Em.		178	219	117	95				
C. D. 0.05		536	651	348	283				
C. V. %		11.8	24.6	10.7	14.1				

Figures in parentheses indicate number of irrigations.

The depth of irrigation water was 5 cm for each treatment. Observations of open pan evaporimeter were recorded daily and cumulated and irrigations were given as per the treatment. The chemical analysis for nitrogen (A.O.A.C., 1970) nicotine, reducing sugars (Harvey *et al.*, 1969) and chloride (Murthy *et al.*, 1962) was carried out by adopting standard methods.

RESULTS AND DISCUSSION

Results of the individual years showed significant differences for cured leaf yield and all the yield attributes except growth score due to irrigation levels. There was significant improvement in yield as the levels of irrigation increased from I_0 upto I_3 (0.4 IW/CPE

ratio) treatment during 1987-88 and 1988-89. In all the years irrigating the crop at 0.4, 0.5 and 0.6 IW/CPE ratios being at par gave significantly higher yield over no irrigation, irrigation upto establishment and 0.3 IW/CPE ratio. In 1986-87 treatment I_2 , I_3 and I_4 being at par gave significantly higher yield over I_0 and I_1 . The cured leaf yield of treatment I_5 (0.6 IW/CPE ratio) was significantly superior to I_0 , I_1 and I_2 in 1986-87 and 1988-89. These variations were due to ill distribution of rainfall. The years 1986-87 and 1987-88 were severe drought and drought, respectively, while 1988-89 was a normal year wherein sufficient rainfall was received (Table 4).

Pooled results also showed significant differences for yield and its attributes except

TABLE 2

Effect of irrigation levels on yield attributes of GT 5.

Treatment	Growth score (0-10)	Plant height (cm)	Leaf length (cm)	Leaf width (cm)	Spangle score (0-5)
No irrigation	(I_0) 3.8	55.4	36.8	17.2	1.2
Irr. upto Esta.	(I_1) 5.4	60.8	36.9	17.8	1.7
Irr. at 0.3 IW/CPE ratio	(I_2) 5.3	61.7	43.5	19.7	2.2
Irr. at 0.4 IW/CPE ratio	(I_3) 5.8	65.2	47.1	22.4	2.5
Irr. at 0.5 IW/CPE ratio	(I_4) 5.7	66.5	46.2	21.9	2.6
Irr. at 0.6 IW/CPE ratio	(I_5) 6.1	62.8	47.1	23.1	2.7
Irr. at 0.7 IW/CPE ratio	(I_6) 6.2	67.5	48.9	22.5	2.6
S. Em.	0.63	1.89	2.07	0.95	0.19
C. D. 0.05	NS	5.33	6.39	2.93	0.60
C. V. %	9.4	10.2	9.6	11.0	12.3

TABLE 3
Chemical constituents as influenced by irrigation levels.

Treatment		Per cent oven dry basis			
		Nitrogen	Nicotine	Reducing sugar	Chloride
No Irrigation	(I ₀)	3.11	6.73	3.66	1.49
Irrigation upto Eista.	(I ₁)	3.14	7.30	3.35	1.65
Irrigation at 0.3 IW/CPE ratio	(I ₂)	3.27	7.76	3.33	2.04
Irrigation at 0.4 IW/CPE ratio	(I ₃)	3.00	7.82	3.55	2.04
Irrigation at 0.5 IW/CPE ratio	(I ₄)	3.13	7.62	3.42	2.14
Irrigation at 0.6 IW/CPE ratio	(I ₅)	3.08	8.11	3.49	2.21
Irrigation at 0.7 IW/CPE ratio	(I ₆)	3.08	8.07	3.51	2.46
S. Em.		0.08	0.24	0.22	0.19
C. D. 0.05		NS	0.75	NS	0.59
C. V. %		8.5	6.0	9.7	11.8

TABLE 4
Rainfall pattern during crop period.

Month	1986-87		1987-88		1989-80	
	RF	RD	RF	RD	RF	RD
June	123.8	6	130.0	1	26.0	3
July	87.5	7	76.2	4	638.7	24
August	72.1	8	199.0	9	210.7	12
September	—	—	—	—	178.9	8
October	4.8	1	4.5	1	—	—
November	—	—	1.8	1	—	—
December	—	—	8.6	1	—	—
January	—	—	—	—	4.0	1
February	—	—	—	—	—	—
March	—	—	—	—	—	—
Total	288.2	22	420.1	17	1058.3	48

RF = Rainfall in mm; RD = Rainy days

growth score. Treatments I_3 , I_4 , I_5 and I_6 were at par but were significantly superior to I_0 , I_1 and I_2 in respect of yield, height, leaf length, leaf width and spangle score. At these levels it required 4 to 6 irrigations each of 5 cm depth.

Pooled results of chemical constituents showed significant differences for nicotine and chloride content due to irrigation levels. The treatment I_1 was at par with I_2 but contained significantly lower nicotine than rest of the treatments and I_1 gave significantly lower

chloride content than the rest, barring I_2 , I_3 and I_4 .

From economic points of view it could be concluded that GT 5 tobacco should be irrigated at 0.5 IW/CPE ratio which requires 4 to 5 irrigations each 5 cm depth. These findings were in conformity with those of Ramachandram *et al.* (1984) and Razak and Ibrahim (1990) for Virginian tobacco and Khot *et al.* (1989) for bidi tobacco. Sinha *et al.* (1982) also reported beneficial effect of irrigation in hookah tobacco.

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Potassium Response and its Critical Limit for Pearl Millet in Calcareous Soils

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ABSTRACT

A pot experiment was conducted to study the response and critical limit of potassium in soil and plant for pearl millet by collecting 20 medium black calcareous soils (Vertic Ustochrepts) varying in physico-chemical properties and K status. Addition of potassium significantly increased grain, straw yield, concentration of K and uptake by pearl millet. Per cent grain yield response ranged between -34.2 to 48.7 and -20.4 to 38.1 at 50 and 100 kg K_2O ha^{-1} level, respectively. Exchangeable K showed significant positive correlation with available K and 1 N HNO_3 K. Bray's percentage yield was significantly correlated with exchangeable K, available K and 1N HNO_3 soluble K. Critical limits 1N NH_4OAC K in soil and concentration of K in pearl millet were found to be 160 kg K_2O ha^{-1} and 2.4 per cent, respectively.

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INTRODUCTION

Pearl millet is an important food grain cereal, grown in large dry farming areas of Saurashtra. Addition of potassium significantly increased yield of crops (Patel *et al.* 1985). The optimum amount of potassium required for good yields can be determined from its content in soil as well as plant K concentration. The present study was undertaken in medium black calcareous soils (Vertic Ustochrept) to know the forms of K in soils and determine critical limits of K in pearl millet and soils.

MATERIALS AND METHODS

Twenty bulk surface samples representing medium black calcareous (Vertic

Ustochrept) soils were collected for pot experiment to determine the critical limits of potassium. The soil samples were air dried, processed and passed through 2 mm sieve and analysed for different physico-chemical characteristics (Jackson, 1967) and soils were also analysed for different forms of potassium i.e. water soluble, 1 N NH_4OAC (pH 7.0) extractable (Hanway and Heidel, 1952) and boiling 1N HNO_3 soluble K (Wood and De Turk, 1940) and for total potassium it was digested with $HF-HClO_4$ mixture (Pratt, 1965). Sixty kilogram processed soil was placed in each iron pot measuring 37.5 x 60 x 25 cm. Potassium was applied at the rate of 0, 50 and 100 kg K_2O ha^{-1} through pure KCl. The uniform application of 80 kg N ha^{-1} and 40 kg P_2O_5 ha^{-1} through urea and DAP was done in all the pots and the

treatments were replicated twice in Completely Randomized Design. Phosphate and potash were applied as basal while N was applied in two equal splits at the time of sowing and one month after sowing. The seeds of pearl millet variety 'GHB 181' were sown in each pot and after germination, nine healthy plants were maintained. The crop was raised upto maturity. Grain and plant samples were oven dried (65°C) to record grain and dry matter yield. Plant

samples were digested in diacid mixture of HNO_3 and HClO_4 (3:1) and analysed for K by flame photometer.

The critical limit of K in pearl millet crop and soil were determined by plotting Bray's percentage yield against available soil K and plant K concentration, respectively (Cate and Nelson, 1965). Bray's per cent yield was calculated as :

$$\text{Bray's per cent yield} = \frac{\text{Yield without K}}{\text{Yield at optimum K level}} \times 100$$

RESULTS AND DISCUSSION

The soils used in the present investigation varied widely in physico-chemical characteristics (Table 1). The

concentration of water soluble, ammonium acetate extractable and 1N HNO_3 soluble K in soils ranged from 9.4 to 28.3 (16.2), 128.2 to 498.3 (233.0) and 546 to 1584 (807.9) kg K ha^{-1} , respectively.

TABLE 1

Range values of soil chemical properties.

Characteristics	Range
SOIL	
Textural class	Sandy clay loam to clay
pH 1:2.5	7.0 to 8.0
EC 1:2.5 (dSm^{-1})	0.35 to 0.80
$\text{CaCO}_3\%$	1.5 to 42.5
Organic carbon (%)	0.39 to 0.78
Avail. N (kg ha^{-1})	165 to 243
Avail. P_2O_5 (kg ha^{-1})	18.0 to 92.1
Water soluble K (kg ha^{-1})	9.4 to 28.3
1 N $\text{NH}_4\text{OAC-K}$ (kg ha^{-1})	128.2 to 498.3
1 N $\text{HNO}_3\text{-K}$ (kg ha^{-1})	546 to 1584
Total-K (ppm)	3803 to 7803

TABLE 2
Effect of applied K on grain yield and response of pearl millet.

Sr. No.	1 N NH ₄ OAC K (kg ha ⁻¹)	Grain yield g pot ⁻¹ K level kg K ₂ O ha ⁻¹			Bray's % yield	Response (%) K level kg K ₂ O ha ⁻¹	
		0	50	100		50	100
1	139.1	38.6	45.2	36.5	85.40	17.10	-5.44
2	147.8	41.0	50.5	53.1	81.19	23.17	29.51
3	141.1	35.9	49.4	36.0	72.67	37.60	0.28
4	128.3	35.7	38.8	49.3	92.01	8.68	38.10
5	128.3	30.4	39.9	37.9	76.19	31.25	24.67
6	149.1	31.9	36.1	38.6	88.37	13.17	21.00
7	182.2	46.0	48.4	47.1	95.04	5.21	2.39
8	186.7	34.3	37.0	36.7	92.70	7.87	7.00
9	170.3	38.9	50.5	43.1	77.03	29.82	10.80
10	237.9	39.4	50.8	46.5	77.56	28.93	18.02
11	169.5	38.6	45.8	36.9	84.28	18.65	-4.40
12	165.7	34.9	51.9	35.6	67.25	48.71	2.01
13	253.2	43.0	51.4	46.3	83.66	19.53	7.67
14	273.2	37.6	38.9	48.4	96.66	3.46	28.72
15	198.7	54.0	39.8	51.0	135.68	-26.30	-5.56
16	231.6	32.6	33.4	36.4	97.60	2.45	11.66
17	290.0	44.6	40.3	46.0	110.42	-9.44	3.37
18	585.7	47.7	31.4	38.7	151.91	-34.17	-18.88
19	472.7	50.0	43.0	39.8	116.28	-14.00	-20.40
20	408.2	57.0	51.3	50.7	111.11	-10.00	-11.05
Means		40.6	43.7	42.6	94.65	7.64	4.93

CD. 5 % 2.48, Soil : 6.39, K X S : 11.07

K conc. at 60 days

K level kg K₂O ha⁻¹

K conc. at harvest

Total K uptake (g pot⁻¹)

K level kg K₂O ha⁻¹

0 50 100

0 50 100

0 50 100

1.	2.53	3.10	3.64	2.45	2.64	2.97	2.598	3.027	3.192
2.	2.55	2.80	2.88	2.28	2.50	3.11	2.355	2.973	3.297
3.	2.86	3.04	2.83	2.53	2.86	3.00	2.708	3.212	3.280
4.	2.08	2.97	3.75	1.65	2.17	3.14	1.734	2.377	3.355
5.	2.33	3.60	2.55	1.83	2.39	2.56	1.874	2.855	3.156
6.	1.82	3.14	3.03	2.56	2.81	3.04	2.875	3.097	3.320
7.	2.16	2.88	3.21	2.17	2.85	3.14	2.526	3.717	3.735
8.	2.19	3.07	3.14	1.93	2.56	3.11	2.182	3.059	3.539
9.	2.86	2.80	2.88	2.86	2.67	3.07	3.158	3.112	3.667
10.	2.19	2.41	2.72	1.85	2.69	2.83	2.271	3.370	3.773
11.	1.87	2.55	3.04	1.53	2.59	3.08	1.692	2.922	3.363
12.	2.05	2.88	3.03	2.25	2.89	3.11	2.711	3.804	3.752
13.	3.03	2.64	3.00	2.70	2.92	3.22	3.419	4.149	4.223
14.	2.69	3.46	3.75	2.89	3.02	2.97	2.929	3.409	3.390
15.	2.36	2.83	2.79	2.81	2.92	2.96	2.927	3.424	3.431
16.	2.47	2.44	3.86	2.73	2.78	2.97	2.580	2.966	2.942
17.	2.83	2.94	2.94	2.25	2.89	2.95	2.724	3.210	3.595
18.	3.10	2.86	2.53	1.93	2.67	2.70	2.338	2.679	2.948
19.	3.25	2.88	3.00	2.42	2.94	2.31	2.809	3.473	2.605
20.	3.03	3.17	2.86	2.47	3.15	2.59	4.056	4.148	5.114
	2.51	2.92	3.12	2.30	2.75	2.94	2.619	3.251	3.386

Mean

K = 0.044 S = 0.11 KxS = 0.196 K = 0.079 S = 0.0200 KxS = 0.347

K = 0.134 S = 0.348 KxS = 0.600

CD 5%

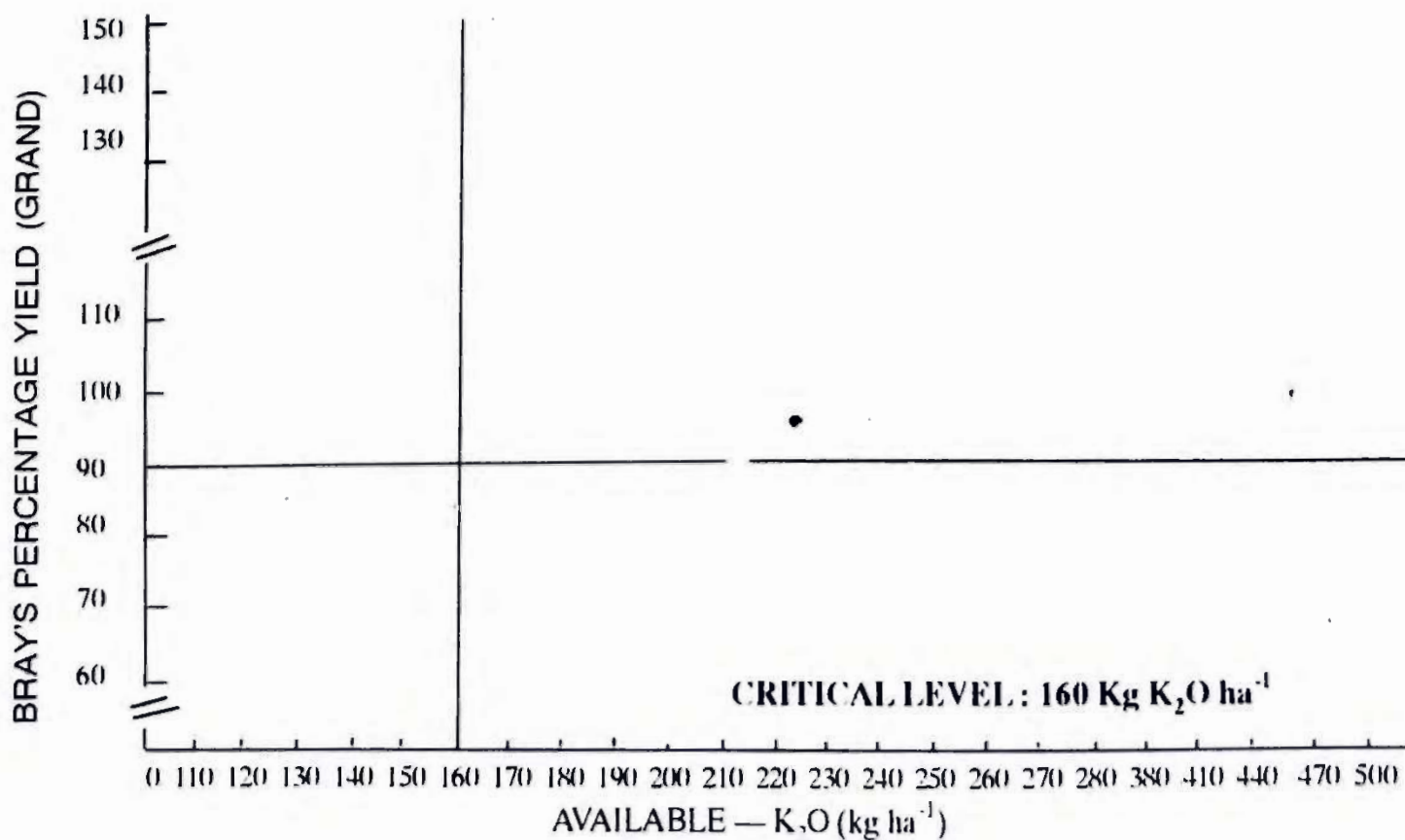
Yield

Potassium application significantly increased the grain in low and medium K soils but in high K status soils it decreased (Table 2). The grain yield (g pot^{-1}) of bajra in various soils ranged from 30.4 to 57.0 (mean 40.6), 31.4 to 51.9 (mean 43.7) and 35.6 to 51.0 (mean 42.6) under 0, 50 and 100 $\text{kg K}_2\text{O ha}^{-1}$, respectively. On the whole treatments of 50 $\text{kg K}_2\text{O ha}^{-1}$ and 100 $\text{kg K}_2\text{O ha}^{-1}$ increased bajra grain yield, it ranged from -34.2 to 48.4 (mean 7.6) and -20.4 to 38.1 (mean 4.93) percentage response, respectively over the control treatment (K_0). Similar trend was observed with straw yield. The trend of results was in conformity with Roy *et al.* (1989), Mehta *et al.* (1991) and Brar and Brar (1992). The effects of soil variation, potash application and interaction ($S \times K$) on yield were significant in both grain and straw. Brar's per cent yield at optimum K level showed wide variation 72.7 to 151.9 with mean values 94.7

in grain yield. Out of 20 samples, Bray's per cent yield was less than 100 in 15 and above 100 in samples indicating response and non responsiveness of the soils for grain yield.

K concentration and uptake

The concentration of K significantly increased in grain by K application, but soils and their interactions did not differ significantly. In case of straw, K levels, soils and its interaction significantly increased the K concentration. The uptake of K was significantly increased by levels of K, soils and $K \times S$ (Table 3). The different levels of K influenced the content of K in bajra at different stages. At 35 days, concentration of K was quite higher than at 60 days and at harvest. The concentration of K decreased with advancement of growth of bajra. Solanki (1985) and Kumar *et al.* (1991) also reported that the application of K increased the content and uptake in wheat plant.



Simple correlations (r) were worked out among the various forms of potassium and Bray's percentage yield. Bray's per cent yield was significantly correlated with exchangeable K ($r = 0.723^{**}$) and 1N HNO_3 soluble K ($r = 0.654^{**}$). Keeping in view these values, critical limit were established by plotting the values of Bray's percentage yield and ammonium acetate K in soil using Cate and Nelson procedure. Accordingly, the critical limit of available K_2O

($\text{NH}_4\text{OAC-K}$) for bajra in calcareous soils could be fixed as $160 \text{ kg K}_2\text{O ha}^{-1}$ (Fig. 1). Roy *et al.* (1989) reported 108 kg K ha^{-1} as critical limit for Puto series and Mehta *et al.* (1991) also reported 155 kg K ha^{-1} as critical limit for pearl millet in Lukhi soil series. The critical K concentration in pearl millet plant at 35 days and maturity has been found to be 3.0 and 2.4 per cent, respectively.

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Impact of Weather Variables on Yield and Yield Attributes of Rabi Maize (*Zea mays* L.)

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ABSTRACT

Two years field experiment on maize cv. Ganga Safed-2 under different environmental conditions created by different dates of sowing and varied moisture regimes during the Rabi season was conducted to study the impact of weather on final yield of maize crop. The relationship between grain yield and total biomass produced were analyzed with respect to micrometeorological features observed within the canopy during different growth stages and their various combinations. The results indicate that grain yield was best related with afternoon vapour pressure during silk emergence to dough stage and total biomass with temperature range during emergence to silk emergence stage. Appropriate regression models were developed.

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INTRODUCTION

Maize (*Zea mays* L.) is grown as Rabi crop where irrigation facilities are available due to its higher production potentiality. The middle Gujarat region and parts of North Gujarat region follow this practice. The prevailing weather greatly influence the final yield. Particularly important is the impact of weather in individual phenophase of the crop, leading to determine critical stages with respect to different weather variables. Further, prior knowledge on onset of critical stages would help in proper crop management. With this in view an attempt was made in this paper to predict onset of different phenophases in maize and to relate grain yield and biomass with micrometeorological features in various phenophases.

Ali and Janabi (1980) determined the optimum sowing date and predicted the tasseling, silking and maturity dates making an use of heat unit accumulation technique, and also observed that the temperature explained most of the variation within plant characters for different season and sowing dates. Girardin (1980) related the global radiation with the rate of appearance of leaves. Gardner *et al.* (1981) found the summation of canopy temperatures and determined the growth stages in corn. Kiniry *et al.* (1983) reported a linear relationship between tassel initiation and degree days. Bonhomme *et al.* (1982) found that the amount of the photosynthetically active radiation (PAR) trapped by corn was dependent on leaf area index and was higher at silking than maturity. Lee and Jung (1988) reported PAR use

efficiency of 4.87 gm/MJ for dry matter production. Baktash (1985) observed significant association of grain yield with air temperature and relative humidity at flowering and pollination stages.

MATERIALS AND METHODS

A field experiment on maize crop cv. Ganga Safed-2 was conducted on the Agronomy Farm of the Gujarat Agricultural University, Anand (22°35 'N; 72°55 'E) during the Rabi season of the years 1989-90 and 1990-91. The soils of the experimental site are of alluvial origin having sandy loam texture with bulk density 1.5 g/cc and pH 8.1. The experiment was laid out in split plot design with three dates of sowing and four irrigation regimes under six replications. The crop was at a spacing of 60 x 20 cm. and fertilized with 40 N + 60 P + 40 K kg/ha as basal dose and 40 kg/ha N each at 25-30 days after sowing (DAS) and 45-50 DAS was given as top dressing. The treatment details are as under :

D₁ : First date of sowing October 5
D₂ : Second date of sowing October 20

D₃ : Third date of sowing November 4
I₁ : Irrigation when IW/CPE=0.8
I₂ : Irrigation when IW/CPE=1.0
I₃ : Irrigation when canopy-air-temperature differential = $\pm 0.5^{\circ}\text{C}$.
L₄ : Farmer's method (12 days interval)

For plots of I₁ and I₂ treatments, measured irrigation was given with the help of a parshall flume. For plots of I₃ treatment, canopy-air-temperature differential (CATD) was measured everyday at 1400 hrs. using an Infra-red thermometer (Teletemp, Inc, AG- 42). The various agronomical measurements were made at an interval of 10 days. Daily micrometeorological observations within the crop environment were recorded through micro-climatic tower (OMNI - DATA) INTL U.S.A.). The photosynthetically active radiation was recorded by Datalogger (Licor-Inc. U.S.A.) at 10 days interval. Regression models were developed for grain yield and total biomass production using the daily weather data. The models are then tested using three years' data of Godhra research station (1990-91, 1991-92 and 1992-93) situated in the same agroclimatic region at Anand.

TABLE 1

Regression of dry matter production on intercepted solar and photosynthetically active radiation under different dates of sowing.

Parameter	Treatments	Constant (a)	Slope (b) gms ⁻¹	R ²
ISR	D ₁	-181.33	2.63	0.89**
ISR	D ₂	071.27	2.02	0.97**
ISR	D ₃	-90.61	1.88	0.97**
IPAR	D ₁	-38.53	4.55	0.82**
IPAR	D ₂	5.08	3.70	0.96**
IPAR	D ₃	-47.45	3.47	0.97**

RESULTS AND DISCUSSION

3.1 Dry matter production and radiation use efficiency

To choose the optimum date of sowing as a function of harvest of radiation by the crop canopy, the intercepted solar radiation (ISR) and photosynthetically active radiation (IPAR) use efficiencies were computed, and regressed over dry matter production through the growing season separately for each date of sowing. The results for the data of the two years are presented in Table 1.

The values of slope given in the table represents the ISR and IPAR use efficiencies, which are highest for first date of sowing

The obtained model was :

$$Y = 63.69 + 9.22 \cdot VP_2(P_8) - 4.46 \cdot \text{Mean } T(P_8) \quad R^2 = 0.94 \quad \text{Eq. 1}$$

Where,

Y = Grain yield (q/ha)

$VP_2(P_8)$ = Mean afternoon vapour pressure (mm of Hg) during silk emergence to dough stage

$\text{Mean } T(P_8)$ = Average mean temperature deg. C during the same stage.

This model predicts grain yield of maize about 20-30 days before maturity.

3.3 Relation between total biomass and weather parameters

Similar analysis in case of biomass indicated the best negative highly significant correlation with daily temperature range during emergence to silk emergence period (Table 4). The regression analysis gave the linear relationship.

(October 5) followed second and third date of sowing. It is thus clear that, the first date of sowing is optimum.

3.2 Relationship between grain yield and weather parameters

The correlation analysis between grain yield and the prevailing weather parameters in different phenophases (Table 3) indicates that, the afternoon vapour pressure during silk emergence to dough stage played the most prominent role. Stepwise regression analysis showed that, the afternoon vapour pressure and the mean temperature during silk emergence to dough stage was most appropriate in model development.

$$Y = 308.57 - 10.09 \cdot TR(P_3) \quad R^2 = 0.85 \quad \text{Eq-2}$$

Where,

Y = Total biomass (q/ha)

$TR(P_3)$ = Mean daily temperature range during emergence to silk emergence period in deg. C

In order to improve prediction efficiency, additional agrometeorological indices were considered and stepwise regression analysis

TABLE 2

Correlation of grain yield with weather parameters and agrometeorological indices observed during different phenological phases of maize crop.

Weather parameters/ Agrometeorological Indices	P h e n o l o g i c a l P h a s e s								
	P1	P2	P3	P4	P5	P6	P7	P8	P9
Ep	-0.197	-0.508	-0.661	-0.628	-0.346	-0.123	-0.206	-0.227	0.301
BSS	-0.735	0.484	0.118	0.314	0.563	-0.536	-0.135	0.202	0.451
Max T	0.349	0.382	0.296	-0.074	-0.288	-0.071	-0.882*	-0.801	-0.742
Min T	0.738	0.769	0.660	0.550	0.359	0.510	0.211	-0.483	-0.807
TR	-0.549	-0.394	-0.750	-0.871*	-0.836*	-0.794*	-0.808	-0.729	-0.594
Mean T	0.606	0.569	0.483	0.259	0.001	0.280	-0.554	-0.830*	-0.783
SR	0.103	-0.851*	-0.798	-0.572	-0.361	-0.225	-0.219	-0.159	0.825*
PAR	0.100	-0.853*	-0.798	-0.572	-0.359	-0.226	-0.219	-0.158	0.825*
VP1	0.747	0.864*	0.838*	0.826*	0.826*	0.699	0.617	0.280	-0.379
VP2	0.729	0.786	0.873*	0.888*	0.864*	0.758	0.871*	0.903*	0.874*
VPR	0.705	0.692	0.709	0.685	0.590	0.194	0.193	0.241	-0.048
GDD	0.308	-0.652	-0.287	-0.093	0.547	0.059	0.081	0.079	0.854*
HTU	0.335	-0.202	-0.228	-0.033	0.595	-0.050	0.044	0.107	0.820*
TIR	-0.650	-0.804	-0.574	-0.395	-0.059	-0.150	0.036	0.391	0.925*

* Significant at 5% level

** Significant at 1% level

P1 = Emergence to 6 leaf stage

P2 = Emergence to tassel emergence

P3 = Emergence to silk emergence

P4 = Emergence to dough stage

P5 = Emergence to maturity

P6 = Tassel emergence to silk emergence

P7 = Tassel emergence to dough

P8 = Silk emergence to dough

P9 = Silk emergence to maturity

TABLE 3

Correlation of total biomass production with weather parameters and agrometeorological indices observed during different phenological phases of maize crop.

Weather parameters/ Agrometeorological Indices	P h e n o l o g i c a l S t a g e s								
	P1	P2	P3	P4	P5	P6	P7	P8	P9
Ep	-0.536	-0.865*	-0.473	-0.218	0.370	0.500	0.351	0.119	-0.707
BSS	-0.301	0.008	-0.042	0.440	0.692	-0.015	0.525	0.490	0.842*
Max T	-0.385	-0.227	-0.277	-0.609	-0.697	-0.280	-0.747	-0.468	-0.227
Min T	0.337	0.262	0.123	0.033	-0.133	0.052	-0.183	-0.109	-0.188
TR	-0.877*	-0.825*	-0.922**	-0.885*	-0.863*	-0.376	-0.459	-0.467	-0.220
Mean T	-0.006	-0.015	-0.086	-0.305	-0.479	-0.098	-0.697	-0.447	-0.220
SR	0.011	-0.890*	-0.257	-0.170	-0.181	-0.441	0.242	-0.028	0.613
PAR	0.007	-0.891*	-0.255	-0.169	0.184	0.414	0.243	-0.028	0.611
VP1	0.436	0.546	0.466	0.481	0.524	0.301	0.316	0.485	0.133
VP2	0.569	0.797	0.682	0.744	0.694	0.348	0.560	0.804	0.278
VPR	0.310	0.359	0.290	0.321	0.407	-0.371	0.050	0.668	0.583
GDD	0.329	-0.777	0.348	0.385	0.950**	0.696	0.596	0.302	0.881*
HTU	0.306	-0.627	0.307	0.043	0.697**	0.620	0.569	0.361	0.915*
TIR	-0.149	-0.346	0.045	0.142	0.486	0.375	0.434	0.353	0.540

* Significant at 5% level.

** Significant at 1% level.

P1 = Emergence to 6 leaf stage
P2 = Emergence to tassel emergence
P3 = Emergence to silk emergence
P4 = Emergence to dough stage
P5 = Emergence to maturity

P6 = Tassel emergence to silk emergence
P7 = Tassel emergence to dough
P8 = Silk emergence to dough
P9 = Silk emergence to maturity

TABLE 4

Testing of the models developed for grain yield and total biomass production.

Year	Parameter	Eq. No. tested	Simulated q/ha	Actual q/ha
1990-91	grain yield	1	45.09	57.51
1991-92	grain yield	1	49.84	38.58
1992-93	grain yield	1	69.49	47.59
	Mean		54.81	47.89
1990-91	total biomass	2	161.26	153.06
		3	150.19	153.06
1991-92	total biomass	2	148.95	107.75
		3	111.76	107.75
1992-93	total biomass	2	141.08	N.A.
		3	149.00	N.A.
	Mean	2	150.43	130.40
		3	136.98	130.40

revealed a multiple linear relationship with temperature range in emergence to dough stage and heliothermal unit in emergence to maturity as independent variables. The following relationship had R^2 of 0.96.

$$Y = 75.36 - 3.61 \text{ TR } (P_4) + 0.0071 \text{ HTU } (P_5) \dots \dots \text{Eq. 3.}$$

Though, the model with simple variable has a lower efficiency 11%, it can provide prediction of biomass 42 to 50 days before maturity. The above models may be used as per the requirement.

3.4 Validation of models

The models developed for grain yield and total biomass of maize have been tested for their validity by comparing the simulated

for the model of Godhra research station with the observed data. Since the number of data points is less, statistical analysis could not be performed. The results presented in Table 4 indicate that there exist an error of about 20% (Eq. 1) in case of grain yield and 40% (Eq. 2) and 5% (Eq. 3) in case of total biomass production. The errors are seen to be significant and therefore indicate a need for refinement of the models, and point to the limitation of their predictability, which may be attributed to the non-availability of the data on duration of various phenophases of the crop and also to the soil factor at Godhra. However, it is observed that, even with these limitations, the models developed under Anand conditions may be used for Godhra conditions.

The study has provided with the following conclusions.

1. Study on dry matter production vs. radiation use efficiencies showed that, the October 5 sowing is most beneficial.
2. The grain yield could be predicted using the afternoon vapour pressure and mean temperature during silk emergence to dough stage (21 to 30 days before maturity) with an accuracy of 94%.
3. Temperature range during emergence to silk emergence period could predict total

biomass with 15 per cent error, while temperature range during emergence to dough stage and heliothermal unit during emergence to maturity provided a prediction accuracy of 96 per cent.

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Natural Control of Gujarat Hairy Caterpillar, *Amsacta moorei* Butler with Bio and Microbial Agents in Middle Gujarat

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ABSTRACT

The study carried out on natural enemies of Gujarat hairy caterpillar, *Amsacta moorei* Butler at Gujarat Agricultural University, Anand Campus, Anand during 1982 to 1989 revealed that the activity of egg parasite, *Telenomus* Sp. near (*T. proditor* Nixon) and larval parasite, *Phloxorista laxa* Curt. was found during 4th week of June to 1st week of August and 4th week of June to 2nd week of August, respectively, whereas NPV incidence was occurred during 4th week of June to 2nd week of August. Effect of meteorological factors on the activity of bio and microbial agents of *A. moorei* was also studied.

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INTRODUCTION

Gujarat hairy caterpillar, *Amsacta moorei* Butler (Arctiidae : Lepidoptera) commonly known as 'Katra' is a seasonal polyphagous pest found in a light soil area of middle and north Gujarat. Female moth lays yellowish white eggs in cluster mostly on the under surface of leaves of weeds and grasses on bunds of the field. The young larvae hatching out from such eggs usually remain in a group and feed on the foliage. The eggs and larvae of *A. moorei* are destroyed by their natural enemies. To have information on the activity of parasite and pathogen which are reducing the population of Gujarat hairy caterpillar in nature, study was carried out in the kharif during 1982 to 1989 at Gujarat Agricultural University, Anand Campus, Anand.

MATERIALS AND METHODS

Eggs and larvae of *A. moorei* were collected from various fields around Anand and reared in the laboratory to study the parasites and microbes activities during 1982 to 1989. Regular collections of the egg masses as well as various size of larvae were made from the different fields immediately after first good rain till their availability. Parasite emergence as well as disease incidence were recorded for each collection throughout the study.

RESULTS AND DISCUSSION

The study (Table 1) revealed that the activity of egg parasite *Telenomus* Sp. near (*T. proditor* Nixon) which is also parasitising the eggs of *Achaea janata* (Kamat et al. 1978,

TABLE 1

Field activity of bio-agents of *A. moorei* But. In different years.

Year	Period month	Week	Parasitism (%)		Larval <i>P. laxa</i>	Larval mortality (%) due to NPV
			Egg mass <i>T. proditor</i>	Egg		
1982	July	III	—	—	2.00	24.00
		IV	—	—	0.00	20.00
	August	I	—	—	1.85	44.17
		II	—	—	2.04	4.08
		Av.	—	—	1.71	36.24
1983	July	I	0.00	0.00	0.00	4.00
		II	3.51	3.23	0.00	12.00
		III	40.00	25.00	0.00	—
		Av.	5.56	4.09	0.00	10.40
1984	June	IV	14.87	3.43	0.00	88.88
	July	I	17.28	22.72	0.00	35.82
		II	96.55	86.81	0.00	18.46
		Av.	28.80	19.79	0.00	28.39
1985	July	III	0.00	0.00	0.00	15.79
		IV	3.33	3.83	0.00	40.71
	August	I	0.00	0.00	2.11	53.16
		Av.	1.01	0.72	0.87	44.81
1986	June	IV	1.49	0.35	—	—
	July	I	53.66	44.97	11.44	64.18
		II	—	—	0.00	58.71
		III	100.00	100.00	1.43	69.29
		IV	91.67	92.57	—	—
	August	I	78.26	85.56	—	—
		Av.	36.81	22.13	7.73	63.12
1987	July	I	0.00	0.00	—	—
		II	20.00	11.77	—	—
		III	25.00	23.79	3.55	61.84
		IV	—	—	6.68	50.21
		Av.	9.51	4.11	4.53	57.30

1.	2.	3.	4.	5.	6.	7.
1988	July	I	29.41	6.42	2.66	0.88
		II	100.00	96.77	3.52	1.76
		III	—	—	0.20	25.40
		IV	—	—	0.00	34.26
		Av.	60.66	46.38	1.00	19.36
1989	June	III	0.00	0.00	—	—
		IV	0.00	0.00	6.67	3.33
	July	I	100.00	95.29	3.51	7.66
		II	100.00	99.39	1.82	5.00
		III	100.00	100.00	2.72	15.45
		Av.	66.67	73.77	3.28	7.67

Phadke and Rao, 1978) was found during 4th week of June to 1st week of August. The maximum (66.67%) egg masses were parasitised in the year 1989 which was followed by 60.66, 36.81, 28.80, 9.51, 5.56 and 1.01 per cent during the year 1988, 1986, 1984, 1987, 1983 and 1985 respectively. Same trend was found in individual egg parasitism. The maximum (73.77%) eggs were parasitised in 1989 which was followed by 46.38, 22.13, 19.79, 4.11, 4.09 and 0.72 per cent during the year 1988, 1986, 1984, 1987, 1983 and 1985 respectively. Thus, *T. proditor* activity was found in middle Gujarat agro-climatic conditions during all the years of study. However, its activity was high in July as compared to June and August.

The activity of larval parasite, *Plaxorista laxa* Curr. was observed during 4th week of June to 2nd week of August. the maximum (11.44%) parasitism was in the 1st week of July 1986 when there was no rain but early good rain in the 4th week of June may have enhanced the activity of larval parasite. In heavy (more than 100 mm) rain period no parasite activity was found. The per cent

parasitism during 1986, 1987, 1989, 1982, 1988 and 1985 was 7.73, 4.53, 3.28, 1.71, 1.0 and 0.87 respectively. No activity was found in 1983 and 1984 may be due to more rain in the 1st week of July. The field collected medium size larvae (Table 2) were comparatively more (6.68%) parasitised than small (1.14%) and full grown larvae (1.13%).

The larval mortality due to microbial agent NPV (Table 1) was observed during 4th week of June to 2nd week of August. However maximum (63.12%) larval mortality due to NPV was during 1986 which was followed by 57.30, 44.81, 36.24, 28.39, 19.36, 10.40 and 7.67 per cent during 1987, 1985, 1982, 1984, 1988 and 1989 respectively. The larval mortality due to NPV (Table 2) was more (40.42%) of field collected medium size larvae as compared to small (31.62%) and full grown larvae (25.39%). Considerable larval mortality was observed in the 4th week of June as well as 1st and 2nd week of July even though in absence of rain. In fact high rain reduced the incidence of NPV in *A. moorei* during 1983, 1988 and 1989, whereas low rain in 1986 and 1987 enhanced the disease incidence.

TABLE 2
Suceptibility of different size larvae of *A. moorei* to *Plaxorista laxa* Curr. and NPV in field condition.

Collection on Year Months		Fort- night	Size of larvae	No. of larvae observed	No (%) to <i>P. laxa</i>	Larval mortality due to NPV
1986	July	I	Small	122	0 (0.00)	119 (97.54)
			Medium	257	31 (12.06)	185 (71.98)
			Full grown	167	2 (1.20)	32 (19.16)
1987	July	II	Medium	140	20 (14.29)	97 (69.29)
			Small	100	0 (0.00)	94 (94.00)
			Medium	570	41 (7.19)	420 (73.68)
1988	July	I	Full grown	543	14 (2.58)	181 (33.33)
			Small	105	0 (0.00)	0 (0.00)
			Medium	245	15 (6.12)	2 (0.82)
1989	June	II	Full grown	158	0 (0.00)	4 (2.53)
			Small	80	0 (0.00)	1 (1.25)
			Medium	240	2 (0.83)	45 (18.75)
1989	July	I	Full grown	892	0 (0.00)	283 (31.72)
			Small	30	1 (3.33)	2 (6.67)
			Medium	30	3 (10.00)	0 (0.00)
1986 to 1989	July	II	Small	265	7 (2.64)	6 (2.26)
			Medium	480	19 (3.96)	44 (9.17)
			Full grown	245	5 (2.04)	20 (8.16)
1986 to 1989	July	II	Full grown	110	3 (2.72)	17 (15.45)
			Small	702	8 (1.14)	222 (31.62)
			Medium	1962	131 (6.68)	793 (40.42)
1986 to 1989	July	II	Full grown	2115	24 (1.13)	537 (25.39)

The study on correlationship between occurrence of egg and larval parasites and Nuclear polyhedrosis virus of *A. moorei* and meteorological factors (Table 3) revealed negative ($r = -0.47$) correlationship between egg parasite *T. Proditor* and maximum temperature, however no correlationship between larval parasite *P. laxa* and any of weather factors was observed during the

study period. The positive correlationship between the incidence of NPV and maximum temperature ($r = 0.41$) whereas negative correlationship with relative humidity ($r = -0.62$), rainfall ($r = -0.48$) and rainy days ($r = -0.48$) was observed. Sharma and Yadav (1994) have similar observations for the correlationship between maximum temperature and relative humidity with predatory coccinellid.

TABLE 3

Correlation coefficient for natural enemies of *A. moorei* and meteorological factors.

Natural enemy	Meteorological factors	Correlation coefficient (r)
Egg parasite <i>Telenomus</i> <i>Proditor</i>	Maximum temperature	-0.47
Neuclear polyhedrosis virus (NPV)	Maximum temperature	0.41
	Relative humidity	-0.62
	Rainfall	-0.48
	Rainy days	-0.48

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Varietal Resistance in Brinjal to Insect-Pests and Disease

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ABSTRACT

Field experiment conducted to study varietal resistance in brinjal to various insect-pests, disease and their yield potentiality in middle Gujarat agro-climatic conditions during kharif 1988 to 1990 showed significant differences in their resistance to jassid, *Amrasca biguttula biguttula* L., whitefly, *Bemisia tabaci* G., shoot and fruit borer, *Leucinodes orbonalis* G. and little leaf disease. Whereas, none of them showed resistance to aphid, *Aphis gossypii* G., Brinjal varieties Chaklasi doli, Doli-5 and Pusa purple cluster were found resistant to jassid, shoot and fruit borer and little leaf disease. Of course, Chaklasi doli and Doli-5 were found more susceptible to whitefly than Pusa purple cluster. However, Chaklasi doli and Doli-5 had significantly higher marketable fruit yield than Pusa purple cluster.

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INTRODUCTION

Brinjal, *Solanum melongena* L. is an important vegetable crop cultivated throughout the year which is damaged by a number of pests and diseases, Butani and Verma (1976). A wide variety of insecticides are used to control insect damage, Awasthi (1985). To minimize the use of synthetic insecticides and problems arising due to their frequent use, it is very essential to cultivate a resistant/tolerant brinjal variety to pests and diseases. In view of this requirement an experiment was conducted to screen out the resistant/tolerant brinjal varieties to pests and diseases at Gujarat Agricultural University during kharif, 1988 to 1990.

MATERIALS AND METHODS

Field experiment was conducted in a randomized block design with three replications. The plot size was 4.2 m x 3.6 m. The row to row and plant to plant spacing was 90 and 60 cm. respectively. Eight brinjal varieties (Table-1) were studied for their resistance to aphid, *Aphis gossypii* Glover, jassid, *Amrasca biguttula biguttula* Ishida, whitefly, *Bemisia tabaci* Gen-dius and shoot and fruit borer, *Leucinodes orbonalis* Guen. The nymphal and/adult populations of sucking pests were recorded on three leaves at different heights of each of 5 tagged plants selected at random from each of the plots. The population counts were taken at an interval of one week starting after four weeks of

TABLE 1

Susceptibility of various brinjal varieties to insect-pests, disease and yield.

Variety	Av. no. of sucking pest/leaf			Damage by		Little leaf disease (%)	Marketable fruit yield (q/ha)
	Aphid	Jassid	Whitefly	<i>L. orbonalis</i> (%)			
				Shoot	Fruit		
Junagadh long	1.31* (2.72)	0.95* (0.43)	1.41* (2.15)	23.65** (18.73)	14.17** (6.57)	51.16** (55.89)	27.08
G. B. 6	1.26 (1.77)	1.03 (0.61)	1.16 (1.11)	26.61 (22.66)	22.37 (16.92)	59.19 (49.69)	36.69
Junagadh oblong	1.41 (3.91)	0.98 (0.49)	1.12 (0.94)	27.41 (25.16)	15.57 (9.31)	59.91 (58.56)	20.66
GB 1	1.34 (3.26)	0.97 (0.46)	1.12 (0.96)	29.60 (28.04)	12.67 (7.10)	44.00 (58.55)	33.53
Chaklasi doli	1.27 (1.69)	0.94 (0.40)	1.18 (1.15)	22.32 (17.90)	13.33 (6.32)	34.18 (35.79)	81.08
Pusa purple cluster	1.19 (1.40)	0.96 (0.46)	1.10 (0.90)	20.01 (15.13)	15.02 (6.96)	28.25 (33.72)	42.93
Pusa Purple long	1.25 (1.64)	1.03 (0.79)	1.05 (0.80)	22.09 (17.10)	17.47 (11.54)	55.47 (55.43)	50.50
Doli 5	1.21 (1.46)	0.94 (0.40)	1.33 (1.82)	19.42 (15.50)	15.29 (7.54)	27.35 (25.59)	71.09
S. Em. ±	0.08	0.02	0.07	2.30	2.00	4.68	8.43
C. D. at 5 %	NS	0.06	0.20	NS	5.68	14.21	23.96
C. V. %	60.88	22.76	25.41	27.44	34.95	22.00	51.11

* $\sqrt{X + 0.5}$ transformed values.** Arcsin $\sqrt{\text{percentage}}$ transformed values.

Figures in the parentheses are original values.

transplanting of brinjal seedlings till the last picking of fruits. The damage caused by shoot and fruit borer, *L. orbonalis* G. to shoots was also recorded at an interval of one week starting from four weeks after transplanting till fruit formation by counting the total number of shoots and the number of infested shoots in the entire plot. The fruit damage was recorded by observing number of healthy and damaged fruits at each picking. The little leaf incidence was recorded by observing all the plants of each plot at weekly interval starting after six weeks of transplanting till the last picking. Yield data of each variety were recorded. The data were analysed statistically by analysis of variance (Table 1).

Correlation coefficient for jassid and whitefly with trichome and *L. orbonalis* with colour of the brinjal fruits was also studied.

RESULTS AND DISCUSSION

Aphid : None of the eight brinjal varieties showed resistance to aphid, *A. gossypii*.

Jassid : The brinjal varieties Doli-5, Chaklasi doli, Junagadh long and Pusa purple cluster were found resistant to jassid, *A. biguttula biguttula* than G.B.-6 and Pusa purple long, which showed equal susceptibility as G.B.-1 and Junagadh oblong.

Whitefly : Pusa purple long, Pusa purple cluster, G.B.-1 and Junagadh oblong showed significantly higher resistance to whitefly, *B. tabaci* as compared to Doli-5 and Junagadh long, whereas G.B.-6 found resistant to whitefly in comparison to Junagadh long.

Shoot and fruit borer : The shoots of all the eight brinjal varieties were found equally susceptible to *L. orbonalis*, whereas the fruits of

G.B.-1, Chaklasi doli, Junagadh long, Pusa purple cluster, Doli-5 and Junagadh oblong were found more resistant to *L. orbonalis* as compared to G.B.-6, which was also found equally susceptible as Pusa purple long. Considering the fruit damage by *L. orbonalis* Chaklasi doli, Doli-5, Pusa purple cluster, G.B.-1, Junagadh long and Junagadh oblong were found highly resistant. However, Lal *et al.* (1976) reported G.B.-6 and Pusa purple long fairly resistant.

Little leaf disease : Brinjal Doli-5 and Pusa purple cluster were found resistant to little leaf disease as compared to rest of the brinjal varieties studied except Chaklasi doli. Chaklasi doli and G.B.-1 showed significantly superiority over G.B.-6 and Junagadh oblong by having low incidence of little leaf disease. Junagadh long, Pusa purple long, G.B.-6 and Junagadh oblong were found equally susceptible to this disease.

Yield : Chaklasi doli and Doli-5 gave higher yield of marketable fruits than rest of all the brinjal varieties except Pusa purple long, which had equal yield as Doli-5. Pusa purple long showed higher yield potentiality than Junagadh oblong.

Thus, from the above varietal screening tests, it was found that due to low susceptibility of brinjal varieties (viz., Chaklasi doli and Doli-5) to insect pests and disease, the higher quantity of marketable fruits were obtained.

The study on relationship between pest incidence and morphological characters of the brinjal plant (Table 2) showed negative ($r = -0.74$) correlation between jassid and trichomes as well as shoot and fruit borer and colour of the fruits ($r = -0.80$). Whereas, the positive ($r = 0.90$) correlation was found

TABLE 2

Correlation coefficient for insect-pests and morphological characters of brinjal.

<i>Insect pest</i>	<i>Morphological character</i>	<i>Correlation coefficient (r)</i>
Average number of jassid/leaf	No. of trichome/cm ² on under surface of leaf x length of trichome	-0.74*
Average number of whitefly/leaf	Length of trichome on under surface of leaf	0.90*
Fruit damage by <i>L. orbonalis</i>	Darkness of the colour of fruit	-0.80*

* Highly significant at 5%.

between whitefly and trichomes. The brinjal varieties Doli-5, Chaklasi doli, Junagadh long and Pusa purple cluster having long and higher

number of trichomes per unit area on the under surface of the leaf were found resistant to jassid (Table 3). Similarly, the brinjal varieties (viz.,

TABLE 3

Morphological characters of various brinjal varieties.

<i>Variety</i>	<i>Colour of fruit</i>	<i>Index</i>	<i>Av. no. of trichomes/cm² on under surface of leaf (X)</i>	<i>Length of trichome (mm) (Y)</i>	<i>Hairytness of leaf (X x Y)</i>
Junagadh long	Taupe brown	5	514.81	0.6438	331.43
GB-6	Violet carmine	1	1300.00	0.2915	378.89
Junagadh oblong	Dark perilla purple	2	1024.07	0.3132	320.74
GB-1	Taupe brown	5	955.79	0.2980	284.83
Chaklasi doli	Raisin black	4	1092.	0.3002	327.94
Pusa purple cluster	Blackish purple	3	903.70	0.3828	345.94
Pusa purple long	Violet carmine	1	520.37	0.2654	138.08
Doli-5	Taupe brown	5	916.67	0.4437	406.73

Doli-5, Junagadh long, G.B.-1 and Chaklasi doli) having dark colour fruits (i.e. Taupe brown/Raisin black) were found resistant to *L. orbonalis*. However, the light colour fruits of G.B.-6 and Pusa purple long showed higher susceptibility to *L. orbonalis*. The variety Junagadh long and Doli-5 having long

trichomes were found more susceptible to whitefly as compared to Pusa purple long, G.B.-1 and Junagadh oblong. Bindra and Mahal (1981) have also reported the low susceptibility to jassid, *A. biguttula biguttula* of brinjal varieties having long and high density hairs on the brinjal leaf.

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Dispersal Flight Activity of *Bemisia tabaci* (Gennadius) in Relation to Time of the Day and Weather Parameters*

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ABSTRACT

Dispersal flight activity of adult whiteflies, *Bemisia tabaci* (Gennadius) in air outside the crops in relation to time of the day and weather parameters was investigated. Flying adults were monitored by yellow sticky traps on hourly count basis. Dispersal movement of adults in air was not closely related to specific time of the day. However, greater number of adults were trapped before noon in most days of the study period. The correlation between trap catches and temperature as well as morning vapour pressure was found to be positively significant whereas it was negatively significant with wind velocity. The effect of relative humidity and sunshine hours on adults dispersal was found non significant.

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INTRODUCTION

The whitefly, *Bemisia tabaci* Gennadius (Homoptera : Aleyrodidae), is a serious pest of *kharif* cotton, winter vegetables (brinjal, tomato, chilli, etc.) and sunflower crop in Marathwada region at Maharashtra. It causes widespread damage in cotton and vegetable crops by direct feeding and by spreading viral diseases that can lead to yield reduction upto 75% (Duffus and Flock, 1982). Movement within and between crop fields by flight activity results in spread of virus diseases and whitefly reinfestation after few days of insecticidal applications. Little is known about the patterns of dispersal flight activity in relation to time of the day or impact of environmental variables on this activity. Therefore, a serious nature of the whitefly problem and the need for information

regarding their dispersal patterns in air in relation to time of the day and weather parameters prompted to the present investigation.

MATERIALS AND METHODS

The dispersal flight activity of adult whiteflies in air was evaluated by trapping them on yellow sticky traps. The traps used were made of cylindrical tins (10 cm diameter and 13.5 cm height). The outer surface of tins was painted with lemon yellow paint and fitted with wooden stick. Three or four evenly spaced marking lines were drawn lengthwise along the cylinder to facilitate counting of the trapped adults. A thin layer of transparent grease yellow in colour was applied on the trap surface, so that it was sticky but not thickly covered. The

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traps were set at a height of 1.25 m above the ground and minimum 5 meter away to the North, South, East and West periphery of the brinjal field which was heavily infested by whitefly. An hourly counts on trap catches beginning from 7 a.m. until 6 p.m. on each day were recorded from 17th November to 15th December, 1989.

The temperature, relative humidity and vapour pressure were recorded at 7 a.m. and 14 p.m. While the wind velocity prevailing between 7 a.m. and 14 p.m. and the sunshine hours recorded every day were taken into account. For detecting the actual inter-relationship between dispersal flight patterns of whitefly with weather parameters, correlation co-efficients were worked out between average number of trap catches obtained between 7 a.m. and 14 p.m. every day during the study period.

RESULTS AND DISCUSSION

An hourly counts on trap catches presented in Table 1 and Figure 1, revealed that dispersal activity of *B. tabaci* adults occurred throughout the day light period. A very few whitefly adults were trapped during night hours from 6 p.m. to 7 a.m. During second fortnight of November, adults movement in air outside the crop fields increased sharply in morning hours until 10 a.m. and maximum trap catches were recorded between 9 and 10 a.m. Thereafter, trap catches decreased gradually in each hour upto 18 hours when observations were terminated. Similar trend of adults dispersal was observed in first week of December except peak period which was recorded one hour late than in the previous weeks. While, during 2nd week of December, movement of adults in air was found to be negligible in early morning between 7 and 9 hours. It slowly

increased thereafter towards noon and reached its peak between 14 to 15 hours, as indicated by trap catches. Thus dispersal flight activity of the adult *B. tabaci* in air was not related to specific time period of the day and did not remain same in all observational weeks.

The perusal of weather data recorded during the study period revealed that when average combined temperature at 7 a.m. during second fortnight of November was comparatively high (14.3° and 12°C in 3rd and 4th week of November). The movement of adults increased sharply from 8 a.m. upto 10 a.m. This might be due to the increased temperature towards noon upto certain temperature threshold. Likewise, during the first week of December, when morning temperature slightly decreased (11.1°C at 7 a.m.) the trap catches comparatively decreased during early morning and peak was obtained one hour late than in the previous weeks. While, during the second week of December, very few adult whiteflies were moving in the air during morning hours between 7 and 9 a.m. as indicated by negligible number of trap catches recorded in this period. This might be due to a very low temperature during that period (8.4°C at 7 a.m.). Thereafter, dispersal flight activity gradually increased towards noon and it was higher between 13 and 16 hours when maximum ambient temperature around 28°C (28.4°C at 14 p.m.). Adults flight activity sharply decreased towards sunset in all days of observations.

These results are similar to those of Gerling and Horowitz (1984) and Byrne and Von Bretzel (1987) on flight activity of *B. tabaci*. In their studies greater number were caught during the day, primarily between 10 and 16 hours. Bellow *et al.* (1988) studied patterns in diel flight activity of the insect and reported that

TABLE 1

Average number of *B. tabaci* adults trapped on yellow sticky traps during different hours of day.

Trapping period	Average* numbers of whitefly adults trapped/day				Mean **
	November 89		December 89		
	Third week	Fourth week	First week	Second week	
7 - 8 a. m.	3.00 (± 1.63)	2.47 (± 2.27)	0.61 (± 0.61)	0.06 (± 0.18)	1.42 (± 1.81)
8 - 9 a.m.	10.14 (± 9.88)	4.57 (± 2.37)	1.50 (± 0.92)	0.11 (± 0.27)	3.95 (± 6.14)
9 - 10 a.m.	22.64 (± 28.57)	10.18 (± 5.61)	3.46 (± 3.43)	2.03 (± 2.00)	9.32 (± 15.93)
10 - 11 a.m.	10.50 (± 7.30)	6.36 (± 3.41)	5.57 (± 3.06)	2.34 (± 1.38)	6.06 (± 5.03)
11 - 12 a.m.	7.75 (± 1.10)	5.39 (± 3.38)	5.39 (± 3.59)	3.50 (± 2.58)	5.44 (± 3.08)
12 - 13 p.m.	7.00 (± 3.92)	4.92 (± 2.59)	3.07 (± 1.44)	3.81 (± 2.63)	4.52 (± 3.02)
13 - 14 p.m.	4.75 (± 2.65)	4.65 (± 3.86)	2.54 (± 1.33)	5.09 (± 3.53)	4.18 (± 3.03)
14 - 15 p.m.	2.71 (± 2.07)	3.68 (± 3.89)	3.32 (± 2.30)	6.56 (± 5.12)	4.17 (± 3.84)
15 -16 p.m.	2.25 (± 2.04)	3.83 (± 3.68)	3.61 (± 2.18)	5.06 (± 2.82)	3.73 (± 2.80)
16 -17 p.m.	1.86 (± 1.52)	3.64 (± 3.16)	2.82 (± 1.50)	2.97 (± 2.41)	2.83 (± 2.23)
17 - 18 p.m.	0.86 (± 0.59)	1.25 (± 1.01)	1.04 (± 0.91)	0.88 (± 0.80)	0.96 (± 0.82)
18 - 7 p.m.	0.43 (± 0.47)	0.39 (± 0.59)	0.00 (± 0.00)	0.13 (± 0.35)	0.23 (± 0.43)
Total	73.21	50.21	33.04	36.78	

* Average of four traps.

** Mean of 29 days observations.

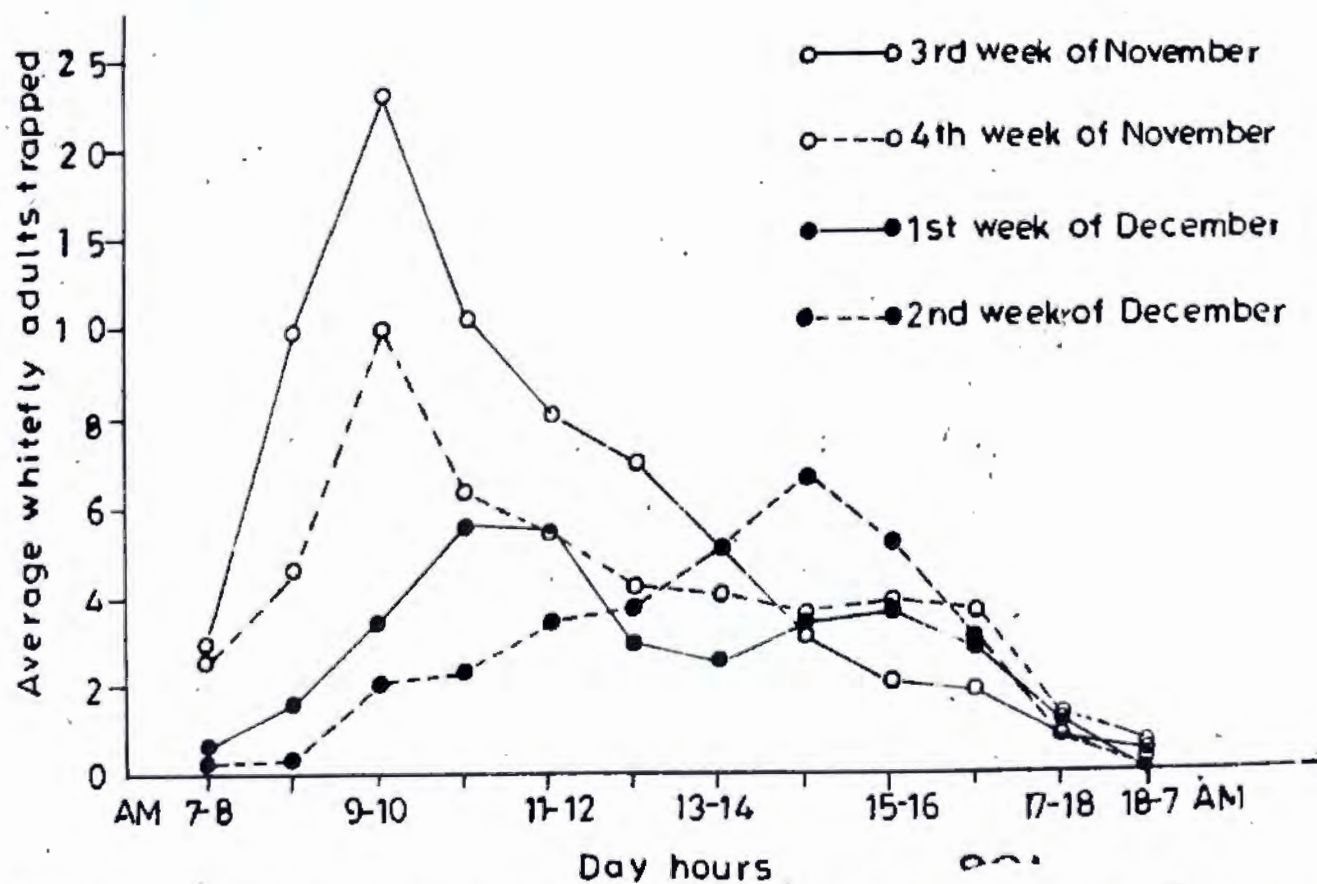
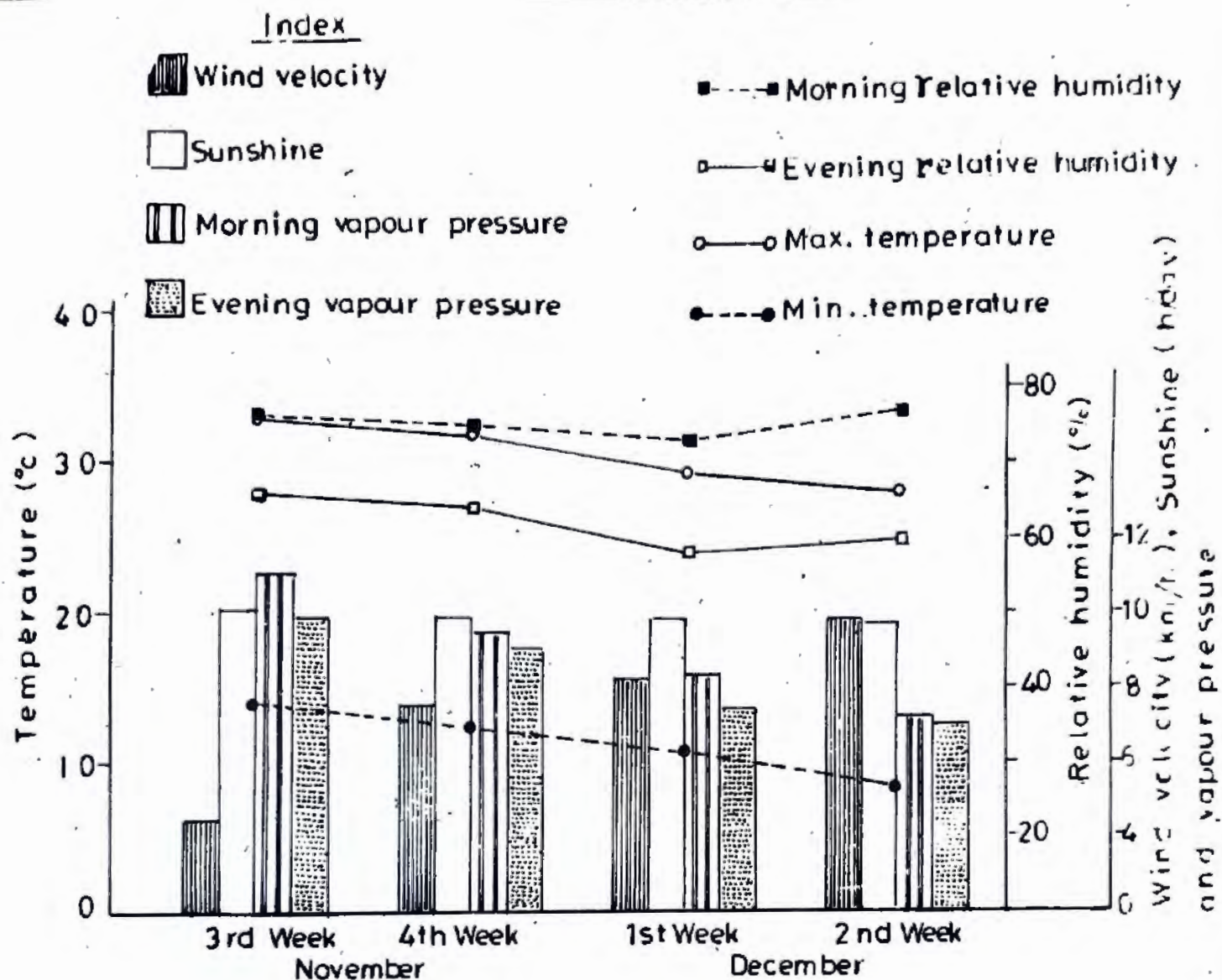


Fig. 1 : Dispersal movement of adult whiteflies in relation to time of day as well as, weather parameters.

adult whiteflies were caught primarily between sunrise and sunset with the general increase in number towards mid day.

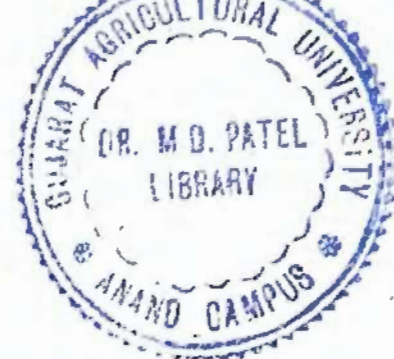
The correlation studies indicated that dispersal flight activity of adult whiteflies was strongly and positively correlated with minimum, maximum temperatures and morning vapour pressure as their correlation co-efficient were highly significant ($r = 0.480, 0.572$ and 0.487 , respectively, $n = 29$). Whereas, the association with wind velocity was found to be negative and highly significant ($r = -0.537$). The effects of relative humidity, sunshine hours and

evening vapour pressure were found to be non significant.

Byrne and Von Bretzel (1987) also found significant positive association between temperature and adults caught. The results of the present study agree with those of Bellow *et al.* (1988), who reported positive and significant relationship between temperature and number of adults caught on traps and non significant relationship with relative humidity. Butler and Henneberry (1989) also reported negatively significant correlation with wind velocity. The present results are almost in agreement with the above results.

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Genotypic Variation Amongst *Heliothis armigera* Baculovirus Isolates

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ABSTRACT

The restriction endonuclease patterns (REN) of three baculovirus isolates of *Heliothis armigera* collected from Anand (Gujarat), Faridabad (Haryana) and Pantnagar (U.P.) have been compared for genotypic variation. The digestion of dsDNA genomes with EcoRI and Sall restriction enzymes resulted in similar, but not identical fragmentation profiles showing minor differences in the size and number of several fragments. The genotypic heterogeneity of these baculovirus isolates is discussed.

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INTRODUCTION

Heliothis armigera is one of the most devastating insect pests among the pod borer (Reed and Pawar, 1982). Nuclear polyhedrosis virus (NPV) has been employed to control *H. armigera* as an alternate method of chemical control (Jayaraj *et al.*, 1987). Nuclear polyhedrosis viruses are members of the family *Baculoviridae*, subgroup A, which are characterized by enveloped rod shaped virions containing circular double-stranded DNA (Bilimoria, 1986). Genotypic heterogeneity within baculovirus population is a common phenomena (Mc Intosh *et al.*, 1987) which is indicated by the presence of submolar bands in restriction endonuclease profiles of virus DNA. REN analysis has been an efficient and precise method of distinguishing genotypic variants of NPVs (Miller *et al.*, 1980; Shapiro *et al.*, 1991).

Considerable differences in the infectivity of NPV isolated from different geographic locations of India in laboratory and pot trials suggest variation in the virulence of NPV isolates (Odak *et al.*, 1982). Similarly variation in the antigenic make up of virions has been shown in geographic isolates of HaNPV (Vyas and Lakhchaura, 1991).

The purpose of this study was to compare three representative HaNPV collected from Anand (Gujarat), Faridabad (Haryana) and Pantnagar (U.P.) for their genotypic variation by comparing EcoRI and Sall restriction profiles.

MATERIALS AND METHODS

Virus multiplication and purification of PIBs

The NPV isolates from Anand, Faridabad and Pantnagar were mass multiplied on

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Heliothis armigera larvae. The virus killed larvae were homogenised in 100 ml, 0.01 M Tris-HCl buffer, pH 7.6 and filtered through a fine polyester cloth. The filtrate was centrifuged at 500 x g for 10 min and supernatant was again centrifuged at 2000 x g for 10 min to pellet the PIBs. Further purification of PIB was done by resuspending the pellet in 20 ml of 0.01 M Tris buffer, pH 7.6 containing 1.0% sodium dodecyl sulfate (SDS), 4 M Urea, 0.1% Mercaptoethanol and 0.5 M NaCl for 30 min at room temperature. After sonication for 30 sec at 20 W, the polyhedra were pelleted at 2000 x g for 10 min at 4°C. The partially purified PIB were subjected to sucrose density gradient centrifugation on a continuous linear gradient of 40-63% sucrose (w/w) at 100,000 g for 20 min. The PIB band was removed and washed thrice with tris-buffer followed by dialysis at 4°C overnight (Langridge *et al.* 1981).

Purification of virions and extraction of DNA

Purified occluded NPVs were disrupted with alkali according to the method of Miller and Dawes (1978) with some modification. An equal volume of alkaline solution of 0.1 M Na₂CO₃, 0.1 M NaCl, pH 11.0 was mixed with purified PIB and incubated at room temperature for 60 min and then at 4°C overnight. The mixture containing the liberated virions was centrifuged at 3000 rpm for 10 min at 4°C for removing the undigested polyhedra. The supernatant was collected and subjected to centrifugation at 100,000 x g for 90 min at 4°C. The pelleted virions were resuspended in 0.01 M Tris-HCl, 0.001 M EDTA, pH 7.6 and washed twice at 96,000 x g for 30 min. The purified pellet of virions was suspended in 0.01 M Tris, 0.001 M EDTA, pH 7.6.

SDS was added to alkali liberated virus solution to a final concentration of 0.5% and the

solution was heated to 65°C for 10 min. The DNA was then separated from virions by phenol extraction method at room temperature (Miller and Dawes, 1978). The DNA was further purified by taking equal volume of chilled chloroform : iso-amyl alcohol (24:1) and mixed with aqueous phase collected from phenol extraction. The contents were gently mixed and phases separated by centrifugation at 12000 x g for 5 Sec. The upper aqueous phase was collected and the entire procedure was repeated twice. The aqueous phase was collected in Eppendorf tube and equal volume of water saturated ether (chilled) was mixed gently and immediately centrifuged at 12000 x g for 5 sec. The upper layer of ether was carefully discarded. The DNA was precipitated by adding half volume of 7.5 M Ammonium acetate and double volume of 95% ethanol and kept at -20°C overnight. The precipitated DNA was pelleted at 12000 x g 15 min on Beckman microfuge T^{EM}. The traces of ethanol were evaporated under vacuum and purified DNA was resuspended in 0.01 M Tris, 0.001 M EDTA, pH 7.6. The ratio of optical density at 260/280 nm was 1.5. The DNA was quantified on the basis of one optical density at 260 nm equivalent to 50 micrograms of DNA.

Restriction endonuclease digestion

The viral DNAs were specifically cleaved by digesting 2 µg of DNA with 5 to 10 units of EcoRI and SalI restriction enzymes in 40 µl of total system containing 0.01 M Tris (pH 7.6), 0.01 M MgCl₂, 0.1 M NaCl and 1 mM dithiothreitol. After 2 hr of incubation, the digestion was stopped by heating at 65°C for 15 min in a water bath, then cooled on ice prior to gel electrophoresis. Lambda DNA (CSIR center for Biochemicals, New Delhi) digested with Hind III (New England Biolabs, USA) was our standard molecular weight marker. The buffer for Hind III

was 0.01 M tris (pH 7.6), 0.05 M NaCl, 0.01 M $MgCl_2$ and 1 mM dithiothreitol.

Electrophoresis of DNA fragments

The DNA fragments produced by REN digestion of viral DNAs were fractionated by electrophoresis through 0.6% agarose. The buffer for the agarose solution and for the electrophoresis contained 10.8 g Tris base, 0.93 g EDTA, sodium salt and 5.5 g boric acid in 1 liter of distilled water (pH 8.3). The DNA fragments were loaded into the wells under TBE buffer plus tracking dye (0.25% bromo phenol blue in 40% sucrose (w/w)). A constant current of approximately 20 mA was applied across the gel for approximately 15 hr until the bromo phenol blue marker reached the acryl amide plug at the bottom of the gel. The gels were stained with ethidium bromide (0.5 $\mu g/ml$)

for 20 min, then destained twice with distilled water for 15 min each. The restriction fragments were visualised with an UV transilluminator (Fotodyne) and photographed with an MP-4 land camera. The sizes of DNA fragments were estimated by comparison to the standard molecular weight marker lambda Hind III.

RESULTS AND DISCUSSION

The fragmentation profiles resulting from the digestion of *Heliothis* NPV DNAs of AND (Anand, Gujarat), FRD (Faridabad, Haryana) and PNT (Panthenagar, Uttar Pradesh) with EcoRI and Sall restriction enzymes are presented in Figures 1 and 2, respectively.

The restriction fragmentation patterns produced by EcoRI digestion of the three isolates were similar with minor variation by

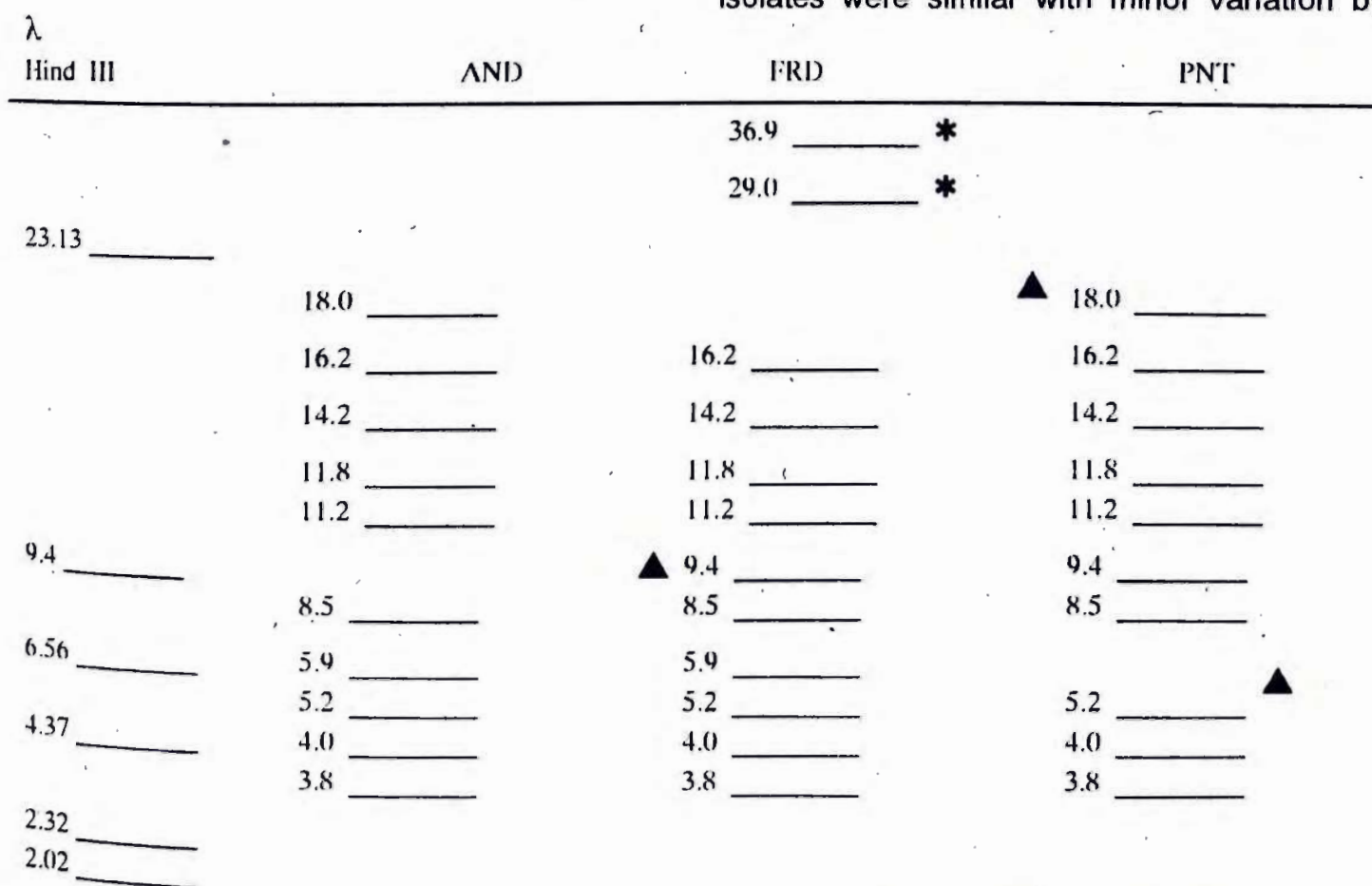


Fig. 1 : A schematic representation of EcoRI fragmentation profiles of the DNA from AND, FRD and PNT *Heliothis baculovirus* isolates.

way of one or two additional or missing fragments (Fig.-1). The FRD isolate produced two additional fragments of 36 and 29 kbp which were absent in AND and PNT isolates. Similarly, a 9.4 kbp fragment was observed in FRD and PNT isolates but absent from AND DNA profile. It can be seen from Fig.-1 that a 5.9 kbp band was present in FRD and AND isolates but could not be detected in PNT

isolate. Conversely, a 18 kbp fragment was absent in FRD isolate. However, over similarities were observed in the profiles of these three isolates.

The REN profiles produced by *SalI* digestion has been presented schematically in Fig-2. The REN patterns of these isolates were characteristically similar, but not identical

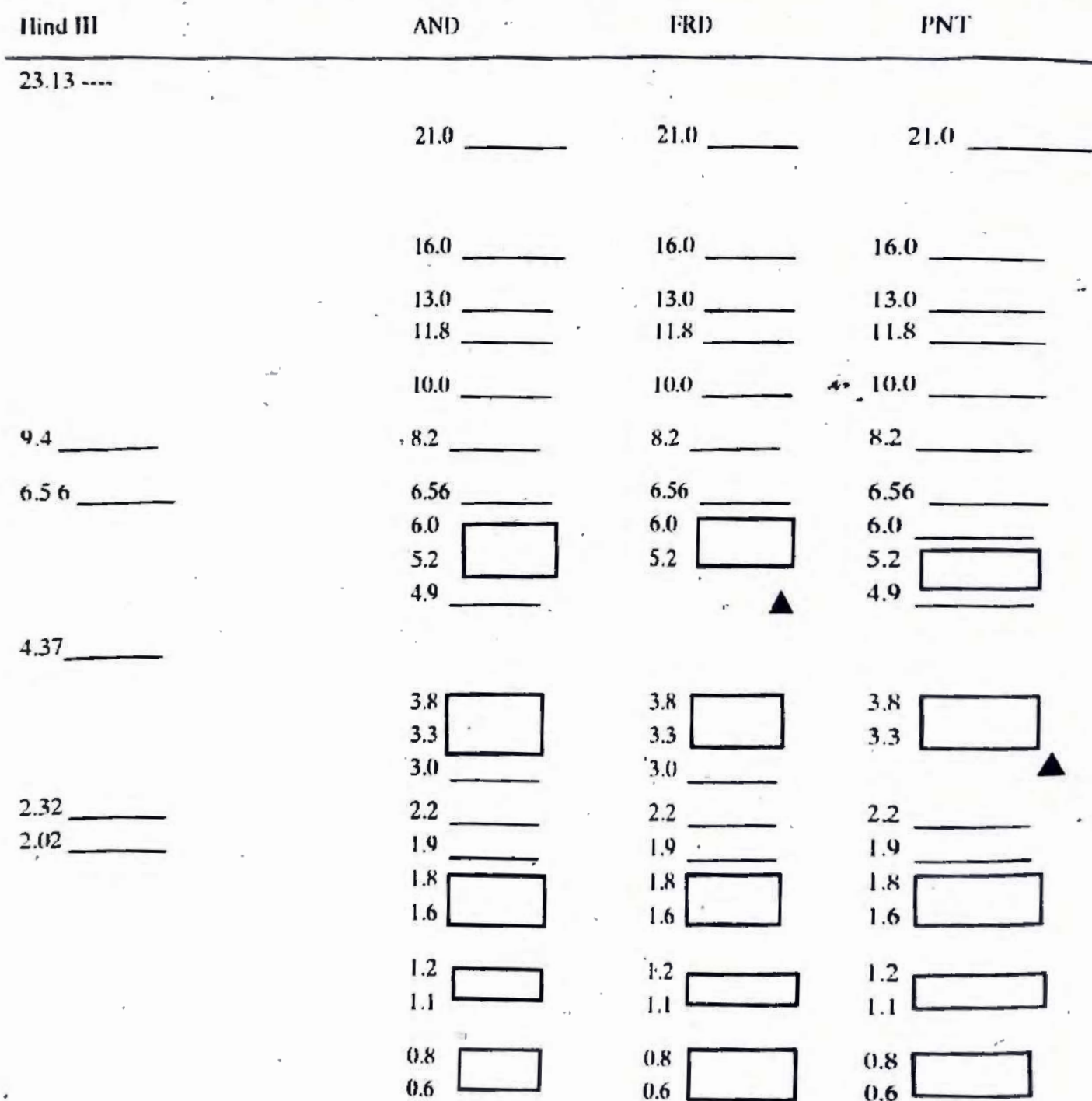


Fig. 2 : A schematic representation of *SalI* fragmentation profiles of the DNA from AND, FRD and PNT *Heliothis baciulovirus* isolates.

There was less heterogeneity in the DNAs. A 4.9 kbp fragment was absent in FRD isolate of HaNPV but present in AND and PNT profiles. Similarly, a 3.0 kbp fragment could not be detected in PNT isolate, but present in AND and FRD profiles.

Diffused multiple bands in the REN profile between 0.6-0.8, 1.1- 1.2, 1.6-1.8, 3.3-3.8 and 5.2-6.0 kbp in the Sall digestion suggests more number of molar equivalents.

A comparison of EcoRI digestion profiles obtained in this study and the reported by Gettig and McCarthy (1982) of Indian strain of HaSNPV revealed that 8.5, 5.9, 5.2, 4.0 and 3.0 kbp fragments were comparable. However, geographic location of HaSNPV of Indian strain is not evident in their study except the fact that it was obtained from southern India. The HaSNPV had the unique EcoRI and Hind III fragmentation profiles which showed additional fragments of 2.43, 1.62, 1.21, 0.92 and 0.51 kbp in EcoRI digestion when the profiles of USSR, China, South Africa, Botswana, Australia and India were compared (Gettig and McCarthy, 1982). In our study, fragments lower than 3.8 kbp could not be resolved properly, hence it is difficult to have an accurate comparison of EcoRI digestion products.

Heliothis MNPV and SNPV genomes show little similarity in their REN profiles and thus probably represent two distinct genotypes of *Heliothis* NPVs. Similar differences have been reported in MNPV and SNPV of *Trichoplusia ni* (Smith and Summers, 1978). The occurrence of genotypic variants in wild isolates of baculovirus populations is a well documented phenomena (Kislev and Edelman, 1982; Shapiro *et al.*, 1991). These variants

could be recognised by presence of submolar fragments in REN digestion products. The exact cause of variation in the REN profiles is unknown. However, variation in restriction patterns of NPV may result from (a) duplication of viral sequences (b) insertions of host DNA into the viral genome and/or point mutations (Brown *et al.*, 1985).

The precise history of all the isolates used in this study is not known. The Anand Isolate of Gujarat was indentified by Patel *et al.*, 1968 and is being used since then. However, genomic analysis has not been done. It is difficult to know whether any mutations has taken place or not. The history of Faridabad isolate is also not available. The Pantnagar isolate was isolated from the fields of chickpea (*Cicer arietinum* L.) during 1988 from Crop Research Station, Pantnagar.

The results of our study is a representative case of only three isolates. These isolates may be genotypic variants of a particular NPV strain. No attempt was made to plaque purify these viral isolates. It is thus, likely that the patterns obtained may reflect the genomic character of only the major variant in the population. The restriction analysis of large number of isolates from many geographic locations of India, plaque purification and bioassay studies will be fundamental to their ecology, development of commercial microbial pesticide and perhaps to an understanding of their evolution.

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Bio-Efficacy of Various Insecticidal Formulations Against Sorghum Shootfly, *Atherigona soccata* Rondani

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ABSTRACT

Trials conducted during kharif 1984 and 1985 at Surat for the protection of sorghum CSH 5 variety from shootfly (*Atherigona soccata* Rondani) infestation showed that seed treatment with carbofuran (3.5 ST) 3.5 per cent, soil application of carbofuran (3 G) and monocrotophos (10 G) 2 g/m row were most effective treatments for obtaining high grain and stover yields.

(Received on 13th June, 1994)

INTRODUCTION

The sorghum shootfly (*Atherigona soccata* Rondani) is a limiting factor for sorghum CSH 5 cultivation. Paul *et al.*, (1981) reported its incidence in late sown kharif crop to the extent of 84 to 89 per cent with 43 to 51 per cent loss in grain yield. Use of insecticides viz., phorate, disulfoton, carbofuran, fensulfothion and isofenfos provided satisfactory protection to the sorghum crop against shootfly (Vedamoorthy *et al.* 1965 and Jotwani and Sukhani, 1968). However, for the South Gujarat region no information on the bio-efficacy of synthetic insecticides against *Atherigona soccata* Rondani is available.

MATERIALS AND METHODS

An experiment was conducted at the Main Sorghum Research Station, Gujarat Agricultural University, Surat during late kharif

seasons of 1984 and 1985, using high yielding hybrid sorghum CSH 5. The trials were carried out in a randomized block design with three replications. The sowing of the experiment was done on August 18, 1984 and September 9, 1985. The crop was nourished with 80 kg N and 40 kg P_2O_5 per hectare. There were seven treatments including control (Table 1) in the experiment. The shootfly attack was counted on the 28th day after germination on the basis of deadhearts. The data on the grain and stover yields were also recorded. The data were subjected to statistical analysis and the results are furnished in Table 1.

RESULTS AND DISCUSSION

The pooled data on the bio-efficacy of various insecticidal formulations against sorghum CSH 5, in South Gujarat Agro-climatic condition (Table 1) revealed the effectiveness

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TABLE 1

Bio-efficacy of various insecticidal formulations on *A. soccata* and yield of sorghum. (Pooled over 1984 and 1985).

Treatments	Deadheart (%)	Yield (%/ha)	
		Grain	Stover
Carbofuran 3 G @ 2 g/m row at the time of sowing	39.96 (41.25)	29.64	63.16
Oncol 50 WP 5% a.i. seed treatment	42.68 (45.96)	25.98	59.04
Carbofuran 50 SP 5% a.i. seed treatment	44.60 (49.30)	21.75	59.04
Carbofuran 35 ST @ 3.5% a.i. seed treatment	40.36 (41.94)	28.04	62.43
Monocrotophos 10 G @ 1.5 g/m row at the time of sowing	42.20 (45.12)	25.75	59.53
Monocrotophos 10 G @ 2 g/m row at the time of sowing	40.83 (42.75)	27.94	65.58
Untreated control	55.50 (67.92)	18.20	46.70
S. Em. +	1.25	0.89	2.13
C. D. 0.05	4.33	2.57	6.14
C. V. %	4.46	9.52	9.75

Figures in parentheses are retransformed values.

of all insecticidal treatments as compared to control. However, among the insecticides, soil application of carbofuran (3 G) @ 2 g/m row had the maximum effect on the shootfly as it produced minimum deadhearts percentage (41.25%). This was significantly lower than carbofuran (50 SP) 5 per cent seed treatment. All the remaining treatments were at par with these treatments. These results are partially in

agreement with those of Singh and Thobbi (1982), who found that 5% a.i. seed treatment of oncol (50 WP) and granular application of monocrotophos (5 G) and carbofuran (3 G) gave effective control of sorghum shootfly.

Soil application of carbofuran (3 G) gave significantly higher grain yield as compared to carbofuran (50 SP) 5 per cent seed treatment.

oncol (50 WP) 5 per cent seed treatment and soil application of monocrotophos (10 G) @ 1.5 g/m row. In case of other treatments the differences in the grain yield were at par. However, all these insecticides gave significantly higher yield than no treatment. Effect of insecticides on stover yield showed

significantly higher yield than control. However, monocrotophos (10 G) produced significantly higher fodder yield than oncol (50 WP) and carbofuran (50 SP), whereas remaining three treatments were at par with monocrotophos (10 G), oncol (50 WP) and carbofuran (50 SP).

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Genetic Studies in Bottle Gourd (*Lagenaria siceraria* (Mol.) Stand 1.)

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ABSTRACT

The nature of gene action involved in the inheritance of days to first picking, crop span, fruit length, fruit girth, number of fruits per plant and yield per plant was studied in bottle gourd (*Lagenaria siceraria* (Mol.) Stand 1.) in a half diallel involving 6 parents. Estimates of the components of variance indicated predominance of additive genetic effects for crop span, length of fruit and girth of fruit and dominance genetic effects for days to first picking, number of fruits per plant and yield per plant. Graphical analysis revealed the prevalence of non-allelic interactions for number of fruits per plant and yield per plant and additive gene effects for other traits. Overdominance for number of fruits per plant and yield per plant; partial dominance for crop span, length of fruit and girth of fruit and complete dominance for days to first picking were recorded. Narrow sense heritability estimates were high for crop span, length of fruit, girth of fruits; moderate for days to first picking and low for yield per plant and number of fruits per plant. In view of their parallel role, both additive and non-additive genetic effects may be simultaneously exploited through recurrent selection for improvement of yield in bottle gourd.

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INTRODUCTION

Bottle gourd is an important vegetable crop grown extensively throughout tropical and sub-tropical regions of the world. Information on the nature and magnitude of genetic variability and its appropriate exploitation is important to direct the breeding research in any crop. Such information is scanty for yield and its related characters in this crop. Hence the present study was undertaken to determine the genetics of seven important characters in bottle gourd.

MATERIALS AND METHODS

Six genetically diverse lines of bottle gourd, viz., Pattiwali, BP-11, Pusa Manjari, B.

Dang, JLT (Junagadh Long Tender) and J. Sel. 1 were crossed in all possible combinations, excluding reciprocals to obtain 15 F_1 s. The 6 parental lines and 15 F_1 s were sown at the Instructional Farm, Gujarat Agricultural University, Junagadh during summer 1993 in randomized block design with three replications. Each plot consisted of 14 m long single row. The crop was planted at a distance of 3.5 m between rows with 2 m spacing between plants. The observations were recorded on five plants for days to first picking, crop span, length of fruit (cm), girth of fruit (cm), number of fruits per plant and yield per plant (kg). The mean values were utilized for component and graphical analysis following the

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techniques of Jinks and Hayman (1953) and Hayman (1954). Heritability in narrow sense was calculated following Mather and Jinks (1971).

significantly from zero, but not deviated significantly from unity, indicating the fitness of additive-dominance model for all these characters.

RESULTS AND DISCUSSION

The slope of regression line in the variance – covariance graph deviated

The estimates of components of variation and their different ratios are given in Table 1. Both the additive (D) and dominance

TABLE 1

Components of genetic variance for different characters.

Components	Days to first picking	Crop	Length of fruit	Girth of fruit	Number of fruits per plant	Yield per plant
D	6.06** ± 0.71	19.78** ± 1.57	116.02** ± 2.05	107.51** ± 7.74	1.54* ± 1.63	2.73* ± 0.77
H ₁	6.45* ± 1.80	11.71* ± 3.98	31.39** ± 5.14	88.55* ± 19.64	13.56* ± 4.14	6.15* ± 1.94
H ₂	6.87* ± 1.60	9.28 ± 3.56	29.30** ± 4.59	76.35* ± 17.55	10.32* ± 3.70	4.44 ± 1.74
h ²	9.04** ± 1.08	8.33* ± 2.39	73.27** ± 3.09	50.58* ± 11.81	5.17 ± 2.49	1.35 ± 1.17
F	– 2.11 ± 1.73*	7.89 ± 3.83	4.57 ± 4.95	68.25* ± 18.90	– 2.19 ± 3.99	0.29 ± 1.87
E	1.24* ± 0.27	2.40* ± 0.59	1.16 ± 0.77	2.21 ± 2.92	1.21 ± 0.62	1.07* ± 0.29
(H ₁ /D) ^{0.5}	1.03	0.77	0.52	0.91	2.97	1.50
H ₂ /4H ₁	0.27	0.20	0.23	0.22	0.19	0.18
(4 DH ₁) ^{0.5} + –P	0.71	1.70	1.07	2.11	0.61	0.93
(4 DH ₁) ^{0.5} – F						
h ² / H ₂	1.31	0.89	2.50	0.66	0.50	0.30
Heritability (ns.) %	30.93	59.56	78.66	78.68	6.95	20.30

*, ** Significant at 5% and 1 % level, respectively.

FIG. 1. V_r, W_r DAYS TO FIRST PICKING

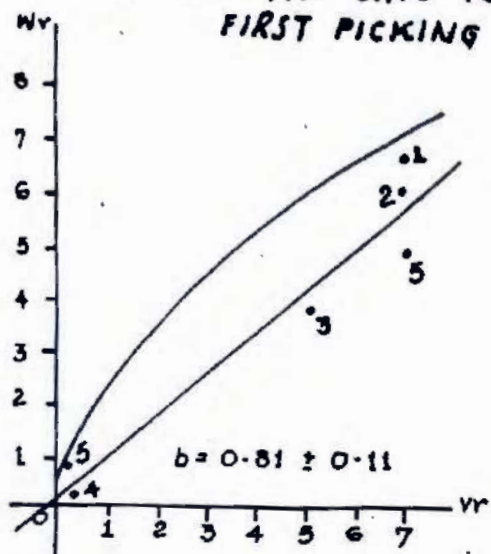


FIG. 3. V_r, W_r LENGTH OF FRUIT

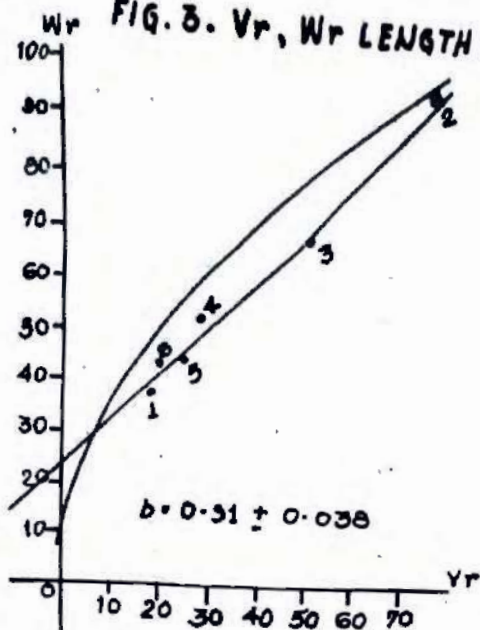


FIG. 5. V_r, W_r NUMBER OF FRUITS PER PLANT

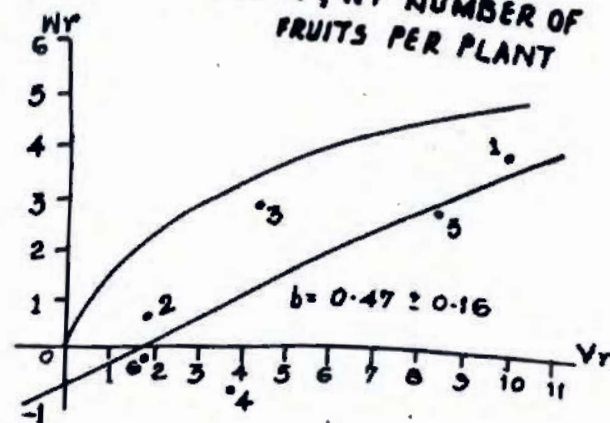


FIG. 2. V_r, W_r CROP SPAN

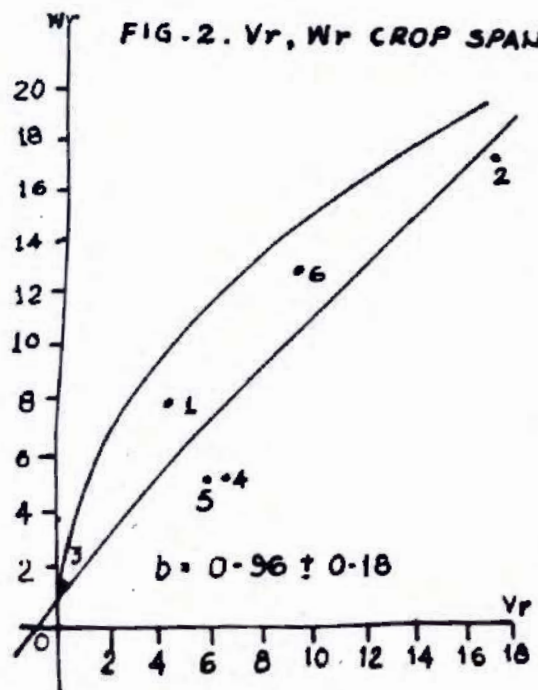


FIG. 4. V_r, W_r GIRTH OF FRUIT

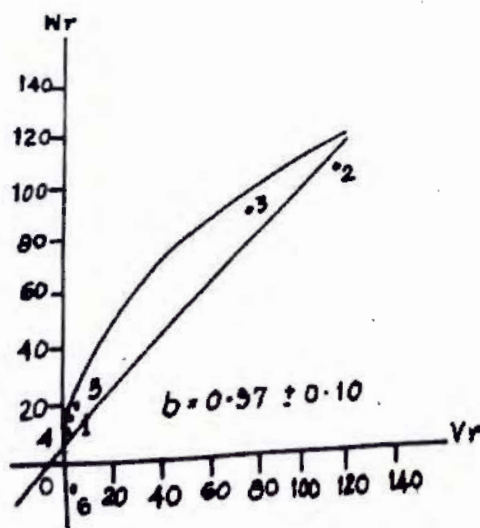
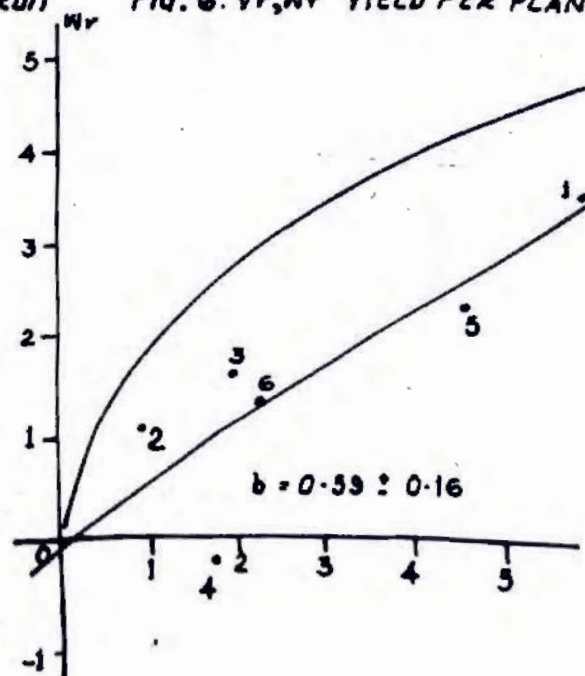


FIG. 6. V_r, W_r YIELD PER PLANT



P_1 = Pattiwali
 P_2 = B. P. - 11

P_3 = Pusa Manjari
 P_4 = B. Dang

P_5 = JLT
 P_6 = J. Sel. - 1

component (H_1) of variances were significant for all the characters studied, except number of fruits per plant. This indicated the presence of both additive and non-additive gene action in the expression of these characters. Magnitude of non-additive variance was higher for days to first picking, number of fruits per plant and yield per plant, indicating preponderance of non-additive gene effects for the inheritance of these traits. There was a predominance of additive genetic variance for crop span, length of fruit and girth of fruits. Hence, these could be fixed by selection in later generations of hybrid progeny. H_1 was greater in magnitude than H_2 for crop span, girth of fruit and number of fruits per plant suggesting that genes with positive and negative effects were not in equal proportion in the parents for these characters. The non-significant value of F for all the characters except girth of fruit indicated an equal distribution of dominant and recessive genes in the parents. The degree of dominance suggested partial dominance for crop span, length of fruit and girth of fruits; overdominance for number of fruits per plant and yield per plant; and complete dominance for days to first picking. These results were also further confirmed by graphical analysis. Similar results were observed by Sharma *et al.*, (1983) and Sirohi *et al.*, (1988) in bottle gourd. The proportion of $H_2/4H_1$ indicated asymmetrical distribution of genes with positive and negative effects in the parents. The ratio h^2/H_2 is an estimate of the number of gene groups controlling the character suggested that one to three genes or gene groups were responsible for the inheritance of different traits under study.

The estimates of heritability in narrow sense were high for crop span, length of fruit and girth of fruit; moderate for days to first picking and low for yield per plant and number

of fruits per plant. Low to high heritability estimates for different characters in bottle gourd have been also reported by Tyagi (1972) and Sharma and Dhankhar (1990).

The wider scattering of array points on the regression line indicated diversity among the parents for all the characters studied. The position of array points suggested that a higher proportion of dominance genes observed in different parents, viz. Pattiwali for crop span, fruit length and fruit girth; BP-11 for number of fruits per plant and yield per plant; Pusa Manjari for crop span and yield per plant; B. Dang for days to first picking, crop span and fruit girth; JLT for crop span, fruit length and fruit girth and J. Sel. 1 for days to first picking, fruit length, fruit girth, number of fruits per plant and yield per plant.

On the other hand a higher proportion of recessive genes was found in the parent Pattiwali for days to first picking, number of fruits per plant and yield per plant; BP-11 for days to first picking, crop span, fruit length and fruit girth; Pusa Manjari for days to first picking, fruit length and fruit girth; JLT for days to first picking, number of fruits per plant and yield per plant; and J. Sel. 1 for crop span. Parent B. Dang exhibited complementary type of gene interaction was for number of fruits per plant yield per plant.

For the characters, viz., days to first picking, length of fruit, crop span and girth of fruit there were high heritability estimates coupled with preponderance of additive gene actions indicating that simple selection would be effective for improvement of these traits. Low heritability estimates for number of fruits per plant and yield per plant indicated that both additive and

non-additive components were important in the inheritance of these traits. Therefore, recurrent selection would be fruitful for effective utilization of both type of gene actions, as it would select

for desirable alleles and at the same time it maintain sufficient heterozygosity for the exploitation of dominance gene action in the population.

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Genetic Analysis of Yield Characters in Grain Sorghum*

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ABSTRACT

Estimates of additive, dominance and epistatic gene effects for eight quantitative characters, viz., days to flowering, plant height, panicle weight, panicle length, panicle breadth, length of primary branch, grain yield per plant and grain weight have been obtained in grain sorghum. The material studied included the parental lines and the F_1 , F_2 , B_1 and B_2 derivatives of the crosses SPV 981-1 x GJ 35 and ICSR 89022-3 x GJ 35. The results revealed that most of the characters are under the control of additive and non-additive genetic components, the later being more important. Preponderance of dominance (h) effect was observed for grain yield, grain weight, panicle weight, plant height and flowering. The type of gene action appeared to favour the crosses for exploitation of hybrid vigour.

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INTRODUCTION

Studies on nature of gene action governing complex quantitative characters are of great value to the breeder in selecting appropriate procedure for the improvement of yield contributing characters. Information on the presence of type of epistatic gene effects in the inheritance of various quantitative characters is important for adopting suitable breeding procedures to improve the characters. In the present study, an attempt has been made to know the nature and magnitude of additive, dominance and epistatic gene effects for eight quantitative characters under varying environments.

MATERIALS AND METHODS

Genotypes SPV 981-1, ICSR 89022-3 and GJ 35 were crossed by hand emasculation

and pollination in 1991. The F_1 , F_2 , B_1 , B_2 and parental generations were grown at the College Farm, College of Agriculture, Junagadh during summer (S) and kharif (K) season of 1992 with three replications. P_1 , P_2 and F_1 were grown in single-row plots, B_1 and B_2 were sown in two-row plots and F_2 in four-row plots. Row length was 5.0 m with a spacing of 45 x 15 cm. Observations on 5 plants in parents and F_1 , 10 plants in B_1 and B_2 and 20 plants in F_2 randomly selected per replication were recorded for days to flowering, plant height (cm), panicle weight (g), panicle length (cm), panicle breadth (cm), length of primary branch (cm), grain yield per plant (g) and grain weight (g) in summer (S) and kharif (K) seasons.

The gene effects were estimated by 6 parameter (Hayman 1958) and 3 parameter

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models (Jinks and Jones, 1958) following the weighted least square technique of Cavalli (1952).

RESULTS AND DISCUSSION

The analysis of variance revealed significant generation differences in cross SPV 981-1 x GJ-35 for days to flowering, grain yield per plant and grain weight under both the seasons, whereas for plant height, panicle weight, panicle length, panicle breadth and length of primary branch significant differences were observed only in kharif season. In cross ICSR 89022-3 x GJ 35 significant differences were observed for all the characters except for plant height and panicle weight in summer and panicle breadth in kharif.

Non-significant values for days to flowering in kharif and grain yield in summer in cross SPV, 981-1 x GJ 35, whereas in cross ICSR 89022-3 x GJ 35 for panicle length, panicle breadth and length of primary branch in summer indicated the adequacy of additive dominance model. Clear influence of environments was observed for days to flowering and grain yield in cross SPV 981-1 x GJ 35 and for panicle length and length of primary branch in cross ICSR 89022-3 x GJ 35 as the additive dominance model was adequate for another season.

Additive (d) effect was significant in cross SPV, 981-1 x GJ 35 for days to flowering and grain weight in both the seasons and for panicle weight, panicle breadth and grain yield per plant in kharif season only (Table 1). In cross ICSR 89022-3 x GJ 35 significant additive (d) effect was observed for days to flowering and panicle length in both the seasons, panicle breadth and grain weight in summer and plant height,

panicle weight, length of primary branch and grain yield per plant in kharif season. Additive type of gene action was also reported for panicle breadth by Hussain Sahib *et al.* (1988).

Dominance (h) effect was significant in cross SPV 981-1 x GJ 35 for grain yield and grain weight in both the seasons, for days to flowering in summer and panicle weight, panicle length, panicle breadth and length of primary branch in kharif season. High magnitude of dominance effect was observed for all the characters in this cross.

In cross ICSR 89022-3 x GJ 35 dominance (h) effect was significant for days to flowering, length of primary branch and grain weight in both the seasons, panicle length and panicle breadth in summer and grain yield in kharif. High magnitude of dominance effect was also observed in this cross (Table 2).

All the epistatic effects were significant in cross SPV 981-1 x GJ 35 for days to flowering in summer and panicle weight and grain yield in kharif season. In cross ICSR 89022-3 x GJ 35 epistatic effect were significant for days to flowering in both the seasons, for grain weight in summer and plant height in kharif.

A perusal of gene action (Table 1 and 2) revealed that additive and non-additive gene effects controlled the inheritance for most of the traits under study which suggested the possibility of obtaining transgressive variation in early generations. Naykar (1973), Rana and Murthy (1978) and Amsalu and Bapat (1990) reported additive and non-additive type of gene action for days to flowering; Kambal and Webster (1965) and Naykar (1973) for plant height; Srihari and Nagur (1980) and Nimoalkar *et al.* (1988) for panicle length.

TABLE 1

Estimates of gene effects for eight characters in SPV 981 - 1 x GJ-35.

Characters		SPV 981-1 x GJ-35						X^2 /Type of epistatic
		<i>m</i>	<i>(d)</i>	<i>(h)</i>	<i>(i)</i>	<i>(j)</i>	<i>(l)</i>	
Days to flowering	(S)	69.00	-5.16**	-44.30**	-35.53**	-7.07**	62.47	1692.89**
		+0.17	±0.29	±1.02	±0.91	±0.51	±1.65	D
	(K)	69.43	03.27**	-0.31	—	—	—	7.25
		±0.23	±0.21	±0.44	—	—	—	
Plant height (cm)	(K)	184.10	07.00	-16.83	-13.07	-0.43	-75.53**	0053.49**
		±3.26	±5.32	±17.65	±16.84	±6.11	±27.12	
Panicle weight (g)	(K)	41.33	04.23**	34.07**	22.7**	02.37	-18.53**	0089.09**
		±0.64	±0.70	±3.01	±2.92	±0.83	±4.08	D
Panicle length (cm)	(K)	19.67	-0.90	10.50**	08.33**	00.73	-12.20**	0040.09**
		±0.22	±0.51	±1.40	±1.34	±0.58	±02.35	D
Panicle breadth (cm)	(K)	04.13	-0.43**	02.53**	02.13**	-0.67**	-02.80	0050.77**
		±0.06	±0.15	±0.39	±0.38	±0.16	±00.68	D
Length of primary branch (cm)	(K)	03.88	00.02	04.38**	03.33	-0.10	-3.60**	0052.97
		±0.08	±0.21	±0.59	±0.53	±0.23	±1.03	D
Grain yield per plant (g)	(S)	35.00	-1.94	21.48**	—	—	—	0004.43
		±1.23	±1.24	±2.30	—	—	—	
	(K)	31.23	04.30**	33.67**	21.93**	02.50**	-18.93**	0091.56**
		±06.64	±0.65	±2.94	±2.87	±0.76	±3.88	
Grain weight (g)	(S)	34.89	-2.85**	-10.46	-16.31	00.27	10.56**	0170.44**
		±0.35	±0.40	±1.68	±1.61	±0.46	±2.34	D
	(K)	21.43	1.87*	5.67**	2.93	-0.53	7.20**	0100.20**
		±0.29	±0.53	±1.65		±0.59	±2.59	

TABLE 2

Estimates of gene effects for eight characters in ICSR 89022 - 3 x GJ 35.

		ICSR 89022 - 3 X GJ 35						X^2 /Type of epistatic
Characters		m	(d)	(h)	(i)	(j)	(l)	
Days to 50 per cent flowering	(S)	69.32	7.03**	-11.27**	-10.40**	-06.43**	28.47**	342.67**
		± 0.13	± 0.27	± 1.12	± 0.75	± 0.50	± 2.04	D
	(K)	74.87	-4.00	13.93	11.47**	-9.13	-25.73**	343.49**
		± 0.37	± 0.60	± 1.99	± 1.92	± 0.71	± 3.02	D
Plant height (cm)	(K)	192.42	-6.67**	-117.83**	-115.67**	-29.17**	183.33**	158.29**
		± 2.51	± 2.39	± 11.96	± 11.11	± 4.23	± 16.46	D
Panicle weight (g)	(K)	42.35	-1.70**	10.70**	3.87	-6.07**	2.53	57.17**
		± 0.48	± 0.76	± 2.58	± 2.43	± 0.93	± 3.97	
Panicle length (cm)	(S)	21.63	3.68**	2.19	—	—	—	0.45
		± 0.54	± 0.53	± 0.92	—	—	—	
	(K)	23.63	1.47	0.40	-21.3	1.00	11.87**	19.28**
		± 0.35	± 0.58	± 2.05	± 1.80	± 0.68	13.32	
Panicle breadth (cm)	(S)	4.12	0.28	1.12**	—	—	—	5.49
		± 0.13	± 0.13	± 0.19	—	—	—	—
Length of primary branch (cm)	(S)	5.32	-0.03	0.83**	—	—	—	0.73
		± 0.07	± 0.07	± 0.14	—	—	—	
	(K)	6.33	0.59	2.98**	1.74**	-0.09	-1.63	15.74**
		± 0.07	± 0.24	± 0.64	± 0.56	± 0.25	± 1.17	—
Grain yield per plant (g)	(S)	42.85	6.80	27.47	19.27	0.47	-65.53	13.52**
		± 3.22	± 5.36	± 17.15	± 16.76	± 5.71	± 26.04	
	(K)	32.18	-1.67	11.03**	4.73	-5.63**	1.20	59.62**
		± 0.46	± 0.70	± 2.46	± 2.32	± 0.88	± 3.73	—
100-Grain weight (g)	(S)	30.53	4.09**	18.14**	15.43**	2.85**	-21.79**	334.54**
		± 0.17	± 0.32	± 1.00	± 0.93	± 0.38	± 1.64	D
	(K)	24.00	-0.07	3.43	1.47	-2.37	-0.47	21.71**
		± 0.21	± 0.48	± 1.37	± 1.27	± 0.55	± 2.32	—

Duplicate type of epistasis was observed for days to flowering and grain weight in summer and for panicle weight, panicle length, panicle breadth, length of primary branch and grain yield per plant in cross SPV 981-1 x GJ 35. In cross ICSR 89022-3 x GJ 35 duplicate type of epistasis was observed for days to flowering in both the seasons, for grain weight in summer and for plant height in kharif. Goyal and Joshi (1984) also reported duplicate type of epistasis for length of primary branch.

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Effect of Some Treatments on the Keeping Quality of Sapota [*Manilkara Achras* (Mill.) Forberg.] Fruits Cv. Kalipatti After Transportation

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ABSTRACT

For extending the storage life and stabilizing the market demand, the sapota fruits may be treated with GA 150 ppm + Bavistin 500 ppm which helps in safe transportation of sapota fruits to the distant market and reduced physiological weight loss, spoilage and also maintained the marketability of the fruits for a longer period.

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INTRODUCTION

Sapota (*Manilkara achras* (Mill.) forberg.) fruits is highly nutritious, delicious when fully ripe and sweet in taste, with a slight flavour of astringency. However, it is highly perishable, ripen fast during summer and becomes unconsumable very soon. The abundant supply of sapota fruits in market from majority of orchard is done in a short span which caused gult in the market thereby reduction in prices. Therefore the lost in total returned incurred to the orchardists. Also fruits can not be stored for a longer period at ambient temperature and hence farmers are bound to sell their produce. So it become essentials that fruits must be transported to the distant market without spoilage. Therefore, the present study was undertaken to investigate the possibilities of extending the shelf-life by delaying ripening and transporting to the distant market. Such type of information was not available in sapota fruits.

MATERIALS AND METHODS

The study was carried out in the laboratory of Department of Horticulture, N. M. College of Agriculture, Gujarat Agricultural University, Navsari during summer season of 1992. Sapota fruits were transported from Navsari to Sardar Krushinagar, which is 550 km far away from Navsari. The experiment was laid out in a completely randomized design with six treatments and three times replicated. Mature fruits of uniform size, shape and free from injuries were selected for the study. Sapota fruits were obtained from Fruit Research Station, Gandevi of Navsari Zone. The fruits were washed thoroughly with tap water and surface dried. The fruits were then separated into different lots of 15 kg fruits for each treatment. The fruits were dipped in the respective chemical solution for 8 to 10 minutes and dried for 60 minutes. Similarly, for waxol treatment the fruits were dipped in it for 2 minutes and shade dried.

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for 60 minutes. Treated fruits were packed in wooden boxes having 16 kg capacity with paddy straw as a packing material.

Treatments are as under :

1. MH 2000 ppm + Bavistin 500 ppm
2. Kinetin 10 ppm + Bavistin 500 ppm
3. Waxol-2%
4. GA 150 ppm + Bavistin 500 ppm
5. GA 200 ppm + Bavistin 500 ppm
6. Control

Observation of fruits were recorded at one day interval.

For determination of physiological loss in weight, the initial weight of fruits were recorded prior to packing and subsequently at one day interval. The reduction in weight was expressed on percentage basis. For marketable fruits, the

number of visibly sound fruits that can be marked were counted and expressed on percentage over the total number of fruits at specific interval. Similarly, for spoilage percentage, the number visibly diseased, over ripe fruits were counted and expressed as percentage over the total number of fruits at specific interval. Total soluble solids percentage of the pulp was recorded by using a Eroma hand refractometer. Organoleptic evaluation of the fruits for assessing the taste of the fruits was done by a pannel of five experts who scored on a 9 point Hedonic scale (Amerine *et al.*, 1965). The fruit pressure (firmness) was tested by means of pocket penetrometer in term of pressure required by piecing through the fruit.

RESULTS AND DISCUSSION

The detail studies regarding transportation aspects are rather scanty in sapota fruits.

The results of pooled analysis for different storage period after transportation of fruits

TABLE 1

Effect of post harvest tratements on physiological weight loss (%) of sapota fruits after transportation.

Sr. No.	Treatments	Storage period (days)				Pooled
		3	4	5	6	
1.	MH 2000 ppm + Bavistin 500 ppm	11.15	14.43	19.89	20.08	16.32
2.	Kinetin 10 ppm + Bavistin 500 ppm	10.11	12.5	17.50	17.85	14.49
3.	Waxol - 2%	5.55	7.34	9.40	11.60	8.87
4.	GA 150 ppm + Bavistin 500 ppm	8.60	10.89	13.89	14.54	11.98
5.	GA 200 ppm + Bavistin 500 ppm	8.90	11.00	16.50	16.85	13.31
6.	Control	12.60	14.81	20.00	22.00	17.35
	S. Em. +	00.66	00.74	00.85	00.81	00.41
	C. D. at 5%	1.96	2.192	2.528	2.402	1.165
	C. V. %	13.92	12.47	10.36	9.42	11.19

revealed that there were significant differences among various ripening retardants for physiological weight loss, spoilage, marketable fruits and total soluble solids.

The results of per cent physiological weight loss of sapota fruits after transportation as a result of post harvest treatments are presented in table 1. Minimum weight loss (8.87%) was recorded in the fruits treated with waxol-2% followed by GA 150 ppm + Bavistin

500 ppm (11.98%) and GA 200 ppm + Bavistin 500 ppm (13.31%). The reduce weight losses with waxol application have been reported in sapota by Ramkrishna and Rao (1989) and Gautam and Chundawat (1990). The treatment with waxol significantly reduced the PLW and delay the ripening of sapota fruits but had an adverse effect on taste and flavour of ripe fruits and increased the incidence of rotting of sapota (Kariyanna, 1990).

TABLE 2

Effect of post harvest treatments on spoilage (%) of sapota fruits after transportation.

Sr. No.	Treatments	Storage period (days)				Pooled
		3	4	5	6	
1.	MH 2000 ppm + Bavistin 500 ppm	12.50	36.25	60.00	90.45	49.65
2.	Kinetin 10 ppm + Bavistin 500 ppm	7.50	35.42	63.34	91.00	49.32
3.	Waxol - 2 %	5.50	39.75	70.00	100.00	53.80
4.	GA 150 ppm + Bavistin 500 ppm	2.38	26.13	50.00	62.47	35.22
5.	GA 200 ppm + Bavistin 500 ppm	5.26	32.24	59.20	70.00	41.67
6.	Control	14.85	47.06	79.27	100.00	60.30
	S. Em., +	2.06	2.22	4.40	1.54	3.00
	C. D. at 5 %	6.12	6.58	13.08	4.57	9.06
	C. V. %	51.51	12.26	13.84	3.59	11.50

The results of per cent spoilage of sapota fruits with the effect of post harvest treatments are presented in table 2. Lowest spoilage (35.22%) was recorded in the fruits treated with GA 150 ppm + Bavistin 500 ppm followed by GA 200 ppm + Bavistin 500 ppm (41.67%). This

may be due to treatment effect which retarded ripening and reduced weight loss. Similar observations were also made by Ramakrishna and Rao (1989) and Banik *et al.*, (1988) in sapota fruits.

TABLE 3

Effect of post harvest treatments on marketable fruits (%) of sapota fruits after transportation.

Sr. No.	Treatment	Storage period (days)				Pooled
		3	4	5	6	
1.	MH 2000 ppm + Bavistin 500 ppm	87.50	63.75	40.00	9.65	50.23
2.	Kinetin 10 ppm + Bavistin 500 ppm	92.50	64.58	36.66	9.00	50.69
3.	Waxol - 2%	94.50	60.25	30.00	00.00	46.20
4.	GA 150 ppm + Bavistin 500 ppm	97.75	73.87	50.00	37.63	64.78
5.	GA 200 ppm + Bavistin 500 ppm	95.49	67.76	40.80	30.00	58.51
6.	Control	85.15	52.94	20.73	00.00	39.70
	S. Em. +	2.08	2.21	4.40	1.52	3.00
	C. D. at 5 %	6.19	6.58	13.08	4.52	9.04
	C. V. %	4.52	6.94	24.21	21.18	10.76

TABLE 4

Effect of post harvest treatments on organoleptic score of sapota fruits after transportation.

Sr. No.	Treatments	Storage period (days)				Pooled
		3	4	5	6	
1.	MH 2000 ppm + Bavistin 500 ppm	6.00	7.25	6.12	5.15	6.46
2.	Kinetin 10 ppm + Bavistin 500 ppm	6.25	7.00	6.00	4.00	6.48
3.	Waxol - 2%	6.15	6.55	5.15	5.00	5.94
4.	GA 150 ppm + Bavistin 500 ppm	5.50	7.60	7.25	5.20	6.78
5.	GA 200 ppm + Bavistin 500 ppm	5.75	7.40	7.00	5.10	6.70
6.	Control	7.00	6.50	5.00	2.25	6.17
	S. Em. +	0.34	0.29	0.22	0.39	0.42
	C. D. at 5 %	NS	NS	0.66	0.15	NS
	C. V. %	11.10	8.25	7.23	17.45	8.96

The results of per cent marketable fruits with the effect of post harvest treatments are presented in table 3. Highest marketable fruits (64.78%) was observed in the fruits treated with GA 150 ppm + Bavistin 500 ppm followed by GA 200 ppm + Bavistin 500 ppm (58.51%). This

may be due to treatment effect which retarded ripening and reduced weight loss through controlled transpiration and respiration rate. Similar findings were reported by Ramakrishna and Rao (1989) and Banik *et al.*, (1988) in sapota fruits.

TABLE 5

Effect of post harvest treatments on T.S.S. (%) of sapota fruits after transportation.

Sr. No.	Treatments	Storage period (days)				Pooled
		3	4	5	6	
1.	MH 2000 ppm + Bavistin 500 ppm	20.00	21.00	22.55	22.15	21.43
2.	Kinetin 10 ppm + Bavistin 500 ppm	19.66	20.66	23.00	22.70	21.51
3.	Waxol - 2 %	21.15	22.66	24.15	23.65	22.90
4.	GA 150 ppm + Bavistin 500 ppm	21.33	23.33	24.60	24.05	23.33
5.	GA 200 ppm + Bavistin 500 ppm	22.00	23.00	23.85	23.70	23.13
6.	Control	20.00	20.36	22.00	21.87	21.06
	S. Em. +	0.81	0.89	1.04	0.35	0.41
	C. D. at 5 %	NS	NS	NS	1.03	1.15
	C. V. %	7.84	8.15	8.90	3.00	7.33

TABLE 6

Effect of post harvest treatments on pressure test (kg/cm) of sapota fruits after transportation.

Sr. No.	Treatments	Storage period (days)				Pooled
		3	4	5	6	
1.	MH 2000 ppm + Bavistin 500 ppm	4.50	2.00	1.15	0.69	2.09
2.	Kinetin 10 ppm + Bavistin 500 ppm	4.00	1.95	1.00	0.71	1.92
3.	Waxol - 2 %	4.25	1.99	0.95	0.65	1.96
4.	GA 150 ppm + Bavistin 500 ppm	4.75	2.10	1.46	0.87	2.29
5.	GA 200 ppm + Bavistin 500 ppm	4.60	2.00	1.00	0.65	1.82
6.	Control	4.00	1.05	0.80	0.40	1.80
	S. Em. +	0.24	0.13	0.17	0.06	0.13
	C. D. at 5 %	NS	0.39	NS	0.16	NS
	C. V. %	11.00	14.02	32.21	16.51	16.49

The results of T.S.S. of fruits as influenced by various treatments are presented in table 4. From the data it is observed that highest T.S.S. (23.33%) was observed in the fruits treated with GA 150 ppm + Bavistin 500 ppm followed by GA 200 ppm + Bavistin 500 ppm (23.13%). Similar observations were also made by Ramakrishna and Rao (1989) and Banik *et al.*, in sapota fruits.

No significant differences were observed among different treatments for fruit pressure

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and organoleptic test (Table 4 and 6).

For prolonging the storage life and stabilize the market demand the sapota fruits should be treated with GA 150 ppm + Bavistin 500 ppm for 8 to 10 minutes and then packed in wooded boxes using paddy straw as a packing material.

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Parents' Attitude Towards Early Marriage of Girls

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ABSTRACT

Early marriage at immature age, results in grave physical effect on the girls and pre-mature child birth. So, it contributes very largely to maternal and infantile mortality. Four villages were selected at random from Palanpur taluka and from each villages, ten fathers and ten mothers belonging to selected caste were interviewed. A scale to measure parents' attitude towards early marriage of girls has been developed at M. S. University, Baroda. The scale consisted of 18 attitude statements with equal number of positive and negative statements. The majority of the parents were found to possess favourable attitude towards early marriage of girls. The significant difference was found between the attitude of fathers and mothers. Education, family education, social participation and cosmopolitaness were found to have positive and significant relation with their attitude.

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INTRODUCTION

Daughters in many parts of India mean great pecuniary expense in providing for marriage. This has created a tendency of early marriages of girls among many communities. Early marriage implies cohabitation at an immature age, sometimes even before puberty and practically always immediately on the first signs of puberty, resulting in grave physical effect on the girls and premature child birth. Enquiries conducted in Baroda (1931) show that when marriage of young people is consummated at an early age (boy-16, girl-12 to 13), fairly large percentage of wives die of child birth. Commenting on the Child Marriage Restraint Act of 1930, Rathbone observed child

marriage have much to do with high death rates. Such deaths are nothing less than deaths on the rack, due to straining of muscles and serious, nerves and tendons in the body's effort to perform a function for which it is too weak, immature and ill-formed. Dr. Megaw observed that, 'one in every ten girl wives is deemed to die in the child birth.'

It is on this ground the present study, "parents" attitude towards early marriage of girls' was conducted with following specific objectives :

- (i) To study the personal characteristics of the respondents;

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- (ii) To know the parents' attitude towards early marriage of girls, and
- (iii) To ascertain the relationship between the personal characteristics of parents and their attitude towards early marriage of girls.

MATERIALS AND METHODS

The present study was conducted in Banaskantha District of Gujarat State. Palanpur taluka was selected from the district randomly. Early marriage of girls is in practice among two castes. Among these two castes, one caste was selected. A list of the villages where more than half of the population is of selected community was prepared with the help of the District Statistical Officer. From the list, four villages were selected at random and from each villages, ten fathers and ten mothers belonging to the selected caste were interviewed. Thus, final sample was comprised of 80 parents.

A scale to measure parents' attitude towards early marriage of girls developed at

M. S. University, Baroda, was used in the present study. The scale consisted of 18 attitude statements with equal number of positive and negative statements. Parents' response to each statement was recorded on three point continuum viz., 'Agree', 'Undecided' and 'Disagree'. In case of positive statement, score of 3, 2 and 1 was assigned to the response in the form of 'Agree', 'Undecided' and 'Disagree', respectively. The procedure for negative statement was reverse. Information regarding selected personal characteristics of the parents was collected through structured schedule.

RESULTS AND DISCUSSION

Personal characteristics of the respondents

It can be seen from Table 1 that 37.50 per cent of father respondents were found having primary education and 55 per cent of mother respondents having been illiterate. The illiteracy among fathers was found to be 20 per cent. Middle education was found among 22.50 per cent fathers and 15 per cent mothers. Only 12.50 per cent and 7.50

TABLE 1

Distribution of respondents according to their personal characteristics.

Sr. No.	Characteristics	Category	Father (n=40)		Mother (n=40)		'Z' value
			Number	Percentage	Number	Percentage	
1. Education	1	Illiterate	8	20.00	22	55.00	2.687**
	2	Primary	15	37.00	8	20.00	
	3	Middle	9	22.50	6	15.00	
	4	S. S.C.	5	12.50	3	7.50	
	5	H. S. C.	1	2.50	1	2.50	
	6	College	2	5.00	0	0.00	

1.	2.	3.	4.	5.	6.	7.	8.
2.	Family education	1 low (Upto 2)	6	15.00	9	22.50	
		2 Medium (3 to 10)	27	67.50	28	70.00	
		3 High (Above 10)	7	17.50	3	7.50	1.883
3.	Family type	1 Nuclear	23	57.50	20	50.00	
		2 Joint	17	42.50	20	50.00	0.666
4.	Family size	1 Small (Upto 4)	8	20.00	6	15.00	
		2 Medium (5 to 8)	30	75.00	31	77.50	1.905
		3 Large (Above 8)	2	5.00	3	7.50	
5.	Occupation	1 Labourer	3	7.50	5	12.50	
		2 Only farming	30	75.00	24	60.00	
		3 Farming + Business	3	7.50	10	25.00	0.159
		4 Farming + service	4	10.00	1	2.50	
6.	Family income	1 Low (Upto Rs. 7000)	6	15.00	7	17.50	
		2 Medium (Rs. 7001 to 21000)	24	60.00	32	80.00	2.936**
		3 High (Above Rs. 21000)	10	25.00	1	2.50	
7.	Social participation	1 No participation	4	10.00	12	30.00	
		2 Low (upto 3)	20	50.00	23	57.50	3.071**
		3 High (Above 3)	16	40.00	5	12.50	
8.	Cosmopoliteness	1 Non-cosmopolite	3	7.50	10	25.00	
		2 Low (Upto 3)	20	50.00	23	57.50	2.560**
		3 High (Above 3)	17	42.50	7	17.50	

**Significant at 1 per cent level.

per cent mothers. Only 12.50 per cent and 7.50 per cent fathers and mothers, respectively were found having S.S.C. education. Only one respondent in both the categories was found having passed H.S.C. examination. Family education of majority respondents was found medium. Only 17.50 per cent and 7.50 per cent families of the male and female respondents respectively were found to be highly educated.

Nearly 58 per cent fathers and half of the mothers were found to be the members of nuclear family. Nearly two-thirds respondents in both the categories were found to be the members of medium family consisting of 5 to 8 members. Small family was observed in case of 20 per cent fathers and 15 per cent mothers.

The table further reveal that the main family occupation of both the categories of respondents i.e., fathers (75 per cent) and mothers (60 per cent) was farming. The families of 7.50 per cent male respondents and 25 per cent female respondents were found to run their business alongwith farming. Only four male and one female respondent was found

to be government servants. Annual family income from different occupations was found medium (Rs. 7001-21000) among both fathers (60 per cent) and mother (80 per cent) respondents. 15 per cent families among male respondents and 17.50 per cent families among female respondents were found earning less than Rs. 7000 per year.

Half of the fathers and 57.50 per cent mothers were found with medium social participation. High social participation was observed among 40 per cent fathers and 12.50 per cent mothers. Ten per cent fathers and 30 per cent mothers were found to be socially inactive. Low cosmopolitaness was observed among 50 per cent fathers and 57.50 per cent mothers. 7.50 per cent fathers and 25 per cent mothers were found to be non-cosmopolite in nature.

The 'Z' value in the table further indicate that fathers and mothers were found to differ significantly with respect to education (2.687), family income (2.936), social participation (3.071) and cosmopolitaness (2.560). So far as family education, family type, family size and occupation was concerned, no significant

TABLE 2

Parents attitude towards early marriage of girls.

Sr. No.	Attitude	Father (n=40)		Mother (n=40)		'Z' value
		Number	Percentage	Number	Percentage	
1.	Highly favourable	10	25.00	4	10.00	2.908**
2.	Favourable	28	70.00	23	57.50	
3.	Unfavourable	2	5.00	13	32.50	

** Significant at 1 per cent level.

difference was observed between male and female respondents.

Parent's attitude towards early marriage of girls

The data in this regard are depicted in Table 2. Table visualise that majority of the fathers (70 per cent) and mothers (57.50 per cent) were possessing favourable attitude towards early marriage of girls. Highly favourable attitude was observed among 25 per cent fathers and 10 per cent mothers. It is

interesting to note that the percentage of respondents possessing unfavourable attitude was higher among mothers (32.50 per cent) as compared to fathers (5 per cent). This was further supported by the calculated 'Z' value indicating significant difference between the attitude of fathers and mothers. Higher percentage of mothers with unfavourable attitude might be due to the fact that being a women, she might be well aware of the consequences of early marriage.

TABLE 3

Relationship between the personal characteristics of respondents and their attitude towards early marriage of girls.

Sr. No.	Characteristics	Co-efficient of correlation 'r'	
		Father (n=40)	Mother (n=40)
1.	Education	0.3365*	0.6216**
2.	Family education	0.4973**	0.6305**
3.	Family type	0.2004	0.2156
4.	Family size	0.2087	0.0580
5.	Occupation	0.0506	0.0415
6.	Family income	0.2616	0.4345**
7.	Social participation	0.6200**	0.5138**
8.	Cosmopolitaness	0.5197**	0.4091**

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

Relational analysis

In order to study the relationship between personal characteristics of parents and their at-

titude towards early marriage of girls, correlation of coefficient was calculated. The results are depicted in Table 3.

It could be observed from the Table that so far as the relationship between personal characteristics of parents and their attitude towards early marriage was concerned, fathers and mothers could not differ much more. Out of the eight characteristics of the parents, four characteristics viz., education, family education, social participation and cosmopolitaness were found to have positive and significant relation with their attitude towards early marriage of girls.

Positive relation between parents' education and their attitude might be due to the fact that education opens the faculty of thoughts which in term makes a person aware of the mental and physical effect on the girls getting early marriage. Social participation was the another variable found establishing positive relationship with parents' attitude towards early marriage of girls. Social participation play an important role in getting acquainted with the customs, norms and beliefs of the other societies and also the consequences of the early marriage. Those who know and under-

stand the consequences will definately be in against of the early marriage. Cosmopoliteness also makes one aware of the other societal norms and customs. Cosmopolite person is frequently visiting the peoples from other societies. He also have an opportunity to observe the life style of urban people. This helps in opening the new vision, and thereby helping them to see the early marriage of girls as social evil. On the other hand family type, family size and occupation of respondents could not establish significant relation with their attitude.

Implications

The present study clearly indicated that majority parents expressed favourable attitude towards early marriage of girls. They need to be made aware of the consequences of early marriage of girls. Early marriage of girls is a social custom in many castes and every body in the caste has to follow it willingly or unwillingly. Creating social awareness and motivating the caste leaders to bring about desirable changes in their present custom is necessary.

Hierarchy Motives of TRYSEM Beneficiaries

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ABSTRACT

The study was conducted to see the communication sources utilized by the trainees of TRYSEM Programme in tribal and non-tribal areas. It was found that village level worker (VLW) was the prominent source of information in both tribal and non-tribal areas. Further, self actualization was the main motive for tribal and non-tribal beneficiaries to participate in the TRYSEM Programme. Economic security was given second preference by both the categories of trainees of the selected trades.

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INTRODUCTION

Nearly one fourth of India's rural population comprises of youth in the age range of 15 to 25 years. This vast human resource at present is away from direct involvement in the national development process. In view of the emphasis that is being placed in accelerating the tempo of rural development, both in terms of infrastructure and human development, the need to formulate programmes for around development of the youth and their participation in the national growth process has been taken up as the central theme of national planning process particularly from the sixth plan onwards. As a part of this effort both the central and state governments have been encouraging the formation of Yuvak Mandals or Youth Clubs to cover the countryside, such that the youth find an organizational support and frame of reference for undertaking development programmes. Both for self development and

rural development of country side. In this support TRYSEM aims at equipping the rural youth in the age group of 18-35 years and below the poverty line with necessary skills and technology to enable them to take to self employment according to their physical and mental dispositions.

MATERIALS AND METHODS

The aim of present paper is to know the causes for attending the TRYSEM programme by the youth. The specific objectives are as under :

- (i) To know the communication sources for the trainees of the TRYSEM programme
- (ii) To identify the motives of the trainees in participation of the TRYSEM programme

The present study was conducted in Udaipur, Rajsamand, Chittorgarh, Banswara

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and Dungarpur district of Udaipur division. 14 Panchayat Samities (9 tribal and 5 non-tribal) having maximum number of trainees and similarity in trades were selected. Three trades i.e. electric motor rewinding, wireman and carpentry (out of 19) which were common and comparable in the selected tribal and non-tribal panchayat samities of Udaipur division were included. A total of 420 youth were trained in carpentry, wireman and electric motor rewinding trades. Out of 420 trainees, 318 trainees (194 tribals and 124 non-tribals) were selected on random basis in 114 villages of selected panchayat samities. The data were collected by personal interview technique at their farm or home.

RESULTS AND DISCUSSION

Communication Sources for the TRYSEM Beneficiaries

TRYSEM beneficiaries were asked to name the sources from where and from whom they known about the programme. Sources as identified by participants of the selected trades are presented in table -1.

The table 1 indicates that sarpanch was the most popular source of information for tribal as well as non-tribal beneficiaries of TRYSEM programme as selection had almost been done by the sarpanch and the group secretary of village panchayat and from whom TRYSEM beneficiaries got first hand information. In case

TABLE 1

Sources of information to beneficiaries about TRYSEM Programme.

Communication Sources	Total tribals (194)	Total Non-tribals (124)	Tribal+ Non-tribals (318)	Rank
(A) Localite				
1. Sarpanch	178 (91.75)	97 (78.22)	275 (86.47)	1
2. Individual craftman	39 (20.10)	10 (8.06)	49 (15.40)	2
3. Ex-trainees	18 (9.27)	2 (1.61)	20 (6.28)	3
4. Neighbour	3 (1.54)	13 (10.48)	16 (5.03)	4
5. Friends	7 (3.60)	3 (2.41)	10 (3.14)	5
6. Relatives	2 (1.03)	4 (3.22)	6 (1.88)	6
(B) Cosmopolite				
1. V.L.W.	17 (8.76)	45 (36.29)	62 (19.50)	1
2. Non-Govt. Voluntary Organization	9 (4.63)	—	9 (2.83)	2
(C) Mass Media				
	—	—	—	—

Figures in parentheses showing percentage.

of tribals, individual craftsman got second rank whereas, by non-tribals it was ranked third. These findings are in close with Verma and Kothari (1986). Verma was in view that majority of respondents got information about IRDP from village leaders, VLW relatives and friends and the officials of the centre located in the area. Kothari reported that master craftsman/master trainer was the most important source of communication and helpful for motivating the trainees for TRYSEM programme. She further reported that Mass Media such as newspapers, radio, handbills does not play any role for informing the people regarding the programme. The findings are also supported by Dubey (1961) and Bose (1965).

Regarding cosmopolite sources of information, village level worker (V.L.W.) was

considered as an important source both by tribal and non-tribal trainees. Further, by the tribal trainees, Narayan Seva Sansthan (A Non-Govt. Voluntary Organization) was ranked second as a source of information about TRYSEM Programme.

Relatives and friends played very little role, whereas, mass media did not play any role for making tribal and non-tribal beneficiaries aware regarding TRYSEM Programme.

Motives of the trainees in the participation of the TRYSEM Programme

Regarding motives of the trainees, responses of selected beneficiaries was recorded and presented in table 2.

TABLE 2

Rank order of motives as perceived by the beneficiaries of selected grades of TRYSEM programme.

Sr. No.	Total tribal trainees (N = 194) Mean Score	Total Non-tribal trainees (N = 124) Mean Score
1. Economic Security	2.62 (2)	2.73 (2)
2. Need of recognition	2.32 (3)	2.24 (4)
3. Self actualisation	2.73 (1)	2.86 (1)
4. Affiliative	1.88 (6)	2.47 (3)
5. Economic freedom	1.99 (4)	2.13 (5)
6. Innovative	1.14 (9)	1.08 (9)
7. Prestige	1.95 (5)	1.85 (7)
8. Patriotism	1.80 (7)	1.99 (6)
9. Family need	1.71 (8)	1.84 (8)
Rank correlation coefficient (r)	0.86	
Test of significance	6.31	

Figures in parentheses showing rank.

Tribal and non-tribal trainees of the selected trades (electric motor rewinding wireman, carpentry) were combined and it was observed that both the categories of trainees mainly join the programme for need of self actualisation, as it was ranked first with mean score 2.73. Thus, both the categories of trainees mainly got the training for utilisation of their extra time.

Kothari also concluded that tribal women joined the TRYSEM Programme to fulfill the future needs of the family, whereas, non-tribal women participated in the TRYSEM Programme in order to utilize their free time. She pointed out that economic security was the most important motive behind participation in TRYSEM Programme.

Further, second preference for both the categories of trainees was also same. In the opinion of TRYSEM participants, programme provides economic security to youth in their life. Trainees wanted to become self sufficient and have desired to earn money through wage or self-employment after training. However, there is variation in third choice. In the opinion of tribal trainees, need of recognition got third rank, whereas, non-tribal participants put the same need on six rank and third preference was assigned to need of affiliation. Moreover, the need of innovativeness was assigned least mean score by tribal and non-tribal trainees (i.e. 1.14 and 1.09 respectively). Conclusion may be drawn that none of the selected beneficiaries attend the programme for testing the fruitfulness of the government programme. The main aim of the rural youth is to utilize

their time by acquiring the skill in the trades for which they were selected and thereafter wanted job through trades as a profession.

Rank order correlation coefficient was also calculated and calculated value of 'r' was found to be greater than tabulated value at 0.05 per cent level of significance. It can be said that there was significant difference with respect to ranking of the statements by trainees of the identified trades.

Conclusion

The most utilized source of information for TRYSEM programme was found to be sarpanch, followed by Master Craftsmen. It is, therefore, suggested that these people be involved more and more for making the TRYSEM Programme and other youth programmes more popular among the rural masses. Further, sarpanch can also motivate the youth for their own development as well as family as a whole. Youth mainly got the training in TRYSEM trades for utilization of their time and acquiring the skills. After perfection in trades, some youth wanted to start their own independent business and others desires to get employment in wage form.

Implications of the study

The results of present study will provide a strong basis and will serve a guideline for organizations, institutions and policy makers in formulating effective, realistic and need based programme in order to provide economic opportunities to rural youth.

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Role of Rural Women in Agriculture

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ABSTRACT

The present study was carried out in Daskroi taluka of Ahmedabad district of Gujarat State in 1989, to explore the participation of rural women in household tasks, agricultural operations and animal husbandry activities. The results revealed that cooking had got highest mean score (2.83) among six household tasks, hand weeding had got highest mean score of 2.66 and obtained first rank among all the twelve agril. activities and milking had obtained highest mean score of 2.72 and secured first rank among all nine animal husbandry activities. The results also stated that there is significant relationship between personal and socio-economic characteristics (viz.) education, caste, type of family, size of family, number of other working family members, social participation, socio-economic status, annual family income, size of land holding and herd size and overall extent of contribution in agricultural operations of the rural women.

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INTRODUCTION

Farming is a family enterprise in India. Involvement of women in agricultural production throughout the year contribute substantially towards the labour force required on farm. Women are the pivot around whom the family, the society and the whole huminity move. The importance of rural women can be appreciated by the fact that 80 per cent of the rural female engaged in agriculture among female workers in rural India (Srivastava, 1982). The welfare of rural women in India is essentially, the welfare of the farm families, which are the economic units of the community. Agricultural labour and farm cultivation are the main areas of the economic activities for rural women. It is well

recognised fact that more than 60 per cent of agricultural operations have been traditionally handled by women (Mankekar, 1989).

Several studies have indicated that women's participation is more in the cultivation of rice, sorghum and berseem, while men take more active part in raising pegeonpea, chickpea, culsterbean and sugarcane. Women are more efficient than men by 16.00 per cent in transplanting rice and sowing wheat fields, by 24.00 per cent in harvesting pearlmillet and by 37.00 per cent in picking cotton. Their efficiency in harvesting and processing of tea, coffee and plantation of horticultural crops have never been in doubt (Grover and Kapoor, 1988).

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Being illiterate and ignorant, she is over-exploited. A victim of man made system, she is hardly considered equal to man in wage and social status. Her life is listless routine of labour. In hut drudgery of cooking meals on a smoky chullah and rearing children hygienically, carrying fuel, fodder and water over long distances, is her ageless responsibilities.

Considering the multidimensional role of rural women in agriculture, the present study was undertaken to explore the participation of rural women in household tasks, agricultural operations and animal husbandry activities.

Objectives

1. To study the personal and socio-economic characteristic of rural women.

2. To determine the extent of participation of rural women in household tasks, agricultural operations and animal husbandry activities.
3. To ascertain the relationship between certain personal socio-economic characteristics of rural women and their overall extent of contribution in agricultural operations.

MATERIALS AND METHODS

This study carried out in Daskroi taluka of Ahmedabad district of Gujarat State in 1989. Two stage random sampling design was used to select a sample for the study. Thus, 100 respondents were randomly selected from 10 randomly selected villages of the said taluka.

TABLE 1

Distribution of the rural women according to their personal and socio-economic characteristics.

(N=100)

Sr. No.	Characters	Group	Number of respondent	Per cent
1	2	3	4	5
A. Personal				
1. Age	Young age (upto 30 years)		29	29.00
	Middle age (31 to 50 years)		69	69.00
	Old age (above 50 years)		2	2.00
2. Education	Illiterate		59	59.00
	Can read only		6	6.00
	Can read and write		10	10.00
	Primary		19	19.00
	Secondary		5	5.00
	Higher secondary		1	1.00
3. Marital status	Married		85	85.00
	Unmarried		0	0.00
	Widow		14	14.00
	Divorced and separated		1	1.00

1.	2.	3.	4.	5.
B. Social				
1.	Caste	Lower (Harijan, Thakor etc.)	61	61.00
		Intermediate (Patel, Rajput)	37	37.00
		Higher (Brahmin, Baniya etc.)	2	2.00
2.	Family type	Nuclear	51	51.00
		Joint	49	49.00
3.	Family size	Upto 5 members	51	51.00
		More than 5 members	49	49.00
4.	Number of other working family members	No member	4	4.00
		One to two members	51	51.00
		Two to five members	25	25.00
		More than five members	22	20.00
5.	Social participation	No membership	92	92.00
		Member in one organisation	8	8.00
		Holding position	2	2.00
6.	Socio-economic status	Low (below 16.96 scores)	15	15.00
		Medium (below 16.96 to 37.24 scores)	74	74.00
		High (above 37.24 scores)	11	11.00
C. Economic				
1.	Annual family income	Low (upto Rs. 10,000/-)	41	41.00
		Medium (Rs. 10,000/- to Rs. 20,000/-)	27	27.00
		High (above Rs. 20,000/-)	32	32.00
2.	Occupation	Household affairs only	0	0.00
		Household and labour work in farming	0	0.00
		Household affairs and animal husbandry	1	1.00
		Household affairs, labour work in farming and animal husbandry	17	17.00
		Household affairs and farming	5	5.00
		Household affairs, farming & animal husbandry	77	77.00
3.	Land holding	Landless (0.00 ha.)	18	18.00
		Small size (upto 2.00 ha.)	49	49.00
		Medium size (2.10 to 5.00 ha)	24	24.00
		Large size (above 5.0 ha)	9	9.00
4.	Herd size	No animal	8	8.00
		One to two animals	68	68.00
		Three to five animals	16	16.00
		Above five animals	8	8.00

Frequency of participation in various activities by the rural women measured with the help of 3 points rating scale 'Most frequently' 'Frequently' and 'Least frequently' with the score value of 3, 2 and 1 respectively. To lay down the most frequent participation, the mean score for each item was calculated on the basis of which ranks were assigned to them.

RESULTS AND DISCUSSION

Personal and socio-economic characteristics of the rural women

Generally it is believed that the personal and socio economic characteristics play an important role in participation of rural women in different activities viz., household, agricultural and animal husbandry. Data presented in Table 1 show that majority (69.00 per cent) of the rural women belonged to middle age group followed by the young age group (29.00 per cent). Majority (59.00 per cent) of the rural women were illiterate followed by primary education (19.00 per cent). Majority (85.00 per

cent) of the rural women were married followed by widow (14.00 per cent). Slightly more than half of (51.00 per cent) the rural women belonged to nuclear type and small size of family with one to two number of other working family members. Majority of the rural women belonged to medium socio-economic status group (74.00 per cent) having no membership in the formal organisation (92.00 per cent). Slightly more than one third (41.00 per cent) of the rural women had low annual family income i.e. upto Rs. 10,000/- followed by (32.00 per cent) high annual family income i.e. above Rs. 20,000/-. Majority (77.00 per cent) of the rural women consulted with household, followed by household affairs, labour work in farming and animal husbandry (17.00 per cent). Nearly half of the rural women (49.00 per cent) possessed small size of land holding, followed by 24.00 per cent of the rural women with medium size of land holding. Majority of the rural women (68.00 per cent) had one to two milch animals, followed by 16.00 per cent of the rural women who had three to five milch animals.

Participation of rural women in household activities

TABLE 2

Distribution of the rural women according to their frequency of participation in different household activities. (N = 100)

Sr. No.	Activity	Frequency of participation			Mean score	Rank
		Most frequently	Frequently	Least frequently		
1.	Cooking	88	9	1	2.83	I
2.	Fetching water	1	14	75	1.06	V
3.	Fetching firewood	1	9	38	0.59	VI
4.	Washing clothes	76	14	3	2.59	II
5.	Children's care	21	42	35	1.82	III
6.	Food grain preservation	2	24	68	1.22	IV



It can be seen from the Table 2 that among six household activities, cooking had got highest mean score (2.83) and secured first rank followed by washing clothes (2.59), children's care (1.82), food grain preservation (1.22), fetching water (1.06) and fetching firewood (0.59) which had obtained second, third, fourth, fifth and sixth rank respectively.

Participation of rural women in agricultural activities

TABLE 3

Distribution of the rural women according to their frequency of participation in different agricultural activities.

Sr. No.	Activity	Frequency of participation			Mean score	Rank
		Most frequently	Frequently	Least frequently		
1.	Ploughing	0	0	0	0.00	XII
2.	Manuring (organic)	25	5	22	1.07	VIII
3.	Nursery raising/ uprooting of seedlings	48	14	19	1.91	VI
4.	Sowing/planting	48	20	19	2.03	IV
5.	Transplanting	54	18	19	2.17	II
6.	Hand weeding	84	3	8	2.66	I
7.	Fertilizer appli.	1	2	4	0.12	X
8.	Irrigation	0	0	5	0.05	XI
9.	Harvesting/winnowing threshing	49	22	18	2.11	III
10.	Supervision of fields	57	11	8	2.01	V
11.	Storage of grains	22	35	19	1.55	VII
12.	Marketing of farm produces	7	20	18	0.79	IX

Data presented in table 3 reveal that among all the twelve agricultural activities, hand weeding got highest mean score of 2.66 and obtained first rank followed by transplanting (2.17), harvesting/winnowing/threshing (2.11), sowing/planting (2.03), supervision of fields (2.01) and nursery raising/uprooting of seedlings (1.91) secured

second, third fourth and fifth and sixth ranks respectively. Other six activities in order of priority viz., storage of grains (1.55), manuring (organic) (1.07), marketing of farm produces (0.79), fertilizer application (0.11), irrigation (0.05) and ploughing (0.0) were ranked seventh eighth, ninth, tenth, eleventh and twelfth respectively.

Participation of rural women in animal husbandry activities

TABLE 4

Distribution of the rural women according to their frequency of participation in different animal husbandry activities.

Sr. No.	Activity	Frequency of participation			Mean score	Rank
		Most frequently	Frequently	Least frequently		
1.	Collection and cutting of fodder	6	47	20	1.32	IV
2.	Feeding the animals	3	53	37	1.52	III
3.	Grazing the animals	1	0	35	0.38	VIII
4.	Providing the water to animals/ bringing the animals to water source	1	24	66	1.17	V
5.	Cleaning the cattleshed and animals	10	77	3	1.87	II
6.	To take care of animals	1	9	81	1.02	VI
7.	Milking	82	13	0	2.72	I
8.	Marketing of milk and milk products	1	7	25	0.42	VII
9.	Making curd, whey, ghee, cheese etc.	2	11	3	0.29	IX

It can be seen from Table 4 that among all the nine animal husbandry activities, milking had obtained highest mean score of 2.72 and secured first rank followed by cleaning the cattle shed and animals (1.87), feeding the animals (1.52), and collection and cutting of fodder (1.32) were ranked second, third and fourth respectively. Rest five activities in order of priority were providing water to animals/bringing the animals to water source (1.17), care of

animals (1.02), marketing of milk produces (0.42), grazing the animals (0.38) and making curd, whey, ghee and cheese etc. (0.29) were ranked fifth, sixth, seventh, eighth and ninth respectively.

Overall extent of contribution in agricultural operations

To know the overall extent of contribution of the rural women in agricultural operations, contribution of each rural women was recorded

in hours spend daily, weekly or seasonally. The weekly and seasonally hours of contribution were converted in the daily hours contribution. Finally the total hours per day spent on the basis of daily, weekly and seasonally hours were summed up to calculate the mean hours ($\bar{X}$). With a view to categorise the overall extent of contribution of the rural women in to low, medium and high extent of contribution, mean and standard deviation were calculated. To form the extent of contribution group, the maximum and minimum hours limits were formulated with help of following formula :

$$Xi = \text{Mean} \pm \text{Standard deviation.}$$

As per the calculation majority of the rural women (67.00 per cent) were in medium

contributing (3.38 to 7.36 hours) group followed by 17.00 per cent and 16.00 per cent in high (> 7.36 hrs.) and low contribution group (< 3.38 hrs.) respectively.

Relationship between certain personal socio-economic characteristics of the rural women and their overall extent of contribution in agricultural operations

To study the relationship between personal and socio-economic characteristic and the overall extent of contribution in agricultural operations are of great importance. The different personal and socio-economic characteristics studied were age, education, marital status, family type and size, caste, number of other working family members,

TABLE 5

Zero order correlation coefficient between the extent of overall contribution in agricultural operations and some of the personal and socio-economic characteristics of the rural women.

(N = 100)

Sr. No.	Independent variables	r' value with overall extent of contribution in agril. operations
A. Personal characteristic		
1.	Age	— 0.13 NS
B. Social Characteristics		
1.	Number of other working family members	— 0.54**
2.	Socio-economic status	— 0.97**
C. Economic characteristics		
1.	Annual family income	— 0.61**
2.	Size of land holding	— 0.76**
3.	Herd size	— 0.46**

**Highly significant at 0.01 level of significance and 98 d.f.

N.S.= Non significant.

social participation, socio-economic status, annual family income, occupation, land holding and herd size etc. These different factors influence the behaviour pattern of rural women, the data were analysed by two tests viz., correlation co-efficient test for quantitative characters and chi-square (X^2) test for

qualitative characters in order to ascertain the existence or non-existence of relationship between some of the personal and socio-economic characteristics and overall extent of contribution of rural women in agricultural operations (Table 5 & 6).

TABLE 6

Association between the extent of overall contribution in agricultural operations and some other personal and socio-economic characteristics of the rural women.

(N = 100)

Sr. No.	Characteristics	x^2 value with overall extent of contribution in agricultural operations
A. Personal		
1.	Education	30.22**
B. Social		
1.	Caste	14.19**
2.	Family type	12.56**
3.	Family size	14.09**
4.	Social participation	8.87*
** Highly significant at 0.01 level		
*Significant at 0.05 level.		

It is evident from data presented in table 5 & 6 that among different personal and socio-economic characteristics of the rural women, age was found nonsignificant at 0.05 level of significance indicating that there was no relationship of age with overall extent of contribution in agricultural operations. But education, caste, type of family, size of family, number of other working family members, social participation, socio-economic status,

annual family income, size of land holding and herd size were found significant at 0.01 level of significance indicating highly significant relationship of said variables with overall extent of contribution in agricultural operations.

Implications

Clear-cut fact can be seen from the present study that rural women play an

important role in agricultural development. The planner and the extension worker should have to take in account the back born role of rural women and accordingly they should design various schemes in the village to enable rural

women to derive benefit from them. They should also concentrate their efforts on rural women and make them aware of the latest recommended technologies.

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Statistical Estimation of Crop Loss Due to Leaf Curl Disease in Bidi Tobacco

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ABSTRACT

A field survey was carried out during the crop season of 1988-89 for assessing crop loss due to leaf curl disease in bidi tobacco (*Nicotiana tabacum*, L.) at two locations (Anand and Sarsa) in Kheda district of Gujarat State. Maximum crop loss of 41.3% and 26.9% was observed in the varieties GT-5 and A-119 at Anand while at Sarsa (Ta. Anand), the over all crop loss was 9.1 and 4.7 per cent in early and late planted variety A-119 respectively. The results thus revealed that the variation in crop loss estimation due to leaf curl disease in the bidi tobacco crop depends on location, variety and time of planting. The comparison of different sampling methods for estimation of crop loss indicated that the stratified random sampling with 10 per cent sample size was the most appropriate sampling plan.

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INTRODUCTION

Tobacco is an important cash crop of the country suffering from many devastating diseases, caused by virus, fungi, bacteria, nematodes, etc. Among viral diseases, leaf curl is the most destructive disease causing quantitative as well as qualitative losses. This disease is very serious in FCV and bidi tobacco. Very limited work has been reported on tobacco. The present study was conducted on bidi tobacco cultivated in Gujarat to estimate the losses caused by leaf curl disease during monsoon, 1988 at two locations viz. (1) Bidi Tobacco Research Station, Anand (Dist.

Kheda) and (ii) Patel Dairy Farm, Sarsa (Dist. Kheda), with a view to assess the crop losses due to leaf curl disease in bidi tobacco.

MATERIALS AND METHODS

The observations on the incidence of the leaf curl disease were recorded after 3 months of planting of crop. At Anand two fields one each of tobacco variety A-119 and GT-5 and at Sarsa two fields of tobacco variety A-119 were selected for the purpose. The intensity of disease was scored on the basis of outward symptoms of the plants. The scoring was as under :

Score	Plant description
0	Plant having not a single leaf affected by the disease.
1	Plant having upper one to two leaves affected due to disease.
2	Plant having upper three to four leaves affected due to disease.
3	Plant having severe attack of the disease

Percentage loss in yield due to intensity of disease was worked out as under :

$$(PL) i = \frac{\bar{Y}_0 - \bar{Y}_i}{\bar{Y}_0} \times 100$$

Where :

(PL) i = Percentage loss due to i th score :
i = 1, 2, 3

$\bar{Y}_0$ = Average yield per disease free plant

$\bar{Y}_i$ = Average yield per plant having i th score of incidence

Overall percentage loss (L) was estimated by using following relation :

$$L = \sum_{i=1}^3 [(PL) i \times N_i/N]$$

Where,

N_i = No. of plants possessing i th score of incidence

N = Total number of plants in the population

With a view to find out appropriate sampling plan for estimating percentage loss due to

leaf curl disease, three sampling methods viz., (i) simple random sampling, (ii) stratified random sampling and (iii) cluster sampling were also compared using different sample sizes (Singh *et al.* 1977).

RESULTS AND DISCUSSION

The results presented in Table 1 indicated that at Anand, bidi tobacco variety GT-5 had maximum overall loss of 41.3 per cent in crop yield, while variety A-119 had overall loss of 26.9 per cent. Both these varieties were transplanted late in first week of October hence suffered more. At Sarsa, variety A-119 transplanted during third week of August had overall loss of 9.1 per cent, while same variety transplanted little late during third week of September yielded overall loss of 4.7 per cent.

The results thus revealed that the crop loss due to leaf curl disease in bidi tobacco depended on locations, varieties and planting period.

The results presented in Table 2 indicated that overall loss as estimated by simple random sampling for both the varieties at Anand with 10 per cent sample size had the estimates deviating less from their population value (26.9%), when incidence was more severe. While at Sarsa, 20 per cent sample size for early planted crop had the estimate deviating less from their population value, while for the late planted crop simple random sampling (SRS) could not give satisfactory estimate with any of the sample size studied.

Crop loss estimated by stratified random sampling, it was observed that with 10 per cent sample size had the estimates less deviating from their population value of over all loss in all the fields under study.

TABLE 1

Per cent loss in tobacco green leaf yield due to leaf curl disease and their plant density coefficient at Anand and Sarsa.

Location Anand									
Variety A 119					Variety GT 5				
Disease intensity score	Average yield, kg/plant	Plant density coefficient	Per cent loss	Overall per cent loss	Disease intensity score	Average yield, kg/plant	Plant density coefficient	Per cent loss	Overall per cent loss
0	0.73	0.35	—	26.9	0	0.92	0.23	—	41.3
1	0.64	0.09	12		1	0.65	0.10	29	
2	0.50	0.18	32		2	0.56	0.20	39	
3	0.34	0.38	53		3	0.32	0.47	65	
S. Em.	0.03					0.03			
CD at 0.05 %	0.08					0.09			
CV %	41.65					45.56			

Location Sarsa									
Early planted A 119 variety					Late planted A 119 variety				
Disease intensity score	Average yield, kg/plant	Plant density coefficient	Per cent loss	Overall per cent loss	Disease intensity score	Average yield, kg/plant	Plant density coefficient	Per cent loss	Overall per cent loss
0	0.85	0.73	—	9.1	0	0.67	0.85	—	4.7
1	0.66	0.13	22		1	0.56	0.07	16	
2	0.58	0.09	32		2	0.37	0.06	45	
3	0.27	0.05	68		3	0.36	0.01	46	
S. Em.	0.05					0.06			
CD at 0.05 %	0.13					0.18			
CV %	42.17					41.75			

TABLE 1
Estimation of overall crop loss by various sampling designs in bidi tobacco.

Location		Anand				Sarsa				Anand				Sarsa			
Samples	Samples	Simple Random Sampling				Stratified Random Sampling				Cluster		Sampling					
size		A 119	GT 5	A 119*	A 119@	A 119	GT 5	A 119*	A 119@	A 119	GT 5	A 119*	A 119@				
5	1	8.1	38.0	8.3	1.2	21.9	40.0	13.4	3.9	27.0	36.7	7.3	4.1				
	2	24.2	27.7	9.7	0.0	23.7	40.3	5.7	5.2	21.8	27.6	6.5	5.9				
	3	16.3	34.0	15.8	0.0	37.7	46.1	6.4	0.2	25.8	30.6	8.3	3.1				
	4	26.0	44.5	13.4	2.9	29.0	8.9	11.3	3.0	9.3	30.7	12.2	14.1				
	5	27.4	41.1	11.6	4.9	28.8	30.9	11.0	1.1	18.9	45.3	12.1	4.0				
10	1	15.8	49.9	12.6	4.2	24.1	47.8	5.8	3.0	24.2	45.5	7.6	9.9				
	2	27.3	34.6	4.6	0.0	30.1	38.4	4.5	10.3	22.4	40.3	10.5	3.4				
	3	28.1	37.1	12.6	1.4	25.3	33.6	5.1	5.1	20.4	42.1	5.1	5.8				
	4	19.1	39.4	4.5	5.1	29.3	40.8	8.9	2.6	24.2	37.8	3.5	2.6				
	5	19.0	41.5	14.7	3.6	32.8	49.3	8.1	4.5	31.3	18.5	9.4	4.9				
15	1	27.2	43.5	13.6	0.0	31.9	29.1	10.0	7.9	5.6	37.7	4.8	2.8				
	2	22.8	40.7	14.0	3.9	25.9	38.1	4.3	4.3	25.7	37.2	6.7	1.8				
	3	22.4	42.1	7.6	0.0	27.4	32.2	6.4	2.4	37.2	37.7	10.9	6.0				
	4	10.4	32.6	13.1	0.2	25.9	35.8	9.9	6.8	25.2	34.2	5.2	3.6				
	5	28.1	35.6	11.5	4.2	28.8	38.2	6.5	3.3	18.4	22.6	9.3	1.9				
20	1	24.9	33.6	7.9	4.2	19.0	40.2	6.6	2.3	25.5	36.3	5.1	0.7				
	2	22.1	42.0	12.2	1.3	20.1	47.2	10.0	6.0	23.4	42.8	12.2	3.3				
	3	21.4	38.1	9.9	4.3	30.5	49.7	8.3	3.9	33.4	39.6	10.5	2.1				
	4	22.4	45.0	12.7	1.7	32.9	40.9	10.2	4.7	23.9	38.8	7.8	3.9				
	5	24.7	38.6	8.1	3.4	29.0	50.3	14.7	3.0	20.2	41.2	6.0	4.9				
Over all loss %	—	26.9	41.3	9.1	4.7	26.9	41.3	9.1	4.7	26.9	41.3	9.1	4.7				

* Indicates early planted variety;

@ Indicates late planted variety.

The over all loss as estimated by cluster sampling with 5, 10, 15 and 20 per cent sample sizes ranged from 3.1 to 14.1 per cent, 2.6 to 9.9 per cent, 1.8 to 6.0 per cent and 0.7 to 4.9 per cent respectively for a population value of 4.7 per cent. Thus, for such low incidence of disease, cluster sampling does

not seem to give very satisfactory estimates of crop loss.

The results thus revealed that, for estimation of crop loss, the stratified random sampling with 10 per cent sample size was the most appropriate sampling plan as compared to simple random sampling and cluster sampling.

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Statistical Estimation of Relative Changes in P Content with Different Levels of Applied Phosphorus in Groundnut

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ABSTRACT

An experiment with five levels of phosphorus (0, 25, 50, 75 and 100 kg/ha) on summer groundnut crop in latin square design was conducted during 1987 at GAU, Anand with a view to study the effect of various phosphorus levels on the dry matter production at different growth stages and pod yield. The study revealed that summer groundnut crop did not respond to phosphorus for pod yield but responded to cumulative as well as periodic dry matter production.

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INTRODUCTION

Groundnut is a leading oilseed crop in India and has a major role to play in agricultural economics of our country. Although India is a largest groundnut growing country, its yield per hectare is one of the lowest (Kanwar *et al.*, 1983). The need is therefore to boost up the productivity which in turn would result in higher production. One of the ways for improving the productivity of any crop is efficient utilization and application of manures and fertilizers. Generally inconsistent response of nitrogen and phosphorus to the yield of groundnut is observed. The non response of phosphorus is of serious concern, because it has an important role to play in N utilization which ultimately result in higher production. It is, therefore, necessary that quantum of available phosphorus, the concentration and uptake of it at different stages of crop growth alongwith their

relationship with dry matter production and pod yield for different doses for applied phosphorus be looked into. This may provide an indication of the availability of applied phosphorus and its utilization pattern.

MATERIALS AND METHODS

With a view to study the effect of various phosphorus levels on the dry matter production of different growth stages of summer groundnut and its pod yield, an experiment was planned during summer 1987 at B.A. College of Agriculture, Anand. Groundnut bunch variety GG-2 was selected for the study. Five levels of phosphorus viz., 0, 25, 50, 75 and 100 kg/ha were included in the experiment. At different growth stages, plant and soil samples were collected from each experimental unit. From the periodic plant samples, dry matter yield, phosphorus content and subsequently phosphorus uptake were estimated.

RESULTS AND DISCUSSION

The data on average dry matter production of summer groundnut at different growth stages are presented in Table 1.

The results presented in the table revealed that the dry matter production at the first stage was not significantly influenced due to different levels of phosphorus application in the soil. The average dry matter production at

the end of the first stage was 314 kg/ha. Similar results were made at the end of second stage of the crop growth, wherein different levels of phosphorus applied in the soil did not affect the growth of plants significantly. However, it was observed that differences between control i.e. no application of phosphorus and rest i.e. application of phosphorus was significant. The average dry matter production at the end of second stage was 1134 kg/ha.

TABLE 1

Effect of various levels of phosphorus on dry matter production at different growth stages and pod yield of groundnut.

Phosphorus (kg/ha)	Dry matter production and pod yield (kg/ha)					Total
	Growth Stages*				Pod yield	
	First Dry matter production	Second Dry matter production	Third Dry matter production	Fourth Dry matter production		
0	275	1029	1856	4293	725	5018
25	300	1121	2021	4618	764	5382
50	323	1161	2109	4884	847	5731
75	338	1175	2133	5054	904	5958
100	334	1184	2135	5112	899	6011
Average	314	1134	2051	4792	828	5620
S. Em.	19.6	44.7	48.3	69.0	55.2	
CD at 5 %	NS	NS	149	213	NS	
C.V. %	13.93	8.82	5.26	3.22	14.93	
Control V/s Rest						
Control	275	1029	1856	4293	725	
Rest	324	1160	2100	4917	854	
CD at 5 %	48	108	118	168	NS	

*First stage = at the end first month;

Second stage = at the end of second month;

Third stage = at the end of third month;

Fourth stage = at harvest.

At the end of the third stage, however, it was observed that the differences in dry matter production were significant. The dry matter production increased with increase in every level of phosphorus application. However, appreciable increase was observed only upto 50 kg/ha. This was clear from the fact that 50, 75 and 100 kg/ha did not differ significantly.

At the time of harvest, it was observed that different levels of phosphorus application in the soil significantly influenced the dry matter production of the crop. The response trend of phosphorus application was similar

to that observed during the first stage, the quantum of response was however comparatively higher. So far as pod yield was concerned, it was observed that the differences were not significant. Thus it could be inferred that summer groundnut crop responds to phosphorus application for dry matter production only and not for pod yield. However, at all the stages, there was increasing trend in dry matter production and pod yield with increase in phosphorus level. In view of this, second order orthogonal polynomials were fitted for dry matter production at different growth stages. The results are presented in Table 2.

TABLE 2

Growth curves of dry matter production at different growth stages and pod yield in relation to various levels of phosphorus application.

Growth Stage	Character	Constant <i>a</i>	Partial regression		<i>R square</i>		Remarks
			<i>b1</i>	<i>b2</i>	Linear	Quad.	
First	Dry matter	234.2	43.9	- 4.7	87.7	98.9	Quad.
Second	Dry matter	928.9	118.6	-13.7	82.3	98.6	Quad.
Third	Dry matter	1655.0	234.2	-27.9	80.1	99.4	Quad.
Fourth	Dry matter	3854.8	477.4	-45.0	93.8	99.9	Quad.
	pod yield	624.4	97.6	- 8.1	92.0	95.6	Linear

The results presented in Table 2 revealed that for all the growth stages, the quadratic form of curve fitted well. The only exception was that for pod yield, where the quadratic term did not account for significant contribution of variability in pod yield. Which for dry matter, quadratic form for all the stages, gave high degree of fit (*R square* $\approx$ 99 per cent). This clearly indicated that the relationship between the phosphorus application and dry matter production was quadratic in nature and the dry matter increased at decreasing rate with increase in levels of phosphorus.

With a view to get estimates of dry matter production during particular period, the differences between two consecutive growth stages were calculated and analysed. The results of such differences are presented in Table 3.

The results presented in the Table 3 indicated similar trend of phosphorus response as observed in the cumulative growth study. However, it was very clear from an average increase in the growth during different periods that in the fourth period, the dry matter

production increased about three times as compared to the increase in the third period.

No response of phosphorus application for pod and fodder yield was observed by Parmar and Buhecha (1980) in medium black

soil of Targhadia in Gujarat. Similar observation for pod yield in groundnut were made by Agrawal (1968), Cheema *et al.* (1977), Kolar *et al.* (1976), Patel and Sutaria (1972), Dhingra *et al.* (1984) and Anonymous (1986).

TABLE 3

Effect of various levels of phosphorus on dry matter production during different periods and pod yield of groundnut.

Phosphorus (kg/ha)	Dry matter production and pod yield(kg/ha)					Total
	Period				Pod yield	
	First*	Second*	Third*	Fourth*		
	Dry matter production	Dry matter production	Dry matter production	Dry matter production		
0	275	754	827	2437	725	3162
25	300	821	900	2597	764	3361
50	323	838	948	2775	847	3622
75	338	837	958	2921	904	3825
100	334	850	951	2977	899	3876
Average	314	820	917	2741	828	3569
S. Em.	19.6	36.8	43.6	72.9	55.2	
CD at 5 %	NS	NS	NS	225	NS	
C.V. %	13.9	10.00	10.60	6.0	14.9	

* First stage = at the end of first month

Second stage = at the end of second month.

Third stage = at the end of third month and

Fourth stage = at harvest.

The inconsistency in the phosphorus response on pod yield as evident from the research reported could be attributed to the differences in soil fertility, past manuring history, availability of applied sand soil phosphorus (Varma and Bajpai, 1964).

From the results discussed above it can be concluded that (i) various levels of phosphorus influenced the cumulative dry matter production at 90 days crop and at harvest. The quantum of response was however higher at harvest. Periodic dry matter

production followed more or less similar trend as observed in cumulative growth of dry matter production. Non significant differences in pod yield were observed for various levels of phosphorus. This indicated that summer groundnut crop responded to phosphorus application for dry matter production and not to pod yield.

(ii) The quadratic response curves of dry matter production on phosphorus levels fitted well at all the stages but not for pod yield, the quadratic term did not contribute appreciably for improving the predictability. This indicated that dry matter production increased at decreasing rate with the increase in levels of phosphorus.

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Study on Food and Feeding Habit of Two Hermit Crabs Species at Veraval Coast

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ABSTRACT

The studies on food and feeding of hermit crabs at Veraval Coast was carried out to find out food selection by intertidal species. Since, food is one of the limiting factor for intertidal species. Simple numerical method for stomach content analysis was used and it was found that the species at Veraval coast are omnivorous with presence of detritus as well as plants and animal remains within stomach.

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INTRODUCTION

Hermit crabs are anomuran decapod crustaceans that have adapted to occupation of empty gastropod shells (Molluscan shells). The strong association of these two greatly influenced almost all aspects of their biology. The evolution of shell-carrying behaviour in hermit crabs has been accompanied by a number of morphological modifications of the basic decapod body plan. However, hermit crabs entrance into the shell is a complex series of movement of the abdomen and cephalothoracic appendages (Hazlett, 1981). Hermit crabs react to the chemical stimular of a food item before they react to any visual stimulus associated with the item (Hazlett, 1968). The studies on food and feeding behaviour of hermit crabs (Orton, 1927 : Root, 1967 and Reese, 1969) have suggested that they are amnivorous detritivers and they can be

assigned to the "benthic detritus-feeding guild". Observations of Robert (1968) and Caine (1975) illustrated that hermit crabs are highly dependent on benthic detritus as a food source. However, other hermit crabs are able to feed on suspended material without sacrificing their mobility (Bolt, 1961), (Scully, 1978) as well as they are able to remove *Artemia* naupli and unicellular algae from suspension (Gerlach *et al.*, 1976). However, individuals of many species of hermit crabs feed on macroscopic pieces of animals, both living worms (Mc Laughlin and Bailey, 1975) and dead detritus (Hazlett, 1979) seems to be rather primary source of nutrients.

Feeding behaviour of different species of hermit crabs ranges from extreme specialization, accompanied by major morphological modifications to highly opportunistic foraging behaviour that is well adapted to unpredictable environment (Scully, 1983).

MATERIALS AND METHODS

The food analysis of two hermit crab species was carried out by dissecting digestive tract and observing its content under the microscope. For this 10-15 animals of different size group were dissected and food contents were analysed. From this, selectivity of food by hermit crabs was determined.

RESULTS AND DISCUSSION

Studies on food and feeding behaviour of hermit crabs (Reese, 1969) have suggested that they are omnivorous detritus feeders. They are also able to feed on suspended material (Scully, 1978).

The observations made on food and feeding behaviour of the present two hermit crab species, *C. zebra* and *C. nathi* are represented in Table 1. The stomach content analysis indicated presence of various types of diatoms, forming the major part of the food of the hermit crabs (about 70.00 per cent). However, spores also noticed to a considerable amount (9 to 20 per cent) in the food. As found in the other crab species, sand particles were invariably recorded in the food because of its general habit of detritus feeding.

For hermit crabs food is also equally important resource required for the existence of hermit crabs, as well as it has been well recognised as one of the limiting factors for the distribution of intertidal organisms (Newell, 1976). Moreover, the acclaimed means of ecological segregation is that of food partitioning (Lack, 1971).

TABLE 1

Analysis of stomach contents.

Species	<i>C. zebra</i>	<i>C. nathi</i>
Algae		
Corolina	3.11%	4.01%
Spores	20.01%	9.20%
Diatoms		
Navicula	30.13%	31.10%
Fragilaria	00.18%	10.20%
Chaetoceros	45.08%	45.09%
Rhizosolenia	1.49%	00.00%
Sand particles	Rarely	00.40%
Nitzia	—	Rarely
Others	Numerous	Rarely

Studies on food analysis from the stomach contents of the present hermit crab species *C. zebra* and *C. nathi* showed that they are omnivorous detritus feeders, and food mostly consists of detritus, diatoms, algal filaments, crustaceans remaining and organic matter. Thus, the feeding habit of these two species is like that of other *Clibanarius* spp., *C. longitarsus* described by Ajmal Khan and Natrajan (1982). In the case of the present two species of hermit crab, food does not seemed to be a limiting factor for competition, as abundance of detritus and algae in the intertidal zone is considerably very high (Author's personal observation, Ramkrishna, 1982), at Veraval coast.

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Seasonal Incidence of Sucking Pest Complex of Cotton Under Rainfed Condition of South Gujarat

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ABSTRACT

Studies on seasonal incidence of sucking pests of Cotton (Digvijay) in rainfed condition were conducted at Regional Cotton Research Station, Guj. Agril. University, Bharuch during 1979-80 and 1981-82. Results revealed that aphids population was peak (43.05/plant) in the second fortnight of October. The population of jassids was ranged from 0.59 to 2.78 per plant while thrips were ranged from 0.61 to 4.64 per plant. In case of spider mite, maximum (17.51) population noted in the second fortnight of November.

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INTRODUCTION

The cotton plant in India is attacked by 130 species of insects and a few species of mites which cause an average loss of 25% in yield (Sohi, 1964). Cotton suffers a substantial loss due to ravages of sucking pest viz., *Aphis gossypii* G., *Amrasca bigutulla bigutulla* I., *Scirtothrips dorsalis* R., and *Tetranychus telarius* L. The seasonal incidence of these pests were studied by different workers in India (Lad, 1974; Sidhu and Dhawan, 1980; Thangvelu 1983; Jose and Shah 1984; Intodia and Sharma 1977 and Mathur and Sharma; 1977). In view of the importance as a serious pests of this crop, it was properly planned to study its seasonal incidence under rainfed condition of South Gujarat.

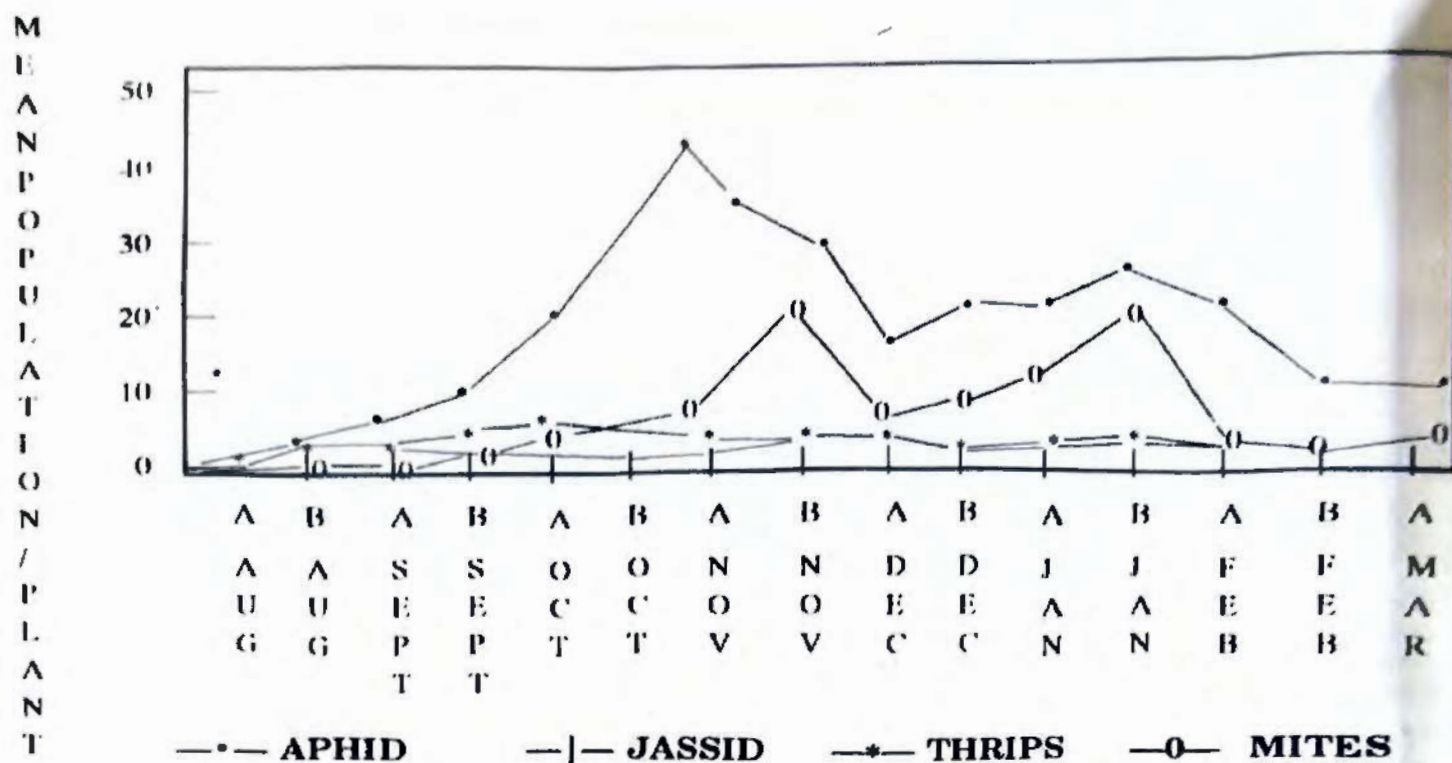
MATERIALS AND METHODS

An investigation was carried out at the Research farm of Regional Cotton Research

Station, Gujarat Agril. University, Bharuch during the three consecutive season of 1979, 1980 and 1981. For the study, 0.5 ha area of cotton (var. Digvijay) was kept under isolated natural condition. To assess the population of sucking pests, 50 plants were selected at random and tagged. The number of aphids, jassids, thrips and mites were recorded by selecting three random leaves, one each from upper, middle and lower portion of the each tagged plant. In case of aphids, thrips and mites both nymphs and adults were counted, whereas in case of jassids only nymphs were counted. Observations were recorded at an interval of 15 days and graphically represented in Figure 1.

RESULTS AND DISCUSSION

The data presented in Table 1 indicates that the aphids population was at peak in the



A = 1st Fortnight B = 2nd Fortnight
Average mean of three years

Figure - 1 : Seasonal incidence of sucking pests in cotton at Bharuch.

second fortnight of October followed by first and second fortnight of November. It was again decreased in the month of December slightly increasing in January. Similar results were also obtained by Mathur and Sharma (1977) who reported that the incidence of *Aphis gossypii* was occurred from 11nd week of August to 1st week of February. On the other hand, the population of jassids and thrips were very low during the investigation. Jassid population was ranged between 0.59 in August and 2.78 in the first fortnight of October, then after it remained more or less during the season. Sidhu and Dhawan (1980) also reported that jassid population was higher in July-August. The population of thrips varied from

0.61 (1st fortnight of August) to 4.64 (first fortnight of October). Then it fluctuated between 1.10 in second fortnight of December to 2.73 in first fortnight of October. A similar trend was also earlier reported by Thangvelu (1983). The incidence of spider mite was observed from the first fortnight of October. It gradually increased and reached its peak (17.51) in the second fortnight of November. Then its population suddenly dropped to 4.07 in the first fortnight of December. It again gradually increased and occurred its second peak (15.95) in the second fortnight of January. According to Jose and Shah (1984), incidence of spider mite was occurred from October (3.5) to February (26.00).

TABEL 1

Seasonal incidence of different sucking pest complex attacking cotton crop at Regional Cotton Research Station, Bharuch during 1979-80 to 1981-82.

Period of observation	Mean population/plant			
	Aphids	Jassids	Thrips	Mites
Ist fortnight of August	0.80*	0.59*	9.61*	0.00*
IIInd fortnight of August	1.53	0.69	1.17	0.02
Ist fortnight of September	3.00	1.13	1.27	0.00
IIInd fortnight of September	8.14	2.73	2.18	0.32
Ist fortnight of October	19.73	2.78	4.64	2.95
IIInd fortnight of October	43.05	1.57	2.73	2.56
Ist fortnight of November	36.81	1.01	2.64	5.80
IIInd fortnight of November	30.35	1.49	1.40	17.51
Ist fortnight of December	11.71	0.90	0.79	4.07
IIInd fortnight of December	18.87	1.36	1.10	4.91
Ist fortnight of January	18.81	0.89	1.35	10.71
IIInd fortnight of January	25.73	1.41	1.91	15.95
Ist fortnight of February	18.57	0.52	0.34	1.49
IIInd fortnight of February	6.35	0.47	0.25	0.79
Ist fortnight of March	5.71	0.54	0.42	1.97

* Mean of 3 Years

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The Rate of Natural Increase of Red Spider Mite When Reared on Okra

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ABSTRACT

The red spider mite, *Tetranychus macfarlanei* Baker and Pritchard hitherto recorded as a minor pest, is now on the verge of acquiring a pest status inflicting appreciable damage to vegetable and fiber crops in South and Central Gujarat. The rate of multiplication of *T. macfarlanei* was studied when reared on okra leaves under laboratory conditions at 29.67°C average temperature and 87.30 % average relative humidity. The maximum female birth ($mx = 6.18$) was on 11th day of pivotal age. Under a given set of conditions and food supply, its population was able to multiply on leaves. A Ro-net reproductive rate of 30.74 female/female/generation in a generation time of 14.02 days was observed. The intrinsic rate of natural increase (rm) was 0.2443 female/female/day. In the stable age-distribution, 93 % contribution was made by immature stages including egg, larva, protonymph and deutonymph.

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INTRODUCTION

The red spider mite, *Tetranychus macfarlanei* Baker and Pritchard, a little known species has now assumed a greater importance, causing appreciable damage to okra, brinjal and cotton in South and Central Gujarat (Jose and Shah, 1989; Rai *et al*, 1991). There are a few reports on host range of this mite in India and abroad (Gupta, 1985). It was observed abundant on okra during summer, 1989. It generally prefers the lower side of the leaf. Feeding by this mite results in the appearance of chlorotic spots which merge to form bigger patches. Studies on its biology and development have been reported (Jose and Shah, 1989b), but, no information is available on the aspects of the

reproductive potential of this mite pest. The construction of life table is vital to the description and understanding of the population dynamics of species. This studies also determine the contribution of various stages of the pest in population growth/trend.

The present contribution deals with the rate of multiplication in the population of *T. macfarlanei* when reared on okra host.

MATERIALS AND METHODS

The initial culture of *T. Macfarlanei* was started by collecting a large number of mites in April, 1989, from okra fields around the Agriculture Research Farm of Gujarat Agricultural University, Navsari and reared

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continuously in laboratory to obtain pure mass culture and constant supply of materials for different studies. To construct life fecundity tables, ten colonies each of six newly moulted females and three new males obtained from stock culture were released on okra leaves. Next morning, the number of eggs laid were counted and marked for subsequent development and these adults were removed from the leaf. After hatching, all the larvae were reared individually on okra leaf bit (2 x 2 cm). Each leaf bit was placed on an absorbent 7 x 5 cm filter paper cushioned with a 8 x 6 x 0.4 cm pad of cotton in petri-dish (15 cm diameter and 1 cm height). A thin layer of lincline was applied peripherally to confine the mite to the leaf bits. The cotton and absorbent were wet daily with water to maintain the leaf bits in turgid condition. The leaf bits were replaced every alternate day to avoid leaf deterioration and

consequent poor nutrition. Observations on hatching, larval, nymphal and adult development and age-specific mortality in larvae, protonymphs, deutonymphs and adults were made twice daily. For determining age-specific fecundity (m_x), all the adults (female) emerging on a particular day were transferred to fresh okra leaf bit and reared individually for egg laying to determine the age-specific fecundity. Each female was provided with a male for mating. The average fecundity on subsequent days was noted every day until all the females died. As the sex ratio (male : female) was 1 : 6.5 (based on 150 adults), the number of female births (m_x) at each age interval was worked out keeping in view this ratio. Parthenogenetically, all females invariably gave rise to male progeny.

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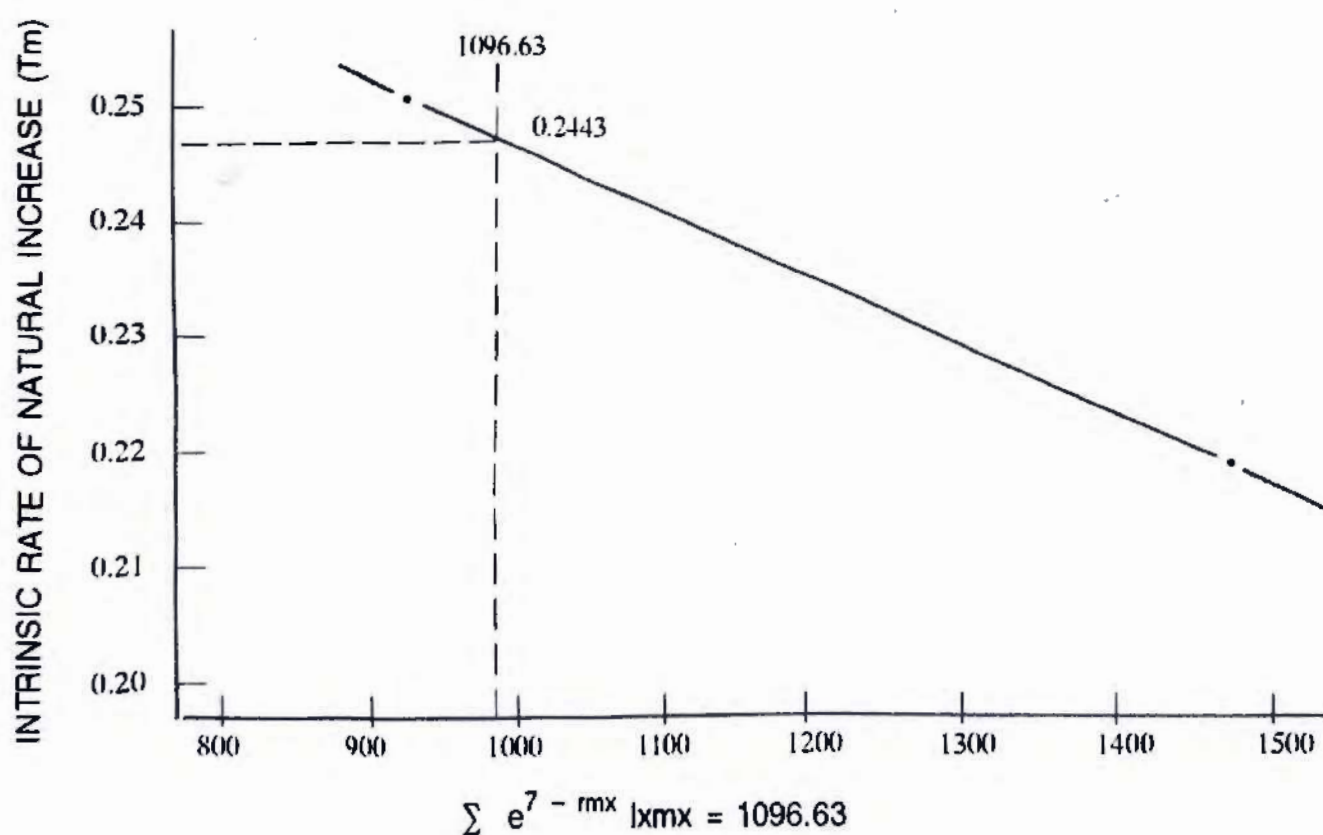


Fig. 1. : Determination of the intrinsic rate of increase of *Tetranychus macfarlanei* on okra.

Birch(1948), elaborated by Howe (1953) and Atwal and Bains (1974) were used for construction of life table. The values of X (pivotal age in days), $1x$ (survival of females at different age intervals) and m_x (number of female progeny per female) were calculated from the data in life-table. The number of individuals surviving at each age-interval was recorded and also the mean number of female offspring produced at each age interval was calculated. The intrinsic rate of increase (r_m), net reproductive rate (R_0) and mean generation time (T) were the basic population parameters used to assess the population growth in the laboratory. The true value of r_m was calculated by taking two trial values arbitrarily selected on either side of it, differing in second decimal place, by interpolation method (Birch, 1948; Watson, 1964). Tables were then constructed

with the column x and $1 \times m \times$ for each trial r_m . The two trial values of $\sum e^{7-rmx} \cdot 1 \times m \times$ were then plotted on the horizontal axis against their respective arbitrary r_m 's on the vertical axis with line drawn from the desired value of $\sum e^{7-rmx} \cdot 1 \times m \times = 1096.63$. The point of intersection gave the value of true r_m accurate to the four decimal places (Fig.1). The stable age-distribution (% distribution of various age groups) was worked out with the knowledge of r_m and the age-specific mortality of the immature as well as mature stages when grown in limited space. All the observations on growth parameters for construction of life-fecundity table were taken under laboratory condition at 29.67°C average temperature and 87.30 per cent average relative humidity during July-August.

TABLE 1

Life table and age-specific fecundity for *Tetranychus macfarlanei* on okra.

Pivotal age (days) (X)	Life table for female birth (lx)	Age schedule for female birth		
		m_x	lxm_x	Lxm_x
1.	2.	3.	4.	5.
0-9	0.6875	Immature stages		
10	0.6875	2.180	1.498	14.987
11	0.6875	6.180	4.248	46.736
12	0.6875	4.727	3.249	38.997
13	0.6875	4.818	3.312	43.060
14	0.6875	4.273	2.937	41.127
15	0.6875	3.364	2.312	34.691
16	0.6875	3.364	2.312	37.004
17	0.6875	1.818	1.249	21.247
18	0.6875	0.636	0.437	7.870
19	0.6875	0.273	0.187	3.566

1.	2.	3.	4.	5.
20	0.5625	3.111	1.749	34.998
21	0.5625	2.445	1.375	28.881
22	0.5625	4.222	2.374	52.247
23	0.4375	1.429	0.625	14.379
24	0.4375	0.429	0.187	4.504
25	0.3125	1.200	0.375	9.375
26	0.2500	4.250	1.062	27.625
27	0.1875	3.000	0.562	15.187
28	0.1875	2.000	0.375	10.500
29	0.1875	1.000	0.187	5.437
30	0.1875	0.667	0.125	3.751
31	0.1875	0.000	0.000	0.000
$R_0 = \sum x_m x$ $= 30.737$				$\sum x_m x \cdot x$ $= 496.169$

RESULTS AND DISCUSSION

Both sexes of *T. macfarlanei* consisted of egg, larva, protonymph, deutonymph and adult. At the end of larval and each nymphal instar, there was short quiescent phase in which mites anchored and moulted to the succeeding stage. Usually, this behaviour is normal and common to almost all tetranychids.

The maximum durations of egg, larva, protonymph and deutonymph were 4, 2, 2 and 1 days respectively. Observations on pre-oviposition, oviposition and fecundity were also recorded. Data on the survival of the female progeny at egg x are presented in table 1. The survival of the immature stages (lx) from egg to the adult stage on okra leaf was 68.75 per cent. The maximum contribution ($m_x = 6.18$ female-births) in the life cycle was made by female on 11th day of pivotal age i.e. on 2nd day of adult emergence. The survival of females declined

from 10th day after emergence as an adult i.e. on 19th day of the pivotal age ($l_x = 0.6250$). The net reproductive rate (R_0) representing the total female births were 30.737. Thus, the population of *T. macfarlanei* would be able to multiply 30.737 times per generation on okra leaves. The results obtained intrinsic rate of increase (r_m) and finite rate (λ) and mean generation time are presented in table 2 and Fig. 1. The value for intrinsic rate of natural increase was 0.2122 female/female/day. The corrected innate capacity for increase in numbers (r_m) was calculated by using the formula, $\sum e^{-7 \cdot r_m x} \cdot l_x m_x = 1096.63$. The two trial values of 1493.38 and 1019.24 were plotted on horizontal axis against their respective arbitrary r_m values 0.22 and 0.25 on vertical axis and the corrected r_m was calculated as 0.2443 female/female/day by interpolation method (Fig. 1.). It is evident that the corrected innate capacity for increase in numbers (r_m) was 0.2443 female per female per day and with

TABLE 2

Mean length of generation, Innate capacity for increase in number of *Tetranychus macfarlanei* on okra leaves.

Population growth statistics	
Mean length of generation	
$\frac{T_c = \sum l \times m \times X}{R_0}$	16.14 days
Innate capacity for increase in number	
$\frac{r_c = \log_e R_0}{T_c}$	0.2122 female/female/day
Arbitrary rm 0.22 and 0.25 corrected rm $\sum e^{7-rm} \cdot l \times m \times X = 1096.63$	0.2443 female/female/day
Corrected generation time	
$\frac{T = \log_e R_0}{rm}$	14.02 days
Finite rate of increase in number $\lambda = \text{antilog}_e rm$	1.2767 female/female/days
Weekly multiplication of population	5.62
Doubling time	2.84 days
Hypothetical F_2 female	944.76

a daily finite rate of increase (λ) 1.2767 female per female per day, the population would multiply 5.62 times every week under the given set of conditions on okra. The mean time required to complete one generation was 14.02 days. The hypothetical female population in F_2 generation was 944.76. The doubling time and weekly multiplication was 2.84 days and 5.62, respectively. It could be seen from the table 3 that on reaching stable age-distribution, the population of *T. macfarlanei* in its

various stages viz; egg, larva, protonymph, deutonymph and adult contributed to the tune of 75.84, 10.53, 5.64, 1.79 and 6.20 per cent. Thus, more than 93% contribution was made by immature stages. In literature, no information is available on these aspects in case of *T. macfarlanei*. There are a few reports available on life-table studies for other *Tetranychus* species like *T. urticae* (Laing, 1969; Shih et al., 1976; Ho & Lo, 1979) and *T. cinnabarinus* (Shih & Shieh, 1978) and *T. neocaledonichus* (Gutierrez & Chazeau, 1972); Ho & Lo.

TABLE 3

Stable age-distribution of *Tetranychus macfarlanei* on okra leaves ($rm = 0.2443$).

Pivotal age in days (X)	l_x	e^{-rm} ($x + 1$)	$L \times e^{-rm}$ ($x + 1$)	% distribution	% contribution
0	1	0.7832	0.7832	23.443	
1	1	0.6134	0.6134	18.361	
2	1	0.4805	0.4805	14.383	
3	0.9761	0.3763	0.3763	11.264	
4	0.9512	0.2947	0.2804	8.393	75.84 eggs
5	0.8837	0.2308	0.2040	6.106	
6	0.8175	0.1808	0.1478	4.424	10.53 larva
7	0.7750	0.1416	0.1097	3.284	
8	0.7100	0.1109	0.0787	2.356	5.64 protonymph
9	0.6875	0.0868	0.0597	1.787	1.787 Deutonymph
10	0.6875	0.0680	0.0467	1.398	
11	0.6875	0.0533	0.0366	1.096	
12	0.6875	0.0417	0.0287	0.859	
13	0.6875	0.0327	0.0224	0.670	
14	0.6875	0.0256	0.0176	0.527	
15	0.6875	0.0200	0.0137	0.410	
16	0.6875	0.0157	0.0108	0.323	
17	0.6875	0.0123	0.0084	0.253	6.20 adults
18	0.6875	0.0096	0.0062	0.188	
19	0.6250	0.0075	0.0047	0.141	
20	0.5625	0.0059	0.0033	0.099	
21	0.5625	0.0046	0.0026	0.078	
22	0.5000	0.0036	0.0018	0.054	
23	0.4375	0.0028	0.0012	0.037	
24	0.3750	0.0022	0.0008	0.025	
25	0.2812	0.0017	0.0004	0.015	
26	0.2187	0.0013	0.0003	0.009	
27	0.1875	0.0010	0.0002	0.006	
28	0.1875	0.0008	0.0001	0.004	
29	0.1875	0.0006	0.0001	0.003	
30	0.1875	0.0005	0.0000	0.002	
31	0.0937	0.0004	0.0000	0.001	

(1979) Laing (1969) found almost similar value of R_0 as 30.93 for *T. Urticae* at 15-28°C, but he found lower r_m value (0.143) and higher mean generation time (24.0 days) than that recorded in present study (r_m 0.2443 and $T = 14.02$ days). In this context, as per Birch (1948), the comparison of two or more population by means of their net reproductive rates may be quite misleading

unless the mean length of generation are the same. Two or more populations may have the same reproductive rate but their intrinsic rate of increase may be quite different because of different lengths in generation time.

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Efficacy of Modified Trap Over Conventional Trap in Trapping Fruit Flies in Sapota Orchard in South Gujarat

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ABSTRACT

Efficacy of a modified trap (methyl eugenol alone) with the conventional bait trap (methyl eugenol + DDVP) for trapping the fruit flies in sapota orchard was studied under South Gujarat conditions. The two years (1991-1992) pooled results established that the modified trap, designated as "Patel fruit fly trap" proved to be equally effective in trapping the flies without extra cost in sapota orchard. The trap involves no use of insecticide. So, it is ecofriendly and can be conveniently fitted in the module of the organic farming High (125 to 614) number of flies were caught from April to October.

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INTRODUCTION

Fruit flies, *Bactrocera* Spp. (Tephritidae : Diptera) find most tropical fruits including sapota equally attractive which produce a two fold problem. For buyer, its infestation results in a one time loss but for producer it imposes a recurring loss; i.e. a loss of good wills and as such the buyer quickly switch more reliable supplier. The countries like the United States, Japan and Australia which are warm enough for fruit fly establishment, impose quarantine restrictions on import of whole fruits that may carry new fruit flies into their countries. Secondly, fumigation with ethylene dibromide to kill hidden infestation if any in whole fruits, is now virtually unacceptable because of strong public opinion against residue hazards. Under these circumstances, other methods that minimize

chemical hazards and guarantee a pest free consignment of fruits are to be developed. The bait traps containing methyl eugenol alongwith insecticide are found to be useful in reducing the intensity of infestation (Patel, 1989). The fruit flies that were trapped could easily escape in short time in absence of the killing substance. Looking to the trend of reducing pesticide usage, it was felt necessary to modify the existing fruit fly trap into ecofriendly trap in such a way that it will require only the lure, i.e. methyl eugenol. The fruit fly species, *Dacus zonata* (Saunders) and *Dacus dorsalis* (Hendel) were observed to be attracted towards methyl eugenol (Gupta *et al.*, 1990). The results of the studies on the efficacy of the modified version with the conventional fruit fly trap are discussed in this paper.

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MATERIALS AND METHODS

Design of fruit fly trap

1. **The conventional trap :** The trap (Figure 1) consisted of plastic jar measuring 11 cm diameter; 20 cm height having a circular hole of 3 cm diameter on each on lid and bottom of the jar. It was provided with a metal hook through which the trap can be hanged in horizontal position. To attract and kill the flies the cotton swab impregnated with five drops of methyl eugenol and three drops of DDVP was placed in glass petri dish (5.5 cm diameter; 1.5 cm height) to avoid adverse effects on plastic jar.

2. **The modified trap (Patel fruit fly trap) :** The trap was prepared by cementing a plastic funnel of 7.5 cm diameter with a tubular passage of 2.5 cm length and 0.7 cm internal diameter, one each on inner side of lid as well as bottom. The funnel were fixed inside the body of jar using a synthetic resin fevicol (Figure 2). This trap was baited with cotton swab impregnated with only methyl eugenol. The tubular passage of funnels allowed the flies to enter, but prevented their escape and as such the trapped male flies died subsequently without pesticide in about 1 to 2 days.

Both types of traps were installed 20 m. apart in a sapota orchard at Horticulture farm of

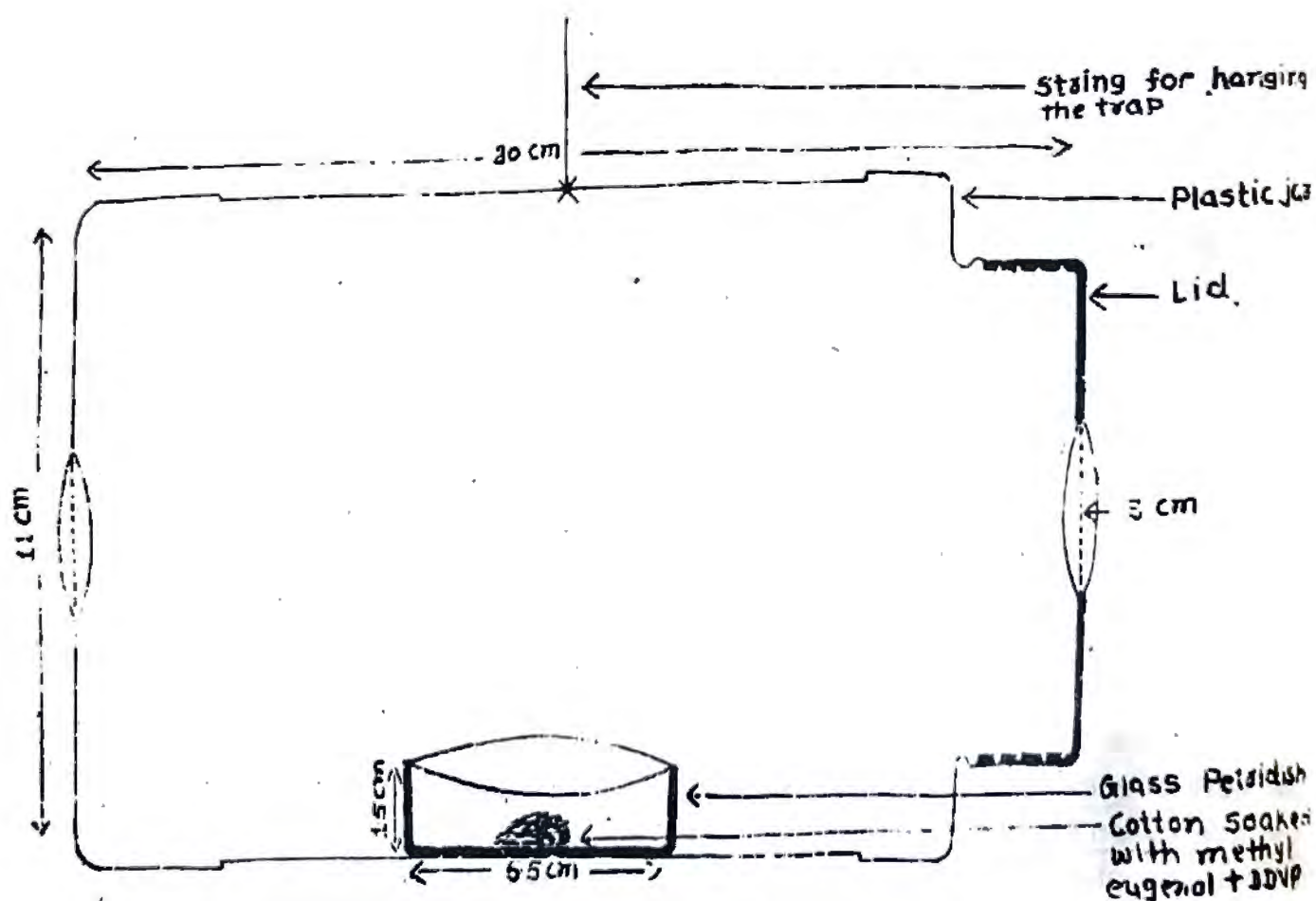


Fig. 1. : Conventional Trap

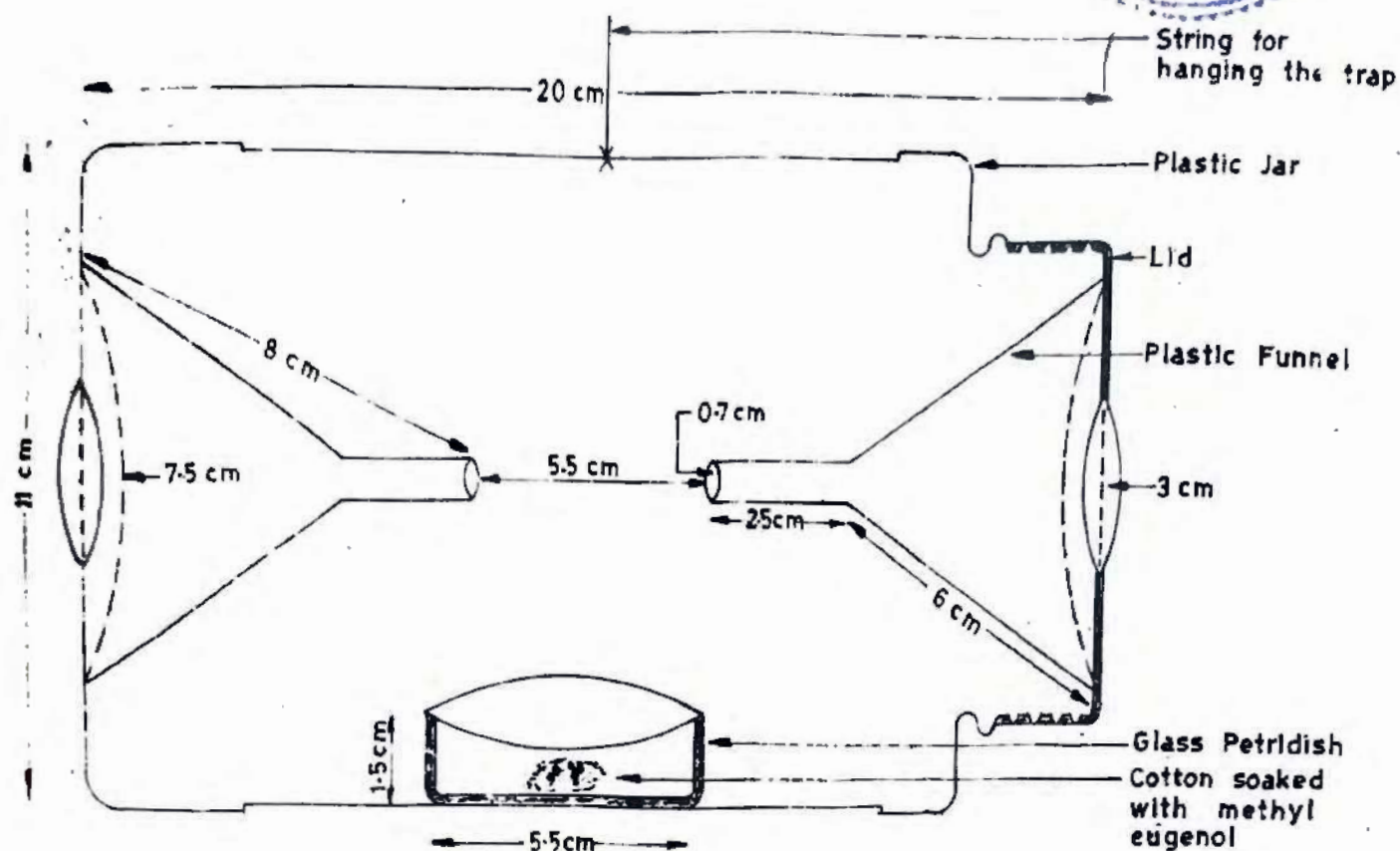


Fig. 2. : Modified Trap

N. M. College of Agriculture, Gujarat Agricultural University, Navsari during November, 1991 to October, 1993.

Observations on number of fruit flies trapped in each trap were recorded weekly. The dead fruit flies were collected and counted separately for each trap. The traps were changed every week with a mixture of lure + pesticide or lure alone as the case may be. The efficacy of the traps were judged on the basis of number of fruit flies trapped during the period of study.

RESULTS AND DISCUSSION

The data obtained on number of fruit flies trapped in conventional fruit fly trap (methyl eugenol + DDVP) and modified fruit fly trap

(methyl eugenol alone) are presented in Table 1.

The fly catches in the both types of traps showed more or less similar trend during the year 1991-92 and 1992-93 (Table 1). The total number of fruit flies trapped in conventional trap was little more (2359 to 2631 flies) as compared to that found in modified trap (2345 to 2591 flies). However, the statistical analysis ruled out significant differences between these two traps.

Pooled analysis of the flies catches of both the years (Table 1) showed that 2495 and 2468 fruit flies were trapped in conventional and modified traps, respectively. The paired 't' test indicated that the difference observed in fly

TABLE 1

Comparative efficacy of conventional and modified trap for trapping male fruit flies in sapota orchard.

Total* No. of fruit flies trapped per trap							
Sr. No.	Months	1991-92**		1992-93**		Pooled**	
		Conventional trap	Modified trap	Conventional trap	Modified trap	Conventional trap	Modified trap
		(ME + DDVP)	(ME)	(ME + DDVP)	(ME)	(ME + DDVP)	(ME)
1.	2.	3.	4.	5.	6.	7.	8.
1.	Nov.	8	12	10	17	9.0	14.5
2.	Dec.	8	7	5	13	6.5	10.0
3.	Jan.	28	14	22	16	25.0	15.0
4.	Feb.	41	54	48	44	44.5	49.0
5.	Mar.	139	118	145	147	142.0	132.5
6.	Apr.	564	581	663	651	613.5	616.0
7.	May.	207	191	335	325	271.0	258.0
8.	Jun.	358	316	500	494	429.0	405.0
9.	Jul.	609	594	521	528	565.0	561.0
10.	Aug.	227	255	213	180	220.0	217.5
11.	Sep.	132	152	117	131	124.5	141.5
12.	Oct.	38	51	52	45	45.0	48.0
Total		2359	2345	2631	2591	2495	2468
Std. error of diff.		5.96		3.59		2.94	
Mean of diff.		1.17		3.33		1.42	
Value of Cal. 't'		0.20		0.93		0.48	
Value of table 't'		2.20		2.20		2.20	
Conclusion		N.S.		N.S.		N.S.	
* Total of 4 weeks				M.E. = Methyl eugenol			
** Paired 't' test				N.S. = Non significant			

catches between conventional and modified trap was non significant. This indicated that there was no significant difference in fly trapping ability of the conventional and modified traps under test. The number of flies caught/trap ranged from 6.5 to 614 (Table 1). Subsequently high (125 to 614) number of flies caught from April to September.

Thus, the overall results clearly indicated that the modified trap has parallel potential to conventional one. On the other hand, the modified trap can be conveniently fitted in the module of organic farming since it eliminates the use of chemical pesticide. From the economic point of view, the cost of modification can be compensated against the cost of pesticide to be charged at every week in conventional trap.

In other countries, steinar trap (Queensland modification) is in use which

require lure + chemical pesticide. Its two entry holes were provided with a small plastic tube having diameter equal to that of entry hole. The entry hole is covered to half size by a piece of metallic wire gauze (Drew, 1982). Although, this mechanism helps to reduce the chances of fly escape to some extent, it requires chemical impregnation to kill the trapped flies. Whereas, the modified trap ensures killing of trapped flies by preventing their escape and thus proved to be superior than the existing models.

Summary and Conclusion

The overall results indicated that the modified trap has equal fly catching potential to that in the conventional trap. Former has additional benefit of ecofriendly usage without extra cost. The modified trap could be designated as "Patel Fruit Fly Trap" and is recommended on large scale to the fruit and vegetable growers to reduce the fruit fly problem.

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Optimum Size and Shape of Plot for Field Experiments on Gram

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ABSTRACT

A uniformity trial was conducted during *rabi* season of the year 1993 at the Agricultural Research Station, Gujarat Agricultural University, Derol, Gujarat State to determine the optimum plot size and shape for field experiments on gram crop. The coefficient of variation (CV) decreased with an increase in plot size upto 4 m² for grain weight as well as for biomass weight. The rate of decrease in CV was rapid in the East-West direction for both characters. The plot shape had a little influence on variability. Smith's (1938) equation $Y = aX^b$ explained the relationship between coefficient of variation (Y) and plot size (X). The variation explained for grain weight and biomass weight were found to be 86.67 and 89.24 per cent, respectively. Plot size of 4 x 1 m² with 3 replications was considered as an optimum size and shape of plot for field experiments on gram.

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INTRODUCTION

Efficient planning of any field experiment depends on the magnitude of experimental error (which is usually expressed in terms of coefficient of variation in per cent) associated with various (assignable/non assignable) factors. Variation in soil fertility is a major source of experimental error (Federer, 1955). The knowledge of variation in soil fertility of the Agricultural Research Station, Derol is evaluated through a uniformity trial on gram to determine the optimum size and shape of plot for field experimentation on gram for which the information is lacking for Middle Gujarat.

MATERIALS AND METHODS

A uniformity trial on gram crop was conducted during the *rabi* season of the year 1993

at the Agricultural Research Station, Gujarat Agricultural University, Derol with recommended agronomical practices. The crop was sown in rows along North-South direction with a spacing of 30 cm between rows. A plot of 24 m wide and 30 m long in a contiguous unit of 1 m² giving in all 720 units was harvested to collect the data on grain weight and biomass weight for each unit, separately. The yield of adjacent units were combined to form the all possible combinations of different sizes and shapes of plots.

The coefficient of variation in per cent (CV) for all possible combinations of various plot sizes and shapes were calculated for both characters separately using the relationship given by the equation 1 (Gomez and Gomez, 1984).

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$$CV = \frac{\left[\frac{1}{N} \sum_{i=1}^N (z_i - \bar{z})^2 \right]^{1/2}}{\bar{z}} \dots \dots (1)$$

where, z_i ($i = 1, 2, \dots, n$) is the i th value of the characteristic under study,

$$\bar{z} = \text{Mean value} = \frac{1}{N} \sum_{i=1}^N z_i \text{ and}$$

N = Number of observations of the characteristic

The method of "Point of Maximum Curvature" was employed to obtain the optimum plot size (Day, 1920). The optimum plot size was considered the point on the curve where the rate of change in CV was found to be maximum.

The relationship between CV (Y) and plot size (X) was examined through the Smith's (1938) equation as

$$Y = a X^{-b} \dots (2)$$

The number of replications for different plot sizes were worked out by the formula

$$r = (CV)^2 / p^2 \dots (3)$$

where, CV was the average coefficient of variation over different plot shapes for a fixed plot size and p was the standard error of means (S. Em.) at 90 per cent of confidence interval (Rambabu *et al.*, 1980).

The total area required for an experiment was obtained by multiplying the plot size with the number of replications at p per cent S. Em. for different sizes of plots. Land use efficiency

TABLE 1

Coefficient of variation for thirty eight different dimensions.

Plot size (m ²)	Shape of plot		Coefficient of variation (%)				Predicted CV on Smith's equation	
	Width in meter	Length in meter	Grain weight	Average for plot size	Biomass weight	Average for plot size	GW	BW
1	1	1	30.10	30.10	26.98	26.98	28.79	26.48
2	2	1	21.21	23.30	18.65	20.91	23.25	21.24
	1	2	25.38		23.17			
3	3	1	18.08	20.45	16.25	18.77	20.51	18.67
	1	3	22.82		21.29			
4	4	1	15.86	16.72	14.71	15.18	18.77	17.03
	2	2	17.57		15.64			
5	5	5	20.47	20.47	18.83	18.83	17.52	15.87

1.	2.	3.	4.	5.	6.	7.	8.	9.
6	6	1	13.93	16.30	12.01	14.77	16.57	14.97
	3	2	15.37		13.72			
	2	3	15.95		14.79			
	1	6	19.96		18.57			
8	8	1	12.43	12.82	11.09	11.88	15.16	13.66
	4	2	13.22		12.68			
9	3	3	14.42	14.42	13.31	13.31	14.62	13.16
10	2	5	14.06	16.13	12.68	14.58	14.16	12.73
	1	10	18.19		16.48			
12	12	1	10.21	12.16	8.37	10.90	13.38	12.01
	6	2	12.22		10.34			
	4	3	12.52		12.38			
	2	6	13.70		12.54			
15	3	5	12.70	15.04	10.91	13.35	12.49	11.18
	1	15	17.37		15.78			
16	8	2	10.44	10.44	9.51	9.51	12.24	10.96
18	6	3	11.84	12.12	10.40	10.64	11.80	10.55
	3	6	12.40		10.88			
20	4	5	11.34	11.56	10.85	10.49	11.43	10.21
	2	10	11.78		10.14			
24	24	1	6.66	9.07	5.97	8.33	10.80	9.63
	12	2	8.33		6.98			
	8	3	10.29		9.56			
	4	6	11.00		10.81			
30	6	5	10.76	12.40	9.11	10.48	10.08	8.97
	3	10	11.38		9.26			
	2	15	11.17		9.26			
	1	30	16.27		14.31			
36	12	3	8.21	9.36	7.09	8.11	9.53	8.46
	6	6	10.52		9.13			

for various plot sizes were computed with respect to 1 unit plot area (Patel and Patel, 1968).

RESULTS AND DISCUSSION

The comparisons were made among 17 different plot sizes on the basis of CV criterion which covered 38 different plot shapes. The CV obtained for different sizes and shapes of plots for both characters (i.e., grain weight and biomass weight) were presented in Table 1.

Optimum plot size : It can be observed from Table 1 that CV decreased with an increase in plot size in either directions. This result was parallel to those reported by Agarwal and Deshpande (1967) and Patel and Patel (1968). The decreased was more rapid with an increased in plot size along with than length for grain weight as well as biomass weight. CV decreased from 30.10 to 16.72 per

cent for grain weight and from 26.98 to 15.18 per cent for biomass weight, respectively when the area per plot increased from 1 unit to 4 units. Thereafter, a consistent decreased was not observed, hence, 4 units plot size (i.e., 4 m²) was considered an optimum plot size for field experimentation on gram crop. The same result can be also be observed from Figure 1.

Optimum plot shape : For a fixed plot size, the plot shape indicates a consistent effect on CV. It was found less for plots having greater width than length, however, compact plots showed more variability than plots elongated in E-W direction for both characters. Among all combinations of 4 m² plot, a plot shape of 4 width 1 m length had a minimum CV (15.86 per cent) for grain yield. In case of biomass weight, a plot shape of 4 m width and 1 m length showed a minimum CV (14.71 per cent). It can be revealed from Table 1 that a plot of 4

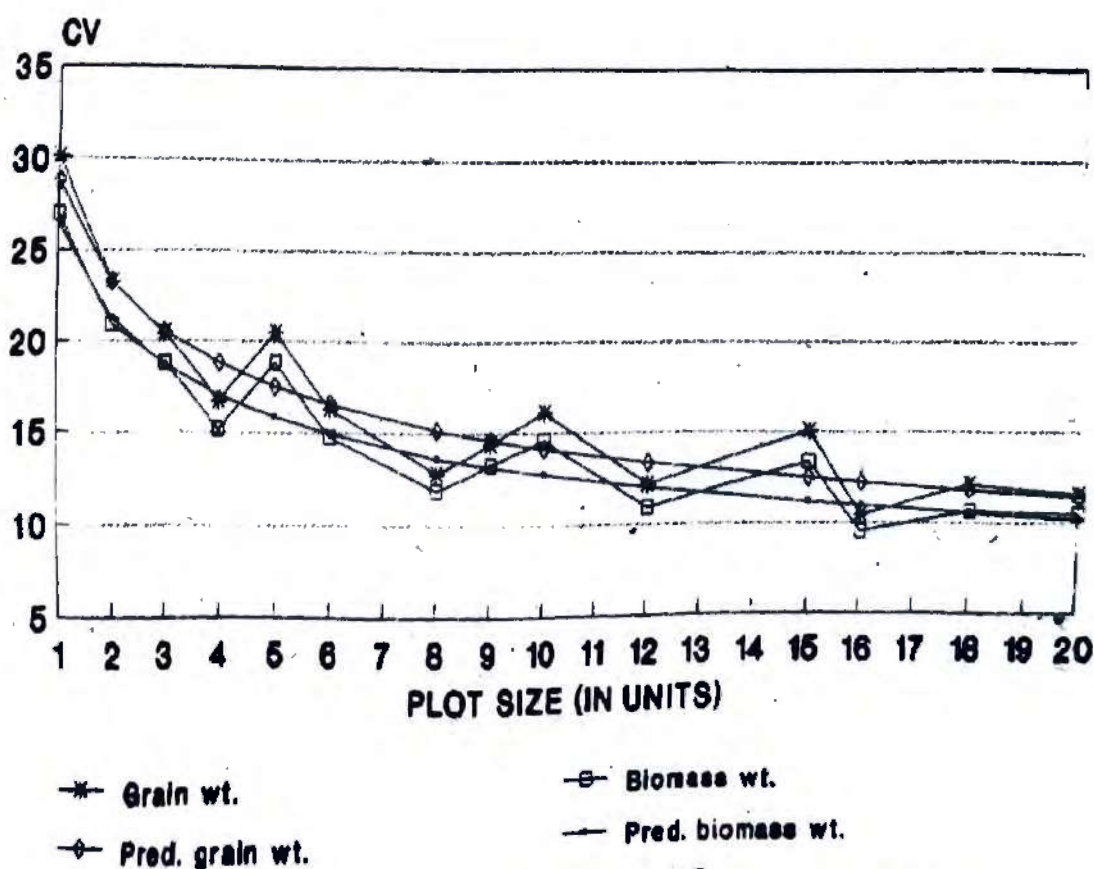


Fig. 1. : Observed and predicted CV for grain and biomass weight.

units having the shape of 4 m along width and 1 m along length could be considered an optimum plot shape for field experiments on gram crop.

Soil heterogeneity index : Smith's coefficient of soil heterogeneity index, 'b', for grain weight and biomass weight were found to

be 0.3083 and 0.3182 which indicate change in number of replications and plot size would be effective in reducing the experimental variability (Lin and Binns, 1986) with 86.67 and 89.24 per cent of variation as explained by the relationship between CV (Y) and plot size (X) respectively. The estimated form of Smith's equations are presented in Table 2.

TABLE 2

Smith's equation (estimated) for grain and biomass weight.

Character	Smith's equation	Variation explained (in per cent)
Grain weight	$Y = 28.78 X^{-0.3083}$	86.67
Biomass weight	$Y = 26.48 X^{-0.3182}$	89.24

Number of replications and relative land use efficiency :

The number of replications and required area of land for different plot sizes at 10 per cent standard error of means were computed from estimated CV for grain weight and biomass weight (Table 3). Table 3 showed that the number of replications and the relative land use efficiency of a plot decreased as the size of plot increased. These results were in agreement with the results obtained by Rambabu *et al.* (1980) and Sethi (1985). Due to practical difficulties in conducting the field experiments with small plots, a plot size, having relatively high efficiency with less number of replications should be considered for field experimentation (Ali and Singh, 1986). Such a situation arises for the plot of size 4 m², which is having considerably less number of replications (3) and a high land use efficiency (83.33 per cent) for grain weight.

Therefore, 3 replications could be considered optimum number of replications for 4 m² plot size at 10 per cent probability level for grain yield. Parallel result was observed for biomass weight with a minimum number 3 replications and 66.67 per cent of land use efficiency.

Conclusion

Coefficient of variation per unit area decreased with an increase in plot size up to 4 m², thereafter a constant decrease was not found. The plot shape had a little influence on variability within the range of plot sizes considered. For a given area, the smallest plot was found to be the most efficient. The number of replications required for a given level of accuracy decreased with an increase in plot size. Considering the characters, viz., grain weight and biomass weight simultaneously, it was concluded that 4 m² plot size with

TABLE 3

Number of replicalons and area required for 10% SE of mean and relative land use efficiency in per cent for grain weight (GW) and biomass weight (BW) with respect to unit plot size.

Plot size (m ²)	CV		No. of replications		Area required (in units)		Relative land use efficiency	
	GW	BW	GW	BW	GW	BW	GW	BW
1	30.10	26.98	10	8	10	8	100.00	100.00
2	23.30	20.91	6	5	12	10	83.33	80.00
3	20.45	18.77	5	4	15	12	66.67	66.67
4	16.72	15.18	3	3	12	12	83.33	66.67
5	20.47	18.83	5	4	25	20	40.00	40.00
6	16.30	14.77	3	3	18	18	55.56	44.44
8	12.82	11.88	2	2	16	16	62.50	50.00
9	14.42	13.31	3	2	27	18	37.04	44.44
10	16.13	14.58	3	3	30	30	33.33	26.67

replications could be considered an optimum plot size. 12 rows each of 1 m length was found to be the optimum plot shape for the optimum plot size (4 m²). Therefore, 4.0 x 1.0 sq. m was considered the best size and shape of plot for field experimentation on gram crop.

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Short Communications

Influence of Different Levels of Nitrogen and Phosphorus on Yield and Nutrient Uptake by Castor (*Ricinus communis* L.)

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A field experiment was carried out at Main Oilseeds Research Station, Gujarat Agricultural University, Junagadh during *kharif* 1986-87 with five levels of nitrogen (0, 25, 50, 75 and 100 kg N ha⁻¹) and four levels of phosphorus (0, 25, 50 and 75 kg P₂O₅ ha⁻¹) under rainfed conditions in randomized complete block design with four replications. The variety GCH-4 evolved recently at Main Oilseeds Research Station, Gujarat Agricultural University, Junagadh was sown on 30th July, 1986 at 90 x 60 cm spacing with 6 kg ha⁻¹ seed rate and harvested according to maturity of different spikes. The soil was clayey in texture (74.96 clay) having pH 7.8, EC 0.51 mmhos cm⁻¹, organic carbon 0.63 % total nitrogen 1340 kg ha⁻¹, available P₂O₅ 36.96 kg ha⁻¹ and available K₂O 307.02 kg ha⁻¹. According to different treatment combinations, the full dose of phosphorus in

the form of single super phosphate and half dose of nitrogen as urea were applied before sowing and remaining half the quantity of nitrogen was top-dressed in the form of urea after one and half month of sowing.

Perusal of data presented in Table 1 revealed that the 100-seed weight was significantly influenced by nitrogen levels and increased with each incremental level of nitrogen. Application of 100 kg N ha⁻¹ recorded the highest test weight but remained at par with 75 and 50 kg N ha⁻¹. Higher uptake of nitrogen and phosphorus by seed under 50, 75 and 100 kg K ha⁻¹ levels might have produced and converted more photo-synthate needed for seed development. The results corroborate the report of Paidar (1976). Oil content of seed considerably decreased from 48.44 per cent under control to 47.86 per cent under 100 kg N ha⁻¹. Remarkably higher test weight and uptake of nitrogen by seed under higher levels of nitrogen may be responsible for lower oil content. Moreover, there is a marked competition for photosynthate between different metabolic sinks in oilseed crops, hence increasing the level of N nutrition may enhance the crude protein content but lower the oil content. Oil yield increased appreciably with each increment in level of nitrogen.

TABLE 1

Effect of nitrogen and phosphorus on quality and nutrient removal by castor.

Treatment	100-seed weight (g)	Oil content (%)	Oil yield (q ha ⁻¹)	N uptake (kg/ha ⁻¹)		P uptake (kg/ha ⁻¹)		Seed yield (q ha ⁻¹)	Stalk yield (q ha ⁻¹)
				Seed	Stalk	Seed	Stalk		
N-kg ha ⁻¹									
0	26.48	<u>48.44</u>	6.46	39.08	22.68	7.45	2.94	13.92	15.94
25	26.88	48.41	6.65	39.81	22.78	7.56	2.95	13.73	15.52
50	27.71	48.24	7.15	41.88	24.02	7.80	2.97	14.81	16.34
75	27.96	48.11	<u>7.20</u>	42.10	24.07	7.87	2.97	14.96	16.59
100	<u>28.19</u>	47.96	7.19	<u>43.00</u>	<u>24.91</u>	<u>7.93</u>	<u>2.98</u>	<u>14.99</u>	<u>16.77</u>
C. D. at 5 %	0.80	0.23	0.43	2.46	1.24	0.22	0.02	0.87	0.28
P ₂ O ₅ kg ha ⁻¹									
0	27.27	48.09	6.76	39.90	23.31	7.67	2.95	14.06	15.59
25	27.46	48.24	6.87	40.78	23.50	7.72	2.96	14.23	15.72
50	27.50	48.26	6.95	41.70	23.67	7.74	2.97	14.39	16.56
75	27.57	48.35	7.14	41.92	23.81	7.76	2.97	14.77	16.58
C. D. at 5 %	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	0.01	N.S.	0.70

Application of 100 kg N ha⁻¹ recorded the highest oil yield but was at par with 75 and 50 kg N ha⁻¹. A marked increase in seed yield under higher levels of nitrogen was directly responsible for higher oil yield. The findings are in accordance with those of Ignatev and Gubarev (1970) and Tokareva (1973).

An appreciable increase in nitrogen and phosphorus uptake by seed as well as stalk was observed due to 50, 75 and 100 kg N ha⁻¹, but the differences among themselves were not significant. The higher N and P removal by castor under higher levels of nitrogen was probably due to higher seed and stalk yields under these levels. In addition to these, N fertilization increases the cation exchange capacity of plant roots and thus makes them more efficient in absorbing nutrient ions.

Application of phosphorus did not show any remarkable influence on 100-seed weight, oil content and oil yield. It may be due to the fact that different levels of phosphorus failed to

exert their significant influence on N and P uptake by seed. P application has not any remarkable effects on seed yield and oil content, hence ultimately led to non-significant differences in oil yield. The findings are in agreement with those of Paidá (1976) and Patel (1985).

Different levels of phosphorus did not exert their significant effects on N uptake by seed and stalk as well as P uptake by seed. Non-significant differences in seed yield might have been accounted for such results. Castor roots have a great capacity to uptake the phosphorus from not easily soluble calcium phosphate. Further calcareousness and high clay content of experimental soil with medium status of available phosphorus might have been responsible for such types of results. However, phosphorus uptake by stalk was significantly higher under 50 and 75 kg P₂O₅ ha⁻¹ levels which may be due to higher stalk yields under these levels.

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Effects of Organic, Inorganic and Biofertilisers of Yield and Net Income of Wheat (*Triticum aestivum*)

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The rising cost of chemical fertilisers and changing pattern of productivity and fertilisers response in wheat have lead to the promotion in use of organic manures and biofertilisers. Keeping this in view, a field experiment was conducted on cultivators field in Junagadh district of Gujarat during *Rabi* season of 1992-93

to evaluate effectiveness of organic, inorganic and biofertilisers on yield and net income of wheat. The soil was sandy loam, moderate in nitrogen (0.078% O.C.), high in phosphorus (60 kg/ha) and potassium (180 kg/ha). The experiment compromised 5 treatments viz, FYM @ 10 t/ha, slurry compost @ 10 t/ha, chemical fertiliser (120-60-0 kg/ha), wet slurry @ 8000 lit/ha and slurry compost + biofertilisers (Azotobacter and phosphate culture 250 g/10 kg seeds). The treatments were replicated 4 times in Randomized Block Design. The wheat crop was sown on 13th November, 1992 and harvested on 15th February, 1993. The nutrients content of the slurry compost were 1.2 % N, 1.3% P₂O₅ and 1.3% K₂O.

TABLE 1

Effects of different treatment on yield and net income of wheat.

Treatments	Yield (kg/ha)	Net income (Rs./ha)
FYM @ 10 t/ha	2766	2329
Slurry compost @ 10 t/ha	3133	3368
Chemical fertiliser (120-60-0 kg/ha)	3783	4474
Wet slurry @ 8000 lit/ha	2649	3104
Slurry compost + biofertiliser	3283	3599
C. D. at 5%	81.06	—

GADHIA

The grain yield was significantly affected by different treatments. The significant increase was observed by application of chemical fertiliser (3783 kg/ha) followed by slurry compost + biofertiliser (3283 kg/ha). Such variation might be observed due to high nutritional requirement of wheat crop but bio-fertiliser helped in conversion of unavailable fixed nutrients to available form which leads to increase in production. The similar results were noticed by Reddy *et al.* (1977) in maize. The wet slurry produced significantly less yield and this may be due to low dose applied. The chemical fertiliser

gave highest net income of Rs. 4474/ha followed by slurry compost + biofertiliser (Rs. 3599/ha).

The present study therefore suggests that chemical fertiliser was superior from yield and net income point of view however, increase in grain yield with combined use of organic and biofertiliser suggests that complimentary use of both these sources is advantageous and substantial amount of inorganic fertiliser may be saved (Gill and Meelu, 1982).

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Response of Spreading Groundnut (*Arachis hypogea* L.) to Row Spacing Under Rainfed Condition

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Groundnut is a C_3 plant which is subjected to photo-respiration. One of the reason for low yield of groundnut is photo-respiration. It can be minimized by following proper crop geometry which can be obtained by sowing the crop at proper spacing. In case of groundnut crop, proper spacing provide sufficient interception of sunlight and satisfactory absorption of nutrients and water from the soil due to proper development of underground root system. Generally, farmers of Saurashtra area are followed wider row spacing of 90 cm for spreading groundnut.

A field experiment was conducted at the Research Station, Dhari (Rajkot) on medium black soil during *kharif* seasons of 1981-82 to 1985-86 to find out the optimum inter-row spacing for spreading groundnut (GAUG-10). Five inter row spacings (30, 45, 60, 75 and 90 cm) were tested in

randomised block design with low to medium in available nitrogen and phosphorus but high in available potash. The crop was fertilized with 12.5 kg N + 25 kg P_2O_5 /ha. Crop was sown using 80 kg seed/ha after sufficient rains received during *kharif* seasons of all the five years.

It is evident from the data in (Table 1) that the treatment differences were significant in respect of fodder yields during 1981-82, 83-84 and 84-85, whereas non-significant in 1982-83, 1985-86 and in pooled data. Significantly the highest pod yield of groundnut was recorded during 1982-83 to 1985-86 and in pooled data with row spacing of 60 cm, whereas non-significant in the first year. The pooled data revealed that significantly maximum pod yield (643 kg/ha with gross income 4500 Rs/ha) of groundnut was recorded with 60 cm row spacing. It was also reflected that pod yields reduced with wider row spacing (75 and 90 cm) as compared to lower spacing (30 and 45 cm). Similar trend was also recorded in respect of gross income under 75 and 90 cm (3558 and 3511 Rs/ha) as compared to 30 and 45 cm (3917 and 3994 Rs/ha). These findings are also in close confirmation with those of Saini and Tripathi (1974). The superiority of closer spacing over wider spacing in groundnut has also been reported by

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TABLE 1

Yield of spreading groundnut (GAUG 10) as influenced by different row spacings.

Treatment (spacing)	Years												Gross income Rs/ha
	1981-82		1982-83		1983-84		1984-85		1985-86		Pooled		
	Pod	Fodder	Pod	Fodder	Pod	Fodder	Pod	Fodder	Pod	Fodder	Pod	Fodder	
30 cm	799	3950	612	6268	513	707	213	781	482	1259	524	2593	3917
45 cm	794	3602	668	6646	571	786	260	955	365	1345	532	2667	3994
60 cm	877	3277	830	6559	803	907	352	998	356	1259	643	2600	4500
75 cm	783	2875	528	5912	640	821	181	833	250	1333	476	2355	3558
90 cm	725	2279	509	6495	634	807	117	825	360	1259	469	2333	3511
S. Em. $\pm$	40	71	42	244	40	27	15	28	21	55	33	142	—
C. D. at 5 %	NS	219	131	NS	124	84	47	86	66	NS	98	NS	—
C. V. %	10.18	4.44	13.50	7.64	12.78	6.74	13.66	6.35	11.74	8.47	12.84	9.35	—

Gross income is calculated as under :

Y X T interaction, S. Em. $\pm$ 34 (D = 96 at 5 %)

Sr. No.	Item	Rs./q
1	Groundnut pod	500
2	Groundnut fodder	50

Gopalswamy *et al.* (1979). Similarly Patel *et al.* (1985) reported lower pod yield of groundnut with wider row spacing.

It was concluded that potential pro-

duction from rainfed spreading groundnut could be secured by keeping inter-row spacing of 60 cm in North Saurashtra Agro-Climatic Zone.

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Economic Attributes of Inputs on Yield of Mustard (*Brassica juncea* L.)

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Contribution of inputs in different levels of productivity is one of the established facts in crop production but the extent of variation in contribution of input varies according to agroclimatic situations. Mustard is one of the predominant crops in cropping system of Chambal division. No information is available on contribution of different factors of production on yield and economics of mustard (*Brassica juncea* (L) Czernj & Coss). Therefore, an experiment was conducted to work out the per cent contribution of different inputs.

Field experiment was laid out at JNKVV-Zonal Agricultural Research Station, Morena (M.P.) during *rabi* season of 1982- 83 on sandy loam soil. The soil had 7.6 pH and available N, P_2O_5 and K_2O content was in the order of 200-20, 22.00 and 400 kg/ha, respectively. Total rainfall received during the crop season (Oct. 1982-Feb. '93) was 53.4 mm. There were eight different treatments, viz., T_1 = control (without fertilizer, irrigation and

plant protection), $T_2 = T_1$ + Fertilizer (75 kg N + 40 kg P_2O_5 + 20 kg K_2O /ha, $T_3 = T_1$ + irrigation only (once at pre-flowering stage), $T_4 = T_1$ + plant protection (seed treatment with thiram, one spray of metasystox + Dithane M-45 and second of Dimecron), $T_5 = T_1$ + Fertilizer + Irrigation, $T_6 = T_1$ + Fertilizer + Plant protection, $T_7 = T_1$ + Irrigation + Plant protection and $T_8 = T_1$ + Fertilizer + Irrigation + Plant protection.

The above eight treatments were tried in Randomized Block Design with four replications having a net plot size of 12 square meter. The Varuna (T-59) variety of mustard was sown on 22nd October, 1982 and harvested from 20-26th Feb. 1983. Data on main yield attributes and yield were recorded. Economics was calculated on the basis of marginal cost concept and rate of return.

Yield and Its attributes

Data presented in Table 1 show that differences due to treatments were significant for number of primary branches/plant, siliqua/plant, seeds/siliqua, Test weight and seed yield kg/ha. Appreciable treatment differences were also noted in case of secondary branches. The highest seed yield of 1104 kg/ha was recorded by treatment T_8 (Fertilizer + irrigation + plant protection) which was significantly superior to all other treatments

TABLE 1

Plant stand, yield attributes and yield as influenced by different treatments.

Treatments	Plant stand/ net plot	No. of branches plant		No. of siliqua/ plant	No. of seeds/ siliqua	Test weight (g)	Seed yield (kg/ha)	Per cent contribution over control
		primary	secondary					
T ₁	191	3.30	2.95	114.25	12.15	4.46	364	—
T ₂	203	3.60	4.40	146.55	13.36	4.90	812	123.8
T ₃	221	3.67	3.75	126.85	12.20	4.73	427	17.34
T ₄	223	3.55	3.50	126.00	12.29	4.82	527	43.13
T ₅	219	3.65	4.80	139.45	13.31	4.87	771	111.81
T ₆	224	3.35	4.95	149.60	13.40	4.95	1010	177.47
T ₇	191	4.20	3.85	121.05	12.29	4.91	572	57.14
T ₈	205	4.60	5.00	162.30	13.46	4.98	1104	203.30
S. Em ±	20.30	0.27	1.04	10.81	0.31	0.12	75.8	
C. D. (5 %)	N.S.	0.79	N.S.	31.58	0.95	0.37	222.1	

TABLE 2

Production cost of mustard cultivation under different treatments (yield q/ha, cost and return Rs/ha).

Treat- ments	Yield		Total return	Cost		Total (TC)	Net return	Additional		Marginal cost/kg (YC/Q)	Rate of return (%)
	Seed	Stover		Fixed	Variable			Yield (Q)	Cost (VC)		
T ₁	3.64	11.65	1479.12	519.47	575.00	1094.47	348.65	—	—	—	35.14
T ₂	8.12	22.50	3304.25	536.46	1390.41	2066.87	1237.38	4.48	972.40	2.17	37.44
T ₃	4.27	13.24	1741.10	522.31	711.00	1233.31	507.78	0.63	136.00	2.15	41.17
T ₄	5.21	15.89	2123.72	526.71	922.50	1449.22	674.5	1.57	354.75	2.25	46.57
T ₅	7.71	23.13	3141.82	538.67	1496.41	2175.00	966.82	4.07	1080.53	2.65	44.44
T ₆	10.10	30.30	4115.75	546.83	1887.91	2434.74	1681.00	6.46	1340.27	2.07	69.04
T ₇	5.72	17.73	2328.32	528.92	1028.50	1557.42	770.89	2.08	462.95	2.22	49.49
T ₈	11.04	32.89	4738.22	549.04	1993.91	2542.95	2195.27	7.40	1448.48	1.81	86.32

Note : Average cost of mustard seed @ Rs. 400/- and stover @ Rs. 2.50 per quintal at that time.

except (T₆) Fertilizer + plant protection (1010 kg/ha). Control yielded only 364 kg/ha. Anonymous (1983) also reported similar results.

The contribution of fertilizer on seed yield was to the tune of 123.08%, of irrigation 17.34%, of plant protection 43.13%, of fertilizer + irrigation 111.81% of fertilizer + plant protection 177.47%, of irrigation + plant protection 57.14% and combination of fertilizer + irrigation + plant protection 203.30%. These results are in close conformity with observations made by Saini (1984).

Economics

Least cost input-output combination is climate criteria for selecting the best input-output combination for productivity and return. Additional productivity and cost per hectare of different inputs were worked out for calculating the marginal cost and per cent rate

of return (Table 2). Net return per hectare of irrigation + fertilizer + plant protection combination was highest among all combination of input i.e. Rs. 2195.27. Fertilizer and irrigation input combination i.e. Rs. 1681 per hectare ranked second. Additional productivity per hectare of most of the other treatments were found comparatively low. The pattern of additional cost was almost same. On the basis of marginal cost analysis and per cent rate of return, further determine that lowest cost of marginal productivity was occurred in combination of irrigation + plant protection + fertilizer i.e. Rs. 1.81 per kg and highest ranked in combination of fertilizer + plant protection i.e. Rs. 2.65 per kg. More or less same pattern was observed in per cent rate of return. Almost similar results in oilseed crop with respective inputs were reported elsewhere (Anonymous, 1989).

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Effect of Irrigation Schedules on Moisture Extraction Pattern and Consumptive Use of Mustard (*Brassica juncea* L.)

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A field experiment was conducted on clayey soil during *rabi* season of 1992-93 at Regional Sugarcane Research Station, Navsari by adopting randomized block design with twelve irrigation treatments scheduled on

critical crop growth stages which replicated thrice. Field capacity, permanent wilting point and bulk density of the experimental field was 31.10 per cent, 17.63 per cent and 1.47 g/cc, respectively. The sowing of mustard variety Gujarat Mustard-1 was done on the November 4, 1992 and harvested on February 17, 1993. Measured quantity of irrigation water was applied with the help of Parshall flume. The first common irrigation of 60 mm depth was applied immediately after sowing and second after a week to ensure uniform emergence and establishment of the crop. The remaining irrigations were given as per schedule.

TABLE 1

Soil moisture extraction pattern consumptive use of water and water use efficiency of mustard as influenced by different irrigation treatments.

Treatment	Percentage of moisture extracted from different layers (cm)				Consumptive use of water (mm)	Water use efficiency (kg/ha-mm)	Seed yield (kg/ha)
	0-30	30-60	60-90	90-120			
I ₁ (B)	39.51	24.71	22.37	13.41	159	2.98	474.83
I ₂ (F)	40.23	24.79	22.01	12.97	167	3.07	512.95
I ₃ (A)	41.31	24.98	21.37	12.34	170	3.32	565.05
I ₄ (BA)	42.27	25.35	20.40	11.98	211	3.78	797.70
I ₅ (FS)	43.52	25.54	19.75	11.19	213	3.84	818.30
I ₆ (FG)	41.97	25.17	20.68	12.17	206	3.71	765.20
I ₇ (BAG)	44.48	25.65	18.78	11.09	248	3.49	867.65

1.	2.	3.	4.	5.	6.	7.	8.
I ₈ (FSG)	45.25	25.77	18.15	10.83	250	3.59	899.07
I ₉ (FAS)	48.35	26.02	17.61	8.02	259	3.98	1032.75
I ₁₀ (BASG)	48.20	25.98	17.72	8.10	279	3.68	1028.50
I ₁₁ (BFSG)	47.93	25.82	18.13	8.12	277	3.67	1019.35
I ₁₂ (BFAS)	49.12	26.12	17.22	7.54	282	3.91	1103.32
Mean	44.34	25.49	19.52	10.65	227	3.59	
Note : B = Branching, F = Preflowering, A = Anthesis.						S Em. ±	65.54
S = Siliquae formation, G = Grain filling stage						C. D. at 5%	192.23
						C. V. %	13.78

The data on moisture extraction (Table-1) revealed that the mean percentage of moisture extracted from first two layers i.e. from 0-30 and 30-60 cm was 44.34 and 25.49, respectively. Similarly extraction of soil moisture from 0-60 and 60-120 cm layers was 69.83 and 30.17 per cent, respectively. The moisture absorption from upper half was elevated with increase in irrigation frequency, may be due to increase in surface evaporation and water utilization by mustard crop. At lower layers (60-120 cm), the quantity of water depleted was higher under lower irrigation frequencies than that of higher irrigation frequencies. This might be due to presence of longer and finer rootlets in the deeper layers which utilized more amount of water from these layers of the soil. Similar results were also reported by Tomer *et al.* (1992). Consumptive use of water (Table 1) elevated sharply with the enhancement in the frequency of irrigation. The highest

(282 mm) consumptive use of water was recorded with I₁₂ (BFAS) treatment of 4 irrigations applied at branching, pre flowering, anthesis and siliquae formation stages, while the lowest (159 mm) value was noticed under I₁ (B) where one irrigation was applied at branching stage. Increase in consumptive use of water with more number of irrigation, may be due to improvement in plant water status, decrease in stomatal resistance and greater vapour pressure gradient between plant canopy-air under wet than under moisture stress conditions. Similar view was also expressed by Tomer *et al.* (1992).

In case of water use efficiency (Table 1), it was improved steadily from I₁ (one irrigation) to I₉ (three irrigations) treatments and reduced thereafter. The impressive higher water use efficiency was recorded with 3 irrigations applied at pre flowering, anthesis and siliquae formation stages (I₉). The

improvement in the efficiency of water utilization with increased water application indicated that the seed yield was remarkably enhanced proportionately to consumptive

use of water. Silimar trend was also observed by Samui *et al.* (1986).

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Effect of Row Spacing, Nitrogen and Phosphorus on Dry Matter Production, Yield and N, P Uptake of Unirrigated Safflower in Vertisol of South Gujarat

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Safflower is a rich source of vegetable oil and hence the importance of increasing safflower seed yield with better quality by agronomic methods, needs no emphasis. Since this crop is mainly grown as a mixed crop, sufficient information is not available with regards to its agronomic aspects when grown as a sole crop. For this purpose, an experiment was conducted to study the effect of row spacing and levels of N, P fertilizers on the yield and quality of safflower variety 'Bhima' on vertisol of college farm, Gujarat Agricultural University, Navsari Campus in the *rabi* season of 1988-89. The soil of the experimental plot was clayey in texture, low in nitrogen, medium in phosphorus and high in available potash, having pH 8.0. Twenty seven treatment combinations consisting of three levels, each of spacing (30, 45, 60 cm), nitrogen (0, 25, 50 kg N/ha) and phosphorus (0, 25, 50 kg P_2O_5 /ha), were tried in factorial randomised block design with three replications.

Effect of spacing

The results in Table 1 indicated that the dry matter production was continuously increased upto harvest with all the spacings. Significantly higher dry matter production per plant was recorded with closer spacing than 60 cm in initial stages, but at the later stages, wider spacings (45 and 60 cm) recorded significantly higher dry matter yield than closer spacing of 30 cm, might be due to better development of crop and crop canopy. Similar observations were recorded by Ahuja *et al.* (1981).

The seed yield of safflower was significantly influenced by spacing and the maximum seed yield of 11.81 q/ha was recorded with narrow spacing of 30 cm due to higher plant population (Table 2). The respective increase in seed yield by 30 cm spacing was of the order of 4.48 and 15.80 per cent over 45 and 60 cm row spacing. Similarly the straw yield of safflower was significantly influenced by spacing and the highest yield was recorded with narrow spacing of 30 cm, followed by 45 and 60 cm. Similar results were obtained by Bhan *et al.* (1980) and Chauhan *et al.* (1979). Looking to the data in Table 2 on uptake of nitrogen and phosphorus in safflower seeds, the highest uptake of both these nutrients were also recorded with narrow spacing of 30 cm. This

has also helped in boosting up the seed and straw yield of safflower in closer spacing.

Effect of nitrogen

The dry matter production in safflower recorded at various crop growth stages showed

an increasing trend with an increase in the rate of nitrogen application (Table 1). At harvest, the increase in dry matter production with application of 25 and 50 kg N/ha to a safflower crop was 25.10 and 36.90 per cent higher over control, respectively. The increase in dry matter yield by nitrogen application might be due to

TABLE 1

Periodical dry matter production per plant (g) of safflower as affected by spacing and fertilizer treatments.

Treatment	Dry matter production/plant (g)			
	30 DAS	60 DAS	90 DAS	At harvest
Spacing (cm)				
30	1.50	10.30	34.02	37.19
45	1.58	11.15	37.30	39.66
60	1.73	12.97	37.85	40.38
S. Em. ±	0.03	0.36	0.71	0.65
C. D. at 5%	0.10	1.02	2.03	1.86
Nitrogen (kg N/ha)				
0	1.30	7.93	29.48	32.33
25	1.64	12.08	37.88	40.64
50	1.87	14.41	41.81	44.26
S. Em. ±	0.03	0.36	0.71	0.65
C. D. at 5%	0.10	1.03	2.03	1.86
Phosphorus (kg P₂O₅/ha)				
0	1.43	10.90	34.81	37.50
25	1.66	11.58	37.28	39.61
50	1.72	11.94	37.07	40.12
S. Em. ±	0.03	0.36	0.71	0.65
C. D at 5%	0.10	NS	2.03	1.86

DAS = Days After Sowing.

better assimilation of nitrogen by the crop which enhanced the growth and development of the crop.

Significantly the highest seed yield of safflower was obtained with the application of 50 kg N/ha, which was 20.53 and 55.05 per cent more than 25 kg N/ha and control, respectively (Table 2). Outrightly the highest straw yield was recorded with the application of 50 kg N/ha, followed by 25 kg N/ha and the control. The respective increase

in yield due to 50 and 25 kg N/ha was 26.75 and 48.92 per cent than the control. This might be due to higher nutrient uptake by the crop with nitrogen application and low N status of the soil. These results are in conformity to those of Pisal and Shinde (1987).

Effect of phosphorus

The dry matter yield of safflower recorded at different crop growth periods was significantly increased with application of phosphorus. But the rate of phosphorus

TABLE 2

Seed and straw yield (q/ha) and nitrogen and phosphorus uptake by safflower (kg/ha) as influenced by treatments.

<i>Treatment</i>	<i>Seed yield (q/ha)</i>	<i>Straw yield (q/ha)</i>	<i>'N' uptake (kg/ha)</i>	<i>P₂O₅ uptake (kg/ha)</i>
Spacing (cm)				
30	11.81	37.86	38.93	10.38
45	11.31	35.30	37.99	9.65
60	10.20	30.14	32.88	8.88
S. Em. ±	0.109	0.427	0.773	0.253
C. D. at 5%	0.311	1.211	2.195	0.718
Nitrogen (kg M/ha)				
0	8.69	27.50	22.99	7.02
25	11.17	34.85	37.45	10.16
50	13.47	40.95	49.36	12.17
S. Em. ±	0.109	0.427	0.773	0.253
C. D. at 5%	0.311	1.211	2.195	0.718
Phosphorus (kg P₂O₅/ha)				
0	10.42	32.94	34.96	7.60
25	11.49	35.40	38.56	10.94
50	11.41	34.95	36.28	10.37
S. Em. ±	0.109	0.427	0.773	0.253
C. D. at 5%	0.311	1.211	2.195	0.718

application did not influence the dry matter accumulation in safflower (Table 1). This might be due to marginal effect of higher rate of phosphorus on growth. Sinha *et al.* (1985) also recorded similar observations.

The seed yield of safflower was significantly influenced by application of phosphorus upto 25 kg P_2O_5 /ha, which was 10.28 and 0.71 per cent higher than control and 50 kg P_2O_5 /ha. The uptake of nitrogen and phosphorus was also significantly im-

proved by the application of 25 kg P_2O_5 /ha (Table 2). This also reflected in to efficient utilization of nutrients and ultimately increased the seed yield of safflower. The phosphorus application also affected the straw yield of safflower significantly. The maximum yield (35.40 q/ha) was recorded with 25 kg P_2O_5 /ha and found to be statistically at par with 50 kg P_2O_5 /ha. These results are in accordance with the findings of Singh *et al.* (1983).

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Effect of Rice (*Oryza sativa* L.) + Pulse Intercropping System on Yield and Nutrient Uptake

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In terms of land use, growing crops in mixed stand is regarded as more productive than growing them separately (Andrews and Kassam, 1976). Besides yield advantage of intercropping, it becomes necessary to know the nutrient uptake pattern of such system. The intercropping of legumes with cereal offers scope for developing energy efficient and sustainable agriculture (Papendick *et al.*, 1976).

A field experiment was conducted during the summer season of 1989 at Assam Agricultural University, Jorhat to evaluate the nitrogen and phosphorus uptake pattern in rice + pulse intercropping system and its effect on grain yield of rice and pulse. Two pulses viz., greengram 'AAU-34' and blackgram 'T-9' were intercropped with direct-seeded rice 'Rasi' in 2:1, 4:1, 2:2 and 4:2 row proportions of rice : pulse. Sole crops of each variety was raised for comparison. The experiment was laid out in randomised block design with 3 replications. The soil of the experimental

site was sandy loam in texture with pH 5.1, organic carbon 0.89% and available N, P_2O_5 and K_2O 249, 25.75 and 167.5 kg/ha, respectively. Plant samples were analysed for N and P following standard procedure. The total rainfall received during the crop season (February-June) was 656.4 mm.

The uptake of N and P was significantly influenced by different treatments (Table 1). The total uptake of N was maximum at rice + greengram system and was statistically superior to rice + blackgram. This was due to the differential response of component crops included in the system (Ahmed and Rao, 1982). Among the sole crops, greengram removed maximum quantity of N (Mongia and Gangwar, 1991). Though the individual uptake of N was reduced in intercropping than their respective sole crops, the total uptake of N was statistically superior in intercropping over sole cropping. The demand for total N was significantly more by 2:1 followed by 2:2, 4:1 and 4:2 proportions.

Similar trend of response was observed for P. The total harvest of N and P were 44 and 27 per cent higher in intercropping system over sole cropping. Higher removal of nutrients under inter-cropping over sole crop was reported by Sanchez (1976).

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TABLE 1

Uptake of nitrogen and phosphorus as affected by intercropping and its effect on grain yields.

Treatments	N-uptake (kg/ha)			P-uptake (kg/ha)			Grain yield (kg/ha)		Rice equivalent (kg/ha)
	Rice	Pulse	Total	Rice	Pulse	Total	Rice	Pulse	
Sole crop									
Rice	26.84	—	26.84	3.41	—	3.41	1527	—	1527
Greengram	—	39.68	39.68	—	6.82	6.82	—	341	1363
Blackgram	—	20.34	20.34	—	3.71	3.71	—	262	785
CD at 5 %	—	2.53	4.18	—	1.26	0.51	—	14	112
Cropping system									
Rice + greengram	23.32	21.76	45.08	2.98	3.51	6.47	1136	178	1848
Rice + blackgram	25.86	12.51	38.38	2.87	2.48	5.35	1132	137	1544
CD at 5 %	0.57	1.27	2.09	0.09	0.63	0.25	NS	7	56
Row proportion									
R:P 2:1	29.73	18.64	48.02	2.92	4.19	7.11	1071	178	1702
R:P 4:1	29.65	10.12	39.77	3.60	1.32	4.93	1414	91	1736
R:P 2:2	14.76	22.08	41.84	2.51	3.23	5.74	996	213	1761
R:P 4:2	19.60	17.71	37.31	2.64	3.22	5.87	1052	149	1585
CD at 5 %	0.81	1.79	2.96	0.14	0.89	0.36	63	10	79
Sole Vs. Intercropping									
Mean of sole crops	26.84	30.01	28.95	3.41	5.26	4.65	1527	302	1225
Mean of intercropping	24.59	17.13	41.73	2.92	2.99	5.91	1134	158	1696
CD at 5 %	1.09	1.90	2.75	0.18	0.94	0.34	85	11	74

Market prices of commodities (Rs/ha) : Rice, 200; Greengram, 800; Blackgram, 600; R. Rice; P. Pulse

The grain yields of rice, greengram and blackgram were reduced under intercropping than their respective sole crop yields. However, in terms of rice-equivalent, rice + greengram was more productive over rice + blackgram. This higher yield was supported by significantly higher uptake of nutrients by the

system. Among the row proportions, 2:2 ratio produced higher rice-equivalent over 4:2 and was at par with 4:1 and 2:1. In respect of rice equivalent, intercropping of greengram and blackgram with rice produced 38 per cent yield advantage over sole cropping.

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Micronutrients Status of Mahi-Kadana Command Area of Gujarat

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The Mahi-Kadana irrigation project has been a major source of irrigation in the command area which belongs to South-West part of Kheda district mainly falling in the Middle Gujarat region. The information on micronutrients status in this command area is practically required in view of the intensive cultivation of paddy – paddy, paddy – wheat, tobacco – groundnut, *bajri* – mustard – *jowar*, *bajri* – wheat – *bajri* and banana based cropping sequences. With a view to knowing the available status and vertical distribution of micronutrient cations within the major soil profiles in this command area, the present study was undertaken.

Total 2772 profile soil samples in the command area were collected soil serieswise by a comprehensive reconnaissance soil survey in collaboration with soil survey division, Nadiad. The soil samples were analysed for important physico-chemical properties by using standard analytical methods (Jackson, 1967). The surface (0-25

cm) soils had pH 6.0 to 9.7, EC 0.03 to 9.00 dS m⁻¹, organic C 0.08 – 0.8%, available P₂O₅ 7.4 to 212.4 kg ha⁻¹ and available K₂O 92 to 2097 kg ha⁻¹ with respective mean values of 8.2, 0.56, 0.28, 58.7 and 553. The soils were classified as, mainly Inceptisols and Entisols. Available micronutrients (Fe, Mn, Zn and Cu) were extracted with DTPA extractant from the soil samples and determined with the help of atomic absorption spectrophotometer (Lindsay and Norvell, 1978).

The serieswise data on available micronutrient status in surface soils (Table 1) revealed that the availability of all the micronutrients was sufficient except that of Zn which represented about 21 per cent of overall deficiency. All the series had shown Zn deficiency where the highest per cent deficiency was observed in *Mahelaj* series (46.6%) followed by *Khadiyapura* (41.7%) and *Sokhada* (38.5%) series. In general, the soils of the different series were sufficient in available Fe except that of *Khadiyapura* (8.3%), whereas *Ankhi* and *Chaklashi* series had shown slight deficiency of only 1.0 per cent. The overall deficiency of Fe was also negligible (1.0%). Similarly, the soils were sufficient in available Mn except those of *Ratanpur* and *Tarakpur* series with 2.4 and 8.3 per cent deficiency, respectively. Similar was the case of available Cu where only *Mahelaj* series had shown a deficiency of only 2.3 per cent.

TABLE 1

Available micronutrients (ppm) in surface soils of different soil series in Mahi-Kadana Command Area.

Sr. No.	Soil Series	No. of samples	Iron	Manganese		Zinc		Copper		
				PSD*		PSD		PSD		PSD
1.	Ankhi (Ank)	290	4.3-41.3 (15.3)	1.0	2.7-92.3 (27.4)	0.0	0.05-7.34 (1.39)	11.4	0.9-10.0 (2.6)	0.0
2.	Ratanpur (Rtp)	41	7.6-42.4 (25.6)	0.0	8.7-90.6 (28.6)	2.4	0.26-4.30 (1.40)	12.2	0.4-8.6 (4.1)	0.0
3.	Khadiyalpura (Kdp)	24	4.0-19.2 (8.6)	8.3	5.7-93.8 (21.8)	0.0	0.29-3.89 (0.78)	41.7	0.4-2.8 (1.5)	0.0
4.	Sokhda (Skd)	13	7.5-34.0 (13.2)	0.0	12.1-73.4 (32.7)	0.0	0.24-5.09 (1.16)	38.5	1.2-4.0 (2.5)	0.0
5.	Mahelaj (Mhj)	88	10.5-34.5 (17.3)	0.0	5.7-59.0 (14.0)	0.0	0.20-5.18 (0.91)	46.6	0.1-7.0 (2.3)	2.3
6.	Tarakpur (Tkr)	11	9.4-15.2 (12.1)	0.0	3.8-24.5 (13.5)	8.3	0.29-3.09 (1.44)	8.3	0.3-3.9 (1.9)	0.0
7.	Matar (Mtr)	04	4.8-9.1 (7.0)	0.0	11.2-60.8 (25.3)	0.0	0.34-4.59 (1.10)	25.0	1.0-4.0 (1.4)	0.0
8.	Chaklasi (Cks)	112	4.7-40.5 (16.0)	1.0	6.5-69.5 (23.5)	0.0	0.11-4.49 (0.97)	22.3	0.8-4.0 (1.9)	0.0
		583	4.0-42.4 (14.4)	1.0	2.7-93.8 (23.4)	0.3	0.05-7.34 (1.15)	20.8	0.1-10.0 (2.3)	0.3

Figures in parentheses indicate mean value, * PSD - Per cent soil deficient

Soil deficient in Fe, Mn, Zn and Cu : Less than 5, 5, 0.5 and 0.2 ppm, respectively.

TABLE 2
DTPA-extractable Fe²⁺, Mn, Zn and Cu contents (ppm) in soil profile samples from Mahi-Kadana Command area.

Sr. No.	Soil depth (cm)	No. of Samples	Iron	Manganese		Zinc		Copper	
			PSD	PSD		PSD		PSD	
1.	0-25	583	4.0-42.4 (14.4)	1.0	2.7-93.8 (23.4)	0.3	0.05-7.34 (1.15)	20.8	0.1-10.0 (2.3)
2.	25-50	583	3.8-38.6 (12.8)	0.9	3.4-79.6 (20.3)	1.2	0.09-6.44 (1.12)	37.5	0.1-10.9 (2.0)
3.	50-75	583	3.3-34.2 (11.7)	0.5	2.0-84.5 (20.2)	1.2	0.06-6.55 (1.06)	39.7	0.1-8.4 (1.8)
4.	75-100	583	3.3-44.3 (11.2)	0.5	2.5-96.0 (19.6)	4.8	0.09-6.11 (1.19)	35.9	0.1-6.1 (1.8)
5.	100-150	440	3.3-37.1 (11.4)	1.1	2.0-88.7 (18.9)	3.7	0.11-5.53 (1.14)	33.2	0.1-8.3 (1.5)
Overall			3.3-44.3 (12.3)	0.8	2.0-96.0 (20.5)	2.2	0.05-7.34 (1.13)	33.4	0.1-10.9 (1.9)

* PSD - Per cent soil deficient

Figures in parentheses indicate mean value; Soil deficient in Fe, Mn, Zn and Cu : less than 5, 5, 0.5 and 0.2 ppm, respectively.

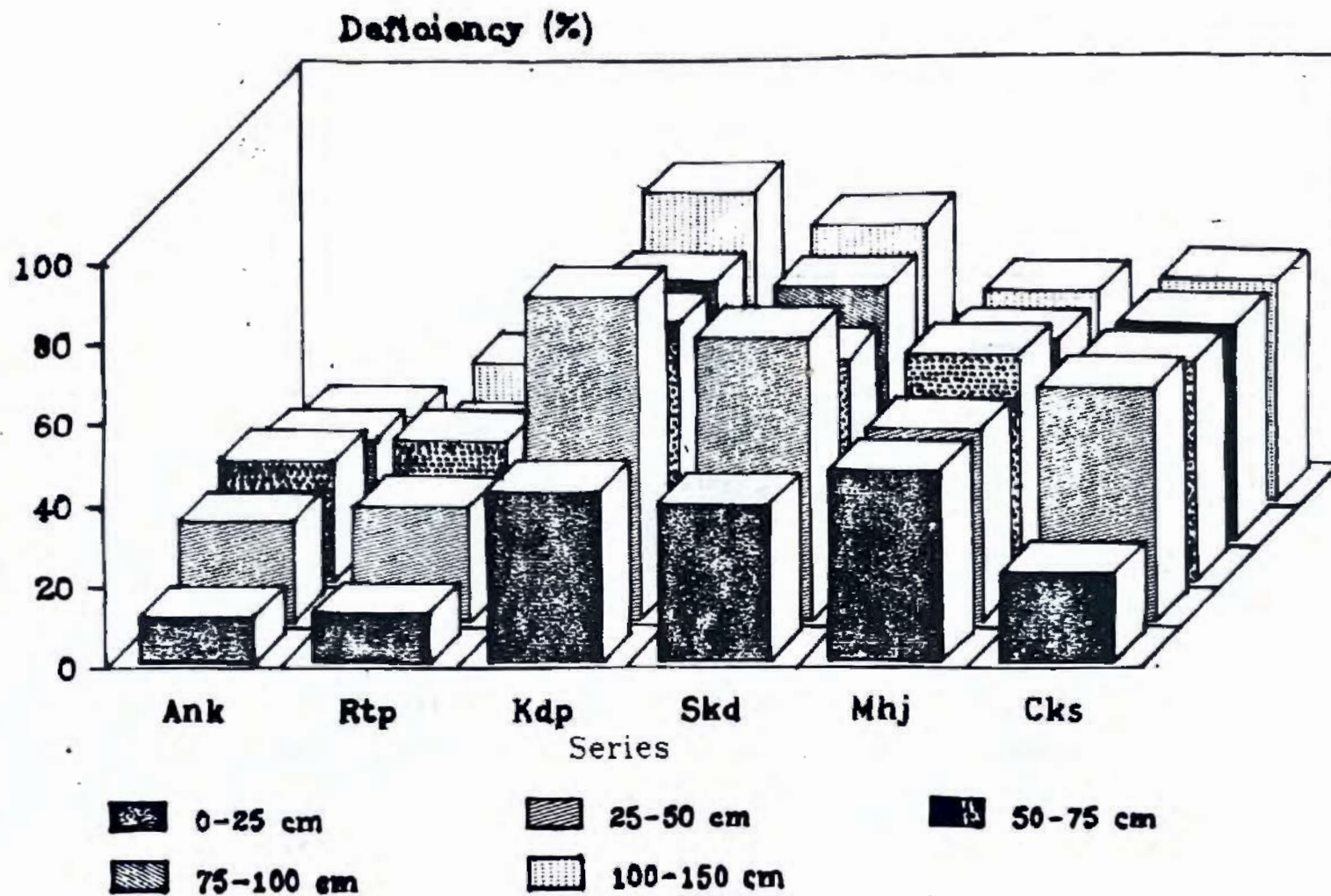


Fig. 1 : Distribution of Zn deficiency in soil series

The results of DTPA – extractable micronutrient cations in soil profiles are given in Table 2. The Fe content in the soils ranged between 3.3 and 44.3 ppm with an average of 12.3 ppm. Mean Fe content showed a decreasing trend with the increase in depth of the profile.

DTPA – extractable Mn varied from 2.0 to 96.0 ppm with a mean of 20.5 ppm. A decreasing trend in Mn content was observed with depth. The overall percentage deficiency was Fe 0.8 and Mn 2.2, whereas that for surface soils was 1.0 and 0.3, respectively.

The availability of Zn varied between 0.05 and 7.3 ppm with a mean of 1.13 ppm (Table 2). With increase in depth of the profile, the available Zn content did not maintain a regular trend. In about 21.0 per cent of the surface soil samples, the DTPA – extractable Zn was below the critical level of 0.5 ppm, whereas in sub-soils the overall deficiency was of 33 per cent.

Surface soils belonging to different series had relatively lower magnitude of Zn

deficiency than their corresponding sub-surface layers (Fig. 1). The top soils belonging to *Mahelaj* series (Vertic Ustochrepts) had the maximum Zn deficiency to the tune of 47 per cent, followed by 22 per cent in *Chaklashi* series (Fluventic Ustochrepts), whereas *Ratanpur* and *Ankhi* series (Vertic and Fluventic Ustochrepts) had deficiency of about 12 and 11 per cent, respectively. However, the overall mean per cent of deficiency for sub-soils of these series were not much different. Further, it was observed that the soils belonging to great group of Ustochrepts were more prone to Zn deficiency as compared to Ustorthents irrespective of their further classification into fluventic or vertic sub-groups.

The Cu – availability could be rated as quite adequate in majority of the soil samples from the command area. The mean Cu content of different profile layers was around 2.0 ppm. About 97 per cent of soils were adequate in available Cu.

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Effect of Bunding Methods on Soil Properties and Yield of Soybean in Medium Black Soils of Madhya Pradesh

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Operational research project on dryland agriculture could play a vital role in changing the cropping pattern of the area to one that approaches optimum production. Contour bunding installed in the area on slopy land under the watershed management programme helped to check soil erosion (Anon. 1993) as well as available nutrients.

An experiment was conducted in farmer's field during 1990 in slopy (2.5%) medium black soils. Three bunding methods (control, vetiver and graded) were tested at eight places of Thoona, Pachama, Fanda and Tumbda villages of Sehore and Bhopal districts. Bunds were made on contour line. The data were statistically analysed in randomized block design. After three years of installation of bund, yield of soybean was recorded and soil samples were collected and analysed for pH, EC, organic carbon, calcium carbonate, available N, P and K as per method described by Jackson (1973), bulk density (Singh 1980), water holding capacity

(Piper 1986), available S by Turbidimetric method (Steinbergs (1953), available B by curcumin method (Bergarland & Troug 1944), available Zn, Cu, Fe and Mn by DTPA method (Lindsay & Norvell 1978) on atomic absorption spectrophotometer.

Perusal of the data in the table showed that the higher level of organic carbon, available N, K, S, Zn, Cu, Fe and Mn water holding capacity of soil and crop yield were recorded in vetiver bund and these were at par with graded bund over control. While, electrical conductivity (1.13 ds/m), available P (10.67 kg/ha) and soil deposition were highest in graded bund, lower values of electrical conductivity (0.79 ds/m) and available P (8.69 kg/ha) were found in vetiver bund and control, respectively. Calcium carbonate, bulk density and available B decreased by vetiver bund over control at par with graded bund. It indicate that the vetiver bund check the soil loss. Rain water with excess salts were sieved. Anon. (1993) reported that the magnitude of average cumulative soil deposition become constant and equal to 11.3 cm for vetiver barrier in the period of six rainy seasons. The stagnation of rain-water in the field of graded bund, salts were collected from other fields and decreased the availability of nutrient and water holding capacity. pH of soil remain unchanged due to any treatments.

TABLE 1

Effect of bunding methods in soil properties and yield of soybean.

Treatment	pH	EC (dS/m)	Org.C (g/kg)	CaCO ₃ (%)	Water holding capa- city (volume basis)	Bulk den- sity (gCm ⁻³)	Available nutrients									Soil depo- sition (cm)	Soy- bean grain yield (q/ha)
							Major (kg/ha)			Minor (mg/kg)							
							N	P	K	S	B	Zn	Cu	Fe	Mn		
Initial value	7.7	1.00	4.5	10.0	35.00	1.30	200.0	9.24	456.50	9.00	0.40	0.50	0.20	4.0	3.0	--	--
Control	7.8	1.04	4.5	10.5	34.75	1.35	196.0	8.69	431.10	8.50	0.45	0.46	0.25	4.5	2.5	0.0	8.4
Vetiver bunding	7.7	0.79	6.5	8.5	40.75	1.15	241.3	10.45	483.48	11.69	0.25	0.66	0.45	7.5	4.5	8.5	12.7
Graded* bunding	7.8	1.13	5.4	9.5	38.75	1.25	214.6	10.67	451.31	9.50	0.34	0.56	0.35	6.5	3.5	9.4	10.1
CD (C = 0.05)	NS	0.11	0.14	0.27	1.21	0.057	6.55	1.31	11.23	1.12	0.041	0.059	0.047	0.60	0.57	NS	1.2

It may be concluded from the foregoing discussion that vetiver bund improve the

physical and chemical condition of soil, and also increased the crop yield.

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Biochemical Factors of Resistance in Little Leaf Disease in Egg Plant (*Solanum melongina* L.)

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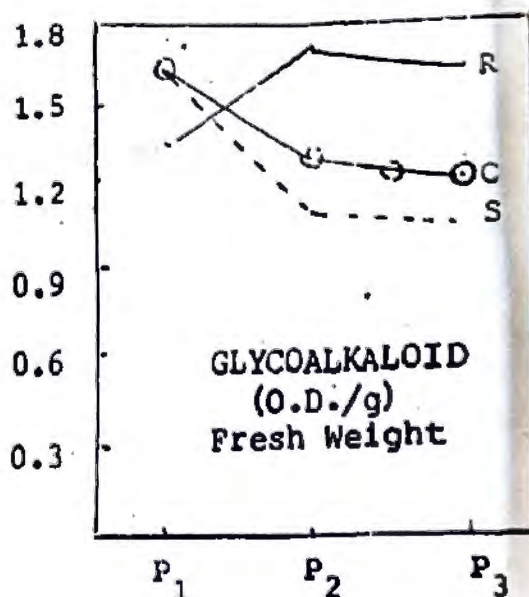
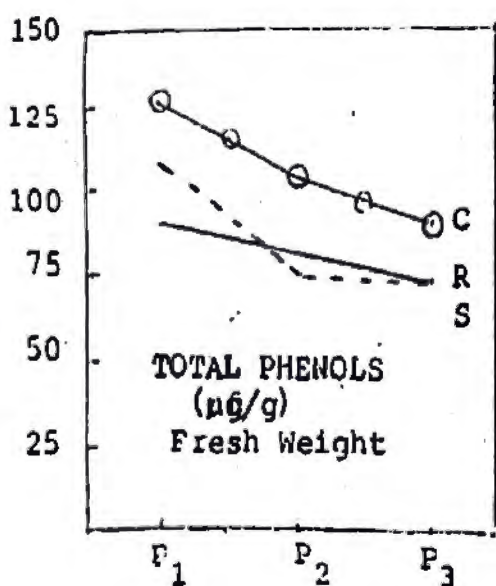
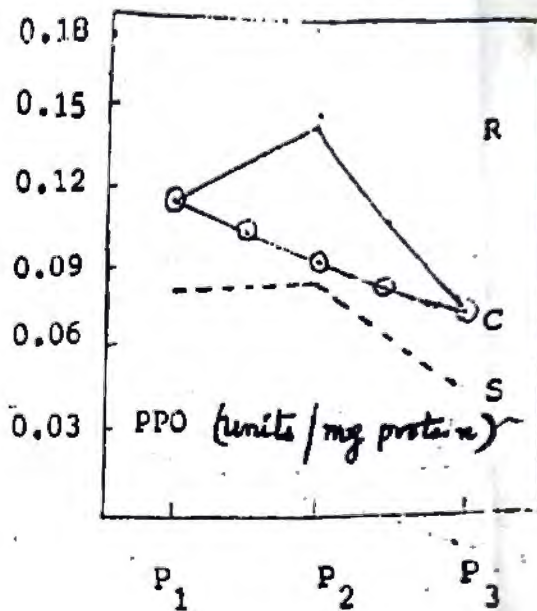
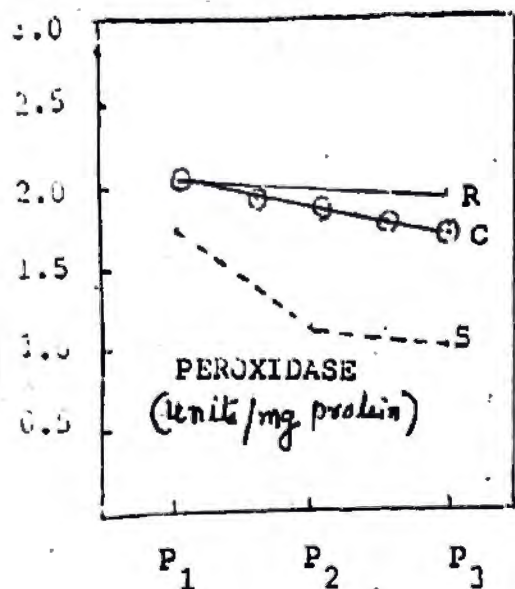
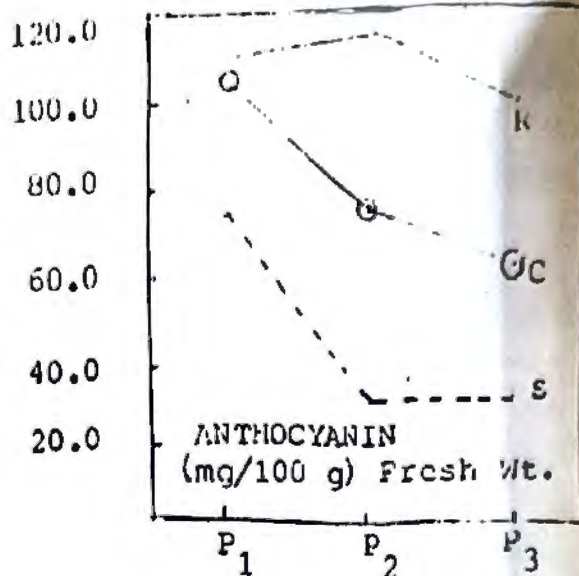
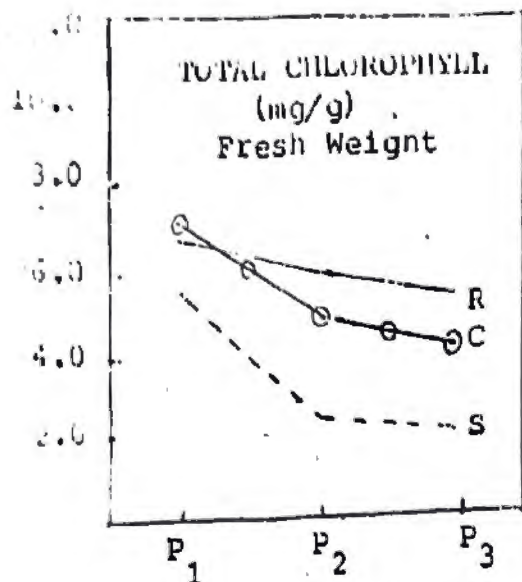
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Egg plant (brinjal) is an important vegetable crop of India. The crop is affected by many pests and diseases of which little leaf disease is an important economic pest. It is caused by mycoplasma like organism (MLO) transmitted by leaf hoppers. Diseased plants show extreme reduction in size of their leaves and nodes giving a bushy appearance. In heavily infected plants flowers and fruit setting become negligible, seriously bringing down the productivity.

In order to elucidate the biochemical factors leading to resistance to this dreaded disease, leaf tissues of a resistant variety (PN-1), a susceptible variety (Morvi 4-2) and their F_1 cross were analysed from field crops grown in experimental field of the College Farm in 1990. Leaf samples were collected at three stages of development: (1) first flowering stage before the onset of disease, (b) at the peak disease period and (c) at the last stage of fruit harvest.

Tissue analyses were done for plant pigments; chlorophyll following the method of Holden (1976) and anthocyanin by Ranganna (1976), enzymes like polyphenol oxidase (PPO) by Malik and Singh (1980) and peroxidase by Guibaults (1976), secondary metabolites like total phenols by Malik and Singh (1980) and glycoalkaloid by Curries and Kuc (1975). Protein for enzyme specific activity estimated from enzyme extract by Lowary *et al.* (1951) and expressed as units/mg protien (1 unit of enzyme = Change in O.D./min). The results are presented in Figure 1.

Ontogenic changes followed by the normal pattern of decrease except anthocyanin, PPO and glycoalkaloid content. PPO and glycoalkaloid increased significantly while anthocyanins remained unaltered in the peak period of disease in resistant plant PN-1. As illustrated in the figure, there was very marginal difference in chlorophyll and peroxidase activity in both the varieties before the onset of disease. With the advance in disease symptom, these constituents showed rapid decrease in infected variety as compared to resistant type. Reduction in chlorophyll in MLO infected plant may be due to inhibition of chloroplast development or stimulation of cell enzyme which attacks chlorophyll. Similar loss of chlorophyll pigments has been noted in chilles infected by CMV (Mishra



P₁ = Prior to disease; P₂ = Peak disease period; P₃ = After disease before harvest

PN - 1 (R)
(Resistant)

P₁ - Cross (C)

MORVI 4-2 (S)
(Susceptible)

and Jha, 1967; Joshi and Dubey, 1975). Sarkar and Joshi (1978) observed decrease in peroxidase activity at the later stage of infection in susceptible variety. Similar trend was observed in the present investigation. The pattern of change of total phenol was different, while the susceptible variety had higher content than the resistant type at the pre-infection stage. At post-infection stage, the varietal difference was negligible making the rate of change less rapid in resistant variety. Singh (1986) suggested production of common phenolics and their accumulation proceeds at a faster rate in resistant variety than in susceptible variety. Similar observation was recorded by Mitra and Mozumder (1978) in pusa purple long resistant variety of brinjal.

The changes in F_1 -cross always showed intermediate behaviour signifying the potentiality of simple inheritance character of these chemical moieties except total phenols which had the maximum content at all three stages.

The most conspicuous change leading to the resistance character in PN-1 appear to be rapid accumulation of glycoalkaloid in leaf tissue at the peak disease period. The significance of glycoalkaloid against disease attack was noted by many scientists in

potato which belongs to same solanaceae family as brinjal (Siden *et al.*, 1973; Mazurczyk and Kuzniewics, 1987). Although no works have been reported in literature on the role of glycoalkaloid in relation to little leaf disease occurrence in brinjal. The present investigation shows that glycoalkaloid increases significantly during the peak disease occurrence period in resistant variety PN-1 but decreases in susceptible variety Morvi 4-2 suggesting its most probable involvement in imparting resistant character. Antifeedant bio-activity of glycoalkaloid – Solanine present in potato tubers has been reported by Dahlman and Hibbs (1967). High level of anthocyanin may be another important factor imparting resistance to PN-1. There was a rapid reduction of anthocyanin content in susceptible variety Morvi 4-2 at peak period of disease infection stage; after that the change was negligible. In resistant variety, on the other hand, anthocyanin level was always high; slight decrease was observed at late stage of plant ontogeny. Anthocyanins are phenolic glycosides. The aglycone part consists of many phenolic compounds like phlorogucinol, p-hydroxy benzoic acid, protocatechuic acid and gallic acid. These phenolic compounds are probably further oxidised and polymerized due to the pre-existing high level of PPO and peroxidase

TABLE 1

Phenols and glycoalkaloid content in brinjal fruit.

Variety	Glycoalkaloid (O.D./g)	on Fresh Wt. Basis
		Phenols (ug/g)
PN-1 (Resistant)	0.384	25.63
Morvi 4-2 (susceptible)	0.493	27.45

in resistant variety giving rise to highly lignified tissues unsuitable for the proliferation of mycoplasma.

Fruit analysis from the infected and resistant plants showed that phenols and glycoalkaloids were less in PN-1 and more in Morvi 4-2 (Table 1). Since phenols give discolouration of cut-fruit and glycoalkaloid

imparts bitter taste in brinjal (Bajaj *et al.*, 1979), these two constituents comprise negative attributes to fruit. Viewed from the above quality standard, the resistant variety produced superior fruit quality in comparison with the infected susceptible variety.

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Stress Degree Days (SDD) in Relation to Yield of Potato (CV. Kufri Badshah JF - 4870)*

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Field experiments were conducted during two consecutive Rabi seasons of 1991-92 and 1992-93 at College Agronomy Farm, Gujarat Agricultural University, Anand in a split plot design. Main plots consists three dates of planting (3rd November — D_1 , 16th November — D_2 and 30th November — D_3) with sub-plots having four irrigation levels (irrigation when available soil moisture-ASM reached a value of 75% of the total ASM- I_1 , irrigation when the ASM reached a value of 50% of the total ASM- I_2 , irrigation at 10 to 12 days interval- I_3 and irrigation when canopy-air temperature differential ($T_c - T_a$) ranged between $\pm 1^\circ\text{C}$ - I_4). Other package of practises were followed as per the recommendation. Infra-red thermometer (AG-42) was used to measure the daily canopy temperature and canopy-air temperature differential at 1400

hours for determining stress degree days (SDD) for different phenophases of the crop.

Salient features of the results of SDD are presented in Table-1 and indicate that period from early vegetative phase and tuber initiation to end of vegetative phase and tuber development ($R_2 - R_1$) exhibited significant negative correlation with SDD for both, tuber as well as total biomass. This clearly indicated that the yield of potato is more sensitive to water stress during the period of 20 days after early vegetative phase and tuber initiation i.e., the period coinciding with late vegetative phase and tuber development. This conclusion is in agreement with that arrived at by Moorby and Milthorpe (1975), Walfe *et al.*, (1963) and Doorenbos and Kassam (1979).

The appereance of positive correlation between SDD at stage R_1 in 1991-92 could, however, be attributed to the exposure of the instrument to the soil rather than leaves due to poor plant population.

For the purpose of predicting crop yields regression equation was worked out (pooled for 2 years) of cumulative SDD from

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stage R_1 to stage R_2 i.e., ($SDDR_2 - SDDR_1$) versus the values of tuber production at physiological maturity is as shown below :

$$Y = 3.301 - 0.028 \Sigma (SDDR_2 - SDDR_1) \\ (R_2 = 0.72)$$

where Y = predicted tuber yield ($Kg M^{-2}$)

This shows that SDD from the stage R_1 to stage R_2 was found to be significantly

correlated with tuber yield. It is also, a convenient method to identify the critical stage with respect to need for water and to estimate the magnitude of yield reduction due to stress at a particular stage. This suggests that there should be no water stress during the period of 20 days after early vegetative phase and tuber initiation for better yields of potato.

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TABLE 1

Correlation coefficients between stress degree days (SDD) at some important crop growth stages and tuber/total biomass at physiological maturity for 1991-92, 1992-93 and pooled.

Cumulative SDD	1991-92		1992-93		Pooled	
	Tuber yield	Total biomass	Tuber yield	Total biomass	Tuber yield	Total biomass
$SDDR_1$	0.25	0.38	-0.46	-0.32	-0.14	0.30
$SDDR_2 - SDDR_1$	-0.98*	-0.95**	-0.81**	-0.58*	-0.85**	-0.85**
$SDDR_3 - SDDR_2$	-0.15	-0.18	-0.31	-0.48	-0.08	-0.15
$SDDR_4 - SDDR_3$	-0.21	-0.11	-0.41	-0.48	-0.15	-0.07
*Significant at 5% level ** Significant at 1% level						
$SDDR_1$	:	Cumulative SDD from emergence stage (VE) to tuber initiation stage (R_1)				
$SDDR_2 - SDDR_1$	:	Cumulative SDD from stage R_1 to canopy closure stage (R_2)				
$SDDR_3 - SDDR_2$	:	Cumulative SDD from stage R_2 to tuber bulking stage (R_3)				
$SDDR_4 - SDDR_3$	:	Cumulative SDD from stage R_3 to physiological maturity stage (R_4)				

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Biology and Relative Proportions of *Brachymeria* Pupal Parasitoids of *Opisina arenosella*

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Among six species of *Brachymeria* parasitising the pupae of coconut leaf eating caterpillar, *Opisina arenosella* Wlk., *Brachymeria nephantidis* Gahan and *B. lasus* Walker are found the most effective species under Mahuva conditions of Gujarat State during the year, 1984-85. Joy and Joseph (1973) reported *B. nosatoi* Habu, and *B. nephantidis* Gahan as the most important pupal parasitoids of the pest. Very little information on the biology of these species is available from the published literature. Some studies on the biology of *B. nephantidis* as pupal parasitoids of the pest has been done by Satpathy and Rao (1972) and Joy and Joseph (1973), but no work on the biology of both the parasitoids has been done in Gujarat. Therefore, the present studies on biology and relative intensity of parasitisation of parasitoids, *Brachymeria nephantidis* and *B. lasus* were made under Mahuva conditions. The results obtained from these studies are presented in the paper.

Initial culture of *B. nephantidis* and *B. lasus* for biological studies was obtained from field collected *Opisina* pupae kept under observations for parasitoid emergence. The adults of both the species were distinguished by an identical coloured mark on the tibiae of hind legs. Further one pair of parasitoid was confined in a glass tube measuring 10 x 2.5 cm. Honey was provided as food for parasitoids which were kept on a piece of wax coated paper. The tube containing parasitoids were kept in subdued sunlight (to stimulate mating) for 10-15 minutes daily for about 3-4 days after which only the host pupae were offered for oviposition. The parasitised host pupae were replaced daily by freshly host pupae. The parasitised pupae were transferred in conical flask and kept for adult emergence. Emergence of parasitoids from total exposed host pupae was counted as fecundity of a single female parasitoid. The study was carried out under room temperature varied 22.8 to 31.7°C and relative humidity 22 to 70 per cent. Egg to adult period, fecundity, longevity and sex ratios of both the parasitoids were recorded (Table 1).

For determining the relative intensity of parasitism of both the parasitoids, the collections of *Opisina* pupae were made from the infested coconut orchards at Plantation Crops Research Station, Mahuva at regular

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TABLE 1

Biology of *Brachymeria nephantidis* and *B. lasus* when reared on *Opisina arenosella*.

Particular	Nos. observed	<i>B. nephantidis</i>		Nos. observed	<i>B. lasus</i>	
Egg-adult period (days)	18	21.13	(20.24)	17	17.29	(17-18)
Longevity (days)				5	54.60	(49-69)
Female	5	46.80	(23-68)	5	45.20	(37-66)
Male	5	37.20	(11-65)			
Fecundity (eggs/female)	5	22.40	(10-38)	5	39.80	(27-52)
Sex ratio (Female : Male)	112	1.24 : 1.00		232	1.00 : 5.63	

*Figures in parenthesis indicate the range.

intervals atleast on 15th each month. The pupae collected were kept in conical flasks for daily observation on emergence of adult and parasitism/month was worked out. Percentage

TABLE 2

Parasitism and sex ratio of *Brachymeria nephantidis* and *B. lasus* during different months of the year, 1985-86.

Month	No. of pupae observed	Total parasitism (%)	Parasitism (%)		Sex ratio (Female : Male)	
			<i>B. nephantidis</i>	<i>B. lasus</i>	<i>B. nephantidis</i>	<i>B. lasus</i>
Sept. - October, 85	542	14.02 (76)*	1.47 (8)	12.55 (68)	1.67 : 1.00	1.00 : 2.16
November, 85	450	26.00 (117)	6.22 (28)	19.78 (89)	1.15 : 1.00	1.00 : 2.00
December, 85	777	4.76 (37)	3.49 (27)	1.27 (10)	1.86 : 1.00	1.00 : 1.00
January, 86	600	9.33 (56)	8.02 (49)	1.31 (7)	1.58 : 1.00	1.33 : 1.00
February, 86	35	20.00 (7)	20.00 (7)	0.00 (0)	2.50 : 1.00	0.00 : 0.00
March, 86	163	12.88 (21)	10.43 (17)	2.45 (4)	1.43 : 1.00	3.00 : 0.00
April, 86	33	12.12 (4)	12.12 (4)	0.00 (0)	0.00 : 0.00	0.00 : 0.00
May, 86	145	7.58 (11)	7.58 (11)	0.00 (0)	1.20 : 1.00	0.00 : 0.00
June, 86	94	0.00 (0)	0.00 (0)	0.00 (0)	0.00 : 0.00	0.00 : 0.00
July, 86	173	1.73 (3)	1.73 (3)	0.00 (0)	0.00 : 3.00	0.00 : 0.00
August, 86	30	0.00 (0)	0.00 (0)	0.00 (0)	0.00 : 0.00	0.00 : 0.00

Figures in parentheses indicate the actual number of pupae parasitised by individual species.

of total parasitisation by individual species of parasitoids were recorded every month of the year, 1985-96. Sex ratios of both parasitoids were also recorded monthly. Data collected are presented in Table 2.

1. Biology

(a) Egg-adult period

The duration of egg to adult emergence of *B. nephantidis* was on average 21.23 days, having range of 20-24 days while they were 17.29 days with a range of 17-18 days in case of *B. lasus*. Satpathy and Rao (1972) reported the development period of immature stages of *B. nephantidis* to be 16-18 days. The similar period in case of *B. lasus* was also reported by Joy and Joseph 1973.

(b) Fecundity

Fecundity of *B. nephantidis* was on an average 22.40 with a range of 10-38 and 27-52 with an average of 39.80 in case of *B. lasus*. Thus *B. lasus* had the higher fecundity than *B. nephantidis*. According to Satpathy and Rao (1972), *B. nephantidis* female laid 15-23 eggs during its life-span.

(c) Longevity

The females and males of *B. nephantidis* survived for 23-68 and 11-65 days with an average of 46.80 and 37.20 days, respectively, whereas in case of *B. lasus* females and males survived for 49-69 days and 37-66 days with an average of 54.60 and 45.20 days, respectively. Joy and Joseph (1973) reported the longevity of females and males of *B. nephantidis* to be 40-80 and 25-60 days, respectively and 40-70 and 20-50 days, respectively in case of *B. nosatoi*.

(d) Sex ratio

The sex ratios of *B. nephantidis* and *B. lasus* was observed to be 1.24 females : 1 male and 1 female : 5.63 males, respectively when they were reared in laboratory. Under field conditions the females of *B. nephantidis* outnumbered males almost all the months of the year except April and July while in case of *B. lasus* males outnumbered females in September - October and November and onward females preponderated to males in the active months. Joy and Joseph (1973) reported that *B. nosatoi* females slightly outnumbered males (54 females : 49 males) in the field conditions.

2. Relative intensity of parasitism

Observations on the parasitism by *B. nephantidis* and *B. lasus* during different months of the year, 1985-86 are presented in Table 2. It is clear that parasitism by *B. lasus* dominated (12.55 - 19.79%) over *B. nephantidis* (1.47 - 6.22%) during the month of September to November and onward *B. nephantidis* was found dominant (2.32 - 20.00%) over *B. lasus* (1.27 - 2.45%). *B. lasus* disappeared in the months of April to August while the parasitism by *B. nephantidis* was observed in more or less of same intensity throughout the year.

Pillai and Nair (1981) reported that the aggregate parasitism of *Opisina* pupae at Kayangulam area was 51.73 per cent which included 29.60% by *B. nosatoi*, 13.90% by *B. nephantidis* and 0.62% by *B. lasus*. They also reported that *B. nephantidis* maintained a more or less steady population almost throughout the period.

The study concluded that *B. lasus* was found to be preponderated to *B. nephantidis* for short development period, higher fecundity and field activity. Joy *et al.*, (1978) reported also the shorter development period for *B. lasus* (10-17 days) as compared to *B. nephantidis* (13.-18 days).

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Chemical Control of Seed Midge (*Systole albipennis* Walker) Infesting Stored Fennel

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The fennel (*Foeniculum vulgare* Miller) is one of the important spices crops cultivated in Gujarat. The seed midge (*Systole albipennis* Walker) belonging to family eurytomidae, order hymenoptera, is a serious pest of stored fennel (Subba Rao and Bhatia, 1963; Gupta, 1962; Butani and Mittal, 1989). The infestation starts from field condition through deposition of eggs in immature fruits. The larvae continue to develop in seed and adults are found to emerge during storage. The infested seeds, show the circular exit holes through which the adults of the pest emerged out. Thus, this makes it difficult to identify the pest infestation under the field condition as well as during early stages of storage. The feeding by larva renders the seeds hollow and consequently reduced the weight of seeds. The infestation varies from 16 to 19 per cent and thus the value of seeds is reduced up to 40 per cent. (Butani and Mittal, 1989). According to Patel *et al.*, (1986) the pest activates from March to September in stored seeds and cause, as high as 20.7 per cent loss in weight of seeds. The

pest can be managed by application of insecticides on standing crop which destroys the adult wasps depositing their eggs in immature seeds. The present study was therefore carried out to know the most effective insecticides against seed midge, *Systole albipennis* W.

The experiment was conducted at departmental farm, Junagadh in randomized block design with seven treatments including control and replicated thrice during the year 1990. The crop was seeded on 14-09-90. The first picking of seeds was made on 10-02-91. The variety used was PF-35. All other agronomical practices were adopted as per the recommendations in vogue. The treatments tried were endosulphan 0.07 per cent, methyl parathion 0.025 per cent, monocrotophos 0.036 per cent, methyl-o-demeton 0.025 per cent, thiometon 0.03 per cent and DDVP 0.05 per cent. The first spraying was carried out at the time of emergence of flowers and the subsequent three at 15 days interval. Before flowering, the crop under experiment was kept free from insect-pests infestation i.e., jassids and thrips by spraying conventional insecticide dimethoate 0.03 per cent. The spray solution required was estimated by spraying the known quantity of water on control plot. After harvesting of crop, the sample of hundred grams of seeds of fennel was collected from

each plot of the treatments. The samples thus collected were kept under observations for the emergence of adult wasps up to nine months. Randomly, thousand seeds from each of the

samples of 100 gms were observed for the infestation of midge. The seeds exhibiting circular exit holes were considered as infested seeds. The treatment wise per cent infestation

TABLE 1

Effect of different insecticides on per cent infestation of midges (*Systole albipennis* Walker) and yield/ha in fennel seeds during storage.

Treatments	Percentage of infestation due to seed midges	Weight of healthy seeds (kg/ha)
1. Endosulphan 0.07 per cent	16.27* (7.85)**	1293.98
2. Methyl parathion 0.025 per cent	14.53 (6.29)	1386.57
3. Monocrotophos 0.036 per cent	17.12 (8.66)	1631.94
4. Methyl-o-demeton 0.025 per cent	18.67 (10.24)	1671.30
5. Thiometon 0.03 per cent	20.43 (12.19)	1578.70
6. DDVP 0.05 per cent	15.40 (7.05)	1230.32
7. Control	27.57 (21.42)	820.60
S. Em. ±	0.730	56.306
C. D. at 5%	2.250	173.511
C.V %	6.809	7.099

*Data after angular transformation.

**Figures in parentheses are retransformed values.

due to midge was worked out. The data thus obtained were subjected to statistical analysis after angular transformation. The weight of healthy seeds was estimated on the basis of per cent infestation. The result thus obtained are presented in Table 1.

The result (Table 1) showed that the insecticidal treatment have significantly reduced the infestation due to seed midge over control. The lowest per cent infestation was recorded in plots treated with methyl parathion 0.025 per cent (6.29 per cent) followed by DDVP 0.05 per cent (7.05 per cent), endosulphan 0.07 per cent (7.85 per cent), monocrotophos 0.036 per cent (8.66 per cent), methyl-o-demeton 0.025 per cent (10.24 per cent) and thiometon 0.03 per cent (12.19 per cent), while in control it was recorded as 21.42 per cent. However, the treatment of methyl parathion 0.025 per cent, endosulphan 0.07 per cent and DDVP 0.05 per cent were found equally effective in reducing the damage due to midges.

The result (Table 1) also showed that the yield of healthy seeds was significantly increased in all the insecticidal treatment over control. However, the highest yield of 1671.30 kg/ha was obtained in the treatment of methyl-o-demeton 0.025 per cent followed by monocrotophos 0.036 per cent (1631.94 kg/ha), thiometon 0.03 per cent (1578.70 kg/ha), methyl parathion 0.025 per cent (1386.57 kg/ha), endosulphan 0.07 per cent (1293.98 kg/ha) and DDVP 0.05 per cent (1230.32 kg/ha). While in control it was

recorded as 820.60 kg/ha. The insecticides methyl-o-demeton 0.025 per cent, monocrotophos 0.036 per cent and thiometon 0.03 per cent were found equally effective in increase of weight of healthy seeds. Perhaps, this might be due to control of severe attack of aphids at flowering stage. Mittal and Butani, (1989) have also reported that the treatment of methyl parathion 0.025 per cent, endosulphan 0.07 per cent and DDVP 0.05 per cent proved effective in control of aphids.

The insecticides applied at flowering stage on standing crop proved effective in minimization of infestation due to seed midges during storage of fennel. The treatment of methyl parathion 0.025 per cent, endosulphan 0.07 per cent and DDVP 0.05 per cent was found to be the most effective in reduction of damage due to midges. While the treatment of methyl-o-demeton 0.025 per cent, monocrotophos 0.036 per cent and thiometon 0.03 per cent proved effective in increasing the weight of healthy seeds. Thus, it can be concluded that these three treatments should be applied at flowering stage on standing crop of fennel to minimize the infestation due to seed midges during storage.

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Population Dynamics of Aphid (*Aphis gossypii* Glover) on Coriander in Relation to Ecological and Biological Parameters

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Coriander (*Coriandrum sativum* Linnaeus) commonly known as *Dhania* is an important spice crop. The entire young plant is used in preparing of chutney whereas, the leaves are used for flavouring the curries, sauces and soups. Dry fruits are extensively used in the preparation of curry powder, pickling spices, sausages, seasoning and *dhanadal*. Among the insect pests, aphid is the most predominant one and reduces the yield of coriander fruits to a tune of 5.30 q/ha (Mittal and Butani, 1989). The ecological approach to the pest management suggests the use of pesticides only when and where necessary. It has become therefore, absolutely imperative that a fresh approach to pest management be undertaken by studying its population fluctuations in relation to ecological factors.

In order to determine the population fluctuations of aphids, the crop was seeded in

November, 1990 at the College Farm, College of Agriculture, Junagadh. Five quadrates of 2 x 2 square meter were randomly fixed in coriander field. Absolute population of aphids was recorded from 25 randomly selected and tagged plants from each quadrate. The population of aphids was recorded till the harvest of the crop. The population of aphids was estimated by adopting zero to four grade through the observations made on leaves, twigs and umbels. The following indices were fixed for estimation of population :

Indices	Description
0	Plant free from aphids.
1	Aphids present but colonies did not build up. No injury due to pest apparent on the plant.
2	Small colonies of aphids were present.
3	Large colonies of aphids were present on tender parts, in colonies where counts of aphids were possible and tender plant parts showed the damage symptoms due to aphids.
4	Entire plants were covered by aphids. Counts of aphids in colonies were impossible and plants showed the damage symptoms due to aphids. The average aphid grade was worked out by adopting the following formula :

TABLE 1

Effect of abiotic and biotic factors on population of *A. gossypii*.

Standard week	Date of observation	Av. aphid population (Grade/Plant)	Av. population of adults and larvae of coccinellid predators [†] (No./Sqm)	Temperature (°C)		Relative humidity (%)		Sunshine (hrs)
				Min.	Max.	Min.	Max.	
49.	09-12-1990	0.08	00.00	15.9	32.8	36	74	8.3
50	16-12-1990	0.20	00.00	10.3	31.0	23	75	9.2
51	23-12-1990	0.52	00.00	12.9	29.6	26	63	9.3
52	30-12-1990	1.16	00.20	11.6	29.4	28	71	8.5
1	06-01-1991	1.40	02.60	5.0	24.7	17	64	9.2
2	13-01-1991	1.92	07.00	9.8	16.4	26	55	9.5
3	20-01-1991	2.08	12.00	10.0	28.1	13	40	9.7
4	27-01-1991	2.56	16.40	12.6	34.5	19	69	9.7
5	03-02-1991	2.12	18.20	18.6	31.0	25	77	9.5
6	10-02-1991	1.76	18.00	13.6	33.5	25	71	9.7
7	17-02-1991	1.76	08.80	12.4	28.2	18	43	8.5
8	24-02-1991	0.08	00.00	13.0	31.3	23	65	8.7
9	03-03-1991	0.00	00.00	15.5	32.6	21	66	9.9
Correlation			0.8486	-0.1474	-0.1465	-0.3918	0.2340	0.4496

** Significant at 1 per cent level.

† Consolidated population of *C. septempunctata*, *C. transversalis* and *M. sexmaculatus*.

$$\text{Average aphid grade per plant} = \frac{0N + 1N + 2N + 3N + 4N}{\text{Total number of plants observed}}$$

Where 0 1 2 3 4 are the aphid indices

N = Number of plants showing respective aphid index.

The population of coccinellid predators was also recorded. The weather parameters viz., temperature, relative humidity and sunshine hours were also recorded.

Seasonal abundance and population fluctuations of aphids on coriander crop from 25 randomly selected plants of coriander field (Table 1) revealed that the infestation of aphids on coriander commenced in the second week of December and the population increased up to the last week of January. The highest population was observed during the

month of January and February. The pest population assumed its peak from quite a few days in to 2.56 grade/plant on 27th January, 1991 and thereafter it continued to decline up to the crop harvesting time.

The coccinellid predators viz., *Coccinella septempunctata*, *Linnaeus C. transversalis*, Egg Fabricius and *Menochilus sexmaculatus*, Sri Fabricius appeared on the crop in the last week of December and maintained their increasing trend up to the first week of February. Thereafter the population of coccinellid predators declined and the decreasing trend continued up to the last week of February, where coccinellids totally disappeared.

Ecological parameters

The results (Table 1/Figure 1) revealed that the pest was able to multiply rapidly even at the low temperature. The results clearly indicated that among the different weather

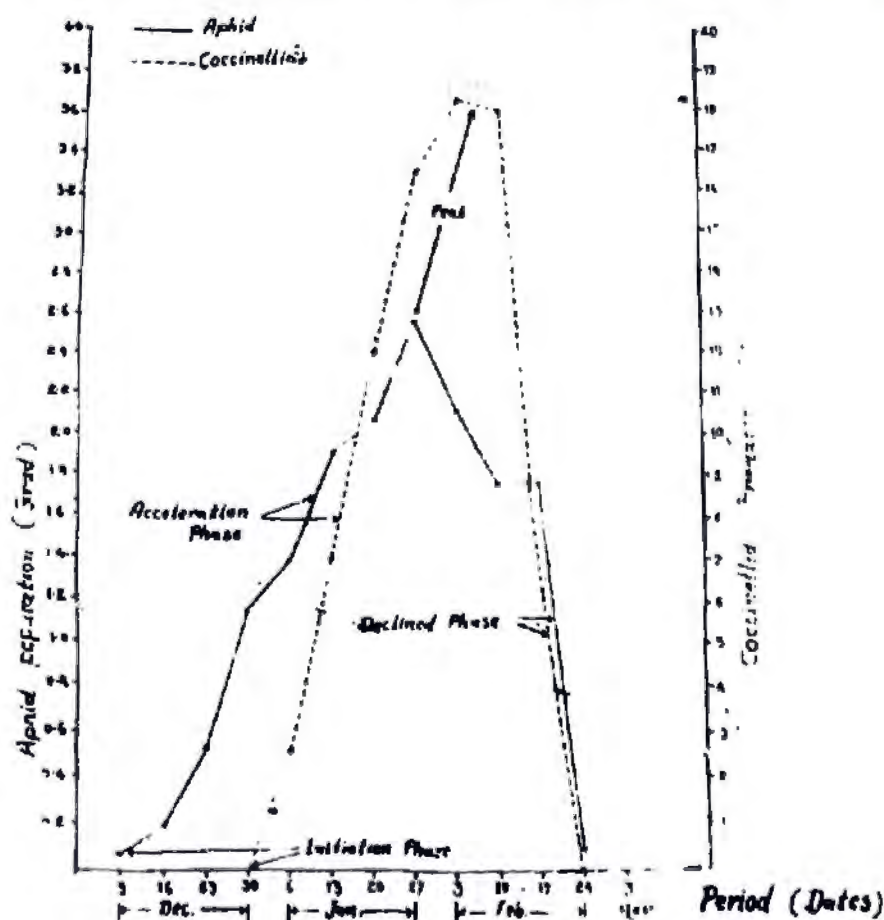


Fig. 1 : Population fluctuation of aphids in relation to biological parameters.

parameters, the maximum and minimum temperature and minimum relative humidity had negative effect on the population of aphids. The maximum relative humidity and sunshine hours had positive effect on population of aphids. The correlation studies have clearly indicated that the aphid population was found to increase with decrease in minimum temperature. The increasing trend of maximum temperature had shown the decreasing trend of population of aphids from the last week of January to the last week of February. The other weather parameters have no marked effect on the population. The correlation study between aphid population and physical factors indicated the nonsignificant effect on population of the aphids. Becquer and Ferrandiz (1983) reported that the population of aphids in bean was found to be negatively correlated with relative humidity. Araujo and Sales (1985) claimed that the population dynamics of *A. gossypii* on cotton were not affected by the minimum, maximum or mean temperature. They also reported that the increase in population has been favoured by sunshine. Thus, the present findings are more or less similar to that of earlier workers.

Biological parameters

An attempt was also made to understand the role of coccinellid predators on population

fluctuation of the aphids on coriander crop. The coccinellid predators were found to appear after three weeks from the incidence of *A. gossypii* on coriander crop. The study clearly indicated that the population of coccinellid predators had positive effect on the population of aphids. The correlation studies have clearly indicated that the population of coccinellid predators was found to increase with the increased population of aphids initially. Thereafter, the population of aphids decreased suddenly from 2.56 aphid grade. The highest population of aphids was observed in the last week of January, while the highest population of coccinellid predators was recorded in the first week of February. Thereafter, the population of both predators as well as their host declined. The population of coccinellid predators and aphids showed the highly significant positive correlation. Gravena *et al.*, (1976) also reported that the population of coccinellid predators was positively correlated with the aphids. Chandra and Kushwaha (1987) reported that the predators *C. septempunctata* and *M. Sexmaculatus* actively suppressed the pest population after two to four weeks of their incidence. Thus, the present findings are more or less similar to that of earlier workers.

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Variability Parameters in Highly Heterogeneous Populations of Pigeonpea

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Assessment of the genetic variability in the base population is the first step in any breeding programme. The knowledge of nature and magnitude of genetic variance controlling yield and its components is useful for deciding the breeding procedure to be followed improvement of a crop. The selection of superior plants commences from F_2 populations, therefore the information on genetic basis of expression of different characters in such populations provide better idea of practicing selection. The F_2 populations has not been studies earlier. An attempt was made in present study to evaluate individual F_2 plants from 45 F_2 populations.

Fortyfive F_2 population were produced following a diallel cross involving 10 cultivars. These 45 F_2 's were evaluated in a randomized block design with four replications at College Farm, GAU, Sardar Krushinagar. The plants were selected in each plot for recording observation for various traits in each F_2 's,

resulting forty plants per F_2 . These 40 plants were used to compute different variability parameters on plant height (cm), number of braches per plant and seed yield per plant (g). Genotypic coefficient of variation and phenotypic coefficient of variation were worked out as per procedure of (Burton, 1952). The heritability (broad sense) and expected genetic advance were also worked out (Allard, 1960).

The differences among the genotypes were significant for all the characters studied. A wide range of variability existed for seed yield, number of pods, number of branches and plant height as evidenced by range (Table 1). The variance components, coefficients of variability, heritability and genetic advance are presented in Table 1. Character wise description is given below :

Plant height

Various populations exhibited high variability for plant height. It varied from short stature of 58 cm. to the tallest height of 190 cm. The variable population GAUT 82-99 x BWR 245 exhibited high mean height value (144.38) followed by GAUT 82-99 x ICPL 312 (118.48) ICPL 87 x H 76-208 (112.60), H 76-208 x ICPL 151 (110.95) and H 76-208 x ICPL 8306 (96.35).

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TABLE 1

Genetic parameters of four characters in pigeonpea.

<i>F₂</i> populations	Plant height							Number of branches per plant					
	Range	Mean	PCV	GCV	<i>h</i> ²	GA (%)		Range	Mean	PCV	OCV	<i>h</i> ²	GA (%)
1. ICPL 269 X Pusa Sweta-2	72-140	100.80	19.34	13.25	46.96	18.70		2-10	5.55	38.91	28.77	54.72	43.86
2. ICPL 269 X ICPL 87	74-135	89.83	19.33	12.41	41.31	16.45		3-12	7.18	32.48	24.12	55.24	36.96
3. ICPL 269 X GAUT 82-99	65-140	110.60	19.81	15.01	57.40	23.42		1-12	4.63	48.69	38.64	63.24	63.43
4. ICPL 269 X H 76-208	72-120	95.50	17.92	10.08	31.65	11.68		2-8	5.80	31.52	22.21	49.70	32.28
5. ICPL 269 X ICPL 312	80-152	121.48	16.25	12.08	55.32	18.52		2-12	7.03	34.94	29.53	71.47	51.44
6. ICPL 269 X ICPL 151	58-120	90.50	19.63	12.90	43.22	17.48		3-13	6.30	34.14	14.46	17.92	12.60
7. ICPL 269 X ICPL 8306	81-135	95.68	17.06	8.29	23.56	8.28		2-15	6.90	42.77	38.18	79.68	70.20
8. ICPL 269 X BDN 31	105-155	125.48	13.34	8.08	36.76	10.10		2-14	7.38	41.01	36.58	79.58	67.23
9. ICPL 269 X BWR 245	90-146	119.75	12.77	8.08	20.69	5.54		3-11	6.03	36.73	29.05	62.65	47.40
10. Pusa Sweta-2 X ICPL 87	70-132	90.85	19.15	16.82	77.16	30.44		3-11	6.33	87.12	12.83	22.45	12.54
11. Pusa Sweta-2 X GAUT 82-99	80-157	117.70	19.30	17.41	81.34	32.34		1-11	5.98	34.84	87.12	60.74	43.59
12. Pusa Sweta-2 X H 76-208	100-160	136.68	14.96	13.22	78.04	24.05		4-18	8.03	41.33	38.30	86.00	73.22
13. Pusa Sweta-2 X ICPL 312	70-120	87.90	17.74	15.16	72.96	26.53		2-14	5.65	39.60	32.83	68.80	56.11
14. Pusa Sweta-2 X ICPL 151	72-110	85.35	13.59	9.35	47.28	13.24		3-10	6.73	33.84	18.38	29.54	20.59
15. Pusa Sweta-2 X ICPL 8306	74-145	97.28	19.25	16.42	72.78	28.86		4-12	7.40	32.93	28.08	72.72	89.33
16. Pusa Sweta-2 X BDN 31	67-140	96.18	100.31	13.84	71.99	24.48		3-14	7.70	31.29	26.23	70.22	45.26
17. Pusa Sweta-2 X BWR 245	82-170	136.63	15.41	14.01	82.62	26.23		3-12	7.60	33.29	28.59	73.75	50.58
18. ICPL 87 X GAUT 82-99	69-110	91.10	10.88	5.60	26.47	5.93		3-12	6.75	43.97	38.58	76.96	69.70
19. ICPL 87 X H 76-208	72-170	112.10	24.78	23.46	88.20	45.02		2-11	6.60	38.33	32.32	71.04	56.09
20. ICPL 87 X ICPL 312	100-160	117.75	13.90	12.77	84.43	84.18		3-14	7.35	40.82	23.84	34.11	88.68

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
21. ICPL 87 X ICPL 151	67-100	82.55	12.12	8.92	54.23	13.54	2-12	5.03	43.34	17.56	16.46	14.70
22. ICPL 87 X ICPL 8306	85-164	108.25	13.69	11.25	67.50	19.04	2-9	5.70	35.58	25.84	52.69	38.79
23. ICPL 87 X BDN 31	64-120	83.53	13.65	11.05	65.52	4.33	3-10	6.45	32.17	23.36	54.96	36.42
24. ICPL 87 X BWR 245	90-160	130.85	12.93	11.67	81.48	21.70	3-13	7.45	34.61	29.01	70.23	50.07
25. GAUT 82-99 X H 76-208	88-152	120.88	16.48	14.03	75.18	25.05	3-8	5.45	29.07	20.43	49.40	29.58
26. GAUT 82-99 X ICPL 312	70-170	118.48	23.99	21.81	82.68	40.86	3-16	8.40	35.44	22.83	41.43	30.32
27. GAUT 82-99 X ICPL 151	65-160	91.60	16.81	13.93	68.73	23.80	3-13	7.25	43.81	35.70	62.03	53.98
28. GAUT 82-99 X ICPL 8306	68-108	92.20	13.87	8.73	39.67	11.33	3-14	7.38	34.42	30.54	78.75	55.83
29. GAUT 82-99 X BDN 31	70-130	92.70	13.58	10.04	54.50	15.27	2-11	6.03	34.55	28.09	66.28	47.17
30. GAUT 82-99 X BWR 245	62-190	144.38	21.58	20.67	91.74	40.78	3-13	7.88	25.43	20.42	64.59	33.84
31. H 76-208 X ICPL 312	92-145	110.50	12.09	9.67	63.94	15.92	3-9	5.08	32.58	24.90	58.39	39.19
32. H 76-208 X ICPL 151	82-153	110.75	22.82	21.55	89.15	41.92	2-17	7.78	44.12	37.58	72.64	66.02
33. H 76-208 X ICPL 8306	60-185	96.35	25.88	23.51	84.50	44.53	3-9	6.38	31.91	26.92	71.25	46.84
34. H 76-208 X BDN 31	80-140	115.43	16.05	14.40	80.32	26.56	3-14	7.93	29.48	25.72	72.19	46.26
35. H 76-208 X BWR 245	100-156	127.10	12.73	10.74	71.10	18.65	3-17	7.33	38.76	35.65	84.63	67.57
36. ICPL 312 X ICPL 151	60-105	85.85	14.17	11.90	70.56	20.60	2-13	6.38	34.75	20.19	33.80	24.20
37. ICPL 312 X ICPL 8306	62-100	81.38	12.45	7.22	33.68	8.64	2-9	5.05	35.01	36.37	61.02	44.00
38. ICPL 312 X BDN 31	60-97	74.28	13.64	10.52	59.57	16.74	4-15	7.45	40.09	37.00	85.20	70.36
39. ICPL 312 X BWR 245	86-165	131.68	13.76	12.67	84.86	24.05	8-14	8.00	31.39	28.03	79.71	51.54
40. ICPL 151 X ICPL 8306	67-118	94.58	14.80	11.71	62.60	19.08	2-10	4.80	47.23	28.18	35.60	34.64
41. ICPL 151 X BDN 31	62-100	81.13	10.84	6.83	39.66	8.86	2-9	5.43	38.23	16.78	20.69	16.29
42. ICPL 151 X BWR 245	100-170	147.05	8.68	7.07	66.30	11.85	3-14	9.20	33.77	27.26	65.18	45.34
43. ICPL 8306 X BDN 31	60-110	92.30	13.19	9.51	51.99	14.13	3-10	7.68	29.71	25.45	73.46	44.96
44. ICPL 8306 X BWR 245	82-153	123.23	16.79	15.13	81.26	28.11	3-15	10.43	27.47	25.13	83.78	47.41
45. BDN 31 X BWR 245	90-105	128.63	18.75	17.88	90.96	35.13	4-13	7.48	31.92	27.59	74.87	49.23
Ranges	58-190	83.53- 147.05	8.68- 25.58	5.60- 23.51	20.69- 91.74	4.33- 45.02	1-18	4.63- 10.43	25.43- 48.64	12.83- 38.64	16.46- 86.00	12.60- 73.22

TABLE 1 (Contd.)

F ₂	Populations	No. of pods per plant						Seed yield per plant					
		Range	Mean	PCV	GCV	h^2	GA (%)	Range	Mean	PCV	OCV	h^2	GA (%)
1.	ICPL 2698 X Pusa Sweta-2	50-217	153.25	42.33	38.39	82.70	72.11	16.3-76.9	38.7	37.13	25.10	45.72	34.97
2.	ICPL 269 X ICPL 87	53-399	166.50	44.76	40.69	82.65	78.21	16.8-89.9	39.05	43.11	36.26	70.74	62.82
3.	ICPL 269 X GAUT 82-99	28-330	130.15	48.50	38.79	63.96	63.90	10.0-60.8	31.36	55.58	49.08	77.96	89.26
4.	ICPL 269 X II 76-208	15-299	107.23	54.53	42.75	61.46	69.04	7.2-59.1	23.51	46.86	21.12	20.31	19.61
5.	ICPL 269 X ICPL 312	45-487	161.03	61.33	58.82	92.00	116.23	8.0-134.1	37.43	67.04	59.75	79.42	109.68
6.	ICPL 269 X ICPL 151	22-357	128.50	59.37	54.81	85.23	104.24	8.8-109.1	34.35	63.69	54.59	73.48	96.41
7.	ICPL 269 X ICPL 8306	50-275	119.85	40.31	29.23	52.58	43.66	14.8-125.9	38.26	57.22	53.34	86.91	102.44
8.	ICPL 269 X BDN 31	33-281	147.90	48.61	44.43	83.53	83.73	10.0-117.2	45.40	58.75	54.94	86.87	105.13
9.	ICPL 269 X BWR 245	10-244	124.58	44.95	40.46	81.01	75.01	6.0-78.6	32.54	49.35	44.08	79.78	81.11
10.	Pusa Sweta-2 X ICPL 87	45-358	135.33	57.28	54.65	90.05	106.26	13.5-103.7	41.43	56.06	50.45	80.97	93.51
11.	Pusa Sweta-2 X GAUT 82-99	12-282	143.65	44.62	39.38	77.91	71.61	10.0-91.2	36.19	54.39	47.82	77.56	86.75
12.	Pusa Sweta-2 X II 76-208	34-332	150.33	54.27	50.15	85.42	95.50	7.0-92.5	38.95	59.38	51.43	75.03	91.78
13.	Pusa Sweta-2 X ICPL 312	12-303	111.98	49.99	46.41	86.19	88.73	11.2-90.0	35.63	49.9	43.18	77.36	78.23
14.	Pusa Sweta-2 X ICPL 151	61-232	137.73	36.56	32.66	79.80	60.10	11.0-88.7	38.11	38.82	30.17	62.00	49.58
15.	Pusa Sweta-2 X ICPL 8306	35-243	101.73	43.22	33.69	60.77	54.11	10.0-100.0	32.55	68.68	62.78	83.51	118.15
16.	Pusa Sweta-2 X BDN 31	46-406	154.65	45.69	43.32	89.89	84.61	10.7-90.8	42.97	43.69	30.89	50.00	45.00
17.	Pusa Sweta-2 X BWR 245	38-343	187.93	44.06	43.26	96.38	87.48	9.2-127.0	49.44	49.88	43.59	76.37	78.47
18.	ICPL 87 X GAUT 82-99	70-359	141.40	38.24	29.84	60.91	47.98	20.5-114.9	40.47	42.08	36.50	75.23	65.21
19.	ICPL 87 X H 76-208	62-530	178.25	48.53	44.45	83.89	83.84	5.8-146.2	40.79	62.96	57.76	84.17	109.16
20.	ICPL 87 X ICPL 312	44-566	204.60	53.51	52.00	94.43	104.09	15.2-83.5	35.87	47.47	41.31	75.72	74.05
21.	ICPL 87 X ICPL 551	37-203	123.63	35.04	27.18	60.18	43.44	12.6-63.7	36.50	38.31	32.58	72.35	57.10
22.	ICPL 87 X ICPL 8306	47-383	160.35	51.59	47.11	83.38	88.61	5.1-82.5	34.87	52.51	48.15	84.08	90.95
23.	ICPL 87 X BDN 31	67-337	152.48	35.74	30.97	75.08	55.28	12.1-100.5	37.46	47.31	40.42	73.03	71.17

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
24. ICPL 87 X BWR 245	41-377	175.05	45.54	43.77	92.40	88.68	5.4-87.4	44.21	44.63	42.11	89.02	81.82
25. GAUT 82-99 X N 76-208	37-345	152.98	43.40	35.26	66.03	59.03	6.2-113.2	37.03	54.87	48.64	78.58	88.82
26. GAUT 82-99 X ICPL 312	38-581	225.65	46.81	44.75	91.40	88.14	22.6-138.8	62.38	44.45	40.47	90.20	78.88
27. GAUT 82-99 X ICPL 151	27-340	133.00	51.70	45.67	78.03	83.10	12.8-141.7	43.29	60.12	58.48	94.60	117.16
28. GAUT 82-99 X ICPL 8306	44-644	200.35	53.80	50.74	88.94	98.57	11.2-141.3	43.78	53.02	51.05	92.74	102.29
29. GAUT 82-99 X BDN 31	21-292	152.95	40.38	34.49	72.96	60.56	12.2-66.7	38.57	38.85	32.37	69.42	55.56
30. GAUT 82-99 X BWR 245	45-406	163.78	55.67	53.00	90.68	103.86	11.3-114.2	42.49	50.03	48.53	94.09	96.98
31. H 76-208 X ICPL 312	20-537	212.13	45.36	42.78	88.96	83.13	15.6-94.9	45.62	38.86	31.99	67.77	54.25
32. H 76-208 X ICPL 151	25-346	142.03	58.11	53.21	83.83	100.35	7.0-103.8	37.49	63.49	58.55	85.00	111.17
33. H 76-208 X ICPL 8306	62-472	192.38	50.29	46.53	85.60	88.68	10.0-115.0	40.2	55.71	50.80	83.19	95.47
34. H 76-208 X BDN 31	52-488	147.50	54.01	49.13	82.73	98.05	12.5-91.8	36.49	51.03	41.67	66.67	70.08
35. H 76-208 X BWR 245	52-531	179.30	46.94	44.07	88.17	85.26	9.0-158.1	39.84	63.17	59.38	88.37	115.00
36. ICPL 312 X ICPL 151	47-281	124.60	53.00	49.46	87.07	95.06	9.6-76.0	54.46	43.72	38.51	77.57	69.86
37. ICPL 312 X ICPL 8606	32-334	119.13	39.06	30.91	62.58	50.35	8.1-83.4	34.6	50.43	46.08	83.50	86.74
38. ICPL 312 X BDN 31	32-188	120.28	49.06	44.96	84.01	84.90	6.8-80.0	28.1	63.60	54.80	74.42	96.50
39. ICPL 312 X BWR 245	46-332	161.28	42.45	41.06	93.60	81.85	8.4-112.4	42.08	58.84	56.86	93.38	113.19
40. ICPL 151 X ICPL 8306	33-320	101.63	56.23	51.46	83.76	97.02	10.0-91.3	37.24	38.02	55.88	92.74	110.82
41. ICPL 151 X BDN 31	20-220	101.30	51.07	32.66	63.25	53.51	5.8-56.8	26.12	59.29	44.62	67.57	82.53
42. ICPL 151 X BWR 245	65-375	184.60	41.77	40.42	93.60	80.54	11.6-105.0	46.27	52.17	51.11	96.00	103.17
43. ICPL 8306 X BDN 31	45-302	148.43	38.16	32.53	72.65	57.11	11.7-80.6	33.72	52.42	46.70	79.36	85.69
44. ICPL 8306 X BWR 245	63-453	236.43	38.03	36.52	92.26	72.28	10.0-137.6	54.08	53.13	52.40	97.27	106.46
	43-271	130.38	46.77	41.82	79.99	77.07	14.0-118.9	41.41	72.42	70.22	94.01	140.25
Ranges	10-644-	101.3-	35.04-	27.18-	20.31-	43.44-	5.1-158.1	25.51-	37.13-	21.12-	21.12	19.61-
		236.43	61.33	58.82	96.38	116.23		62.38	72.42	70.22	97.27	140.25

These crosses exhibited high PCV as well as GCV coupled with high heritability and moderate genetic advance among respective F_2 's. This suggest that simple selection would not be effective for the improvement of this character.

Number of branches per plant

The magnitude of variability for branches per plant in the F_2 's was of high order. The number of branches varied from 1 to 18. It was more prominent in Pusa Sweta 2 x H 76-208 (4.18) and H 76-208 x BWR 245 (3-17) with mean values of 8.03 and 7.33, respectively.

The estimates of phenotypic and genotypic coefficients of variability were highest in cross ICPL 269 x GAUT 82-99 followed by ICPL 87 x GAUT 82-99. Pusa Sweta 2 x H 76-208, ICPL 269 x ICPL 8306 and ICPL 269 x BDN 31 along with high heritability and high genetic advance. This suggested the effectiveness of selection for this character based on phenotypic performance.

Number of pods per plant

A wide range for pods per plant from minimum value of 10 (ICPL 269 x BWR 245) to maximum of 644 (GAUT 82-90 x ICPL 8306) was observed among 45 F_2 's. The values of phenotypic as well as genotypic coefficient of variability were highest in crosses ICPL 269 x ICPL 312 followed by ICPL 269 x ICPL 151, Pusa Sweta x ICPL 87, H 76-208 x ICPL 151 and GAUT 82-99 x BWR 245. These corsses also exhibited high heritability coupled with high genetic

advance. These crosses, therefore, would enhance chances for selection.

Seed yield per plant

The seed yield per plant of 45 F_2 populations exhibited wide range of variability. It ranged from 5.1 g. to 158.1 g. The F_2 of H 76-208 x BWR 245 showed maximum range (9.0 g. — 158.1 g.) with mean yield of 39.84 g. The highest mean yield of 62.89 g. was recorded by GAUT 82-99 x ICPL 312. The estimate of phenotypic and genotypic coefficient of variation were high in respect of all the F_2 populations. The highest phenotypic and genotypic coefficients of variation were noticed in BDN 31 x BWR 245. The other variable F_2 's were Pusa Sweta 2 x ICPL 8306, ICPL 269 x ICPL 312, H 76-208 x BWR 245, H 76-208 x ICPL 151 and GAUT 82-99 x ICPL 151. These F_2 populations would increase the scope for selection and isolation of high yielding segregants.

The most variable F_2 's discussed earlier for the character such as number of pods, number of branches and seed yield, exhibited high heritability alongwith high genetic advance, indicated the effectiveness of selection. The condition appears due to additive gene action, thereby, indicating that selection based on phenotypic performance can be effectively exercised in this material for genetic improvement of these characters with a satisfactory degree of accuracy. Results of Rathnaswamy *et al.* (1973) and Gupta *et al.*, (1975) confirmed the present findings. Shoram (1983) had also reported similar results for number of pods per plant and plant height.

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Genetic Divergence in Chickpea

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Genetical adversity among genotypes to be used in breeding programme is a must, which can be ascertained by D^2 analysis. In the present study 76 chickpea genotypes were studied for their diversity.

The experimental material was planted on Instructional farm of Agriculture College, Navsari during rabi 1991-92, following randomised block design and 3 replications. The each genotype consisted of single row plot of 5 m length having a planting distance of 30 x 10 cm. The observations were recorded on 5 randomly selected plants for 10 agronomical characters. D^2 analysis was done as per Mahalanobis (1936) and clustering of groups was done by Tocher method (Rao, 1952).

TABLE 1

Cluster group of seventy six genotypes on the basis of D^2 - statistics.

Cluster	Number of genotypes	Genotypes	Source/origin
1.	2.	3.	4.
I	35	BDNG 154, ICCV 89230, 8120002-23, 810098-3. ICC 2662, ICC 6384, ICC 8397; ICCL 86213, ICCV 88105 RSG 180, RSG 47 DPC (K) 14 P 47 JCP 6, JCP 28, JCP 29, JCP 39, JCP 45, JCP 46, JCP 49, JCP 50, Chaffa, D. Yellow, Godhara, Ghelod, JCP 13, JCP 192, JCP 233 Kharad, Khedbrahma, LS 48, Puhari, SPS 136/129, JCP 5	Maharashtra ICRISAT Rajasthan U.P. Haryana Gujarat

1.	2.	3.	4.
II	20	BKG 21, DGM 713 BG 364, BG 361 ICCV 88110, ICCV 32, ICCV 4, ICC 51254 KPG 24, KPG 160-3, K 173-4, DPC (K) 10, DPG (K) 12 mDPC (K) 15. Phule G 5 HK 88-232 LS 50 JCP 40, JCP 112, JCP 72	Rajasthan Delhi ICRISAT U.P. Maharashtra Haryana Punjab Gujarat
III	8	BKG 45 JCP 52, JCP 65, JCP 71, JCP 98 ICC 10399 IG 226-18 K 1122	Rajasthan Gujarat ICRISAT M.P. UP
IV	4	JCP 109, JCP 167 ICCV 820487, ICC 12266	Gujarat ICRISAT
V	2	ICCV 820128 LS 25	ICRISAT Gujarat
VI	2	K 8 L 144	U. P. Punjab
VII	2	PDG 85-11 ICCV 90301	U.P. ICRISAT
VIII	1	BDNG 345-19	Maharashtra
IX	1	ICC 9944	ICRISAT
X	1	Punia	Gujarat

Significant variation was noted among genotypes for all the characters. On the basis of D^2 analysis 76 genotypes were grouped in 10 clusters (Table 1). The cluster I was the largest comprising 35 genotypes of different origin. Cluster II possessed 20 genotypes whereas III and IV accommodated 8 and 4 genotypes, respectively. The clusters V, VI and VII had 2 genotypes each, while the remaining clusters were of single genotype. It was noted that the genotypes of same state, scattered into different clusters and of different states into same cluster. Thus the grouping

pattern of the varieties was spread across their geographical boundaries.

The inter and intra-cluster distance (Fig. 1, Table 2) revealed that the former was higher in magnitude than later. The lowest intra-cluster distance was in cluster V ($D = 6.72$) and the highest in cluster II ($D = 15.83$). The high intra-cluster distance was because of wider genetic diversity among its genotypes.

The maximum inter-cluster distance (D) was observed between cluster V and IX

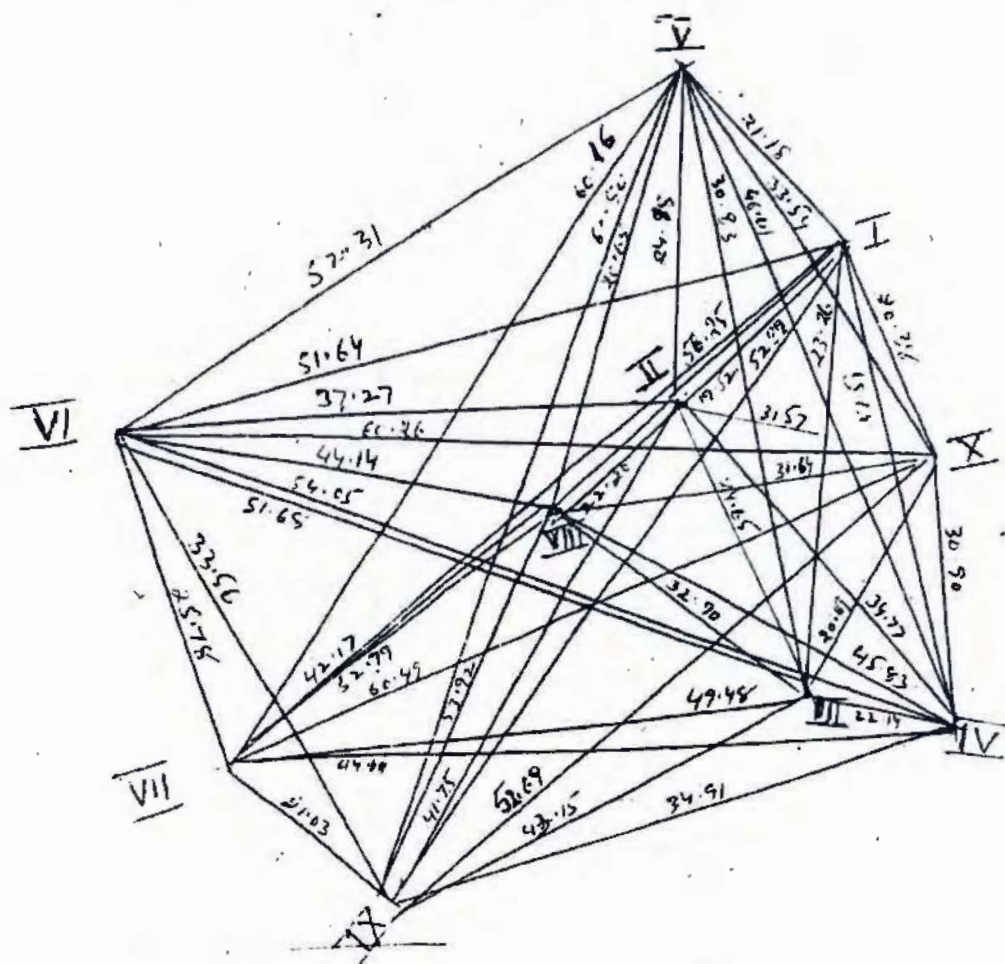


Fig. 1.: Inter cluster distance (D) values) between different clusters in chickpea.

(60.50) followed by cluster VII and X (60.49) while the closest proximity was noticed between cluster I and VIII (19.52). The genetically diverse genotypes of cluster V (LS 25 and ICCL 820128), IX (ICCC 9944), VII (PDG 85-11 and ICCV 90301) and X (punia) could well be used in hybridization programme of chickpea for creating variability.

The cluster means of 10 clusters (Table 3) denoted high range in values. The cluster V was good for early flowering (44.0), number of pods per plant (66.53), number of pods per primary branch (18.23), 100 seed weight (20.15) and harvest index (53.86). The cluster VII had the highest mean values for seed yield (18.07) and plant height (52.93). While cluster IV was superior for number of seeds per pod (1.61) and cluster VI for branches per plant (4.93).

Hence genotypes of above cluster be utilised for the development of respective characters.

A considerable variation for characters among single and multi genotypic clusters was observed. However, the differences were conspicuous for 100 seed weight, seed yield per plant, number of pods per primary branch and days to flowering and to some extent for number of pods per plant that have contributed largely to the total diversity. Dumbre and Desmukh (1984), Samal *et al.*, (1989), and Mishra and Rao (1990) have also reported significant contribution of these attributes towards total diversity in chickpea.

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TABLE 2

Inter and intra-cluster average distance $D (\sqrt{D^2})$ values in chickpea.

Cluster	I	II	III	IV	V	VI	VII	VIII	IX	X
I	14.04	23.01	23.26	37.51	21.18	51.44	56.25	19.52	52.88	20.38
II		15.83	24.65	34.77	24.18	37.27	42.17	22.20	41.75	31.57
III			15.34	22.14	30.83	51.68	49.48	32.90	43.15	20.69
IV				13.18	46.01	54.05	44.11	45.83	34.91	30.90
V					6.72	52.31	60.16	20.65	60.50	33.54
VI						9.83	25.78	44.14	33.56	60.26
VII							15.40	52.79	21.03	60.49
VIII								0.00	53.92	31.64
IX									0.00	52.69
X										0.00

TABLE 3
Cluster means for different characters in chickpea.

Cluster No.	Number of populations	Seed yield/plant (g)	Day to flowering	Day to maturity	No. of primary branches/plant	Plant height (cm)	Number of pods/plant	Number of seeds/pod branch	Number of pods/primary branch	100-seed weight (g)	Harvest index (%)
		X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}
I	35	11.91	46.70	115.83	4.13	39.51	55.56	1.14	13.51	17.15	49.56
II	20	14.64	53.18	132.00	4.56	46.44	57.14	1.16	12.63	22.55	47.34
III	8	12.00	48.92	129.63	4.06	42.10	58.43	1.37	14.47	15.37	50.95
IV	4	11.37	53.67	130.08	3.82	40.77	58.67	1.61	15.37	14.83	49.85
V	2	17.10	44.00	132.00	3.67	46.50	66.53	1.02	18.23	29.15	53.86
VI	2	13.87	71.50	137.33	4.93	48.57	48.40	1.09	9.86	26.05	44.49
VII	2	18.07	72.50	135.83	4.90	52.93	59.70	1.42	12.29	23.22	51.90
VIII	1	14.13	49.67	108.33	3.93	46.33	53.27	1.02	13.60	26.90	41.64
IX	1	9.20	70.67	136.67	3.80	40.80	42.00	1.53	11.13	13.83	45.51
X	1	7.73	45.00	110.00	4.40	37.73	38.73	1.32	8.82	12.97	45.87
Mean		13.00	55.58	126.77	4.22	44.17	53.84	1.27	12.99	20.20	48.10
S. Em. $\pm$		1.08	3.82	3.70	0.15	1.58	2.84	0.07	0.91	2.01	1.26
C.V. %		24.90	20.61	8.75	10.81	10.72	15.81	16.72	21.04	29.89	7.84

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Inheritance Studies in Bitter Gourd (*Momordica charantia* L.)*

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Bittergourd, a cucurbitaceous vegetable, is very popular in market as well as in kitchen garden and grown widely during all the three seasons, provided, the mild cold winter is available. No considerable work on inheritance study in bittergourd in Gujarat State has been reported till now. Hence, the present investigation was undertaken to study an inheritance of some qualitative characters in bittergourd.

The field trial was conducted at Regional Horticultural Farm, N. M. College of Agriculture, G.A.U., Navsari during monsoon 1989, using six parents viz., M_{10} , M_8 , Coimbatore Long, Bittergourd Long Green, Arka Harit and M_1 (M_1 , M_8 , M_{10} are maintenance lines received from G.A.U.; Anand) which were crossed in one way diallel fashion and sown in Randomised Block Design with three replications. The qualitative characters, such as shape of fruits, colour of fruit and the surface of fruit of parents were observed and mode of

inheritance of these characters into their offsprings were studied based on phenotypic observations.

Fruit shape

The parent M_{10} was medium long, M_8 was oblong, Coimbatore Long was long and thin, Bittergourd long Green was oblong, Arka Harit was small and spindle shape and M_1 was small and slightly oblong. The mode of inheritance from parents to offsprings was observed and revealed that the long shape was completely dominant over medium long and oblong fruits, medium long was completely dominant over oblong shape of fruit. Oblong shape was partially dominant over spindle shape. Similar results were also reported by Capinpin (1971) in bottle gourd, Sachan and Nath (1972) and Brar and Nandpuri (1974) in watermelon.

Fruit colour

Dark green, green and whitish green, three colours had been observed in parents. Inheritance study showed that dark green colour of fruit was fully dominant over green and whitish green. Same way, green colour was completely dominant over whitish green colour of fruit. These results are in accordance with those of Nath and Dutta (1970) in long and snap melon, Srivastava and

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Nath (1972) in bittergourd, Sachan and Nath (1972) in watermelon and Tyagi (1976), Patel (1989) in bottlegourd.

Fruit surface

Rought and Smooth, only two kinds of fruit surfaces were observed in parents. Their

inheritance study revealed that the rough surface was fully dominant over smooth surface and thus all the resultant hybrids were found rough surfaced. These results are in conformity with those reported by Patel (1989) in bottle gourd.

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Nutritive Value of Banana Root Bulbs - An Unconventional Feed for Cattle

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India possesses a huge bovine population to the tune of about 262 millions (Anon. 1989-90). It is difficult to maintain such a huge population only on available conventional feeds in view of 36 to 44% shortage of feeds and fodders (Acharya, 1986). This situation gets further aggravated during droughts. During scarcity the migratory cattle owners feed to their cattle and buffaloes banana crop residues including root bulbs. As no data are available for nutritive value of banana root bulbs, this study undertaken.

The banana root bulbs were procured in bulk from University Farm. These bulbs were washed with water to remove mud. After removing the outer covering the bulbs were sliced chaffed in to small pieces and were offered to four adult cross bred (Jersey x Kankrej - F₁) bullocks. Daily 60 kg of banana root bulbs were offered to each bullock under preliminary period of 14 days. A metabolism

trial was conducted following conventional method and the collection period was of 7 days. The samples of feed material offered, leftovers, feces and urine were collected and analysed (AOAC, 1975) for different constituents.

The banana root bulbs contained 83% moisture. The bullocks consumed on an average 41.25 ± 2.66 kg fresh banana root bulbs per day. This worked out to an average dry matter consumption of 5.06 ± 0.15 kg per day, 1.02 ± 0.04 kg/100 kg body weight and 48.27 ± 1.70 g/kg W.^{0.75}. Because of high moisture content bullocks could not consume required quantity of dry matter.

TABLE 1

Experimental details of banana root bulbs feeding experiment.

Duration of the experiment (days)	{ Preliminary period 14 Collection period 7
Breed of animals	J X K - F ₁ bullocks
Av. body weight of animals	494.5 ± 8.21
Number of animals	4
Dry matter intake (kg/day/animal)	5.06 ± 0.15
Dry matter intake (kg/100 kg body weight)	1.02 ± 0.04

TABLE 2

Proximate composition, digestibility and nutritive value of banana root bulbs.

Constituents	Proximate composition (% on DM basis)	Digestibility coefficient
Crude protein	9.59	48.92 $\pm$ 4.17
Ether extract	2.44	87.00 $\pm$ 1.16
Crude fibre	4.06	18.29 $\pm$ 19.98
Nitrogen free extract	76.79	79.03 $\pm$ 2.36
Organic matter	92.88	74.00 $\pm$ 3.15
Ash	7.12	
Silica	0.26	DCP 4.69
Phosphorus	0.28	TDN 70.90
Calcium	0.20	

TABLE 3

Average balances (g/day/animal) of nitrogen, phosphorus and calcium of bullocks fed banana root bulbs.

Particulars	Nitrogen	Phosphorus	Calcium
Total intake	81.20 $\pm$ 1.79	14.68 $\pm$ 0.06	9.66 $\pm$ 0.41
Voided in feces	39.52 $\pm$ 2.68	12.89 $\pm$ 2.12	11.60 $\pm$ 2.23
Voided in urine	36.81 $\pm$ 5.79	0.20 $\pm$ 0.08	1.43 $\pm$ 0.25
Total voided	76.33 $\pm$ 3.44	13.09 $\pm$ 2.15	13.03 $\pm$ 2.35
Balance	+4.87 $\pm$ 1.90	+ 1.59 $\pm$ 1.73	-3.37 $\pm$ 2.10

The banana root bulbs were found to contain 9.59, 2.44, 4.06, 76.79, 7.12, 0.26, 0.28 and 0.20% crude protein, ether extract, crude fibre, nitrogen free extract, ash, silica, phosphorus and calcium, respectively on dry matter basis. The similar data for chemical composition were also reported by Sen *et al.* (1978).

The digestibility coefficients (%) on an average were found to be 48.92, 87.00, 18.29, 79.03, 74.00 and 71.25 for crude protein, ether extract, crude fibre, nitrogen free extract, organic matter and dry matter, respectively. The DCP and TDN values for banana root bulbs were found to be 4.69 and 70.90% on dry matter basis, respectively.

The balance of nitrogen and phosphorus was positive while that of calcium was negative. The bullocks retained 6.00% of nitrogen and 10.83% of phosphorus from their respective total intakes of nitrogen and phosphorus.

Thus it is seen that banana root bulbs can be used as a cattle feed especially during scarcity and that it should be supplemented with suitable source of dry matter, protein and calcium.

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Varietal Preference of *Liriomyza trifolii* (Burgess) to Indian Bean

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The serpentine leaf-miner, *Liriomyza trifolii* (Burgess) (Agromyzidae : Diptera), a new pest introduced recently in India, has been observed damaging many crops including Indian bean. It seems to prefer this host. Fagoonee and Toory (1983) reported that the

density of leaf trichomes and nutritional status of the food plants are important in selection behaviour of this fly. The present study was undertaken to know the selection behaviour of this pest on Indian bean.

Twenty-four varieties of Indian bean grown at the Vegetable Research Farm, Gujarat Agricultural University, Junagadh during winter of 1994-95 were screened against this pest. Three leaves (top, middle and bottom) of the selected plants were observed to count the number of mines per leaf. Number trichome and stomata per 1.5 mm diameter

TABLE 1

Mines density and feeding punctures of *Liriomyza trifolii* on different Indian bean varieties and their morphological characters.

Sr. No. Variety	No. of mines/leaf	Number / 1.5 mm diameter		
		Feeding punctures	Stomata	Hairs
1. No. 7022	1.50* (0.66)	0.71 (0.00)	2.99 (9.00)	2.26 (4.66)
2. JDL-37	2.23 (4.73)	2.63 (6.66)	1.13 (1.33)	2.11 (4.00)
3. JDL-77	1.05 (0.66)	2.66 (6.66)	2.70 (7.33)	1.52 (3.00)
4. JDL-79	1.09 (0.80)	3.17 (10.00)	2.08 (6.00)	2.72 (7.00)
5. JDL-85	2.29 (5.66)	3.47 (11.66)	1.99 (4.00)	3.10 (8.66)
6. JDL-17	2.37 (5.33)	4.55 (20.66)	1.62 (2.66)	2.68 (7.00)
7. JDL-53	1.82 (3.19)	4.21 (17.33)	1.91 (3.66)	3.01 (8.66)

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1.	2.	3.	4.	5.
8. JDL-71	2.53 (6.00)	1.26 (1.33)	2.06 (4.33)	2.84 (7.66)
9. JDL-18	1.58 (2.26)	1.00 (0.66)	2.31 (5.33)	2.70 (7.00)
10. JDL-152	1.52 (2.13)	2.47 (5.66)	2.50 (6.33)	1.43 (2.00)
11. T-2	1.42 (1.73)	3.18 (9.66)	2.93 (8.66)	3.48 (11.66)
12. No. 7010	1.03 (0.73)	2.70 (7.00)	3.16 (10.00)	3.74 (13.66)
13. M-6802	1.42 (1.66)	4.27 (18.00)	2.23 (5.00)	4.00 (15.66)
14. JDL-73	0.78 (0.13)	3.10 (10.00)	3.60 (13.00)	3.48 (11.66)
15. Virpur	0.96 (0.53)	1.18 (1.33)	2.38 (5.66)	2.25 (11.66)
16. Nylone Deshival	01.04 (0.66)	2.75 (7.33)	3.16 (10.00)	4.52 (20.33)
17. Nylone Kalabij	2.81 (7.46)	3.66 (13.00)	2.08 (4.33)	3.05 (9.00)
18. Papadi Rani	0.91 (0.40)	1.85 (3.00)	2.94 (8.66)	3.07 (9.00)
19. Edar Papadi	0.71 (0.00)	4.63 (21.00)	2.31 (5.33)	2.90 (8.00)
20. IC-22006	1.30 (1.40)	3.42 (11.33)	2.08 (4.33)	2.39 (5.33)
21. IC-16167-1	2.64 (6.73)	3.55 (12.33)	2.08 (4.33)	2.58 (6.33)
22. IC-16862	2.12 (4.73)	3.71 (13.33)	1.91 (3.66)	3.93 (15.00)
23. Inbred, 24 line	1.27 (1.20)	3.20 (10.00)	1.99 (4.00)	1.78 (3.00)
24. Inbred, 30 line	1.38 (1.73)	3.27 (10.33)	1.99 (4.00)	2.31 (5.00)
S. Em. $\pm$	0.24	0.32	0.12	0.22
C. D. (P = 0.05)	0.68	0.90	0.34	0.63

* $\sqrt{x + 0.5}$ transformed values,

Figures in parentheses are original values.

area on each leaf were counted under the microscope. The data obtained are presented in Table 1.

No mines were recorded in Edar Papadi. Minimum number of mines (0.13-0.80) were recorded in JDL-73, Papadi Rani, Virpur, No. 7022, JDL-77, Nylone Deshival and JDL-79. Maximum mines were observed in Nylone Kalabij (7.46), IC-16167-1 (6.73), JDL-71 (6.00), JDL-85 (5.66) and JDL-17 (5.33). Feeding punctures were absent in No. 7022, and least number of punctures

were recorded in JDL-18 (0.66), followed by JDL-71 (1.33) and Virpur (1.33). Highest feeding punctures were observed in Edar Papadi (21.10), followed by JDL-17 (20.7). Edar Papadi, Papadi Rani, Virpur, No. 7022, JDL-77, Nylone Deshival, No. 7010, and JDL-79 resisted damage, while, Nylone Kalabij, IC-16167-1, JDL-85, JDL-71 and JDL-17 were susceptible. No. 7022, JDL-18, JDL-71 and Virpur were resistant to feeding of female flies, while Edar Papadi and JDL-17 were susceptible.

Correlations between leaf miner damage and plant characters

Data in Table 1 indicated that mines and feeding punctures were positively correlated (0.2184). Mines density was negatively with stomata (0.6210) and trichome density (0.0495). Mines density was strongly related with stomata. This meant that mines density increased with an increase in stomata density. Feeding punctures were associated negatively with stomata density (0.3468), indicating that feeding punctures decreased with an increase in stomata density. Trichome density possibly did not interfere in feeding

activity. Varieties having hooked trichomes had less feeding punctures. This observation was in conformity with that of Quiring *et al.* (1992).

This study concluded that in Indian bean, Edar Papadi, JDL-73, Papadi Rani, Virpur, No. 7022 and Nylone Deshival were resistant to leaf miner. Higher number of stomata were found related to resistance to this pest. Therefore, stomata density may be considered as a major trait to relief for resistance to *L. trifolii* in Indian bean.

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Abstracts of Ph.D. Thesis

Diallel Analysis Over Environments in Okra

Submitted to Gujarat Agricultural University

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In the present investigation information on the magnitude of heterosis, combining ability and stability parameters were obtained for fruit yield and its components following diallel analysis involving nine elite lines of okra which were tested at Navsari and Junagadh during *kharif*, 1990 and at Navsari during Summer, 1991. Ten characters studied were days to flowering, nodes/plant, internodal length, plant height, branches/plant, fruit length, fruit girth, fruits/plant, fruit yield/plant and YVM virus disease incidence.

The analysis of variance for parents and their hybrids for different characters revealed significant differences among the genotypes, environments and genotype x environment interactions for all the characters, indicating existence of considerable variability in the material studied and between the environments tested. Genotype x environment interactions which were significant for all the characters revealed differential response of the genotype to varying environments. This suggested the importance of testing material over a range of environments.

Highly significant positive heterobeltiosis and standard heterosis for yield and highly significant desirable heterosis for its components in the crosses involving elite lines as parents pointed out that there is a greater scope of exploiting heterosis commercially and also possibility of isolating desirable segregants.

Combining ability analysis indicated the preponderance of additive and additive x additive type of gene action for all the traits. However, non-additive type of gene action was also important in the inheritance of all the characters studied.

Analysis of variance for stability parameter showed that environment component was substantially larger than genotype and $g \times e$ interaction component for all the characters. However, $g \times e$ interaction component was of considerable magnitude for plant height and yield per plant. The analysis further revealed that the component of $g \times e$ (linear) had important contribution for all the nine characters indicating significant difference among the genotypes for their regression on environmental indices. Pooled deviation (non-linear component) variances were, however, significant for all the characters suggesting importance of both linear and non-linear components. None of the parents was found with high mean and average stability for yield. Hybrids Parbhani Kranti Line No. 51, Pusa Sawani x Ankur, Gujarat Bhindi-1 Ankur, Gujarat Bhindi-1 x Line No. 51 and Punjab Padmir x White Velvet exhibited high mean along with b_1 value near unity which lead to the interpretation of the greater production and stability of hybrids.

(Received on 21st Sept. 1994)

**Bionomics, Population Dynamics and
Integrated Management of Mealybug,
Coccidohystrix insolita (Green)
on Pigeonpea**

Submitted to Gujarat Agricultural University

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Coccidohystrix insolita (Green) was found to feed
on pigeonpea, brinjal and night queen plants. Details of
its bionomics on pigeonpea host are discussed in the
dissertation.

Activity of *C. insolita* on pigeonpea during the crop
season showed two peaks, at 35th to 38th (September)
and 47th to 49th (December) standard weeks. Pigeonpea

genotypes viz. ICPL 2, Sehore 197, GAUT 86-10, ICPL
87, GAUT 87-3, T 21 and ICPH 8 were found to be less
susceptible against this pest. Three predators, eight
parasitoids and three entomogenous fungi were found to
check the pest population in nature.

Field application of entomogenous fungi,
Cladosporium cladosporioides gave above 67 per cent
mortality of *C. insolita*.

Quinalphos 0.05%, triazophos 0.04% and
monocrotophos 0.04% were found most effective against
this pest and gave higher net income of Rs. 12759/- to
13875/- per hectare.

The maximum RPT value was recorded in tri-
azophos followed by quinalphos and monocrotophos.
Considering the relative toxicity value, the quinalphos was
more toxic.

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Genetic Studies of Oil and Other Characters in Maize (*Zea mays* L.)

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Sixty four diverse maize genotypes were grown in RBD to evaluate 19 characters for genetic variability, character association, phenotypic stability and oil quality under four environments. In general, Genotypes viz. Vijay composite, Sona x Suwan 2 W, Him- 128 and DHM 101 were superior for grain yield whereas, Iowa 2 Early high oil, Sona x Suwan 2 W and Early DMR composite 2 showed highest kernal oil content. Grain yield and kernel oil

content showed high GCV alongwith high GA in all environments.

Grain yield showed significant positive correlation with days to flowering, plant height, number of leaves and ear length but negative correlation with embryo weight kernel oil content and embryo oil content. Kernel oil content exhibited positive correlation with embryo weight embryo oil content, kernel depth and kernel length and negative correlation with kernel thickness.

Linear and non-linear components of G X E interactions were found responsible for the differences in the stability of the genotypes. Superiority of different genotype for important characters under different farming (poor average and better) conditions is discussed. The fatty acid analysis of oil indicated predominance of linoleic acid followed by oleic acid in the selected genotypes.

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