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Economics of Premonsoon Groundnut As Influenced by Weed Management and Phosphorus Application

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ABSTRACT

The studies on the effect of various weed management practices and phosphate levels on economics of premonsoon groundnut conducted during 1986 and 1987 indicated that the higher net monetary returns/ha were obtained by adopting local practices (two hoeings and one hand weeding) followed by lower doses of fluchloralin (0.90 l/ha) and pendimethalin (0.75 l/ha) each supplemented with one hoeing. The marginal analysis of P response revealed that economic optimum dose would be 20 kg P_2O_5 /ha.

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INTRODUCTION

Considerable area under groundnut exists in summer season in Marathwada but due to inadequate availability of irrigation water in command area for summer season warranted to advance its sowing in *kharif* season with supplemental irrigation. Information regarding economics of various weed management practices and phosphate level especially under Marathwada conditions was not available and hence it was felt worthwhile to workout economics of these factors under preseasonal conditions.

MATERIALS AND METHODS

A field investigation was planned on clayey soils of College Farm, Agronomy Department, Marathwada Agricultural University, Parbhani during premonsoon seasons of 1986 and 1987. The experiment was laid out in a split plot design with 24 treatment combinations comprising of six weed management systems (unweeded control : U W C : local practices

i.e. two hoeings and one hand weeding : LP; fluchloralin @ 1.20 l/ha : F_1 ; fluchloralin @ 0.90 l/ha + one hoeing at 5 weeks after sowing : F_2 ; pendimethalin @ 1.00 l/ha : PM_1 ; pendimethalin @ 0.75 l/ha + one hoeing at 5 weeks after sowing : PM_2 ; in main plots and four levels of phosphorus (0, 20, 40 and 60 kg P_2O_5 /ha) in sub plots. The soils of experimental fields were medium in available phosphorus. The sowing of groundnut Cv. Robut 33-1 using, 45 cm x 15 cm spacing was done on June 3, 1986 and May 28, 1987 and harvested on October 9, 1986 and October 4, 1987, respectively. One pre sowing irrigation followed by 3 and 4 irrigations during 1986 and 1987, respectively, were applied as per requirement of the crop.

RESULTS AND DISCUSSION

Weed Management

A glance at results furnished in Table 1 revealed that the maximum additional net realization of Rs. 15.95 and Rs. 24.74 per rupee invested over control was recorded under local

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TABLE 1

Economic of various weed management treatments.

Treatment	Gross realization (Rs./ha) = A (Pod + haulm)		Expenditure on weed control (Rs./ha) = B		Net realization (Rs./ha) A-B		Additional net realization over control (Rs./ha)		Additional net realization over control/rupee invested		
	1986	1987	1986	1987	1986	1987	1986	1987	1986	1987	Mean
UWC	3946	5929	—	—	3946	5929	—	—	—	—	—
LP	11406	17875	440	464	10966	17411	7020	11482	15.95	24.74	20.34
F ₁	10208	16458	550	550	9658	15908	5712	9979	10.38	18.14	14.26
F ₂	12709	19750	538	538	12171	19212	8225	13283	15.29	24.68	19.98
PM ₁	9030	14488	488	488	8542	14000	4596	8071	9.42	16.54	12.98
PM ₂	11474	18309	487	487	10987	17822	7041	11893	14.46	24.42	19.44
S. Em. ±	—	—	—	—	—	—	—	—	0.71	0.96	1.64
C. D. 5%	—	—	—	—	—	—	—	—	2.24	3.01	5.15

Prices of inputs

1. Hand weeding Rs. 216 and 240/ha in 1986 and 1987, respectively.

2. Hoeing charges Rs. 112/ha.

3. Fluchloralin @ Rs. 185/lit.

4. Pendimethalin @ Rs. 137/lit.

5. Labour charges Rs. 8/day.

Selling Prices (Rs/Q)

	1986	1987
1. Pod	Rs. 407.07	Rs. 687.24
2. Haulm	Rs. 100.00	Rs. 100.00

TABLE 2

Marginal analysis of phosphorus response.

Treatments	Yield		Marginal yield		Value of marginal yield (Rs./ha)		Total value of marginal yield (Rs./ha)	Expenditure incurred on treatments (Rs./ha)	Additional net returns over control/rupee invested		
	Pod	Haulm	Pod	Haulm	Pod	Haulm			1986	1987	Mean
1986											
P ₀	12.38	28.17	—	—	—	—	—	—	—	—	—
P ₂₀	14.86	34.24	2.48	6.07	1010	607	1617	152.20	9.62	16.09	12.85
P ₄₀	16.59	39.63	1.73	5.39	704	539	1243	152.20	7.17	9.73	8.45
P ₆₀	17.22	41.20	0.63	1.57	256	157	413	152.20	1.71	1.45	1.58
S. Em. ±	—	—	—	—	—	—	—	—	1.14	3.49	3.02
C. D. 5%	—	—	—	—	—	—	—	—	3.32	10.18	8.66
1987											
P ₀	13.90	30.52	—	—	—	—	—	—	—	—	Cost of input 20 kg N/ha + Cost of fertilization Rs. 152.20/ha.
P ₂₀	16.51	38.60	2.61	8.08	1794	808	2602	152.20	16.09		
P ₄₀	18.35	42.28	1.84	3.68	1265	368	1633	152.20	9.73		
P ₆₀	18.75	43.06	0.43	0.78	295	78	373	152.20	1.45		

practices during 1986 and 1987, respectively which was statistically identical to lower doses of fluchloralin (0.90 l/ha) and pendimethalin (0.75 l/ha) supplemented with one hoeing. Likewise, higher levels of these herbicides were intermediary in this regard and fall in one range during the course of investigation. In context to pooled results, exactly, similar trend was noticed. The remarkable additional net returns observed under above treatments may be due to higher pod and haulm yields coupled with comparatively lower expenditure on weed control registered under these treatments. These results find the support with those obtained by Yaduraju *et al.*, (1980) in respect of fluchloralin with cultural practices.

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From economic point of view and under the conditions of labour shortage application of fluchloralin at 0.90 l/ha or pendimethalin at 0.75 l/ha each supplemented with one hoeing emerged out to be the most remunerative systems.

Phosphate

Data regarding additional net returns based on marginal analysis of P response are presented in Table 2. The results clearly indicated that the maximum net return/rupee invested (Rs. 12.85) was observed under P₂₀ level of phosphorus though this level was statistically identical to P₄₀ level. Shelke and Khuspe (1981) also reported the similar results.

Yaduraju, N. T., Kulshrestha, G. and Mani V. S. 1980. Herbicides studies in groundnut. *Indian J. Agron.* **25** (3) : 447-452.

Phenotypic Stability for Yield in Wheat

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ABSTRACT

An assessment of phenotypic stability for yield of 20 wheat varieties was made from large scale trial conducted at 7 locations in Gujarat State. Wheat variety VW-126, VW-127 and J-411 were found more stable in yield as they had shown moderate mean performance coupled with regression around unity and least deviation. Second group of wheat varieties VW-89, Kalyansona and Lok-I was found suitable for superior environment as they possessed high mean performance with regression less than unity and minimum deviation. Third group of wheat variety P-164 was found suitable for moderate condition as it showed low mean performance with regression less than unity and minimum deviation. Junagadh, Dhari and Vijapur were favourable locations whereas Dantiwada, Bardoli, Talod and Jamnagar locations were found unfavourable.

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INTRODUCTION

Genotype-environment interaction has a greater value in breeding programme for evaluating more stable genotype for yield and important yield contributing components. Because stable genotype is interacting less under differential environmental conditions when grown at various locations having wide range of agro-climatic conditions. Once stability in yield is achieved, flexibility in other characters could be given minor importance. Because in genetic homeostasis its phenotype and genotype states adjusted according to the change in environment conditions at different locations. Under such situation the good expression of a particular character must be resulted in high stable yield by mutual cancellation of poor expression of another character.

Eberhart and Russell (1966), Freeman and Perkins (1971) developed the methods for estimating stability parameters namely environ-

ment index (li), regression (bi) and deviation from regression (S^2_d) of different genotypes are used widely in various crops. Chaubery and Sastry (1981) studied the stability parameters in Indian and Mexican varieties of wheat and reported that Mexican varieties more stable for grain yield as compared to Indian varieties. Breese (1969), Paroda and Hayes (1971) gave some more highlights in determination of these parameters and suggested that the linear regression simply should be a measure of the response of a particular genotypes. Whereas, the deviation around the regression line should be considered as a measure of stability, genotypes with least deviation being the most stable.

Mallanna *et al.*, (1982) in their study of stability parameters in finger millet suggested that higher value of environment indices recorded at particular location indicates its more favourable condition for such genotypes. They also postulated that genotypes showing

regression around unity with moderate mean performance and minimum deviation from regression are more stable. Those genotypes possessed low mean performance, with regression less than unity and minimum deviation are considered suitable for moderate conditions. Whereas, those recorded higher mean performance are suitable for superior environments.

The present study was undertaken to determine the adaptability in term of stability of newly developed different wheat strains of Gujarat as compared to existing wheat varieties Kalyansona and Lok-1, before its final released in Gujarat State.

MATERIALS AND METHODS

The investigation was undertaken with 20 promising wheat strains at seven locations in Gujarat State during 1982-83. The experiment was conducted in a randomized block design having four replications with net plot size 5.0 m x 2.3 m the grain yield data were subjected to location wise analysis of variance. The genotype environment interaction was estimated through pooled analysis as suggested by Comstock and Robinson (1952) for yield.

Stability was worked out by following the method suggested by Eberhart and Russell (1966), which was elaborated by Singh and Chaudhary (1979). Phenotypic stability was assessed through the mean performance over environments, the linear regression and the deviation from regression.

RESULTS AND DISCUSSION

The pooled analysis of variance for yield is presented in table 1. The mean square due to genotype was highly significant indicating that varieties differed in their yield performance. The environments over which varieties were tested differed significantly, indicated that the varieties were tested across a highly varied environments. The mean square due to variety x location (linear) and pooled deviation due to the non-linear regression or deviation from the linear regression were highly significant, indicating that presence of divergent genetic response to environments. Both the linear and pooled deviation variances were highly significant suggesting that both linear and non-linear components of stability are involved in their phenotypic performance across the environments.

TABLE 1

Pooled analysis of variance for yield.

Source	D. F.	Mean square
Variety	19	0.583**
Location (Variety x Location)	120	1.706**
Location (Linear)	1	181.466**
Variety x Location (Linear)	19	0.101**
Pooled deviation	100	0.213**
Pooled error	420	0.053

** Significant at 1 per cent level.

TABLE 2

Location-wise environment index.

Sr. No.	Name of Location	Environment index
1.	Vijapur	0.8506
2.	Junagadh	1.4204
3.	Dantiwada	-1.9016
4.	Bardoli	-0.9575
5.	Dhari	1.2433
6.	Jamnagar	-0.1879
7.	Talod	-0.4672

TABLE 3

Stability parameters for yield.

Sr. No.	Variety	Origin/ Source	Mean yield Q/ha.	Regression	S^2d
1.	VW-89	Vijapur	37.66	0.8516	-0.0179
2.	VW-108	Vijapur	34.20	0.7064	0.3151
3.	VW-114	Vijapur	36.21	1.0294	0.1966
4.	VW-115	Vijapur	32.19	0.7446	0.5079
5.	VW-126	Vijapur	32.97	0.9156	-0.0067
6.	VW-127	Vijapur	36.28	1.0051	-0.0376
7.	VW-142	Vijapur	31.90	0.9390	0.2740
8.	V-7	Vijapur	28.91	0.8106	0.2639
9.	V-41	Vijapur	27.70	0.6689	0.4546
10.	V-42	Vijapur	34.39	1.0766	0.2414
11.	V-43	Vijapur	33.94	1.1621	0.0166
12.	V-44	Vijapur	31.54	1.2653	0.0828
13.	J-397	Junagadh	32.97	0.9116	0.2435
14.	J-411	Junagadh	34.60	1.0384	0.0616
15.	JU-126	Junagadh	34.92	1.4467	0.2618
16.	JU-129	Junagadh	31.86	1.2591	0.0584
17.	P-184	Palitana	30.60	0.8935	0.1117
18.	Kalyansona	Delhi	35.62	0.8789	0.0045
19.	Lok-1	Sanosara	34.72	0.9093	0.0311
20.	Raj-1555	Durgapura	31.63	1.2012	0.1317
	S. E.			0.153	

The results pertaining to the stability parameters, regression (bi) and deviation from regression (S^2d) alongwith mean yield ($\bar{x}$) performance are presented in table-3, the results revealed that wheat varieties V W-126, V W-127 and J-411 showed high grain yield mean performance alongwith regression coefficient around unity and least deviation from regression, indicating that these varieties were more stable in their yield performance, according to the model of Eberhart and Russell (1968). Besides, all these varieties having Mexican materials in their background and having good stability for grain yield as indicated above. These results are in confirmity with those of Chaubery and Sastry (1981), in which they reported that among the varieties studied, Mexican wheat varieties were more stable for grain yield as compared to Indian wheat varieties. Other group of varieties V W-89,

Kalyansona and Lok-1 were suitable for superior conditions, as they possessed higher mean performance with regression less than unity and minimum deviation. Third group of varieties P-164 is suitable for moderate condition, as it possessed low mean performance with regression less than unity and minimum deviation.

The results for location wise environment indices are presented in table 3. The above results revealed that Junagadh, Dhari and Vijapur were favourable locations for the genotypes, because higher environment indices were recorded at these centres. Whereas, Dantiwada, Bardoli, Talod and Jamnagar were unfavourable locations for these genotypes, as indicated by low environment indices at these locations.

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A Comparative Study on the Effect of Gypsum, Pressmud and Pyrites on Some Soil Properties on a Sodic Soil Under Laboratory Column Leaching Condition

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ABSTRACT

A laboratory column study was carried out to assess the effect of gypsum, pyrites @ 50% gypsum requirement (GR) and pressmud @ 25, 50% GR, based on total sulphur content on some soil characteristics of sodic soil after 15 days and 21 days of leaching. Gypsum gave maximum cumulative water intake and leachate volume. However, the removal of Na^+ , $\text{Ca}^{2+} + \text{Mg}^{2+}$ and $\text{CO}_3^{2-} + \text{HCO}_3^-$ was maximum with pressmud @ 50% GR and least with pyrites. The soil pH and ESP decreased with increasing depth with gypsum than pressmud and pyrites while in surface it was more with pressmud. The increase in exchangeable (exch.) Ca+Mg also gave similar trend. Overall reduction in the soil pH and ESP and increase in exch. Ca+Mg was slightly more after 21 days than 15 days leaching.

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INTRODUCTION

Among the inorganic amendments, gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) has been successfully tried and has proved useful in the reclamation of sodic soils. Its beneficial role has been reported by several workers (Verma and Abrol, 1980; Singh and Abrol, 1988). Apart from gypsum, acids and acid-forming materials are likely to improve the sodic soils by solubilizing calcium carbonate present in the soil, which in turn, replaces exchangeable sodium (Chand et al., 1977). Acid formers that can be used for reclaiming sodic soils includes pressmud, waste product of sugar mills from sulphitation process and pyrites which occurs as a sedimentary deposits containing 10 to 40% sulphur as FeS_2 (Tiwari et al., 1984). Little is known about the use of these amendments in comparison to gypsum. The present study was undertaken to compare the ameliorating effect of gypsum, pressmud and pyrites on sodic soil under laboratory column study at 15 and 21 days leaching.

MATERIALS AND METHODS

A laboratory column study was carried out in the plastic column of 100 cm length and 10 cm diameter. The air dried (8 mm sieved) sodic soil (0-15 cm), collected from Kalanaur silty loam series in Punjab (clay-12.1%, silt-45.1% and sand 42.8% estimated by Piper, 1966) with pH 10.2, EC 1.17 d S m^{-1} in 1:2 soil:water suspension, CEC 12.76 me 100g^{-1} soil, CaCO_3 2.12% (Puri, 1949) and GR 8.4 me 100g^{-1} (Schoonover's method) was packed in the column at a constant bulk density of 1.4 with the treatments gypsum and pyrites (35% S estimated by Vogel, 1961), @ 50% GR (GP- 50 and PR-50 respectively) and pressmud (2.1% sulphur estimated by Chesnin and Yein, 1950), @ 25, 50% GR (PM-25, PM-50), applied on the basis of total S content, mixed in upper 10 cm layer of the soil column in duplicate.

Constant water (distilled) head of 2 cm above the surface layer of the soil was maintained with the help of mortar apparatus

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to comparatively faster removal of exchangeable sodium in the surface soil (Singh *et al.*, 1978). It appears that owing to the presence of free acid, the pyrites sharply reduced the pH and ESP of the surface soil, which resulted in higher water intake in the initial period. However, as the time proceeded, the cumulative water intake started to decrease as a result of its comparatively lower effect on removing exchangeable sodium in the lower depths due to its lack of oxidation (Verma and Abrol, 1980). In case of pressmud treatments, the comparatively lower water intake in initial days might be due to its lower rate of decomposition.

Cumulative Water Intake

The maximum leachate volume was with GR-50 treatment followed by PM-50, PR-50 and PM-25 treatments (Table 1). The overall effect of pressmud was comparatively higher on the removal of Na^+ , $\text{CO}_3^{2-} + \text{HCO}_3^-$ and $\text{Ca}^{2+} + \text{Mg}^{2+}$ than pyrites after 15 days and 21 days leaching. Under continuous leaching organic amendment enhances the solubilization rate of calcium carbonate

The effect of gypsum, pressmud and pyrites on the removal of leachate Na^+ , Ca^{2+} , Mg^{2+} and $\text{CO}_3^{2-} + \text{HCO}_3^-$ contents from the soil column.

Treat- ments	Leachate volume (ml)	After 15 days			After 21 days			
		Na ⁺ (me)	Ca ²⁺ + Mg ²⁺ (me)	CO ₃ ²⁻ + HCO ₃ ⁻ (me)	Leachate volume (ml)	Na ⁺ (me)	Ca ²⁺ + Mg ²⁺ (me)	CO ₃ ²⁻ + HCO ₃ ⁻ (me)
GP-50	825	250.4	11.4	61.8	1125	271.1	12.1	79.3
PP-50	410	132.1	8.7	46.1	670	149.8	9.1	59.3
PM-25	340	216.0	10.7	68.5	610	239.8	11.2	87.9
PM-50	495	267.8	12.1	74.2	535	282.2	13.8	99.2
Control	No leachate after treatment							

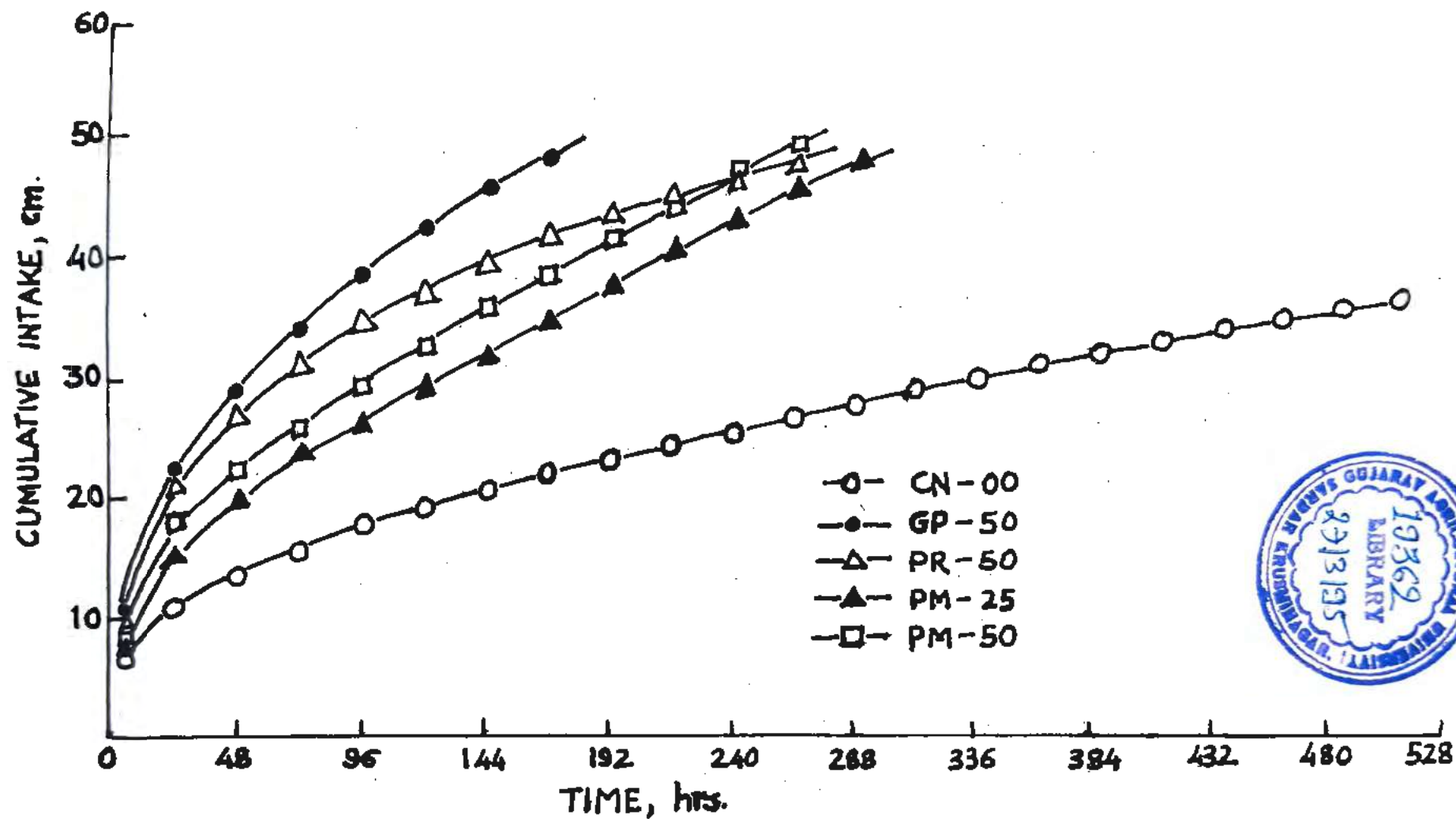


FIG.1 EFFECT OF DIFFERENT TREATMENTS ON CUMULATIVE WATER INTAKE

(Puttaswamygowda *et al.*, 1973), and hence, more removal of the sodium salts than gypsum and pyrites treatments.

Soil Chemical Properties

Soil pH and ESP : All the amendments decreased the soil pH and ESP below 8.5 and 25 respectively upto 15 cm depth (Fig. 2). After 50 cm depth there was no marked differences among the amendments in lowering the soil pH and ESP. In general, gypsum was found to be most effective in lowering soil pH and ESP upto greater depth in the soil column compared with pressmud and pyrites, while pressmud treatments were comparatively more effective in lowering the soil pH and ESP in the surface soil (0-15 cm) than gypsum and pyrites treatments.

The comparatively higher reduction in soil pH and ESP at the higher depth with gypsum application could be due to progressive dissolution, caused by the continuous leaching of Na^+ , $\text{CO}_3^{2-} + \text{HCO}_3^-$ alongwith other ions. Thus, some of the soluble calcium might have utilized in the exchange reaction in surface soil while part of it moved down and lowered the soil pH and ESP as the time proceeded. The reduction in the soil pH and ESP with pressmud application is expected due to the accumulation of carbon-dioxide, reduction in Eh under submergence (Poonamperuma, 1972) and production of organic acids in surface soil (Puttaswamygowda and Pratt, 1973), in addition to its calcium sulphate content (Chander *et al.*, 1977). The reduction in the soil pH and ESP with pyrites application is because of the dominant reaction which occurs in the presence of water :



However, the comparatively lower reduction in the soil pH and ESP with pyrites ap-

plication than gypsum and pressmud may be attributed to its lack of oxidation under submergence (Verma and Abrol, 1980). Moreover, it also appears that the amendments were applied on total sulphur content basis, but only water soluble sulphur (7.8%) seems to be affecting the soil pH. Singh *et al.*, (1978) also made similar observations. The higher reduction to the soil pH and ESP in the surface soil (0-15 cm) was a result of direct contact of the amendments with the soil. Further, the marked decrease in the pH and ESP of the surface soil under control could be a result of accumulation of CO_2 and hydrolysis of calcium carbonate under submergence.

The decrease in the soil pH and ESP was slightly more when continuous leaching was provided upto 21 days than 15 days, particularly in case of pressmud treatments (Fig. 2). Overall effect indicated that the 21 days leaching gave slightly more reduction in the soil pH and ESP with all the treatments than 15 days leaching study. The increase in time of submergence of continuous leaching enhanced the dissolution of gypsum and CaCO_3 in the soil while the beneficial effects with pressmud treatments are expected through higher decomposition of organic matter.

Soil Exch. Ca + Mg : The reduction in the soil pH with the application of amendment was accomplished by the reduction in the soil ESP and increase in the exchangeable calcium and magnesium content in the soil as a result of replacement of exchangeable sodium on the exchange complex. The marked increase in the exch. Ca + Mg contents in the soil was observed with the amendments under both leaching studies, particularly in the surface soil (Fig. 3). The almost similar trend was observed for increase in exch. Ca + Mg, as observed in case of decrease in the soil pH.

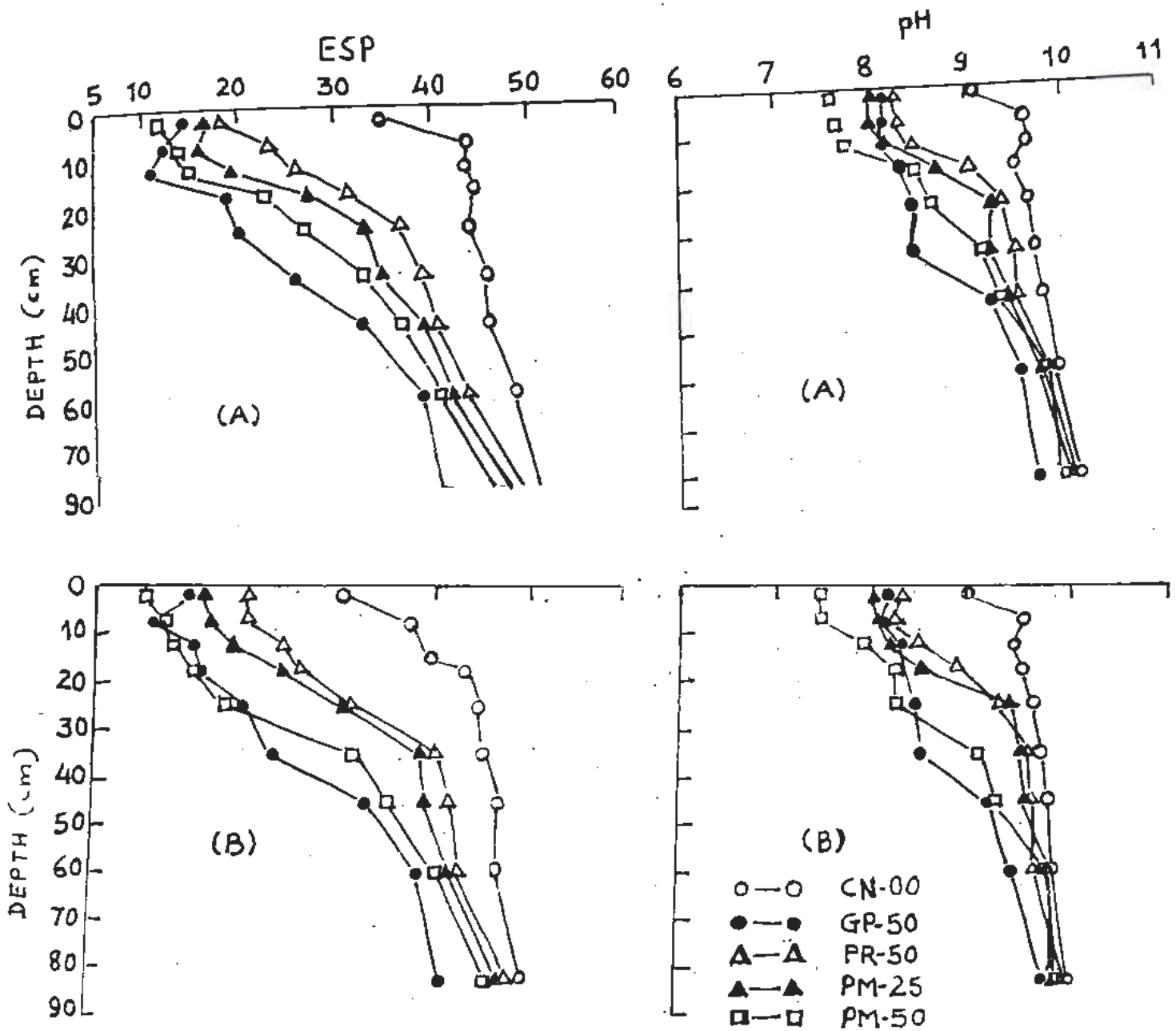


FIG.2 pH AND ESP DISTRIBUTION IN SOIL COLUMN WITH DIFFERENT TREATMENTS AFTER 15 DAYS (A) AND 21 DAYS (B), LEACHING

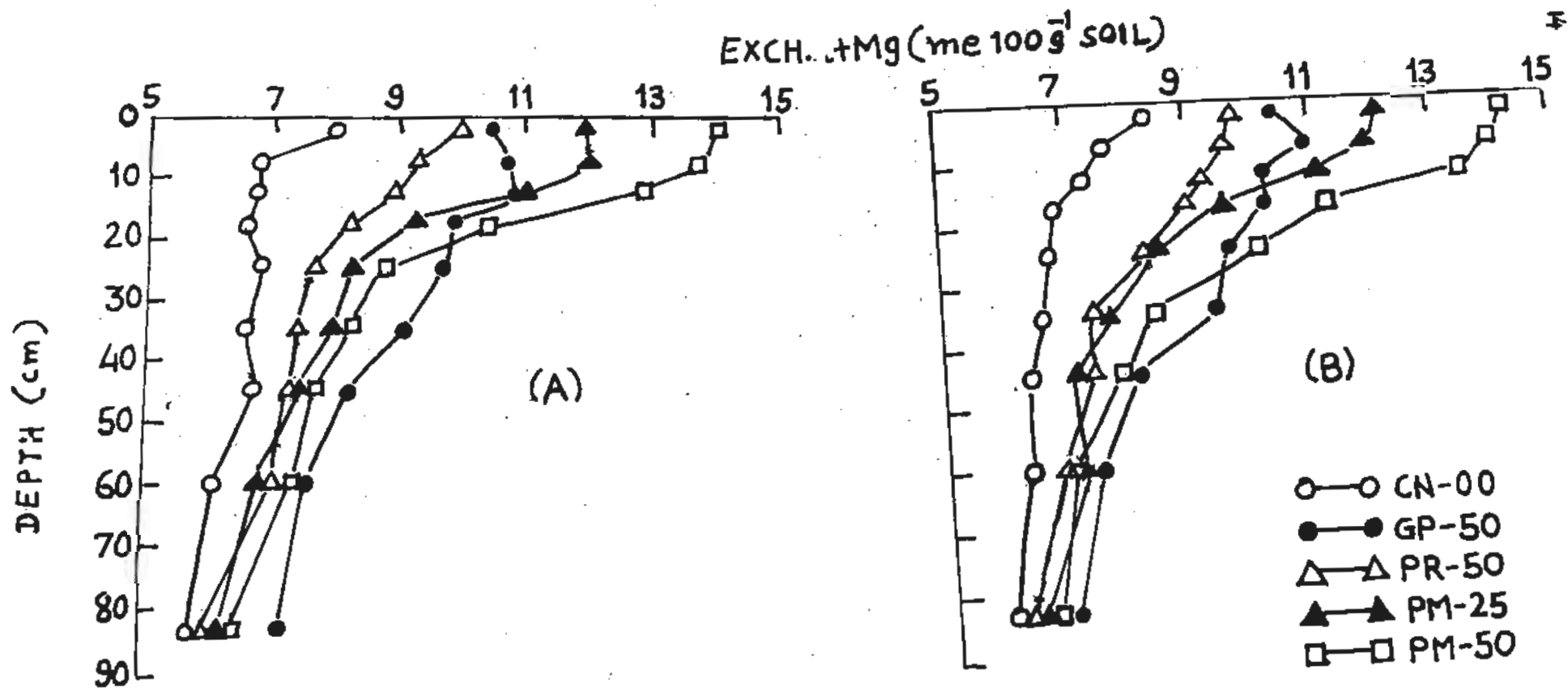


FIG.3 EXCH. Ca+Mg DISTRIBUTION IN SOIL COLUMN WITH DIFFERENT TREATMENTS AFTER 15 DAYS (A) AND 21 DAYS (B) LEACHING

and ESP. In general, gypsum was found to be the most effective in increasing the soil exch. Ca + Mg content upto a greater depth, while pressmud was the most effective in the surface soil. The increase in the exch. Ca + Mg with the application of the amendments was due to either direct supply of soluble calcium through calcium sulphate or from their reaction products.

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Hybrid Vigour in Castor

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ABSTRACT

The performance of F_1 hybrids involving 10 inbreds of castor (*Ricinus communis* L.) was studied to investigate heterosis for seed yield and ten yield related characters. The relative heterosis and heterobeltiosis for seed yield per plant ranged from -50.75 to 104.57 and -60.02 to 66.58 per cent respectively. The F_1 hybrid, 48-1 x SK1-8A exhibiting maximum relative heterosis and heterobeltiosis, also possessed maximum seed yield (396.94 g) per plant. The heterosis for seed yield appeared to be due to high manifestation of heterosis for capsules in main spike, length of pistillate region of main spike, effective branches per plant and seed yield per main spike and were main contributors towards increased seed yield per plant. Selection of crosses on the basis of *per se* performance would be more desirable.

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INTRODUCTION

Gene system does not prevail for yield *per se* in the crop plants and the yield is recognised as the end-product of multiplicative interaction among yield contributing characters (Whitehouse *et al.*, 1958 and Grafius, 1959). Consequently, heterosis for yield should be through heterosis for the individual yield component. Exploitation of heterosis in castor may result in an increase in yield up to 314 per cent over better parent. The present study was, therefore, undertaken to determine the degree of heterosis in castor.

MATERIALS AND METHODS

The experimental material comprised of ten inbred-parents alongwith their 45 single cross hybrids, produced in a diallel fashion excluding reciprocals. The experiment was conducted in a randomized-block design with three replications at Navsari during summer 1989. Each culture represented by a single row of

9 m length keeping row-to-row and plant-to-plant distance of 90 and 60 cm respectively. Observations were recorded on five randomly-selected plants in each replication, and were statistically analysed. Heterosis was calculated as per cent increase (+) or decrease (-) of F_1 hybrid over mid-parent (Briggle, 1963) and better parent (Hayes *et al.*, 1955) performance for days to 50% flowering (main spike), days to maturity (main spike), nodes upto main spike, plant height of main spike, length of pistillate region of main spike, effective branches per plant, capsules per main spike, 100-seed weight, seed yield per main spike and seed yield per plant.

RESULTS AND DISCUSSION

The analysis of variance revealed highly significant differences among the parents and hybrids for all the characters, indicating considerable amount of genetic variability present in the material studied. The parents vs hybrids comparison was significant for all

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the characters (except days to maturity, nodes upto main spike and length of pistillate region of main spike), indicating group heterosis. This showed that the material was appropriate for the study of manifestation of heterosis and genetic parameters involved in the inheritance of different traits.

The degree of heterosis varied from cross to cross for all the characters studied. In the present study seed yield per plant was found to be the most heterotic trait as out of 45 crosses studied, eighteen and twelve crosses depicted significant positive heterosis over their midparent and better parent values, respectively. The cross combination 48-1 x SKI-8A depicted highest relative heterosis (104.57%) and heterobeltiosis (66.58%) with maximum seed yield (396.94 g) per plant followed by cross SH-75 x 48-1 (89.29% and 62.01%). This hybrid had also higher (340.95 g) seed yield per plant. Such crosses are likely to give better transgressive segregants and could be used for further crop improvement. Hooks *et al.*, (1971), Yadava *et al.*, (1978), Kaul and Prasad (1983) and Dangaria *et al.*, (1987) have also reported high values of heterosis for seed yield per plant in castor. High heterosis might be obtained with parents of different origin in the presence of adequate favourable environment for expression of heterosis and in the absence of mutual cancellation of components of heterosis.

Range, number of crosses showing significant heterosis in desired direction and F_1 hybrid showing desired relative heterosis and heterobeltiosis for all characters (Table-1) revealed that magnitude of heterotic effects was high for seed yield per plant, seed yield per main spike, capsules in main spike and effective branches per plant; moderate for days to 50 per cent flowering and 100-seed weight

and low for days to maturity, nodes upto main spike, plant height, length of main spike and length of pistillate region of main spike.

It will be of considerable interest to know the cause of heterosis for seed yield. A comparison of ten most heterobeltiotic crosses for other yield-related characters alongwith average seed yield (Table-2) revealed that high positive heterobeltiosis for seed yield in crosses 48-1 x SKI-8A, SH-75 x 48-1, JI-35 x SKI-14, 48-1 x SKI-54, JI-35 x 1379 and SKI-8A x EC-103745 were accompanied by high positive heterobeltiosis for number of capsules in main spike and seed yield per main spike.

Over and above, highly significant positive heterobeltiosis was exhibited for number of effective branches per plant by SH-75 x 1379, SH-75 x SKI-8A and SKI-8A x EC 103745, for length of main spike by SKI-8A x EC-103745 and 48-1 x SKI-14, for length of pistillate region of main spike by SKI-8A x EC-103745, for 100-seed weight by 48-1 x SKI-54, 48-1 x EC-103745 and 48-1 x SKI-14 and for seed yield main spike by SH-75 x 1379 and SH-75 x SKI-8A. It indicated that in different crosses, pathways for releasing heterotic effects varied from cross to cross. Thus results revealed that capsules in main spike, length of pistillate region of main spike, effective branches per plant and seed yield per main spike were the main contributors towards increased seed yield. Thakkar (1987) has also observed heterobeltiosis in seed yield because of simultaneous heterosis in a number of yield components. Grafius (1959) has also indicated that heterosis in yield is reflected through heterosis in individual yield components or alternatively due to the multiplicative effects of partial dominance of component characters which further substantiated these findings. Williams and Gilbert (1960) have reported that even simple dominance in respect

TABLE 1

Summary table showing range, significant crosses and F₁ hybrids in desired direction for various characters in castor.

Character	Range for desired heterosis over		No. of crosses showing significant heterosis in desired direction over		F ₁ hybrids showing desired heterosis over	
	MP	BP			MP	BP
			MP	BP		
Days to 50% flowering	-33.17-45.25	-26.37-135.80	15	07	48-1 x SKI-8A	48-1 x SKI-8A
Days to maturity	-12.44-23.34	-8.65-33.20	12	03	48-1 x SKI-8A	48-1 x SKI-14
Nodes upto main spike	-21.97-32.94	-14.02-80.00	13	01	EC-103745 x SKI-14	VI-9 x SKI-14
Plant height	-41.07-40.22	-37.73-118.20	12	03	VI-9 x EC-103745	VI-9 x EC-103745
Length of main spike	-19.23-89.68	-41.65-36.87	17	04	SKI-8A x EC-103745	VI-9 x SKI-8A
Length of pistillate region of main spike	-46.31-89.54	-57.92-23.97	08	03	SKI-8A x EC-103745	SKI-8A x SKI-14
Effective branches per plant	-24.19-117.45	-37.13-106.25	26	19	SH-75 x HO	SH-75 x HO
Capsules in main spike	-51.73-89.23	-63.30-66.24	16	11	SKI-8A x EC-103745	48-1 x SKI-8A
100-seed weight	-8.50-48.39	-19.17-31.77	15	06	VI-9 EC-103745	VI-9 x EC-103745
Seed yield per main spike	-41.30-83.16	-47.67-64.16	26	16	SKI-8A x EC-103745	SKI-8A x EC-103745
Seed yield per plant	-50.75-104.57	-60.02-66.58	18	12	48-1 x SKI-8A	48-1 SKI-8A

TABLE 2

Comparative study of ten most heterobeltiotic crosses for seed yield with their heterobeltiotic effects for yield components.

Crosses	Per cent heterosis over better parent (heterobltiosis)							Average seed yield per plant (g)
	Seed yield per plant	Length of main raceme	Length of pistillate region of main raceme	Number of effective branches per plant	Number of capsules in main raceme	100-seed weight	Seed yield per main raceme	
48-1 x SKI-8A	66.58**	2.36	-4.48	-25.75**	66.24**	0.00	32.76**	396.94
SH-75 x 48-1	62.01**	-14.96**	-28.66**	-25.16**	11.27*	-3.07	7.10**	340.95
SH-75 x 1379	53.16**	-41.65**	-57.92**	37.94**	28.02**	5.20	30.44**	322.32
JI-35 x SKI-14	50.56**	-3.30	9.25	-19.12**	27.88**	-2.41	16.75**	303.36
48-1 x SKI-54	49.96**	3.92	-8.47	-29.96**	58.23**	16.09*	23.22**	320.75
48-1 x EC-103745	48.62**	-10.13	-37.81**	-40.11**	-0.21	16.15**	-6.37*	222.61
SH-75 x SKI-8A	47.44**	-5.73	-18.21**	18.18**	-8.25**	-4.05	13.66**	351.33
JI-35 x 1379	45.88**	-5.22	1.66	-0.93	21.51**	1.30	12.38**	264.67
SKI-8A x EC-103745	42.09**	35.40**	21.41**	26.68**	42.78**	9.38	64.16**	338.58
48-1 x SKI-14	35.41**	14.16**	2.84	-35.33**	0.15	14.46**	-6.12*	272.83

* Significant at $P = 0.05$

**Significant at $P = 0.0$

of yield components may lead to expression of heterosis in respect of yield. Hegberg (1952) observed similar effects and termed it "combinational heterosis".

A comparison of best performing five crosses in order with first five most heterobelt-

tiotic crosses (Table-3) further revealed that for the characters like days to 50 per cent flowering, days to maturity and nodes upto main spike the performance of crosses was not associated with the heterotic response i.e. the best performing and most heterotic crosses were different. On the other hand, two crosses

TABLE 3

Best crosses in respect of heterobeltiosis and per se performance.

<i>Character</i>	<i>Most heterobeltiotic crosses</i>	<i>Best performing crosses</i>
Days to 50% flowering	48-1 x SKI-8A SH-75 x HO JI-35 x 48-1 SH-75 X SKI-14 VI-9 x HO	SKI-54 X EC-103745 EC-103745 x SKI-14 VI-9 X EC-103745 SH-75 X 1379 1379 x EC-103745
Days to maturity	48-1 x SKI-14 VI-9 x SKI-14 VI-9 X HO VI-9 x SKI- 8A VI-9 x 48-1	EC-103745 x SKI-14 1379 x EC-103745 SH-75 X EC-103745 SKI-54 x EC-103745 VI-9 x SH-75
Nodes upto main spike	VI-9 x SKI-14 JI-35 x 48-1 VI-9 x 48-1 VI-9 x HO VI-9 x SH-75	1379 x EC-103745 SH-75 x EC-103745 EC-103745 x SKI-14 1379 x SKI-54 VI- 9 x EC-103745
Plant height	*VI-9 x EC-103745 *EC-103745 x SKI-14 VI-9 x SKI-14 SKI-54 x EC-103745 *1379 x SKI-54	1379 x SKI-54 VI-9 x EC-103745 1379 x EC-103745 EC- 103745 x SKI-14 SH-75 x EC-103745
Length of main spike	*VI-9 x SKI-8A *SKI-8A x EC-103745 *SKI-8A x SKI-14 48-1 x SKI-14 1379 x EC-103745	VI-9 x SKI-8A SKI-8A x EC-103745 SKI-8A x SKI-14 SH-75 x SKI-8A VI-9 x SH-75
Length of pistillate region of main spike	*SKI-8A x SKI-14 *VI-9 x SKI-8A *SKI-8A x EC-103745 1379 x EC-103745 *JI-35 x SKI-14	SKI-8A x SKI-14 VI-9 x SKI-8A SKI-8A x EC-103745 JI-35 x SKI-14 VI-9 x SH-75

TABLE 3 (Contd.)

Character	Most heterobeltiotic crosses	Best performing crosses
Effective branches per plant	*SH-75 x HO *SKI-8A x SKI-54 SKI-54 x SKI-14 SKI-8A x SKI-14 *JI-35 x HO	SH-75 x HO JI-35 x HO 48-1 x HO SKI-8A x SKI-54 VI-9 x SH-75
Capsules per main spike	*48-1 x SKI-8A 48-1 x SKI-54 *SKI-8A x EC-103745 *JI-35 x SH-75 *JI-35 x SKI-14	VI-9 x JI-35 48-1 x SKI-8A JI-35 x SH-75 JI-35 x SKI-14 SKI-8A x EC-103745
100-Seed weight	*VI-9 x EC-103745 *SKI-54 x EC-103745 *HO x EC-103745 *48-1 x EC-103745 48-1 x SKI-54	VI-9 x EC-103745 SKI-54 x EC-103745 HO x EC-103745 48-1 x EC-103745 EC-103745 x SKI-14
Seed yield per main spike	*SKI-8A x EC-103745 *VI-9 x JI-35 SKI-8A x SKI-54 *48-1 x SKI-8A SH-75 x 1379	VI-9 x JI-35 48-1 x SKI-8A SKI-8A x EC-103745 JI-35 x 48-1 48-1 x SKI-54
Seed yield per plant	*48-1 x SKI-8A *SH-75 x 48-1 SH-75 x 1379 JI-35 x SKI-14 48-1 x SKI-54	48-1 x SKI-8A VI-9 x SKI-8A SH-75 x SKI-8A SH-75 x 48-1 SKI-54 x EC-103745

*Cross combination common in both comparison.

for seed yield per plant, three crosses each in case of plant height, length of main spike, effective branches per plant, seed yield per main spike and four crosses each in case of length of pistillate region of main spike, capsules in main spike and 100-seed weight were common in both the comparison. This indicated that selection of crosses on the basis

of *per se* performance or heterotic response would be equally important, but the former being more desirable. Thus, on the basis of both criteria the crosses 48-1 x SKI-8A and SKI-8A x EC-103745 appeared to be suitable for practical plant breeding programme.

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Combining Ability for Earliness and its Related Traits in Castor (*Ricinus communis* L.)*

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ABSTRACT

Non reciprocal diallel cross analysis involving ten inbreds of *Ricinus communis* indicated preponderance of additive gene action for all the traits. Parents 1379 and EC-103745 were the best general combiners for all the characters. Crosses 48-1 x SKI-8A and EC-103745 x SKI-14 for days to 50% flowerings and days to maturity; EC-103745 x SKI-8A, 1379 x SKI-54, 48-1 x SKI-8A and SH-75 x EC-103745 for number of nodes upto main spike and VI-9 x EC-103745, 1379 x SKI-14, VI-9 x SKI-14 and EC-103745 x SKI-14 for plant height were the best specific combinations to exploit non-fixable components. The gca effects for all the traits indicated more or less similar trend in *per se* performance. Hence, parents having lower mean performance for nodes upto the main spike could be selected for exploiting earliness in castor hybrids.

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INTRODUCTION

The cultivation of castor is not encouraging in South Gujarat. This is mainly due to long duration and taller varieties in which harvesting and other cultural operations are difficult. Evolving of early varieties is, therefore, essential to popularise this crop in this region. The present study was, therefore, undertaken to know the genetic architecture of these characters and also to select the parents based on combining ability analysis.

MATERIALS AND METHODS

The experimental material consisted of ten inbreds of castor viz., VI-9, JI-35, SH-75, 48-1, 1379, SKI-8A, HO, SKI-54, EC-103745 and SKI-14 selected on the basis of their performance for various characters and were crossed in all possible combination excluding reciprocals. The trial was conducted in a randomized-block design with three replications at Navsari during summer 1989. Each entry was planted in a single-row of 9 m length

keeping an inter and intra-row spacing of 90 x 60 cm. Observations were recorded on five randomly-selected plants for four characters viz., days to 50% flowering (main spike), days to maturity (main spike), number of nodes upto the main spike and plant height upto the main spike. The data were statistically analysed to study the combining ability following Method-2, Model-I of Griffing (1956).

RESULTS AND DISCUSSION

The analysis of variance for combining ability revealed that the variances due to general combining ability (gca) and specific combining ability (sca) were highly significant for all the characters (Table-1), indicating that both additive and non-additive type of gene action were important in the inheritance of the characters. However, the mean squares due to gca were higher in magnitude for all the characters than those due to sca, indicating the preponderance of additive type of genetic variance for governing these traits. Swarna et al., (1984) also reported the predominance of

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TABLE 1

Analysis of variance for combining ability for various characters in castor.

Source of variation	d.f.	Days to 50% flowering (main spike)	Mean Squares		
			Days to maturity (main spike)	Number of nodes upto the main spike	Plant height upto the main spike (cm)
GCA	9	499.86**	150.42**	22.17**	654.97**
SCA	45	59.37**	37.77**	2.29**	59.21**
Error	108	5.42	3.14	0.30	3.54
GCA/SCA	—	8.42	3.98	9.68	11.06

** Significant at $P = 0.01$.

additive gene action for the expression of plant height and number of nodes to flower. Similarly, the predominance of additive gene action for days to flowering, days to maturity and number of nodes upto main spike have been reported by Patel *et al.*, (1984) and Pathak and Dangaria (1987).

The estimates of gca effects of parents (Table-2) indicated that EC-103745, 1379 and SKI-54 for days to 50% flowering; 1379, EC-103745, VI-9 and SH-75 for days to maturity and 1379, EC-103745, SH-75 and SKI-54 for nodes to main spike and plant height were the best general combiners. Thus, 1379 and

TABLE 2

Estimates of gca effects and mean performance of 10 parents for different characters in castor.

Parents	Days to 50% flowering	Days to maturity	Number of nodes upto the main spike	Plant height upto the main spike
VI-9	-0.64 (58.00)	-3.72** (96.00)	-0.29 (14.27)	-0.32 (53.45)
JI-35	8.50** (66.00)	4.19** (97.00)	2.33** (17.53)	15.25** (82.33)
SH-75	1.31* (66.00)	-2.83** (91.00)	-0.62** (13.13)	-4.16** (39.22)
48-1	3.03** (73.00)	2.97** (112.00)	1.09** (18.53)	5.69** (69.22)
1379	-9.39** (30.00)	-4.28** (85.00)	-1.97** (18.33)	-10.95** (30.55)
SKI-8A	5.08** (60.00)	3.08** (94.00)	0.67** (13.80)	-2.67** (48.22)

TABLE 2 (Contd.)

1.	2.	3.	4.	5.
HO	4.44** (62.00)	4.17** (96.00)	0.78** (13.73)	6.67** (56.22)
SKI-54	-2.36** (42.00)	-0.81 (93.00)	-0.47** (12.67)	-2.91** (44.33)
EC-103745	-12.14** (27.00)	-4.11** (81.00)	-2.03** (8.67)	-5.19** (48.00)
SKI-14	2.17** (64.00)	1.33** (104.00)	0.52** (14.40)	-1.42** (51.00)
S. E. (g _i) ±	0.64	0.49	0.15	0.52
S. E. (g _i -g _j) ±	0.95	0.72	0.23	0.77

*Significant at $P = 0.05$ **Significant at $P = 0.01$

Figures in the parenthesis indicate mean performance.

EC-103745 showed significant negative gca effects and were good general combiners for all these traits which may be utilized in crossing programme to generate the genetic variability for effective selection to develop early-maturing and dwarf varieties of castor. Patel *et al.*, (1984) also reported 1379 as good general combiner for these characters. In the present study, gca effect of parents was also more or less associated to their *per se* performance for all the traits.

The perusal of sca effects (Table-3) revealed that crosses 48-1 x SKI-8A and EC-103745 x SKI-14 for days to 50% flowering and days to maturity, EC-103745 x SKI-14, 1379 x SKI-54, 48-1 x SKI-8A and Sri-75 x EC-103745 for number of nodes upto main spike and VI-9 x EC-103745, 1379 x SKI-54, VI-9 x SKI-14 and EC-103745 x SKI-14 for plant height were the best specific combinations to exploit non-fixable component.

A parent showing lower mean performance generally proved to be good combiner for earliness, indicating that earliness could be effectively incorporated in a hybrid by selecting parents on the basis of their *per se* performance (Table-2) for these four characters. However, it is very difficult to record all these 4 traits (to detect earliness) at an early stage of growth of castor. Hence, it is essential to emphasize only on one character by which earliness could be detected. The present study revealed that the gca effects of parents for all the four traits indicated earliness, but a parent having good gca for nodes upto the main spike will also have good gca for the traits responsible for earliness. Hence, among four traits, parents having lower mean performance for nodes upto the main spike should be selected for exploiting earliness in hybrids.

Since additive and non-additive components of genetic variances were important for all these traits, the exploitation of both

TABLE 3

Estimates of sca effects for various characters in some selected castor crosses.

Crosses	Days to 50% flowering	Days to maturity	Number of nodes upto the main spike	Plant height upto the main spike
VI-9 x SKI-8A	-1.99	-5.21**	-0.54	4.18*
VI-9 x HO	-6.68**	-5.63**	-1.05*	10.62**
VI-9 x EC 103745	-9.43**	2.99	-1.24*	-18.74**
VI-9 x SKI-14	-5.74**	-3.46*	-1.39**	-8.74**
JI-35 x 48-1	-9.07**	-6.68**	-0.71	-3.30
SH-75 x 1379	-12.13**	3.93*	-0.63	5.41**
SH-75 x HO	-11.63**	-4.18*	-0.84	3.68*
SH-75 x EC 103745	-4.05	-1.57	-1.91**	-5.79**
48-1 x SKI-8A	-16.99**	-11.57**	-1.92**	-5.60**
48-1 x SKI-54	0.12	-3.35*	-1.64**	-2.81
1379 x SKI-54	1.21	-1.43	-1.98**	-12.39**
SKI-8A x EC 103745	17.18**	13.51**	2.87**	13.50**
EC 103745 x SKI-14	-12.91**	-9.74**	-2.92**	-8.64**
S.E. (Sij) $\pm$	2.15	1.63	0.51	1.73
S.E. (Sij-Sik) $\pm$	3.15	2.40	0.75	2.55
S.E. (Sij-Skl) $\pm$	3.01	2.29	0.71	2.43

* Significant at $P = 0.05$.**Significant at $P = 0.01$.

types of gene action would be imperative and recurrent selection for hybrid varieties would

prove most effective for inducing earliness in castor.

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Effect of Nitrogen and Its Time of Application on Yield of Castor GAUCH-1 (*Ricinus communis* L.) Under Irrigated Condition in North Gujarat

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ABSTRACT

Effect of different levels of nitrogen application 0, 25, 50, 75 and 100 kg N/ha at varying split applications was studied for four years on hybrid irrigated castor (GAUCH-1) grown in sandy soils of North Gujarat. The seed yield and net ICBR values showed that application of 75 kg N/ha in three splits (50% as basal the remaining 50% in two equal splits at 40 and 70 DAS) was advantageous.

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INTRODUCTION

In Gujarat, castor (*Ricinus communis* L.) occupies about 1.95 lakh/ha with an average productivity of 1145 kg/ha. Hybrid castor is extensively cultivated in the State (Fatteh and Patel, 1986), Mehsana and Banaskantha districts of North Gujarat occupying 1.76 lakhs ha with an average yield of 1250 kg/ha. For maximising the yield potential of hybrids, proper fertilizer use plays an important role. Keeping this in view, the present study was taken up to determine the optimum rate and time of nitrogen application for irrigated hybrid castor GAUCH-1.

MATERIALS AND METHODS

An experiment was conducted at Regional Research Station of Gujarat Agricultural University, Sardar Krushinagar during 1981-82-1984-85. The soil was loamy sand in texture with pH 7.2-8.5, low in organic carbon (0.17-0.35%) and available N (100-238 kg/ha); medium to high in available P_2O_5 (55-99 kg/ha) and high in available K_2O (350-400 kg/ha).

The experiment with 14 treatments comprising five levels of N (0, 25, 50, 75 and 100 kg/ha) applied as basal and in different splits (Table 1) was laid out in Randomized Block Design with four replications. The crop was sown in second or third week of July. The recommended dose of 50 kg P_2O_5 /ha was applied as single superphosphate as basal. Nitrogen was applied as urea as per the treatments. Castor variety GAUCH-1 was sown with a spacing of 90 x 60 cm with a seed rate of 6 kg/ha. The rainfall received during 1981-82 to 1984-85 was 519 mm, 584 mm, 413 mm and 525 mm in 31, 20, 29 and 25 rainy days, respectively. The crop was given 3 irrigations in 1981-82 and 1982-83, and 4 irrigations in 1983-84 and 1984-85. Matured spikes were harvested at 90, 120, 150, 210 and 240 days.

RESULTS AND DISCUSSION

Data presented in Table 1 revealed that the differences in castor yield were significant due to various treatments in 1981-82 and 1982-83 only. The pooled data, however, revealed that treatment T_9 (N_{75} , $1/2 + 1/4 + 1/4$) gave

TABLE 1

Seed yield and contributing characters of castor (GAUCH-1) as affected by levels of nitrogen and time of application.

Treatment	Time of application of nitrogen				Seed yield kg/ha					Yield contributing characters		
	Basal	40	70	100	81-82	82-83	83-84	84-85	Pooled	NICBR	No. of effective spike plant	Length of main spike (cm)
		DAS	DAS	DAS								
T ₁ 0 kg N/ha	—	—	—	—	1335	1578	1834	1593	1585	—	6.25	32.87
T ₂ 25 kg N/ha	All	—	—	—	1451	1854	2479	1828	1903	1:4.9	7.77	38.39
T ₃ 25 kg N/ha	1/2	1/2	—	—	1574	1938	2391	1637	1885	1:4.6	6.89	36.24
T ₄ 50 kg N/ha	All	—	—	—	1562	2039	2854	1968	2106	1:4.0	7.99	44.86
T ₅ 50 kg N/ha	1/2	1/2	—	—	1666	2089	2641	2169	2141	1:4.3	7.85	42.35
T ₆ 50 kg N/ha	1/2	1/4	1/4	—	1488	2199	2400	2219	2076	1:3.8	7.69	37.82
T ₇ 75 kg N/ha	All	—	—	—	1554	2203	2795	1991	2136	1:2.8	8.29	43.75
T ₈ 75 kg N/ha	1/2	1/2	—	—	1863	2421	2452	2365	2275	1:3.5	9.38	44.14
T ₉ 75 kg N/ha	1/2	1/4	1/4	—	1880	2016	3276	2579	2438	1:4.4	8.92	45.26
T ₁₀ 75 kg N/ha	1/4	1/4	1/4	1/4	1635	2269	2938	2417	2315	1:3.8	8.51	41.90
T ₁₁ 100 kg N/ha	All	—	—	—	1524	2389	2342	2363	2154	1:2.1	8.51	45.51
T ₁₂ 100 kg N/ha	1/2	1/2	—	—	1671	2225	2382	2466	2186	1:2.3	8.66	46.45
T ₁₃ 100 kg N/ha	1/2	1/4	1/4	—	1954	2203	2854	1829	2210	1:2.4	8.80	45.03
T ₁₄ 100 kg N/ha	1/4	1/4	1/4	1/4	1802	2381	2441	2841	2366	1:3.0	8.69	44.05
S. Em.					89	134	263	308	58			
C. D. at 5%					246	371	NS	NS	163			
CV %					10.8	12.5	20.4	28.5	11.3			
For calculation of prices — Urea 2.24 Rs/kg. Castor seed 3.25 Rs/kg.												

the highest seed yield of 2438 kg/ha, but was at par with treatments $N_{100}, 1/4 + 1/4 + 1/4 + 1/4$; $N_{75}, 1/4 + 1/4 + 1/4 + 1/4$; and $N_{75}, 1/2 + 1/2$. Joshi et al., (1980) reported castor yields of 2.30, 2.54 and 2.43 t/ha with 25 + 25, 50 + 50 and 75 + 75 kg/ha of N + P, respectively. Patel (1985) also found that application of 75 kg N/ha in two splits increased the castor yield. The treatments T_8 ($N_{75}, 1/2 + 1/2$), T_9 ($N_{75}, 1/2 + 1/4 + 1/4$), T_{10} ($N_{75}, 1/4 + 1/4 + 1/4 + 1/4$) and T_{14} ($N_{100}, 1/4 + 1/4 + 1/4 + 1/4$) being at par increased the yield by 43.53, 53.80, 46.10 and 49.30% over unfertilized control (1585 kg/ha). This increase in seed yield may be attributed to greater length of main spike and number of effective spikes/plant (Table 1). The net incremental cost-benefit ratios (NICBR) for T_8 ($N_{75}, 1/2 + 1/2$), T_9 ($N_{75}, 1/2 + 1/4 + 1/4$), T_{10} ($N_{75}, 1/4 + 1/4 + 1/4 + 1/4$) and T_{14} ($N_{100}, 1/4 + 1/4 + 1/4 + 1/4$) were 1:3.5, 1:4.4, 1:3.8 and 1:3.0 indicating thereby the superiority of T_9 ($N_{75}, 1/2 + 1/4 + 1/4$) among these treatments.

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Studies on Mass Production of *Bacillus popilliae* Var. *holotrichiae* a Promising Pathogen of White Grub in Gujarat

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ABSTRACT

Different methods of inoculation for the production of *Bacillus popilliae* var. *holotrichiae* on the white grubs were evaluated. Amongst different methods tried, highest infection was found in inoculation with artificial diet mixed with *B. popilliae* (85%) followed by soil and root inoculation (80%), soil inoculation (65%), root dipping and feeding (60%) and gulping (35%). The cost of production was worked out to be Rs. 305.48/kg of spore powder.

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INTRODUCTION

The white grubs are one of the most destructive and troublesome soil insect pests in India. In recent years, greater attention is paid on biological control of this pest. *Bacillus popilliae* var. *Holotrichiae* (identified by Dr. R. J. Milner, Canberra, Australia) causing milky disease in grubs of *Holotrichia consanguinea* Blanchard was reported from Gujarat by Vyas *et al.* (1986). As much as 76% of the grubs have been found infected by the bacterium in nature. With a view to utilize this bacterium for the control of white grubs studies were made during 1987-88 to evolve suitable method to produce bacteria in sufficient quantity. In addition to this, the economics of mass production of the bacterium was also worked out.

MATERIALS AND METHODS

Since the bacterium is an obligate pathogen, attempts were made to propagate the organism on the grubs of *H. consanguinea*. For this purpose, the eggs laid by the *H. con-*

sanguinea females collected during June-July from the fields were obtained by placing them in laboratory cages (30 cm diameter and 10 cm high) containing moist soil. These grubs upon hatching were reared individually in plastic containers having sterile moist soil and provided washed bajra roots before inoculating with the bacterium. The stock solution of *B. popilliae* having 5×10^9 spores/ml was obtained by aseptically bleeding the field collected diseased grubs. All the experimental grubs of *H. consanguinea* were surface sterilized using 0.2% sodium hypochloride. The grubs were first washed thoroughly with tap water to remove soil adhering to their body and then dipped in the sterilizing solution for 5 minutes. Traces of sterilizing solution were removed by rinsing the grubs with distilled water.

The grubs were inoculated with the bacterial spores and reared individually in plastic containers (3.5 x 7.5 cm) containing sterilized soil. Optimum level of moisture was maintained in the soil. Washed roots of bajra were provided

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as food. The food was changed every alternate day. The rearing of the grubs was done at $25 \pm 1^\circ\text{C}$ at 86% RH in the laboratory. Percentage of disease was recorded under each method at 7, 14, 21 and 28 days after inoculation. The different inoculation methods tried were as follows.

1. Soil inoculation method

The required spore concentrations i.e. 1×10^7 and $1 \times 10^9/\text{g}$ of soil, were obtained by mixing 0.8 ml and 80 ml of stock solution respectively with 400 g of sterilized soil. The soil thus inoculated with bacterium was equally distributed in 20 plastic containers and one grub of *H. consanguinea* was reared in each container. In control, the grubs were reared in sterilized moist soil.

2. Grub gulping

The grubs were starved for 2 days, prior to inoculation and then dipped in spore suspensions for a minute. The extra suspension on surface was air dried and grubs were reared on bajra roots. In case of control, the grubs were dipped in sterile distilled water for a minute.

3. Root dipping and feeding method

Seedlings of bajra were washed well with tap water and then with distilled water. The pots were dipped or immersed in a spore suspension having 1×10^7 and 1×10^9 spores/ml for five minutes. After five minutes the roots were taken out and given as food to the grubs. The grubs were fed with treated roots for first five days and thereafter reared on normal bajra roots. Grubs fed on roots which were dipped in sterile water served as control.

4. Injection method

The grubs were immobilised by keeping them in the deep freezer for 5 minutes and surface sterilized with absolute alcohol. The grubs were injected with 1×10^7 and 1×10^9 spores using sterilized microsyringe and 27 gauge needle. An inoculum of 0.03 ml of spore suspension was injected at dorsal side between second and third posterior abdominal segments of the grubs. Control grubs were injected with 0.03 ml of sterile distilled water. The inoculation procedure was carried out in the laminar flow chamber to avoid contamination.

5. Soil and root inoculation method

Soil as well as roots were charged with required spore concentration and grubs were reared as described earlier. The control grubs were reared in sterilized soil and untreated bajra roots were given as food.

6. Inoculation by artificial diet mixed with bacterium

Preparation of diet

A thick sowing of bajra was done in galvanized iron sheet trays (46.0 x 26.5 x 8.0 cm). Seven days seedlings were uprooted and roots were thoroughly cleaned with water to remove the soil and dried. The cleaned seedlings were blended for about a minute and immersed in acetone to soften the seedlings, and kept in fumehood for 3 days and sieved. The blended material was washed under tap water till it becomes white. This material was then dried in hot air oven at 40°C for 24 hrs. The dried mass was ground and sieved through 80 mesh sieve and stored at 5°C in refrigerator. The dried bajra seedlings (100 g), W. salt mixture (2.5 g), choline

chloride (10 g), linolic acid (1.0 ml) and vitamins (5.0 g) were thoroughly mixed in a mortar and pestle to get fine powder.

The artificial diet thus prepared was mixed with appropriate amount of spore powder to obtain 2×10^7 and 2×10^9 spores/g of diet and 0.5 g of this diet was fed to each grub under treatment.

Economics of mass production of *B. popilliae* : The cost of production of the bacterium was worked based on the data available in the biocontrol laboratory, Anand.

RESULTS AND DISCUSSION

Mass production results revealed that in all the methods except injection, milky disease was induced in the grubs. Out of six methods tried, inoculation by artificial diet mixed with *B. popilliae* was found to be the best (Table 1).

Grub gulping method

This method as compared to the other methods induced lowest (15%) disease in the grubs at 10^7 spore dosage of bacterium after 4 weeks of treatment. It gave 35% mortality when spore concentration was increased to 10^9 spores/ml. With similar method, but at spore concentration of 10^8 /ml, 56% infection was reported in grubs of *H. serrata* Fab. after 28 days of treatment (Veenakumari and Veeresh, 1982). It has also been reported to cause 20% infection by the same method at the rate of 10^5 spores/ml (Anonymous, 1985).

Root dipping and feeding method

This method gave 40% mortality after 4 weeks when spore concentration was 10^7 /ml. The mortality was 60% at 10^8 spore concentration. David and Alexander (1975) reported

61.5% infection in the grubs of *H. serrata* with this method using 10^7 spores/ml, spore concentration. Veenakumari and Veeresh (1982) could get 48 to 76% disease in the grubs of *H. serrata* at the rate of 10^8 spores/ml spore concentration.

Soil inoculation method

This method induced 55 and 65% disease in the grubs at 10^7 and 10^9 spore concentration respectively after 4 weeks of treatment. This method appears to be better than the preceding ones. Some other workers have also found it to be effective in inducing disease in the grubs. Shinde and Sharma (1971) reported 83 to 87% disease, Vora and Ramakrishna (1977) reported 0 to 80% disease and Veenakumari and Veeresh (1982) reported 74% disease in the grubs by the same method using different concentration and in different white grub species.

Injection method

The injection of the bacterium in second instar grubs did not induce any disease. The injected grubs died next day perhaps due to mechanical injury. In the present study, 0.05 ml of inoculum was injected in the grub through the second and third posterior abdominal segments using sterilized microsyringe with 25 gauge needle. Similar mortality in the grubs due to mechanical injury by injection has been reported by Veenakumari and Veeresh (1982).

Soil and root inoculation method

This method gave comparatively better results than the other methods, which are discussed above. The percentage mortality of the grubs by the method was 65% when spore concentration was 10^7 . The mortality was greater (80%) when spore concentration was 10^8 . Here, due to mechanical injury by

TABLE 1

Effectiveness of different methods of artificial infection of *B. popilliae* in *H. consanguinea* Blan. for milky disease development.

Particulars	% infection in <i>H. consanguinea</i> after days							
	7		14		21		28	
	a	b	a	b	a	b	a	b
Soil inoculation method	—	—	10	20	20	35	55	65
Gulping method	—	—	5	5	5	5	15	35
Root dipping and feeding method	—	—	10	10	15	25	40	60
Injection	—	—	—	—	—	—	—	—
Soil and root inoculation method	—	—	15	20	25	45	65	80
Inoculation by artificial diet mixed with <i>B. popilliae</i>	—	5	25	30	50	60	70	85
Control	—	—	—	—	—	—	—	—

Note : a = Spore concentration 1×10^7 , b = spore concentration 1×10^9 . Under each treatment 20 second instar *H. consanguinea* grubs were tested.

methods, the spore dosage becomes double and the chances of infection to the grubs are also increased.

Inoculation by artificial diet mixed with *B. popilliae*

The artificial diet composed of bajra seedlings, W. salt mixture, choline chloride, linoleic acid and vitamins proved very effective for rearing the grubs in the laboratory. The grubs when reared on this diet fed very well on the diet and turned healthy, and successfully completed their development. This is the first report on development of artificial diet for white grub in India. The diet was mixed with spore suspension and fed to the grubs. The

results were very promising giving as much as 85% mortality when spore concentration was 2×10^9 /g of diet. The mortality was 65% at 2×10^7 spores/g of diet.

Thus of all the methods tested, inoculation by artificial diet mixed with bacterium at 10^9 spore, gave maximum mortality (85%), followed by soil and root inoculation methods (80%), soil inoculation (65%), root dipping and feeding (60%) and gulping (35%). The injection method did not induce any disease in the grubs. The results also show that by increasing the concentration of *B. popilliae* 100 times in treatments, 10-20 times more infection in the grubs was observed (Table 1).

Economics of *B. popilliae* production

The details of cost of production involved were calculated as under :

A. Cost of equipments

I. Equipments used for long term basis

1. Refrigerator 1 @ Rs. 6000/- each	6000.00
2. Microscope 1 @ Rs. 13000/- each	13000.00
3. Mixer 1 @ Rs. 1300/- each	1300.00
4. Haemocytometer 1 @ Rs. 250/- each	250.00
5. Balance 1 @ Rs. 1000/- each	1000.00
6. Oven 1 @ Rs. 2000/- each	2000.00
7. Wooden racks 4 @ Rs. 1200/- each	4800.00
8. Iron trays square-100 Rs. 50/- each	5000.00
9. Table 1 @ Rs. 550/- each	550.00
10. Stool 2 @ Rs. 200/- each	400.00
	34300.00

II. Equipments used for short term basis

1. Plastic tubes 2000 @ Rs. 6.50/- each	13000.00
2. Flask 250 ml - 10 @ Rs. 26.00/- each	2600.00
3. Measuring cylinder 100 ml - 1 @ Rs. 25/- each	25.00

4.	Funnel 1 @ Rs. 25/- each	25.00
5.	Plastic bucket - 1 @ Rs. 25/- each	25.00
6.	Spades - 3 @ Rs. 20/- each	60.00
7.	Glass jars - 5 @ Rs. 15/- each	75.00
		<u>13470.00</u>
(a)	Total cost of equipment (I + II)	47770.00
(b)	Depreciation for I @ 10% per annum for one month	285.83
(c)	Depreciation for II @ 30% per annum for one month	336.75
(d)	Total depreciation (a + b)	622.58
(e)	Interest on the capital investment of Rs. 47770/- at the rate of 13.5% per annum for one month.	716.55
	Total cost of equipment for one month (d + e)	1339.13
(B) Salaries and wages per month		
1.	Salary for one microbiologist in charge @ Rs. 2000/- (10% of his working hours)	200.00
2.	Wages for 3 daily paid workers @ 11/- per day	1023.00
	Total expenses on salary and wages for month.	<u>1223.00</u>
(C) House Rent @ Rs. 250.00 per month		250.00
(D) Cost of consumable items for one month		
1.	Bajra seeds 10 kg @ Rs. 3/- per kg	30.00
2.	Muslin cloth 1 m @ Rs. 10/- per meter	10.00
3.	Bags (cotton) 5 @ Rs. 15/- per each	75.00
4.	Glass marking pen-1 @ Rs. 15/- each	15.00
5.	Cotton	10.00
6.	Disinfectant fluid - 100 ml	3.00
7.	Liquid detergent - 100 ml	6.10
8.	Soap-1 @ Rs. 4/- each	4.00
9.	Washing brush - 1 @ Rs. 2.50/- each	2.50
10.	Napkins - 2 @ Rs. 5.00 each	10.00
11.	Glass slides - 10	2.50
12.	CaCO ₃ 7 kg @ Rs. 40/- per kg	280.00
13.	Electricity charges	<u>100.00</u>
	Total cost of consumable articles for one month	<u>548.10</u>

Total cost of milky diseases organism production in white grub

A. Cost of equipments	1339.13
B. Salaries and wages	1223.00
C. House rent	250.00
D. Cost of consumable articles	548.10
Total	3360.23

2. Rearing of white grub for *B. popilliae* production :

1. No. of grubs available in a month for inoculation with <i>B. popilliae</i> (The grubs could be reared by collecting the adults after first heavy showers during June and collecting the grubs from infested fields @ 100 grubs/day)	3800.00
2. No. of milky disease grubs produced in a month (discarding 30% grubs which die due to reasons other than milky disease)	2660.00
3. Number of diseased grubs required for maintaining its culture and subsequent production in a month	460.00
4. No. of grubs ready for harvesting milky disease bacteria	2200.00
5. Total quantity of milky disease powder produced in a month (having 10^9 spores/g considering 1 diseased grubs yields 5×10^9 spores/g)	11 kg

Thus, the cost of milky spore powder on the basis of (1) and (2) comes to be Rs. 305 = 48 per kg. About 10 kg of milky spore powder will be sufficient to treat one hectare field and the cost comes to be Rs. 3054/-

Since the bacterium is not yet available commercially, it would be worthwhile producing it in the laboratory in sufficient quantity and so that its inoculative application in endemic pockets of white grub infestation is made in

the area, so as to study whether this application can cause natural epizootics of the milky disease in the natural populations of white grubs.

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Assay of *Bacillus thuringiensis* Urea Combinations Against *Heliothis armigera* (Hb.) Larvae*

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ABSTRACT

Mortality of third instar *H. armigera* larvae was assayed with *B. thuringiensis* var. *kurstaki* alone and with *B. thuringiensis*-urea mixture in the laboratory, Marathwada Agricultural University, Parbhani, during 1988. LC 50 was 0.179 per cent (1.79×10^9 IU/ml) after *B. thuringiensis* treatment. LT 50(h) values increased when the bacterial concentration was decreased. Maximum mortality (90 per cent) was obtained at 96 h of post treatment with 2 per cent concentration. Combination of *B. thuringiensis*-urea proved ineffective.

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INTRODUCTION

Use of broad spectrum insecticides has led to greater outbreaks of *Heliothis armigera* (Hb) (Wangboonkong, 1981) in cotton. Microbial insecticide *Bacillus thuringiensis* is claimed to be effective in checking the *Heliothis* bollworm damage on cotton (Bull et al., 1979; Johnson et al., 1982). Because of its being non-toxic to natural enemies of the insect pests, its use in *Heliothis* pest management programme on cotton is gaining importance. Microbial insecticide could be applied on pest insects through several methods. On cotton, a combination of microbial insecticide and fertilizer may be applied conveniently, but this has received no attention. Therefore, it is important to study the effect of nitrogen with *B. thuringiensis* against *H. armigera* larvae under laboratory condition, from the point of preparing mixture which can be commercially exploited in future. Reported here are the results of bioassays conducted with *H. armigera* larvae feeding on sunflower leaves

treated with *B. thuringiensis* var. *kurstaki* and with *B. t.* var. *kurstaki* in combination with urea fertilizer.

MATERIALS AND METHODS

The standard preparation of *B. thuringiensis* var. *Kurstaki* used in tests was a wettable powder provided by Paushak Ltd., Vadodara, having spore counts 10×10^8 /mg. The preparation of *B. thuringiensis* was assayed against third instar *H. armigera* larvae collected from healthy culture maintained in the laboratory. The test insects were kept under starvation for 3h.

The initial bioassay was conducted to define the level of mortality resulting from *B. thuringiensis* treatments. *B. thuringiensis* was used in this bioassay at the application rates of 2, 1, 0.5, 0.3, 0.1, 0.05 and 0.03 per cent. All these concentration were tested alongwith untreated control (distilled water). Fresh sunflower leaves were used as food material. The larvae were allowed to feed freely

*Part of Ph. D. Thesis.

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on treated leaves for 24th, after which fresh food was supplied at 24 h intervals. Ten larvae were used for each treatment and such sets were replicated three times. Mortality counts were recorded at 24, 48, 72 and 96 h after treatment. LT_{50} (h) values were also worked out by using formula suggested by Biever and Hostetter (1971).

Another bioassay was conducted to evaluate the efficacy of *B. thuringiensis* in combination with urea. Six concentrations ranged from 0.05 to 2.0 per cent (in which 20 to 100 per cent mortality were obtained in previous test) were evaluated in combination with 2 per cent urea. Two per cent urea solution and distilled water were kept as control treatments. The bioassay was conducted as per methods previously described. Mortality counts at various time intervals and LT_{50} (h) were also recorded as per the previous test.

Estimated LC_{50} 's were determined, using the maximum likelihood method for probit analysis described by Finney (1952).

RESULTS AND DISCUSSION

Efficacy of *B. thuringiensis* var. *kurstaki* against *H. armigera*.

The results of bioassay of *B. thuringiensis* var. *kurstaki* against third instar *H. armigera* larvae are presented in Table-1. From the results it could be seen that corrected per cent mortality was ranging from 11.11 to 100 at 96 h of post treatment. The calculated LC_{50} was 0.179 per cent (1.79×10^9 IU/ml). The preparations of *B. thuringiensis* var. *kurstaki* were also reported to be toxic to third instar *H. armigera* larvae (Dabiet et al. 1979; Anonymous, 1987). The results also revealed

TABLE 1

Results of bioassay of *B.t.* var. *kurstaki* against third instar *H. armigera* larvae.

Concentration (%)	Per cent larval mortality up to 96 hr	Corrected per cent larval mortality
2.00	100.00	100.00
1.00	90.00	88.88
0.50	75.00	72.22
0.30	65.00	61.11
0.10	45.00	38.88
0.05	30.00	22.22
0.03	20.00	11.11
Control (Dist. water)	10.00	—
LC_{50}	0.179	
Fiducial limit (lower)	0.131	
Fiducial limit (upper)	0.239	

that there was significant difference in mortality (Table-2) at all the intervals of observation. None of the treatments gave 50 per cent mortality at 24 h post treatment. Fifty per cent mortality was obtained in 2 and 1 per cent concentration only 72 h of post treatment. At 96 h of post treatment per cent mortality ranged from 18.44 to 90. Maximum mortality

was obtained at 96 h of post treatment with 2 per cent concentration. This would support the finding of Umarov *et al.* (1985). The results further revealed that the LT_{50} values had increased with a decreasing concentrations. It was 51, 68 and 82 h for 1, 0.5 and 0.3 per cent concentrations, respectively. This indicated that the lower concentrations take

TABLE 2

Mortality of third instar *H. armigera* larvae due to *B.t.* var. *kurstaki* at various time intervals.

Con- centration (%)	Cumulative mean per cent mortality (hr after treatment)				LT_{50} (hr)
	24 hr	48 hr	72 hr	96 hr	
2.00	30.00 (33.21) ^a	60.10 (50.85) ^a	90.30 (71.89) ^a	100.00 (90.00) ^a	30
1.00	26.50 (30.99) ^a	46.60 (43.07) ^b	70.00 (56.79) ^b	93.30 (75.00) ^b	51
0.50	16.40 (23.85) ^b	40.00 (39.23) ^b	53.40 (46.92) ^c	73.50 (59.00) ^c	66
0.30	13.00 (21.14) ^{bc}	30.00 (33.21) ^c	40.00 (39.23) ^d	63.40 (52.77) ^c	82
0.10	10.00 (18.44) ^c	16.30 (23.85) ^d	30.00 (33.21) ^c	43.30 (41.15) ^d	—
0.05	0.00 (0.57) ^d	0.00 (0.57) ^e	10.00 (18.44) ^f	30.00 (33.21) ^{de}	—
0.03	0.00 (0.57) ^d	0.00 (0.57) ^e	10.00 (18.44) ^f	19.30 (26.07) ^{ef}	—
Control (Dist. Water)	0.00 (0.57) ^d	0.00 (0.57) ^e	0.00 (0.57) ^g	10.00 (18.44) ^f	—
S. Em.	1.41	1.47	0.67	3.29	
C. D.	4.28	4.48	2.05	9.97	

Figures in the parentheses are angular transformed values.

In a column means followed by same letters are not significantly differing at the 5 per cent level.

TABLE 3

The results of bioassay of *B. t. var. kurstaki* + urea against third instar *H. armigera* larvae*.

<i>B. t. concentration</i> in 2 per cent urea solution	Per cent larval mortality up to 96 hr	Corrected per cent larval mortality
2.00	20.00	20.00
1.00	0.00	0.00
0.50	10.00	10.00
0.30	0.00	0.00
0.10	0.00	0.00
0.05	0.00	0.00
2% urea solution	0.00	0.00
Control (Dist water)	0.00	0.00

*Due to low mortality count probit analysis was not done.

longer time to exert their effect. Dabi et al. (1979) also reported 50 per cent mortality of third instar *H. armigera* larvae after 72 h of *B. thuringiensis* treatment.

Efficacy of *B. thuringiensis* var. *kurstaki* in combination with urea against *H. armigera* larvae.

The results of bioassay of *B. thuringiensis* var. *kurstaki* combined with urea (Table-3) against third instar *H. armigera* larvae indicated that the per cent mortality of larvae was nil in all the *B. thuringiensis* concentrations. This indicated that the urea and *B. thuringiensis* was not compatible. This might be due to higher pH of 2 per cent urea solution, which was 7.9 in the present case. Earlier, Akiba et al., (1979) reported that the threshold for *B. thuringiensis* var. *kurstaki* growth was pH 4.8. Thus, non susceptibility of *H. armigera* larvae

to *B. t.*-urea mixture might be attributed to the alkaline condition of the urea solution. Although, no information in respect of susceptibility of *H. armigera* larvae to *B. t.*-urea mixture might be attributed to the alkaline condition of the urea solution. Although, no information in respect of susceptibility of *H. armigera* larvae to *B. t.*-urea mixture, is available in the literature, the present findings are confirmed to some extent with the finding of West and Burges (1985), wherein they observed that the *B. thuringiensis* population declined in manure supplemented soil to 0.22 x the original value.

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Extent of Losses to Groundnut Varieties by Groundnut Bruchid, *Caryedon serratus* Fab. (Bruchidae : Coleoptera) in Storage

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ABSTRACT

Seven groundnut varieties viz., Improved spanish, RSB-87, TMV-3, Exotic-5, Samarella, RS-1 and TMV-2 were tested to find out the extent of quantitative and qualitative losses, caused by groundnut bruchid, *Caryedon serratus* F. under storage. Average loss in weight per seed of groundnut in the development of mature one grub in different varieties recorded were 0.0242 g (Improved spanish), 0.0585 g (RSB-87), 0.1002 g (TMV-3), 0.0453 g (Exotic-5), 0.0809 g (Samarella), 0.1804 g (RS-1) and 0.0262 g (TMV-2). As regards apparent and real loss per cent in the development of one mature grub, it was 9.29 and 13.94 per cent (Improved spanish), 9.99 and 12.00 per cent (RSB-87), 26.45 and 27.95 per cent (TMV-3), 13.22 and 13.66 per cent (Exotic-5), 14.70 and 16.84 per cent (Samarella), 32.25 and 4.28 per cent (RS-1) and 2.69 and 4.46 per cent (TMV-2). The weight volume ratio of healthy seed was assigned as an unit and was compared with infested (one mature grub developed per seed) and weight/volume ratio difference in healthy seeds and infested seeds were 0.0447 (Improved spanish), 0.0630 (RSB-87), 0.1643 (TMV-3), 0.791 (Exotic-5), 0.0597 (Samarella), 0.1812 (RS-1) and 0.0240 (TMV-2). Quality losses in terms of number of holes made by mature grubs per seed were found 2 (Improved spanish), 1 (RSB-87), 1 (TMV-3), 3 (Exotic-5), 2 (Samarella), 1 (RS-1) and 1 (TMV-2). The addition of frass in development of mature grub per seed, it was found 0.0109 g (Improved spanish), 0.0119 g (RSB-87), 0.0057 g (TMV-3), 0.0158 g (Exotic-5), 0.1118 g (Samarella), 0.0130 g (RS-1), 0.10 g (TMV-2). Loss in fat and protein per cent were 1.9 and 2.10 (Improved spanish), 0.2 and 5.16 per cent (RSB-87), 0.1 and 0.4 per cent (TMV-3), 0.5 and 3.87 per cent (Exotic-5), 0.50 per cent 4.14 per cent (Samarella), 0.5 and 8.76 per cent (RS-1) and 0.2 and 0.2 per cent (TMV-2). The difference in increase, in fatty acids in between healthy and infested seeds was maximum in Samarella (0.5 per cent) followed by TMV-3 (0.2 per cent), Exotic-5, Improved spanish and RS-1 (0.1 per cent) where minimum in TMV-2 and RSB-87, (Zero).

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INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is an important oilseed crop which is attacked under storage conditions by groundnut bruchid, *Caryedon serratus* F. Generally no other pest is found to attack undecorticated groundnut, but groundnut bruchid is exception to it which not only attack undecorticated groundnut but also attacks the decorticated one. For the continuous running of oil mills, it is essential for the oil mills to keep buffer stocks of groundnut, which are generally purchased

by them from the surrounding area. Different varieties of groundnut are grown in the area having differential quantitative and qualitative behaviour as regards the losses done to them by different insects during storage. Insect attack not only reduce the weight of groundnut but also adversely affects the quality of oil and its keeping quality. Although some work on varietal resistance against *C. serratus* of seven varieties has been done (Mittal, 1969). But no work on quantitative and qualitative losses by the pest has been done that is why present studies has been taken up.

MATERIALS AND METHODS

Seven varieties of groundnut (Table-1) were procured from Deputy Director Research, Durgapura from Jaipur Rajasthani. The culture of *Caryedon serratus* F. was procured from storage entomology laboratory of Department of Entomology, Rajasthan College of Agriculture, Udaipur.

Studies on extent of damage in terms of quantitative losses were done in terms of average loss in weight to single seed per development of mature grub, apparent and real loss per cent and weight volume ratio. The methodology was as follow and data on apparent weight loss, real weight loss, average weight volume ratio and weight loss per seed development per grub is given in Table-2.

a. Apparent weight loss

Weight of seed before infestation.	= W_a
Weight of seed after infestation	= W_o
Apparent weight loss	= $W_a - W_o$
Per cent apparent weight loss	= $\frac{W_a - W_o}{W_a} \times 100$

b. Real weight loss

Weight of seed before infestation.	= W_a
Weight of seed after infestation and after removal of frass, etc.	= W_o
Real weight loss	= $W_a - W_o$
Per cent real weight loss.	= $\frac{W_a - W_o}{W_a} \times 100$

Number of mature grub developed per sample	= N_g
Real loss per mature grub development	= $\frac{W_a - W_o}{N_g}$

c. Weight of 50 cc healthy seed

Weight of 50 cc infested seeds	=
Weight/volume ratio of healthy seeds	=
Weight/volume ratio of infested seeds	= $\frac{B}{50}$

Studies on extent of quantitative loss were done in terms of frass produced per mature grub development per seed, and per cent frass production. More number of frass produced per seed, percentage of mature grub developed in the culture of 50 g seed where 10 pairs of adults were released. Loss of protein and protein percentage in development of grub/seeds as well as its effect percentage of fatty acid development were also studied and data are presented in Table-3. Estimation of frass produced in the development of mature grub was estimated as follows

Weight of seeds before infestation.	= X
Weight of damaged seeds with frass and excreta	= X'
Weight of damaged seeds after removal of excreta and frass.	= Y
Total amount of frass and excreta	= $X' - Y$

TABLE 1

Characteritics of seven varieties of groundnut.

Sr. No.	Particulars	Groundnut varieties						
		TMV-3	RS-1	Samaralla	RSB-87	Improved spanish	Exotic-5	TMV-2
1.	No. of pods (per 100 g)	112	67	64	52	138	146	130
2.	No. of seeds (per 100 pods)	204	127	131	148	223	263	247
3.	Shelling %	73	72	73	75	75	75	76
4.	No. of seeds per pod	3	2 or 3	2	3 or 2	2	2	2
5.	Average yield kg/ha	2260	1560	1870 to 2220	1870 to 2220	1550 to 2350	3150	2250
6.	Protein (%)	22.2	26.8	28.2	34.6	28.2	32.2	25.6
7.	Fat (%)	47.2	48.7	47.1	50.00	53.8	52.8	52.1

produced by grubs.

Total number of grubs

developed = G

per sample

Average excreta

produced per = $\frac{Z}{G}$

mature grub

development = G

To study the maximum number of holes per seeds as well as percentage of mature grubs developed per 50 g of seed of each varieties (conditioned at $30^{\circ}\text{C} \pm 1^{\circ}\text{C}$ for 30 days) in three replications were taken in glass jars, in which 10 pairs of newly emerged adults were released. The seeds were maintained at $30^{\circ}\text{C} \pm 1^{\circ}\text{C}$ for 30 days. Maximum number of holes per seeds and per cent grubs developed per replication per 50 g seeds were recorded. Fat and protein content were determined. Crude fat percentage was determined by Soxhlets extraction apparatus using petroleum ether as a solvent having boiling point $40^{\circ}-60^{\circ}\text{C}$ (Knowles and Watkin 1980). The protein percentage of different varieties of groundnut was estimated colorimetrically, while percentage of fatty acid in infested (10 grubs developed per sample) groundnut varieties was estimated by the filtration method using phenolphthelene as a indicator and the results were exposed as percentage of oleic or acid value.

RESULTS AND DISCUSSION

As regards the quantitative loss due to development one mature grubs per seed of groundnut varieties (Table 2) the maximum loss was recorded in variety RS-1 (0.1084 g) followed by TMV-3 (0.1002 g), Samaralla (0.0809

g), RSB-87 (0.0585 g), Exotic-5 (0.0453 g) TMV-2 (0.0242 g) and it was minimum in variety improved spanish (0.0262 g), while apparent loss in weight per cent (Table-2) was maximum in case of variety TMV-2 (2.69%) followed by improved spanish (9.29%), RSB-87 (9.99%), Exotic-5 (13.66%) Samaralla (14.70%), TMV-3 (26.45%), but maximum apparent loss and weight was recorded in variety-RS-1 (32.26%). In case of real loss in weight minimum loss was recorded in variety TMV-2 (4.46%) followed by RSB-87 (12.00), Exotic-5 (13.66%), Improved spanish (13.94%), TMV-3 (27.95%), where RS-1 (39.28%) showed maximum damage of the pest. In case of weight volume ratio maximum difference between healthy and infested seeds was recorded 0.1812, in RS-1 followed by TMV-3 (0.1645), Exotic-5 (0.0791), RSB-87 (0.0650), Samaralla (0.0597) and improved spanish (0.0447), while least different loss recorded in variety TMV-2 (0.0240). It can be concluded from the data of weight loss and weight volume ratio that maximum losses were recorded in RS-1 followed by TMV-3, followed by improved spanish, while the least in TMV-2. Maximum number of 3 holes per seed were recorded in TMV-2 and Exotic-5 followed by 2 holes per seed in varieties Improved spanish and Samaralla, only one hole per seed was recorded in RS-1, RSB-87 and TMV-3 varieties. As regards the production of frass, maximum frass was produced in variety Exotic-5 (0.0015 g) followed by RS-1 (0.0130 g), RS B-87, Samaralla (0.0118 g), Improved spanish (0.01091 g) TMV-2 (0.0104 g) and least in TMV-3 (0.005 g). Loss of fat per cent due to the development of mature grub per seed was maximum in variety Improved spanish (1.90%) followed by Exotic-5, Samaralla and RS-1, RSB-87 and TMV-3 (0.20%), while the least in TMV-2 (0.10%) Incase of protein

TABLE 2

Quantitative loss in different groundnut varieties by *Caryedon serratus* F.

Sr. No.	Groundnut varieties	Av. weight of single seed (gms) (undamaged)	Weight loss per grub development	Apparent loss in weight (%)	Real loss in weight (%)	Weight/volume ratio		
						Healthy seed	Infested seed	Difference
1.	Improved spanish	0.2690	0.0242	9.29	13.94	0.6380	0.5933	0.0447
2.	RSB-87	0.5864	0.0585	9.99	12.00	0.6787	0.1657	0.0650
3.	TMV-3	0.3788	0.1002	26.45	27.95	0.6506	0.4863	0.1645
4.	Exotic-5	0.3426	0.0453	13.22	13.66	0.6280	0.5489	0.0791
5.	Samaralla	0.5502	0.0809	14.70	16.84	0.6330	0.5733	0.0597
6.	RS-1	0.5592	0.1804	32.26	39.28	0.6001	0.4189	0.1812
7.	TMV-2	0.5864	0.0262	2.69	4.46	0.5983	0.5743	0.0240

maximum loss was observed in variety RS-1 (8.76%) followed by RSB-87 (5.16%), Samaralla (4.14%), Exotic-5 (3.87%), Improved spanish (2.10%), TMV-2 (2.04%), while the least in TMV-3 (0.20%). Percentage increase free fatty acid

was maximum recorded in Exotic-5, Improved spanish and RS- 1 followed by Samaralla (0.50%), TMV-2 (0.20%) and it was least in variety TMV-2 (0.00%).

TABLE 3

Qualitative losses to different groundnut varieties by *Caryedon serratus* F.

Sr. No.	Groundnut varieties	No. of holes per seed	Percentage loss due to development of one mature grub		Per cent increase in fatty acid	Frass produced in gram per development of grub
			Fat	Protein		
1.	Exotic-5	3	0.50	3.87	0.10	0.0158
2.	Improved spanish	2	1.90	2.10	0.10	0.0109
3.	RS-1	1	0.50	8.76	0.10	0.0130
4.	RSB-87	1	0.20	5.16	0.00	0.0119
5.	Samaralla	2	0.50	4.14	0.50	0.0118
6.	TMV-2	3	0.10	2.04	0.00	0.0140
7.	TMV-3	1	0.20	0.20	0.20	0.0057

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Estimation of Losses Due to Podfly, *Melanagromyza obtusa* Malloch in Pigeonpea under Junagadh (Gujarat) Condition

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ABSTRACT

The field experiments were conducted at Junagadh during 1984-85 and 1985-86 to estimate the losses due to the podfly, *M. obtusa* on pigeonpea. Results showed that the damaged due to podfly was significantly higher 13.34 per cent in pods and 8.18 per cent in grain and the loss in weight due to this pest was also found 3.13 per cent in unsprayed BDN-2 variety of pigeonpea. However, these losses can be reduced economically to 4.18 per cent in pods, 2.04 per cent in grains and 0.4 per cent in grain weight with the sprays of endosulfan 0.07 per cent at initiation of pods and followed by monocrotophos 0.04 per cent at 50 per cent pods setting. The spraying of these insecticides also gave significantly higher grain yield over control plot. Thus, it can be said that the grain yield increased (35.1%) from 829 kg/ha in isolated control plot to 1120 kg/ha in the plots sprayed with endosulfan and monocrotophos.

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INTRODUCTION

The pigeonpea is an important legume crop cultivated in an area over 3.29 lakh hectares in the Gujarat State. Every year the crop is damaged by the pod borers namely *Heliothis*, plume moth, spotted pod borer, blue butter fly and podfly. But in this State, podfly is an important pest in pigeonpea variety which is matured mid-late and late. The maggots of podfly feed on seeds inside the green pods causing severe damaged to the crop. According to Chandrakar *et al.*, (1981), 30.1 to 49.6 per cent of the pigeonpea pods was damaged by podfly in Raipur. In Gujarat, Kapadia and Talati (1983) also reported that the average percentage of infestation of pods and percentage of loss in weight due to podfly was 37.9 and 60.90 per cent, respectively in T-15-15 variety of pigeonpea. According to Agarwal *et al.* (1985), the losses in yield of pigeonpea

due to podfly was 11.25 per cent in Punjab. However, no comprehensive information is available on losses due to podfly in newly released pigeonpea variety for this State and optimum sprays required for minimize the losses due to this pest. The study was therefore carried out on this aspects in pigeonpea variety BDN-2 during 1984-85 and 1985-86.

MATERIALS AND METHODS

The field experiments were laid out in randomised block design with six treatments (Table 1) with four replications. The plot size was kept 5 x 4.5 m and row to row and plant to plant distance was 75 x 10 cm. The crop was sown on first week of July in both the years. The most effective recommended insecticides namely monocrotophos 0.04 per cent and endosulfan 0.07 per cent included for the spraying of the crop. The respective

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spraying of insecticides for 1st, 2nd, 3rd and 4th spray was done at bud initiation, initiation of pods, 50 per cent pod setting and ten days after 50 per cent pod setting stages of the crop, respectively.

Per cent infestation of pods and grains were worked out on the basis of healthy and damaged pods and seeds counted in all the pods of five selected plants in each treatments. Similarly for per cent weight loss in seeds by podfly was also worked out by following formula given by Khare *et al.* (1975).

$$A = \frac{\text{Weight of healthy grain} \times \text{No. of infested grains}}{\text{Number of healthy grains}}$$

Where, A = Weight of equal number of healthy grain

B = Weight of infested grains

C = Weight loss

$$\therefore C = A - B$$

$$\therefore E = \frac{C}{\text{Weight of healthy grains}} \times 100$$

Where,

E = Percentage weight loss

RESULTS AND DISCUSSION

(i) **Pod Damage** : The results of two years pooled mean (Table 1) on incidence of the *Tur* podfly in different insecticidal spray schedules showed that treatment T_4 was found superior for the control of podfly as it gave minimum per cent pod damaged (3.06%). However, it was statistically equally effective with

the treatment T_2 . Treatment T_2 was treated two time i.e. at initiation of pod formation with endosulfan and it followed by monocrotophos at 50 per cent pod setting. The per cent pods damaged by podfly at harvest of the crop was 6.97, 4.18, 8.04 and 3.06 per cent in treatments T_1 , T_2 , T_3 and T_4 sprayed for one, two, three and four times, respectively. The maximum incidence of podfly was observed in control (12.31%) and isolated control (13.34%). Thus, it is quite clear that insecticides sprayed with endosulfan 0.07 per cent at initiation of pod formation and followed by monocrotophos 0.04 per cent applied at 50 cent pod setting were equally effective to the treatments treated for three and four times. Kapadia and Talati (1983) reported that the infestation in pods due to podfly was 37.9 per cent in T-15-15 variety of pigeonpea under Junagadh condition.

(ii) **Grain Damage** : The results on per cent grains damaged by *Tur* podfly in all insecticidal treatments sprayed at different growth stages were significantly superior over control and isolated control. Treatment T_4 was significantly superior for reducing the per cent grains damaged by podfly over rest of the treatments. The per cent grains damaged by podfly was 1.12, 1.95 and 2.04 per cent in treatments T_4 , T_3 and T_2 , respectively. The significantly maximum grain damaged due to podfly was 8.18 per cent in isolated control.

(iii) **Weight Loss in Grain** : The pooled analysis of two years data showed that minimum per cent weight loss in grain due to podfly was 0.28 per cent in treatment T_4 which was sprayed for four times. Data on per cent weight loss in grain due to podfly also indicated

TABLE 1

Effect of different sprays on pods and grain damage and weight loss in grain by podfly in pigeonpea.

Treatment	Insecticides	Insecticides spray at the stage of the crop	Total cost of treatments application (Rs./ha)	Damaged per cent		Weight loss in grain (%)	Pooled mean grain yield (kg/ha)	Per- centage increased in yield over isolated control	Percent- age of avoidable loss
				Pods	Grain				
T ₁	Monocrotophos	Bud initiation	112.00	15.31 (6.97)	10.03 (3.44)	4.53 (0.62)	900	25.80	22.95
T ₂	Endosulfan	Pod initiation	221.00	11.81 (4.18)	8.20 (2.04)	3.61 (0.40)	1120	35.34	9.95
	Monocrotophos	50% pod setting							
T ₃	Monocrotophos	Bud initiation	333.00	16.84 (8.40)	8.00 (1.95)	3.39 (0.35)	1009	21.71	19.02
	Endosulfan	Pod initiation							
	Monocrotophos	50% pod setting							
T ₄	Monocrotophos	Bud initiation	442.00	10.10 (3.06)	6.07 (1.12)	3.04 (0.28)	1193	43.90	4.25
	Endosulfan	Pod initiation							
	Endosulfan	50% pod setting							
	Monocrotophos	10 days after 50% pod setting							
T ₅	Control	—	—	20.57 (12.31)	15.32 (7.00)	9.64 (2.80)	837	0.90	32.83
T ₆	Isolated control	—	—	21.42 (13.34)	16.62 (8.18)	10.21 (3.13)	829	—	33.47
S. Em. ±				1.57	0.22	0.32	42.0	—	—
C. D. at 5%				3.89	0.64	0.93	116.67	—	—
C. V. %				18.25	6.39	19.24	11.33	—	—

Figures in parentheses are retransformed values.

that only one spray at 50 per cent flowering with monocrotophos 0.04 per cent was not significantly better than two, three and four sprays of different insecticides for minimising the losses in grain due to podfly. The percentage losses in grains were recorded from 0.28 per cent in the plot sprayed for four times to 0.62 per cent in the plot sprayed only once with monocrotophos at 50 per cent flowering. Maximum 3.12 per cent weight loss in grain was recorded in the isolated control plot. Thus, results showed that the loss in grain weight due to podfly was upto 3.12 per cent and this loss can be reduced to 0.28 per cent with the spraying of insecticides for four times. These results are also confirmed with the findings of previous workers (Khare *et al.*, 1975, Balasubramaniam *et al.*, 1976, Sinha *et al.*, 1977, Dhanarkar and Daware, 1979, Srivastava, 1980, Chandrakar *et al.*, 1981, Daware and Dhanarkar, 1981, Kapadia *et al.*, 1983, Babu *et al.*, 1984 and Agarwal *et al.* 1985).

According to Dhanarkar and Dawanre (1979) and Srivastava (1980), spray of endosulfan 0.07 per cent at pod formation stage and followed by monocrotophos 0.04 per cent after 15 days of first spray proved effective against the podfly. Two sprays of endosulfan 0.07 per cent first gave at time of pod initiation followed

by a second one, two weeks later gave very good control of podfly (Balasubramaniam *et al.*, 1976). Daware and Dhanarkar (1981) and Sinha *et al.*, (1977) reported that two sprays of insecticides i.e. first spray with monocrotophos applied at the time of pod formation and second with endosulfan or monocrotophos or quinalphos again a fortnight later were best for reducing the population of podfly.

(iv) **Grain Yield** : The pooled data on grain yield indicated that all the insecticide treatments were significantly better than control and isolated control. The highest yield (1190 kg/ha) was obtained in the treatment T_4 , which was significantly better over all the treatments except T_2 . Treatment T_2 gave 1120 kg/ha grain yield of pigeonpea variety BDN-2. But, the cost of insecticides and the application charges in T_3 and T_4 were not economical. Thus, the one sprays of endosulfan at the time of pods initiation and again at 50 per cent pod formation with monocrotophos is suggested to reduce the incidence of podfly and increasing yield of pigeonpea. These results are also similar with the finding of Kapadia and Talati (1983) and Babu and Rajeshkumar (1984).

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Efficacy, Relative Toxicity and Residual Persistent Toxicity of Different Pesticides to the Adults of *Tetranychus cinnabarinus* (Boisduval) Infesting Brinjal Crop*

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ABSTRACT

Results on efficacy of different pesticides indicated that dicofol 0.03 per cent and sulphur 0.2 per cent were significantly more effective over rest of the treatments tested as they registered 91.00 and 90.15 per cent mortality of *Tetranychus cinnabarinus* (Boisduval), respectively. Considering LC 50 values of different pesticides under test, they were ranked in descending order as phosphamidon > dimethoate > dicofol > demeton-o-methyl > ethion > endosulfan > tetradifon > sulphur > acephate. On the basis of R P T values, the order of persistence toxicity was sulphur > dicofol > methyl o-demeton > dimethoate > phosphamidon > endosulfan > acephate > ethion > tetradifon.

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INTRODUCTION

Red spider mite, *Tetranychus cinnabarinus* (Boisduval), is a polyphagous pest and is cosmopolitan in distribution. Heavy infestation results in stippling or bronzing of the leaves and sometimes leaves fall and fruits drop (Singh, 1976). This species was recorded for the first time on brinjal crop in Junagadh area of Gujarat State during the year 1987. The investigations were, therefore, carried out on efficacy, relative toxicity and residual persistent toxicity of different pesticides to the adults of *Tetranychus cinnabarinus* (Boisduval) infesting brinjal crop.

MATERIALS AND METHODS

The investigation on chemical control of *T. cinnabarinus* was made using nine pesticides and water spray as control. For the evaluation of nine different pesticides, healthy leaves of brinjal were cut into small

pieces and were placed in petri dishes (8 cm x 2 cm) with a layer of moist sand at the bottom. These petri dishes were sprayed directly under potter's spraying tower using 1 ml of spray material at 25 lb/inch² pressure. In control, only water was used. The treated petri dishes bearing brinjal leaf pieces were dried for five minutes under a ceiling fan. Twenty five newly emerged adult mites were then released in each petri dish with the help of camel hair brush from the stock culture and it was replicated four times. Adequate care was taken to wash the sprayer thoroughly well when pesticide was changed. The mortality counts were recorded 48 hours after spraying by observing leaves under dissecting microscope. The corrected mortality percentage in different pesticidal treatments were worked out by using Abbott's formula.

To find out the relative toxicity of different pesticides, healthy brinjal leaves were cut into small pieces and placed in petri dishes

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(8 cm x 2 cm) with a layer of moist sand at the bottom. These petri dishes were sprayed directly under Potter's spraying tower using 1 ml of spray material at a constant pressure of 25 lb/inch². In control only water was sprayed. The treated petri dishes containing brinjal leaf pieces were dried for five minutes under a ceiling fan. The adult mites were then released with the help of a camel hair brush from the stock culture, where its pure culture was maintained. Each treatment was replicated thrice containing twenty adult mites of mixed sexes. Adequate care was taken to wash the sprayer thoroughly well, when pesticide as well as concentration were changed. The mortality counts were recorded 48 hours after the spray under the dissecting microscope. Data were converted to per cent mortality and corrected by using Abbott's formula (Abbott, 1925). The

mortality data were subjected to probit analysis (Finney, 1964). Toxicity ratio of a pesticide was computed according to Jotwani *et al.* 1971.

A field-cum-laboratory experiment was conducted to evaluate residual persistent toxicity of nine pesticides for this pest on brinjal crop. Five rows of brinjal crop (5 m long) were sprayed with different pesticides under test. The spraying was carried out @ 800 litres/ha with the help of knapsack sprayer. The leaves from the respective treatments were brought to the laboratory immediately after spraying and 6, 10, 12, 14, 16 and 18 days intervals. They were cut into small pieces and placed individually in petri dishes (8 cm x 2 cm) with a layer of moist sand at the bottom. Twenty five adult mites were released into each

TABLE 1
Effect of different pesticides on the adults of *T. cinnabarinus* under laboratory conditions.

Treatment	Concentration	Mean per cent mortality of adults 48 hours after spray	
		Transformed value	Retransformed value
Dicofol	0.03	72.53	91.00
Sulphur	0.2	71.70	90.15
Tetradifon	0.03	55.21	67.45
Endosulfan	0.07	53.08	63.92
Dimethoate	0.03	51.03	60.45
Ethion	0.05	48.73	56.50
Phosphamidon	0.03	45.75	51.30
Demeton-o-methyl	0.03	45.59	51.04
Acephate	0.1	39.30	40.12
S. Em. $\pm$		2.32	
C. D. at 5%		6.73	
C. V. %		8.64	

petri dish containing the treated leaves of brinjal crop and each set was repeated thrice. Observations on the mortality were recorded 48 hours after the release of mites. The percentage mortality was corrected by using Abbott's formula (Abbott, 1925). The zero and cent per cent values were removed by using the formula $\frac{1}{4n} \times 100$ and $(1 - \frac{1}{4}) \times 100$, respectively (Bartlett, 1947). The data thus obtained were angularly transformed and subjected to statistical analysis. Persistent toxicity (PT) and relative persistent toxicity (RPT) for each pesticide was worked out as suggested by Sarup *et al.* (1970).

RESULTS AND DISCUSSION

Results indicated (Table-1) that dicofol 0.03 per cent and sulphur 0.2 per cent were significantly more effective over the rest of the treatments as they recorded 91.00 and 90.15 per cent mortality of red spider mite, respectively and were at par. The next best treatments were tetradifon 0.03, endosulfan 0.07, dimethoate 0.03 and ethion 0.05 per cent and they remained at par in effect. These treatments registered 67.45, 63.92, 60.45 and 56.50 per cent mortality, respectively. However, dimethoate and ethion were equally effective with phosphamidon and demeton-o-methyl, whereas the lowest mortality percentage was found in the treatment of acephate 0.1 per cent as it registered 40.12 per cent mortality of this pest.

For finding out relative toxicity of different pesticides against adult mites, five graded concentrations viz., 0.02, 0.01, 0.005, 0.0025 and 0.00125 per cent for phosphamidon, dimethoate, demeton-o-methyl and tetradifon; 0.01, 0.005, 0.0025, 0.00125 and 0.000625 per cent for dicofol; 0.1, 0.05, 0.025, 0.0125 and 0.00625 per cent for acephate and sulphur,

0.04, 0.02, 0.01, 0.005 and 0.0025 per cent for ethion, and 0.06, 0.03, 0.015, 0.0075 and 0.00375 per cent for endosulfan were prepared from commercial formulations of the pesticides and used for these investigations.

It is apparent from Table-2 that phosphamidon ($LC_{50} = 0.004365$) and dimethoate ($LC_{50} = 0.012589$) were the most toxic pesticides against this pest and they were 6.310 and 2.188 times more toxic than dicofol, whereas the treatment acephate ($LC_{50} = 0.316228$) was found least toxic amongst the pesticides tested as it was only 0.087 times less toxic than dicofol.

Considering LC_{50} values of different pesticides under test, they can be ranked in descending order as under :

Phosphamidon > dimethoate > dicofol
> demeton-o-methyl > ethion > endosulfan
> tetradifon > sulphur > acephate.

Goyal and Bath (1967) tested dicofol, tetradifon and methyl-o-demeton. Results indicated that methyl-o-demeton was more toxic and tetradifon was the least toxic than dicofol. According to Nassar *et al.*, (1984) phosphamidon was more toxic than dicofol.

The results (Table 3) indicate that the treatment of sulphur 0.2 per cent gave more than 80.00 per cent mortality up to 14 days followed by dicofol 0.03 per cent by recording more than 70 per cent mortality up to 14 days. Both the chemicals were effective in persistency up to 10 days after spraying although, the effect was decreased with increase in time. However, dimethoate and methyl-o-demeton persisted up to 14 days and remained effective for 10 days by registering more than 60.00 per cent mortality of the pest. On the basis of RPT values, the order

TABLE 2

Relative toxicity of different pesticides against adults of *T. cinnabarinus* infesting brinjal.

Sr. No.	Insecticide	Heterogeneity*		Regression equation	X	=	LC ₅₀	Fiducial limits	Relative toxicity
		x ²	b						
1.	Phosphamidon	0.1805	1.7595 ± 0.3455	Y = 1.7595 X + 3.8889	Log (Conc. x 10 ³)		0.004365	+ 0.7856 - 0.4774	6.310
2.	Dimethoate	0.3102	2.6628 ± 0.5458	Y = 2.6628 X + 2.0014	Log (Conc. x 10 ³)		0.012589	+ 1.1286 - 1.1236	2.188
3.	Dicofol	0.2936	1.0863 ± 0.4119	Y = 1.0863 X + 2.3380	Log (Conc. x 10 ⁴)		0.027542	+ 2.5573 - 2.3437	1.000
4.	Demeton-o- methyl	0.3303	1.1476 ± 0.3868	Y = 1.1476 X + 3.2188	Log (Conc. x 10 ³)		0.038019	+ 2.0899 - 1.0143	0.724
5.	Ethion	0.0769	1.9872 ± 0.4733	Y = 1.9872 X + 1.9079	Log (Conc. x 10 ³)		0.039811	+ 1.7757 - 1.3363	0.692
6.	Endosulfan	0.1413	1.3631 ± 0.3674	Y = 1.3631 X + 2.5672	Log (Conc. x 10 ³)		0.057544	+ 2.1144 - 1.4554	0.479
7.	Tetradifon	0.4577	1.2706 ± 0.4666	Y = 1.2706 X + 2.6697	Log (Conc. x 10 ³)		0.069183	+ 2.5531 - 1.1149	0.398
8.	Sulphur	0.6720	1.2436 ± 0.3834	Y = 1.2436 X + 2.3917	Log (Conc. x 10 ³)		0.100000	+ 2.5041 - 1.6907	0.275
9.	Acephate	0.6299	1.0701 ± 0.4123	Y = 1.0701 X + 2.2157	Log (Conc. x 10 ³)		0.316228	+ 3.4443 - 1.7595	0.087

*In none of the cases the data were found to be significantly heterogeneous at P = 0.05; Y = Probit kill;
LC₅₀ = Concentration calculated to give 50 per cent mortality.

TABLE 3

Residual persistent toxicity of different pesticides against the adults of *T. cinnabarinus* on brinjal crop.

Sr. No.	Insecticide	Concentration (%)	Corrected per cent mortality of red spider mites at different intervals (days)							P	T	PT	RPT
			0	6	10	12	14	16	18				
1.	Dicofol	0.03	84.26 (99.00)*	79.32 (96.60)	68.82 (87.95)	61.72 (77.64)	47.09 (53.65)	36.20 (34.90)	26.67 (20.14)	18	67.13	1208.34	0.870
2.	Sulphur	0.2	84.26 (99.00)	84.26 (99.00)	84.26 (99.00)	77.94 (95.62)	63.73 (80.41)	46.82 (53.20)	21.77 (13.75)	18	77.14	1388.52	1.000
3.	Tetradifon	0.03	44.89 (49.80)	5.74 (1.00)	5.74 (1.00)	5.74 (1.00)	5.74 (1.00)	5.74 (1.00)	5.74 (1.00)	6	25.40	152.40	0.110
4.	Endosulfan	0.07	75.20 (93.52)	31.23 (26.90)	13.30 (5.30)	5.74 (1.00)	5.74 (1.00)	5.74 (1.00)	5.74 (1.00)	10	41.91	419.10	0.302
5.	Dimethoate	0.03	39.12 (39.95)	73.82 (92.40)	60.40 (75.60)	19.81 (11.49)	5.87 (2.22)	5.74 (1.00)	5.74 (1.00)	14	44.33	620.62	0.447
6.	Ethion	0.05	69.27 (87.47)	5.74 (1.00)	5.74 (1.00)	5.74 (1.00)	5.74 (1.00)	5.74 (1.00)	5.74 (1.00)	6	44.24	265.44	0.191
7.	Phosphamidon	0.03	66.42 (84.00)	75.66 (93.88)	13.03 (5.10)	8.41 (2.15)	5.74 (1.00)	5.74 (1.00)	5.74 (1.00)	12	46.28	555.36	0.400
8.	Demeton-o-methyl	0.03	56.12 (68.92)	73.78 (92.20)	50.79 (60.02)	20.48 (12.24)	17.21 (8.75)	5.74 (1.00)	5.74 (1.00)	14	48.43	678.02	0.488
9.	Acephate	0.1	69.68 (87.95)	17.21 (8.75)	5.74 (1.00)	5.74 (1.00)	5.74 (1.00)	5.74 (1.00)	5.74 (1.00)	6	48.35	290.10	0.209
	S. Em. $\pm$		2.70	1.36	0.58	1.90	0.93	0.62	0.73				
	C. D. at (P = 0.05)		7.88	3.97	1.69	5.55	2.71	1.80	1.07				
	C. V. (%)		8.25	5.47	3.39	16.17	10.11	9.01	14.91				

* The figures in parentheses indicate the retransformed percentage values.

P = Period of time.

T = Average toxicity of the pesticides.

PT = Persistent Toxicity

of persistence toxicity was sulphur > dicofol > methyl-o-demeton > dimethoate > phosphamidon > endosulfan > acaphate > ethion > tetradifon. According to Orlando *et al.*, (1968), dicofol 0.037 per cent was effective up to 16 days after treatment.

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Trend of Milk Production in Halfbred Cattle*

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ABSTRACT

To study the trend of milk production at various stages of lactation, an experiment using freshly calved first lactation halfbred cows of each of JK and HK breed groups was conducted. The average total milk production of 308 days of first lactation, average milk, milk yield per day and peak week milk yield were 2988.69 kg, 9.74 and 90.30 kg in case of JK and 34.99.14 kg, 11.34 kg and 101.08 kg for HK half bred cows respectively. The trend of milk production had three phases and it was observed that high yielders had higher rate of ascent and descent. The lactation curves of high yielders were dome or loop shaped, which became flatter for low yielders.

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INTRODUCTION

The trend of milk production within a particular genetic group across various stages of lactation is not uniform. The milk yield in the first trimester of lactation has got a tendency to increase, it remains at peak for a short time and thereafter has got a decreasing trend (Singh and Bhat, 1978). So in this investigation, efforts have been made to estimate the trend of milk production in different phases of lactation in two (J x K and H x K) genetic groups.

MATERIALS AND METHODS

An experiment using freshly calved 12 first lactation cows of each of the two genetic (Jersey x Kankrej (JK) and Holstein x Kankrej (HK) groups during 1983 to 1985 was conducted. The nutrient requirements of each of the animals were met as per Sen *et al.*, (1978). All the animals under experiment were tied in a separate pen and were fed individually during the experimental period. The calves were weaned at birth. Cows were hand milked and milk yield was recorded morning and evening

daily. The weekly milk yields were calculated by adding morning and evening milk yields after 4 days of partition for consecutive 7 days. In order to study the trend of milk production the milk yield of 308 days, weekly milk yield and milk yield per day of the lactation were calculated. The trends of milk yield at various stages of lactation were plotted taking stage of lactation on X axis and milk yield on Y axis.

RESULTS AND DISCUSSION

Comparative production performance of two genetic groups

The average weekly yield during the lactation along with the standard error (SE) and C. V. % 308 days' milk yield and average daily milk yield during the lactation are presented in the table.

It reveals that the weekly milk yield was higher ($P < 0.01$) in H x K halfbreds than in J x K halfbreds through out the lactation. The peak weekly yield of 90.30 ± 4.90 kg and 101.63 ± 4.59 kg was obtained in 4th

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and 3rd weeks of the lactation in the JK and HK halfbreds respectively. After the peak weekly yield there was a decline in the milk yield (@ 1.71% in JK and 1.23% in HK per week) in both the genetic groups and the weekly milk yield (JK, 35.70 kg and HK, 53.85 kg) was observed minimum in 44th week of lactation in both groups.

Milk yield of 308 days and milk yield per day of the lactation were higher ($P < 0.01$) in HK halfbreds (3499.14 kg and 11.34 kg) than those of the JK halfbreds (2988.69 kg and 9.74 kg). Superiority of HK x Haryana halfbreds to J x Haryana halfbreds in milk production was reported by Yadav and Sharma (1983).

Variability at various stages of lactation

Table reveals that standard error for weekly milk yield was maximum for first week yield in Jersey (9.22 kg) and Holstein (7.96 kg) halfbreds and thereafter the values either decreased continuously or had very slight fluctuations up to 39th week of lactation. The decline started increasing thereafter till the end of lactation. Coefficient of variation also measured a slight higher variation in early part of lactation. The degree of variation in weekly milk yield in middle part of lactation was almost uniform as is clear from value of coefficient of variation.

After 36th week of lactation there was continuous increase in values of coefficient of variation of weekly milk yield till the cessation of lactation. This indicates that there is more variation in the weekly milk yield during the early and the late stages of the lactation. This might be due to the environmental stress which affects production to a higher degree during different stages along with the physiological stress, and hence it is not good to evaluate

animals on the basis of the production records of early or late part of the lactation when environmental portion of variation is more. This was also supported by Maust *et al.*, (1972).

Trend of milk production at various stages of lactation

The trend of milk production at various stages of lactation in JK and HK halfbred cows is presented in Fig. 1, which depicts that in general milk production during the lactation had three phases.

First phase was ascending phase; second culminating (peak) and the third phase was descending phase. The ascending phase was shorter than the descending phase. The slope of ascending phase was steeper than that of descending phase indicating high rate of increasing and slow rate of decreasing in the corresponding phase.

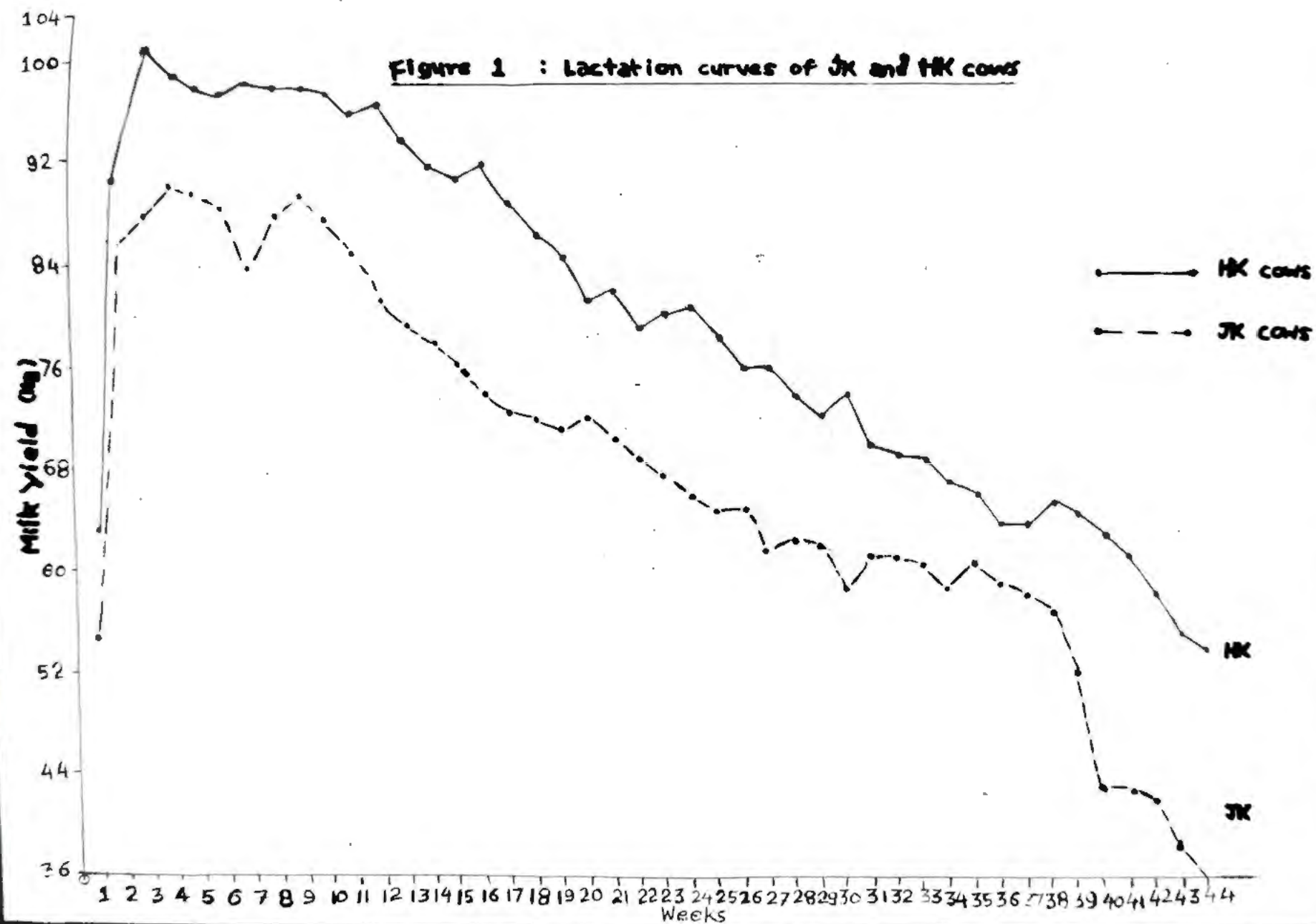
The peak phase was very short lived where the slope of the curve was zero. The initial yield was higher than the yield at cessation point. These observations are in agreement with those of Madalena *et al.*, (1979), Rao and Sundaresan (1982) and Yadav and Sharma (1983).

Comparison of the lactation curves of the different genetic groups reveals that at all the stages of lactation, HK halfbreds were superior to JK genetic group. Both the genetic groups had an ascending phase within four weeks from parturition, peak phase of about two weeks and the descending phase during the remaining part of the lactation; genetic group differences with respect to initial milk yield were less prominent as compared to the peak yield indicating higher level of peak in high yielding HK group compared to that in

Av. weekly milk yield during the first lactation (kg).

Weeks of lact.	Jersey x Kankrej				Holstein x Kankrej		
	Av.	SE	CV		Av.	SE	CV
1	67.51	9.22	47.28		75.32	7.96	49.81
2	85.33	4.92	19.95		90.83	5.41	20.62
3	87.38	4.23	16.79		101.08	5.08	17.40
4	90.30	4.90	18.80		99.63	4.59	15.97
5	89.58	4.68	18.08		97.66	5.89	20.89
6	88.38	4.84	18.96		97.21	6.15	21.90
7	83.61	4.06	16.78		97.37	6.89	24.53
8	87.86	5.75	22.68		97.29	6.68	23.79
9	89.24	5.69	22.07		97.33	7.42	26.43
10	87.13	5.12	20.35		97.14	7.21	25.70
11	84.83	5.63	23.01		95.64	7.13	25.81
12	81.42	5.43	23.09		96.64	7.47	26.76
13	79.15	6.59	28.86		93.69	6.88	25.45
14	78.12	5.03	22.32		91.53	6.67	25.24
15	76.46	4.94	22.39		90.60	6.30	24.09
16	73.98	4.37	20.47		87.83	8.48	33.46
17	72.62	4.24	20.21		88.68	6.58	25.72
18	71.84	4.01	19.34		85.63	6.34	25.65
19	71.28	3.62	17.61		84.83	6.01	24.54
20	72.21	4.41	21.17		81.28	5.46	23.47
21	70.28	3.58	17.64		82.07	5.60	23.63
22	70.21	4.26	21.01		79.13	5.89	25.76
23	67.58	4.78	24.50		80.32	5.38	23.21
24	66.22	4.45	23.27		80.87	5.49	23.51
25	64.93	4.04	21.57		78.50	5.08	22.45
26	64.99	3.51	18.70		75.99	4.62	21.07
27	61.84	3.64	20.36		76.40	5.05	22.89
28	62.64	3.48	19.26		73.83	5.17	24.27
29	61.98	3.20	17.90		70.74	4.95	24.25
30	57.72	3.71	22.29		74.07	5.50	25.74
31	61.50	2.74	15.44		70.83	5.46	26.69
32	60.52	3.52	20.18		69.21	5.05	25.29
33	60.85	3.29	18.73		68.67	5.43	27.42
34	58.67	3.04	17.91		67.14	5.54	28.56
35	61.03	3.28	18.63		66.10	6.03	31.59
36	59.20	4.19	24.52		63.82	5.11	27.31
37	58.32	4.03	25.95		63.63	4.94	27.32
38	57.03	4.60	27.96		65.62	5.23	27.34
39	51.69	4.28	28.66		64.73	5.12	27.41
40	45.20	4.50	34.51		62.33	5.29	29.75
41	42.83	5.38	48.52		61.54	5.40	30.00
42	47.01	6.26	46.39		58.38	5.49	32.58
43	38.31	6.40	57.28		55.15	5.74	36.08
44	35.70	6.31	61.22		53.85	6.15	39.55
Milk yield of 308 days (kg)							
	2988.69	159.40	18.48		3499.14	237.08	23.44
Milk yield/day (kg)							
	9.75	0.52	26.76		11.34	0.77	23.44

Figure 1 : Lactation curves of JK and HK cows



the low yielding JK group. The difference in the peak yield of the two genetic groups was less than those for yields at the tapering stages of the lactation. In broad way the curve appears to be dome or loop shaped for high producers but becomes comparatively flatter for low producers.

A negative correlation between the milk yield in the descending phase of lactation with total lactation yield was also supported by

Rao and Sundaresan (1978). Flat curves of low yielders were also reported by Kellogg *et al.*, (1977) and Madalena *et al.*, (1979).

For the evaluation of the animals and formulating breeding programme, the factors affecting the production performance at various stages of lactation should be paid due attention. The production functions should also be fitted in order to define the actual trend of milk production at various stages of the lactation.

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Biometrical Investigations in Patanwadi Sheep and its Crosses

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ABSTRACT

To investigate the differences in growth rate of Patanwadi and its crosses with Rambouillet and Russian Merino, the body weight and body measurements viz., body length, wither height and heart girth of 58 Patanwadi (PP), 100 Rambouillet X Patanwadi (RP) and 104 Russian Merino X Patanwadi (MP) lambs, at the age of weaning and yearling were studied. Body weight at weaning were 14.69 ± 0.29 , 16.02 ± 0.21 , 14.52 ± 0.26 kg and at yearling age were 22.31 ± 0.43 , 25.42 ± 0.38 and 23.82 ± 0.33 kg for PP, RP and MP lambs respectively. Similarly body length, wither height and heart girth at weaning were 54.09 ± 0.39 , 54.55 ± 0.36 , 62.55 ± 0.83 cm for PP, 56.21 ± 0.35 , 55.62 ± 0.30 , 64.70 ± 0.38 cm for RP and 53.64 ± 0.37 , 53.50 ± 0.33 , 63.21 ± 0.46 cm for MP lambs. While at yearling age these measurements were 62.67 ± 0.44 , 64.84 ± 0.52 , 74.64 ± 0.58 cm for PP, 64.01 ± 0.37 , 67.10 ± 0.45 , 78.18 ± 0.50 for RP and 62.08 ± 0.34 , 65.15 ± 0.41 and 77.18 ± 0.47 for MP lambs respectively. Breed group differences were significant at both the ages for all the traits, but the sex differences were significant for body weight and wither height in PP and RP halfbreds. While in MP halfbreds sex differences were significant only for body weight and wither height at yearling.

Table also provided the phenotypic correlations between body weight and various measurements at both ages for different breed groups. Almost all the correlations coefficients were high and positive.

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INTRODUCTION

Growth of an individual being complex phenomenon, is manifested by increase in body weight and size. Body weight and body measurements have significantly high correlations at various ages, as evidenced by Gupta and Chopra (1975), Mahajan and Bohra (1977) and Bhadulla *et al.*, (1980) in Indian breeds of sheep and their crosses. This study was undertaken to determine the influence of crossbreeding on body weights and body measurements at weaning and at twelve months of age in native Patanwadi and its crosses with Rambouillet and Russian Merino.

and twelve months of age, from 58 Patanwadi (PP), 100 Rambouillet X Patanwadi (RP) and 104 Russian Merino X Patanwadi (MP) lambs born during July-September 1980 at All India Co-ordinated Research Project on Sheep Breeding for Fine Wool, Dantiwada unit were studied.

All body weights and measurements were taken in the morning before sheep had any access to feed and water. All the lambs were raised under identical managerial conditions. Body weights were recorded using 'Salter' brand spring balances of 20.0 kg and 100.0 kg capacity. Body measurements were recorded using tailor's measure tape, after making sheep to stand on levelled ground as suggested by Basuthakur *et al.*, (1967) and Mahajan and Bohra (1977).

MATERIALS AND METHODS

Data pertaining to body weight, body length, wither height and heart girth at weaning

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Statistical analysis was done as suggested by Snedecor and Cochran (1968), to test the significance of genetic groups and sexes. Phenotypic correlations between body weight and measurement traits at both the ages were also calculated.

RESULTS AND DISCUSSION

Mean alongwith standard error of body weights and measurements viz., body length, wither height and heart girth at weaning and yearling age, for PP, RP and MP lambs are presented in Table-1.

Body Weight : Rambouillet X Patanwadi lambs were significantly heavier at weaning, while Merino X Patanwadi lambs were at par with Patanwadi lambs. However, at the age of twelve months, both the halfbred groups outweighed the Patanwadi yearlings by 3.11 and 1.51 kg respectively. The percentage improvement in RP and MP halfbreds was 13.94 and 6.77 over Patanwadi at yearling age. The breed group differences were significant at both the ages.

Males were significantly heavier than females at both the ages in all the three breed groups except for weaning weight in MP halfbreds. These results were in confirmation with the findings of Chaudhary *et al.*, (1982) for weaning in Nali, Chokla and their halfbreds with Rambouillet and Merino. Gupta and Chopra (1975) reported significant breed group differences and sex differences in Gaddi, Poonchi and their crosses with Rambouillet and Merino. Gupta and Pant (1980) also reported significant breed group differences at both the ages in Nali, Chokla and their halfbreds with Rambouillet and Russian Merino. Males were significantly heavier than females at weaning. No significant difference in two halfbred groups were observed, while in present

study all the three breed groups differed significantly. Similarly Arora *et al.*, (1983) reported significant differences in body weight of Nali, Chokla and their halfbreds at both the ages. Heavier weights of males at weaning may be due to better efficiency of utilizing the mother's milk till weaning. Results of present study indicated that both Rambouillet and Merino combined well with Patanwadi with respect to body weight.

Body measurements

(i) **Body length :** The breed group differences were significant for body length at both the ages, but sex of the lambs did not affect this trait. Body length in RP lambs was significantly higher than other two groups which did not differ from each other at both the ages. Similar breed group differences have also been reported by Kalra (1978) in Rambouillet, Chokla and its crosses and by Kishor (1979) in Rambouillet, Malpura and its crosses.

(ii) **Wither height :** The breed group differences were significant for wither height at both the ages. At weaning, all the three breed groups differed significantly but at yearling age MP halfbreds did not differ from Patanwadi. The sex differences were also significant except for height at wither at weaning in MP crosses. Gupta and Chopra (1975) reported significant effect of breed groups on wither height at yearling age. Similarly Wadhwa and Balaine (1971) and Singh *et al.*, (1983) reported significant breed group differences for this trait in Nali, Lohi and their crosses.

(iii) **Chest girth :** The breed group differences were significant for chest girth at both the ages. At weaning, RP lambs differed significantly from MP and PP lambs which did not differ from each other. At yearling age the two halfbred groups

Mean and standard error of body weight and measurement at the age of weaning and twelve months in Patanwadi and its crosses.

Sr. No.	Breed group	No. of obser- vations	Weaning Age				Twelve months age			
			Body weight (kg.)	Body length (cm.)	Wither height (cm.)	Heart girth (cm.)	Body weight (kg.)	Body length (cm.)	Wither height (cm.)	Heart girth (cm.)
1.	Patanwadi	58	14.69 ^a ± 0.29	54.09 ^a ± 0.38	54.55 ^b ± 0.36	62.55 ^a ± 0.83	22.31 ^a ± 0.43	62.67 ^a ± 0.44	64.84 ^a ± 0.52	74.64 ^a ± 0.58
2.	Rambouillet X Patanwadi	100	16.02 ^b ± 0.21	56.21 ^b ± 0.35	55.62 ^c ± 0.30	64.70 ^b ± 0.38	25.42 ^b ± 0.38	64.01 ^b ± 0.37	67.10 ^b ± 0.45	78.18 ^b ± 0.50
3.	Russian Merino X Patanwadi	104	14.52 ^a ± 0.26	53.64 ^a ± 0.37	53.50 ^a ± 0.33	63.21 ^a ± 0.46	23.82 ^c ± 0.33	62.08 ^a ± 0.34	65.15 ^a ± 0.41	77.18 ^b ± 0.47

Figures with similar superscripts do not differ significantly from each other for different traits.

TABLE 2

Phenotypic correlation between body weight and body measurements at the age of weaning and twelve months in Patanwadi and its crosses.

Sr. No.	Breed group	No. of obser.	At weaning				At twelve months			
			body weight	Body length	Wither height	Heart girth	Body weight	Body length	Wither height	Heart girth
1.	Patanwadi	58	—	0.650	0.575	0.672	—	0.634	0.697	0.511
2.	Rambouillet X Patanwadi	100	—	0.542	0.546	0.624	—	0.595	0.756	0.682
3.	Russian Merino X Patanwadi	104	—	1.035	0.974	1.187	—	0.507	1.442	0.597

not differ significantly from each other but differed significantly from native lambs. Sex differences were non significant in PP and MP lambs at both the ages, but were significant in RP lambs at both the ages. Significant effect of genetic groups has also been reported by Gupta and Chopra (1975) and by Singh *et al.*, (1980).

The results indicated the simultaneous increase in all body measurement traits with advancing age till one year. This relative increase in body size of crossbreds might be due to introduction of exotic inheritance in native sheep which in turn has increased body weight.

Phenotypic correlations

The phenotypic correlations between body weight and body measurements at both the ages were positive and high (Table-2). The estimates of correlation co-efficient varied from 0.542 to 1.187 at weaning and from 0.507 to 1.44 at yearling age. Though some of the correlation co-efficients were quite high and

even beyond theoretical range, these findings were in agreement with those of Mahajan and Bohra (1977) in Gaddi sheep at yearling age. Bhadula *et al.*, (1980) also reported positive and significant correlation between body weight and measurement traits ranging from 0.51 to 0.93 at weaning in Muzaffarnagari sheep. Similarly Singh *et al.*, (1980) reported significantly high and positive correlation between body weight and measurements at weaning in Nali and Lohi breeds. Singh and Mahajan (1982) also reported highly significant correlation between body weight and measurements at weaning in Rambouillet X Gaddi halfbreds. However, Kaushik and Singh (1968) reported low and positive phenotypic correlation between body weight and body length at yearling age in Rampur Bushair X Polworth crosses, which was not in agreement with the present findings.

In general, it can be concluded that both Rambouillet and Merino combined well with Patanwadi and has brought improvement in body weight and conformation.

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Factors Affecting the Adoption of Summer Groundnut Technology

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ABSTRACT

The village level workers and service cooperative societies were major formal sources of information, while neighbours, friends and relatives were major informal sources of information. The majority (65.33 per cent) of the respondents were in medium adoption group. The relationship between adoption level and personal and socio-economic characteristics of respondents, the education, knowledge level, social participation and socio-economic status were found to be statistically significant indicating that any increase in these was found to promote adoption level.

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INTRODUCTION

Groundnut is the most thrived age old major oilseed crop as well as cash crop of the country and groundnut oil is main edible oil source in India. But the production of groundnut is not adequate to meet the requirement of India. To overcome the problem of shortage of edible oil, it has been decided at national level to increase area and production of groundnut under the policy, a concept of growing groundnut in summer season, with a new developed technology suitable for summer groundnut, groundnut cultivation is undertaken. In Gujarat also, summer groundnut cultivation has been introduced since 1978.

The summer groundnut is a new crop for Anand taluka. The cultivation was started in this area from 1979-80 and area was increased from about 390 hectares in 1979-80 to 14,125 hectares in 1983-84, but thereafter the area was decreased from 1984-85 (Anon, 1985). There may be variety of factor responsible for decreasing trend. Keeping this

in view a study was undertaken to know some of the factors influencing the adoption and reversion of summer groundnut recommended technology.

Objectives

- (1) To determine the sources of information utilized by the cultivators.
- (2) To find out the extent of adoption of recommended summer groundnut technology.
- (3) To study the relationship between personal and socio-economic characteristics of cultivators and the extent of adoption of summer groundnut technology.

MATERIALS AND METHODS

The study was conducted in Anand taluka of Kheda district of Gujarat State, where the summer groundnut is an important and newly introduced cash crop because of good net work of canal and well irrigation. Out of 91 villages of Anand taluka only 9 villages having

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more than 100 hectares land under summer groundnut cultivation were selected for the present study.

The 150 respondents for the study were determined by porportionate random sampling technique on the basis of area under summer groundnut cultivation from the selected nine villages. Keeping in view the objectives of the study, the interview schedule was developed and the data were collected by personal interview of respondents.

Analysis of data

The extent of adoption of six selected recommended package of practices worked out the composite "adoption index" for the year 1983-84, 1984-85 and 1985-86.

For the qualitative data, the chi-square (χ^2) test was used to find out the relationship

between personal and socio-economic characteristics of cultivators with the adoption level.

In order to measure the knowledge level of cultivators, the scale of knowledge developed by Popat *et al.*, (1985) was used with some modification.

RESULTS AND DISCUSSION

Sources of Information

In order to study the utilization of various sources and media of information as felt by the summer groundnut cultivators for getting technical advice about groundnut cultivation, they were asked to provide information about the sources.

The data presented in table 1 indicated that in all 20 different sources of information have been utilized. Out of these, the village level workers (VLWs) has been mentioned as the most utilised source of information by 98.00

TABLE 1

Sources of information utilized by summer groundnut cultivators.

N = 150

<i>Sources of Information</i>	<i>Number</i>	<i>Per cent</i>	<i>Over all rank</i>
A. Formal Sources			
1. Village level workers	147	98.00	I
2. Agric. Extension Officer	64	42.67	XI
3. Subject Matter Specialist (T & V)	3	2.00	XIX
4. Service Cooperative Societies	82	54.56	X
5. GROFED (Gujarat Cooperative Oilseeds Growers Federation Limited).	45	30.00	XV
6. Agric. College	52	34.67	XIV
7. Taluka Development Officer	2	1.33	XX
8. Agric. Scientists	34	22.67	XVII

<i>Sources of Information</i>	<i>Number</i>	<i>Per cent</i>	<i>Over all rank</i>
B. Informal Sources			
1. Neighbours	140	93.33	II
2. Friends	128	85.33	IV
3. Relatives	122	81.33	V
4. Progressive farmers	92	61.33	VIII
5. Local leaders	59	39.33	XIII
C. Mass Media	140	93.33	II
1. Radio			
2. News papers	117	78.00	VII
3. Written literature	36	24.00	XVI
4. Television	90	60.00	IX
5. Exhibition	118	78.67	VI
D. Other Sources	61	40.67	XII
1. Demonstrations			
2. Self experience	28	17.23	XVIII

per cent of cultivators for obtaining farm information. The second important place was occupied by radio and neighbours, which were served 93.33 per cent of respondents, next to village level workers, radio and neighbours utilized sources were friends, relatives, exhibition and news papers, which were mentioned as utilized sources by 85.33 per cent, 81.33 per cent, 78.67 per cent and 78.00 per cent of the respondents, respectively.

A minute observation of the data presented in table 1 shows that VLWs and service cooperative societies were major formal sources of information, while among different informal sources neighbours, friends and relatives were more utilized. As far as mass media sources are concerned radio, exhibition and news papers were major. Beside these

demonstration was also an important source of information.

Extent of adoption

The data presented in Table 2 indicated that majority (65.33 per cent) of the respondents belonged to the category of medium level of adoption. The probable reason for this might be that summer groundnut crop being a commercial crop, which needs more concentrated efforts than cereal crops.

Factors affecting adoption of summer groundnut cultivation

To study the relationship between personal and socio-economic characteristics and adoption level, the different characteristics studies were education, cultivation experience, knowledge level, social participation and socio-economic status.

TABLE 2

Extent of adoption of summer groundnut cultivation technology by the summer groundnut cultivators.

N = 150

<i>Extent of Adoption</i>	<i>Number</i>	<i>Per cent</i>
Low (below 45)	25	16.67
Medium (45 to 72)	98	65.33
High (above 72)	27	18.00

The data given in Table 3 reveal that with increase in education level, knowledge about summer groundnut cultivation technology, social participation and socio-economic status of cultivators, the adoption level were increased. while in case of cultivation experience, there was no significant effect on adoption level.

Among different sources and media of information village level workers, radio, neighbours, friends, relatives, exhibitions, news papers and television were most utilized sources used by cultivators. Therefore such sources and media should be utilised by the extension agencies to transfer the new technology.

The majority respondents (65.33 per cent) belonged to the category of medium level of adoption, because groundnut crop is a commercial crop which needs more concentrated efforts than cereal crops.

Putting together the finding in regards to the personal and socio-economic characteristics of the cultivators and the adoption of recommended technology it can be concluded that adoption of recommended summer groundnut cultivation technology was associated with education, size of land holding, income, social participation and socio-economic status of the cultivators.

TABLE 3

Relationship between personal and socio-economic characteristics of the summer groundnut cultivators and their level of adoption.

N = 150

Personal and socio-economic characteristics	Adoption level			Total	χ^2 value
	Low	Medium	High		
A. Education					
(1) Illiterate	6 (4.00)	4 (2.67)	0 (0.00)	10 (6.67)	19.69**
(2) Primary (1 to 7 standard)	12 (8.00)	46 (30.67)	10 (6.67)	68 (43.33)	

1.	2.	3.	4.	5.	6.
(3) Secondary (8 to 11 standard)	8 (5.33)	40 (26.67)	9 (6.00)	57 (38.00)	
(4) College (above 11 standard)	1 (0.67)	8 (5.33)	6 (4.00)	15 (10.00)	
Total	27 (18.00)	98 (65.33)	25 (16.67)	150 (100.00)	
B. Summer groundnut cultivation experience					
(1) 2 years	1 (0.67)	5 (3.33)	1 (0.67)	7 (4.67)	3.544 NS
(2) 3 years	7 (4.67)	17 (11.33)	5 (3.33)	29 (19.33)	
(3) 4 years	7 (4.67)	24 (16.00)	5 (3.33)	36 (24.00)	
(4) 5 years	8 (5.33)	35 (23.33)	8 (5.33)	51 (34.00)	
(5) Above 5 years	4 (2.67)	17 (11.33)	6 (4.00)	27 (18.00)	
Total	27 (18.00)	98 (65.33)	25 (16.67)	150 (100.00)	
C. Knowledge level					
(1) Low (upto 25 scores)	4 (2.66)	13 (8.67)	0 (0.00)	17 (11.33)	13.59**
(2) Medium (50 to 82 scores)	22 (14.67)	78 (52.00)	18 (12.00)	118 (78.67)	
(3) High (above 82 score)	1 (0.67)	7 (4.67)	7 (4.67)	15 (10.00)	
Total	27 (18.00)	98 (65.33)	25 (16.67)	150 (100.00)	
D. Social participation					
(1) Membership in one organisation	8 (5.33)	12 (8.00)	1 (0.67)	21 (14.00)	9.575*
(2) Membership in more than one organisation	17 (11.33)	76 (50.56)	18 (12.00)	111 (74.00)	
(3) Office bearer	2 (1.33)	10 (6.67)	6 (4.00)	18 (12.00)	
Total	27 (18.00)	98 (65.33)	25 (16.67)	150 (100.00)	

1.	2.	3.	4.	5.	6.
E. Socio-economic status group					
(1) Low (below 16.4 scores)	7 (4.67)	16 (10.67)	0 (0.00)	23 (15.33)	9.653*
(2) Medium (16.4 to 24.5 scores)	19 (12.67)	64 (42.67)	20 (13.33)	103 (68.67)	
(3) High (above 24.5 scores)	1 (0.67)	18 (12.00)	5 (3.33)	24 (100.0)	
Total	27 (18.00)	98 (65.33)	25 (16.67)	150 (100.00)	

Figures given in parentheses indicate percentage to the total.

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Socio Economic Profile of Gobar Gas Adopters

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ABSTRACT

Survey was undertaken to study the socio economic characteristics of gobar gas adopters in Kaira district of Gujarat State stratified multistage random sampling with proportional allocation method was followed. The results indicated that secondary education, medium family size with 4 to 6 animal as well as extension contact with G.A.I.C. and Banks played an important role for adoption of gobar gas plant.

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INTRODUCTION

The energy problem is an acute since last few years. The Ministry of Agriculture and Rural Development, Government of India has undertaken the gobar gas programme on large scale. Subsequently, the subsidies for construction of gobar gas plant was introduced to increase the adoption rate of gobar gas plants. Various institutions and agencies have made their efforts to popularise the gobar gas plants for solving the problems of fuel as well as manure. India is the world's second largest country as an owner of gobar gas plants, while Gujarat occupies the second position in India after Uttar Pradesh. (Sathianathan 1985).

According to Rogers (1962) the adoption process is the mental process through which an individual passes from the first hearing about an innovation to final adoption. All innovation may not be adopted by the people in a social system, however, socio economic characteristics of an individual may play an important role in the adoption of an innovation. Keeping this view in mind, an effort has been made to study the socio economic profile of gobar gas adopters.

Objective

To study the socio economic characteristics of gobar gas adopters.

MATERIALS AND METHODS

The study was undertaken in Kaira district of Gujarat State. The adopters were selected on the basis of stratified multistage random sampling procedure with proportional allocation methods. The data were collected through interview schedules and analysed with help of statistical tools.

RESULTS AND DISCUSSION

The data collected to know the response of socio economic characteristics of the gobar gas adopters were analysed and the findings are presented in Table-1.

1. Age

The results presented in Table-1 revealed that 50.0, 28.0 and 22.0 per cent gobar gas adopters were in the category of middle, old and young age group, respectively. Thus, it could be seen that the responsibilities of middle to old age adopters plays an important role in adoption of gobar gas plant.

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2. Education

The data further indicated that the majority (70.0 per cent) of the gobar gas adopters having secondary education, while 18.0 and 12.0 per cent adopters educated up to higher and primary level, respectively. It is obvious from the data that the level of education played an important role to understand and decide the adoptability of gobar gas plant by the adopters.

3. Family size

The data recorded in Table-1 revealed that near three fourth (72.0 per cent) of the respondents belong to the medium sized family, whereas 16.0 and 12.0 per cent were of small and large family size, respectively. Thus, it can be concluded that the adopters who belongs to joint families always think for better economy.

TABLE 1

Socio economic characteristics of the adopters of gobar gas plants.

Sr. No.	Characteristics	Numbers (N = 50)	Percentage
1.	Age		
	Young (Below 35 years)	11	22.0
	Middle (35 to 50 years)	25	50.0
	Old (above 50 years)	14	28.0
2.	Education		
	Primary (1 to 7 standard)	06	12.0
	Secondary (8 to 11 standard)	35	70.0
	Higher (above 11 standard)	09	18.0
3.	Family size		
	Small (below 5 members)	08	16.0
	Medium (5 to 13 members)	36	72.0
	Large (above 13 members)	06	12.0
4.	Land size		
	Small (below 2 hectares)	12	24.0
	Medium (2 to 4 hectares)	32	64.0
	Large (above 4 hectares)	06	12.0
5.	Social participation		
	Member of one organization	10	20.0
	Members of more than one organization office bearers	35	70.0
		05	10.0
6.	Herd size		
	1 to 3 animals	10	20.0
	4 to 6 animals	28	56.0
	More than 6 animals	12	24.0
7.	Extension contact		
	Gujarat Agro Industries Corporation	01	02.0
	G.A.I.C. and Banks	29	58.0
	Khadigramodyog Board and Banks	17	34.0
	District Agricultural Officer and Banks	03	06.0

4. Land size

The data presented in Table-1 shows that majority (64.0 per cent) of the adopters were found to have medium land size, while, 24.0 and 12.0 per cent were small and large land size, respectively. From the results it could be seen that the economic condition of small and medium land holders of gobar gas adopters, compelled them to adopt new innovations which are more significant than the traditional one.

5. Social participation

The data presented in Table-1 showed that more than two third (70.0 per cent) of the adopters were members of more than one organisation, followed by, 20.0 per cent members in one and 10.0 per cent adopters were office bearers in their village, thus, the out looks of adopters who belongs to more than one organisation, influenced the adoption behaviour and interest in adoption of gobar gas plant.

6. Herd size

The results presented in Table-1 revealed that majority (56.0 per cent) of the adopters were having 4 to 6 animals. While 34.0 per cent were of more than 6 animal category and only 20.0 per cent were having less than

three animals. Thus, it can be seen that category of 4 to 6 animals played an important role in accepting the adoption of gobar-gas plant. This might be due to at-joining situation of residence and animal shed, which is convenient for the operations of gobar gas plant.

7. Extension contact

The data presented in Table-1 indicated that more than one half (58.0 per cent) gobar-gas adopters approached to G. A. I. C. & Banks, 34.0 per cent to Khadigramodyog & Banks, 6.0 per cent to D. A. Os. & Banks while, only 2.0 per cent to G. A. I. C. The results indicated that majority of the gobar gas plant adopters preferred the help from G. A. I. C. & Banks for its well equipped net work.

Among all socio-economic characteristics of the adopters under study the majority of the respondents were in the middle income group, having secondary education, medium family size, possessed medium land size while more than two third of the respondents were members of more than one organisation. Further it indicated that majority of the adopters who possessed 4 to 6 animal were made extension contact with G. A. I. C. & Banks.

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TABLE 1

Seed yield, its attributes and economics as influenced by doses of nitrogen, phosphorus and its method of application.

Treatments	Plant stand/ha	Branches per plant	Pod bearing length (cm)	Pods/plant	1000 seed wt (g)	Yield kg/ha	Net return (Rs/ha)
Method of application							
Broadcast	109541	7.26	41.50	62.05	79.5	1355 (4342)	3804.04
Drilled below the seed	109979	8.10	42.58	68.66	80.9	1520 (4223)	4315.09
S. Em. $\pm$	531	0.159	0.341	1.562	0.61	45	—
C.D. (5%)	N.S.	0.443	0.945	4.330	N.S.	130	—
Nitrogen levels							
0 kg/ha	109719	7.34	40.51	63.92	79.3	1392 (4195)	3960.80
15 kg/ha	109802	8.21	43.13	65.50	80.6	1479 (4237)	4179.44
30 kg/ha	109760	7.50	43.49	66.00	80.7	1440 (4350)	3986.84
S. Em. $\pm$	662	0.195	0.417	1.913	0.75	57	—
C. D. (5%)	N.S.	0.542	1.158	N.S.	N.S.	N.S.	—
Phosphorus levels							
20 kg/ha	109583	7.12	41.23	60.50	78.1	1347 (4038)	3846.56
40 kg/ha	109979	7.76	42.83	66.41	80.4	1405 (4224)	3937.38
60 kg/ha	109719	8.18	42.06	69.16	82.1	1558 (4440)	4336.95
S. Em. $\pm$	662	0.195	0.417	1.913	0.75	57	—
C. D. (5%)	N.S.	0.542	1.158	5.303	2.04	155	—

Figures in parenthesis indicate the by product.

branches/plant, pod bearing length, pods/plant, 1000 seed weight and seed yield due to application of phosphorus. Application of 60 kg P_2O_5 /ha increased seed yield by 15.0% over 20 kg P_2O_5 /ha, but at par with 40 kg P_2O_5 /ha in case of seed yield. Similar results were reported by Thirunurugan *et al.*, (1982), Shrivastava and Verma (1983), Ramaswamy *et al.*, (1985) and Shrivastava and

Verma (1986). None of the interactions was found significant. Sixty kg P_2O_5 per hectare was having highest net return Rs. 4336.95 among 20 kg and 40 kg phosphorus application. The economic level of fertilizer use was 15 kg N and 40 kg P_2O_5 with drilling which confirmed through more judicious net return and yield per hectare of pigeonpea under rainfed farming.

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Response of Mustard (*Brassica juncea* L.) to Varying Irrigation Schedules, Row Spacings and Levels of Nitrogen in Lowland Condition of South Gujarat

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A field experiment was conducted on clayey soil during *rabi* season of 1986-87 at the Main Irrigation Research Centre, Navsari in split plot design with three irrigation schedules based on IW/CPE ratios (0.4, 0.6 and 0.8) alongwith one control and two row spacings (45 and 60 cm) as main plot treatments and three levels of nitrogen (50, 75

TABLE 1

Yield attributes and seed yield of mustard as influenced by irrigation, row spacing and nitrogen.

Treatment	Grain yield (q/ha)	No. of primary branches/plant	No. of secondary branches/plant	No. of siliquae/plant	Length of siliquae (cm)	Test weight (g)
IW/CPE ratios						
Contol	8.41	4.96	9.39	176.6	4.78	3.31
0.4	12.20	6.70	15.43	232.0	4.92	3.50
0.6	13.20	8.01	19.46	165.2	5.05	3.55
0.8	13.62	8.01	19.77	269.2	5.05	3.55
C. D. at 5%	0.60	0.11	0.96	10.4	0.07	0.04
Row spacings (cm)						
45	11.71	6.71	15.36	204.5	4.95	3.43
60	12.01	7.17	16.66	267.4	4.96	3.48
C.D. at 5%	N.S.	0.08	0.68	7.4	N.S.	N.S.
Nitrogen (kg/ha)						
50	10.94	6.27	14.67	221.8	4.83	3.43
75	12.42	7.24	16.78	245.8	5.01	3.49
100	12.21	7.31	16.80	240.3	5.01	3.50
C.D. at 5%	0.29	0.24	0.59	7.1	0.09	0.05

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and 100 kg N/ha) as sub-plot treatments replicated four times. Field capacity, permanent wilting point and bulk density of the experimental field were 32.0%, 17.5% and 1.4 g/cc, respectively. The sowing of mustard variety Varuna (T-59) was done on the November 22, 1986 and harvested on March, 3, 1987. 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 germination and establishment of the crop. Thereafter, no irrigation was applied in control treatment; whereas in other treatments, the irrigations were scheduled as per treatments based on IW/CPE ratios.

A perusal of data in Table 1 reveals that scheduling irrigation at an IW/CPE ratio of 0.6 and 0.8 were at par but gave significantly higher grain yield as well as the values of yield attributes viz., branches/plant, siliquae/plant, length of siliquae and test weight compared to IW/CPE ratio 0.4 and control treatment. This suggests that IW/CPE ratio of 0.6 can preferably be adopted for scheduling irrigation in mustard crop. This treatment received three differential

irrigations each of 60 mm depth at branching, flowering and pod development stages.

Row spacing treatments failed to give significant difference in seed yield of mustard. Though the plant population per unit area was higher in closer spacing (45 cm), the wider spacing (60 cm) resulted in slightly higher seed yield mainly due to increase in yield attributes.

Yield attributes and seed yield were significantly influenced due to different levels of nitrogen. Seed yield recorded with 75 and 100 kg N/ha were at par but significantly higher over lower level of 50 kg N/ha. The highest seed yield recorded with medium level of 75 kg N/ha seemed to be from more number of branches/plant, number of siliquae/plant, length of siliquae and test weight. These are the important yield attributes which showed significant positive correlation with seed yield of mustard.

Considering the optimum yield, sowing of mustard var., Varuna should be carried out keeping row spacing of 60 cm. Further, the crop requires 5 irrigations each of 60 mm depth and should be fertilized with 75 kg N/ha under clayey soils of South Gujarat.

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Rainfall Pattern and Crop Planning in Bhal Zone

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Quantification of variability in climatic factors has always been a matter of concern for crop planning (Cochemeam and Franquin, 1967 and Hargreaves, 1971). Rainfall behaviour studies in such areas would help in framing the crop planning. The present paper suggests the cropping pattern for the *Bhal* region ($21^{\circ} - 45'$ and $22^{\circ} - 55'$ N, $71^{\circ} - 10'$ and $73^{\circ} - 15'$ E, below 40 ft contour) of Gujarat where major portion of rain is received from the South-West monsoon. The *Bhal* region consists of part of Dholka and Dhandhuka talukas of Ahmedabad, part of Khambhat and Matar talukas of Kheda, part of Vallabhipur and Bhavnagar talukas of Bhavnagar, part of Limbdi of Surendranagar and Vagra and Jambusar talukas of Bharuch Districts.

The daily weather data recorded at the meteorological observatory of Agricultural Research Station, Arnej (1945 to 1987), Dhandhuka (1962-86), Vallabhipur (1975-86) and also at different taluka head quarter i.e., Bhavnagar (1968-86), Limbdi (1963-86), Khambhat (1973-86) and Vagra (1976-87) were used for analysis. The dates of onset, withdrawal and duration of the monsoon for *Bhal* region were analysed using simple frequency based on weekly rainfall data. These data were statistically analysed for Mean and

Median for onset and withdrawal dates as well as standard deviation. Probabilities were calculated to obtain different amount of rainfall during 22 standard meteorological weeks (SMW) to 42 SMW at Arnej. The period of adequate, excess and deficit water availability was obtained by subtracting potential evaporation from precipitation for the meteorological weeks 22 to 42 making the crop growing season. The moisture availability index was worked out on weekly basis according to Book-keeping procedure developed by Thornwaite and his associate for Arnej station.

The analysis of onset, withdrawal and duration of South-West monsoon are presented in Table 1. The early onset decreases the length of growing season while delayed onset increases the length of cropping season. However, the crop yield pattern shows no appreciable differences between normal and late monsoon years (Sastri, 1986).

It is seen that from standard week 27 to 30 water supply equals 72-78% of water demand. There is surplus water from Std. week 31 to 36 barring week 34 in which only about 49% of demand is fulfilled. This period of 56 days (2nd July to 16th Sept.) may be taken as a period of active crop growth. Standard week 23-26, ratio of actual evaporation to potential evapotranspiration ranges from 37 to 46% and therefore sowing operation could be carried out during 25th or 26th standard week in anticipation of assured moisture from 27 standard meteorological weeks.

TABLE 1

Onset, withdrawal and duration of South-West monsoon in *Bhal* zone.

<i>Particulars</i>	<i>Onset</i>	<i>Withdrawal</i>	<i>Duration (Days)</i>
ARNEJ			
Median date	12 June	27 Sept.	105
Mean date	14 June	26 Sept.	105
S D (Days)	10 days	17 days	18
Earliest date	30 May (1945)	11 Aug. (1952)	54 (1952)
Latest date	17 July (1985)	22 Oct. (1975)	141 (1975)
DHANDHUKA			
Median date	11 June	28 Sept.	106
Mean date	14 June	26 Sept.	105
S D (days)	10 days	11 days	14
Earliest date	2 June (1970)	30 Aug. (1986)	74 (1972)
Latest date	2 July (1968 & 1974)	31 Oct. (1968, 1981 & 1983)	127 (1970)
LIMBDI			
Median date	12 June	24 Sept.	101
Mean date	13 June	21 Sept.	102
S D (days)	7 days	16 days	14
Earliest date	3 June (1969)	9 Aug. (1986)	67 (1986)
Latest date	29 June (1974)	12 Oct. (1981)	128 (1975)
BHAVNAGAR			
Median date	13 June	30 Sept.	106
Mean date	13 June	27 Sept.	107
S D (days)	7 days	13 days	15
Earliest date	3 June (1970)	1 Sept. (1986)	77 (1986)
Latest date	26 June (1974)	21 Oct. (1982)	138 (1975)
VALLABHIPUR			
Median date	12 June	2 Oct.	112
Mean date	11 June	28 Sept.	110
S D (days)	6 days	17 days	18
Earliest date	4 June (1975, 1976)	24 Aug. (1980)	79 (1980, 86)
Latest date	21 June (1979)	23 Oct. (1975)	142 (1975)

1

2

3

4

KHAMBHAT

Median date	18 June	25 Sept.	104
Mean date	16 June	24 Sept.	101
S D (days)	9 days	25 days	27
Earliest date	3 June (1980)	8 Aug. (1986)	52 (1986)
Latest date	1 July (1982)	29 Oct. (1983)	141 (1975)

VAGRA

Median date	17 June	25 Sept.	105
Mean date	17 June	26 Sept.	101
S D (days)	11 days	12 days	13
Earliest date	4 June (1976)	27 Aug. (1986)	72 (1986)
Latest date	17 July (1985)	10 Oct. (1983)	115 (1977)

SD — Standard Deviation (days)

On the basis of experimental observations obtained under different weather conditions and the analysis of results, some inferences are drawn as under :

- (i) The crop varieties of about 100 to 105 days duration may be successfully harvested in *Bhal* Zone.
- (ii) For sowing, a rain spell of at least 20 mm in two consecutive days (Virmani, 1975) to 25 mm in the week (Raman, 1974) is desirable. Accordingly, the suitable time/period for sowing *kharif* crops at Arnej is meteorological week 27 which was 68% probability of getting more than 30 mm of rains (Table 2).
- (iii) Crop planning under aberrant weather conditions : The common aberrant weather conditions which affect the dry land farming in semi-arid conditions of *Bhal* Zone are categorised as under :

- (a) Delayed onset of monsoon : From the results it is observed that as compared to normal date of onset of monsoon (normal date 11 to 18 June) it can be as early as 30 May and as delayed as 17 July. As the late onset increases the growing period, crops like cotton during July and mid of August only; castor, sesamum, sunflower and sorghum (fodder) by end of August to mid September should be grown.
- (b) Dry spells during monsoon : During *kharif*, the probability of drought period for 10 and 15 days are 100 and 84%. Short duration dry spells may not be serious concern. However, the long duration dry spells at Arnej (Table 3) create water stress for plants which reduce agricultural production. Yield of drought tolerant crops may not be seriously affected but it is adversely

TABLE 2

Probabilities of rainfall, potential evapo-transpiration and water availability in crop season at Arnej.

Meteorological week	Probability (%) of rains						Potential evapotranspiration	Precipitation	Deficit/surplus water	Moisture availability index
	Any rain	> 10 mm	> 20 mm	> 30 mm	> 40 mm	> 50 mm				
22	19	12	7	2	2	2	93.6	3.4	-90.2	0.06
23	35	12	9	9	5	2	88.3	18.0	-70.3	0.89
24	58	33	23	9	7	7	88.3	16.2	-72.1	0.36
25	67	60	56	47	40	26	88.3	34.1	-54.2	0.76
26	67	58	44	42	33	26	84.2	34.0	-50.2	0.73
27	77	67	60	51	44	35	59.5	48.7	-10.8	1.00
28	84	63	53	47	42	37	59.5	45.1	-14.4	1.00
29	84	70	56	42	40	40	59.5	48.7	-10.8	1.00
30	79	63	49	40	26	26	59.5	42.4	-17.1	1.00
31	81	65	49	47	40	37	49.2	52.1	+ 2.9	1.00
32	86	77	58	47	37	33	45.0	48.0	+ 3.0	1.00
33	79	56	51	40	37	30	45.0	45.8	+ 0.8	1.00
34	70	47	42	30	26	21	45.0	22.9	-22.1	0.62
35	72	49	42	30	28	21	42.4	45.4	+ 3.0	1.00
36	63	49	40	35	26	23	40.7	44.6	+ 3.9	1.00
37	67	53	33	26	23	21	49.7	27.4	-22.3	0.83
38	53	33	23	14	12	9	49.7	16.7	-33.0	0.51
39	37	26	23	16	16	12	49.7	15.8	-33.9	0.43
40	23	16	5	2	2	2	47.8	5.1	-42.7	0.28
41	26	16	14	9	7	7	47.8	10.6	-37.2	0.40
42	14	9	7	7	2	0	47.8	3.3	-44.5	0.21

TABLE 3

Maximum dry spell return period and rainfall days from June to September.

Details	Return period					
	1.01	2.33	5	10	25	100
Dry spell period						
Dry spell days in June	2	16	22	27	33	43
Dry spell days in July	—	12	17	21	27	35
Dry spell days (1st June to 30th September)	10	22	33	40	49	56
Rainfall (mm) days						
Maximum one day rainfall	20	8	132	160	195	247
Maximum two days rainfall	54	163	211	250	299	372
Maximum three days rainfall	80	216	275	329	385	475
Maximum four days rainfall	102	261	330	387	458	564
Maximum five days rainfall	118	298	376	440	521	640

affected in cases of sensitive crops. Even in tolerant crops, the drought may be hazardous at critical stage of growth. Therefore, the crop management practices like interculturing to provide soil as a mulch and avoid cracking in the soil, thinning of plant, removal of weeds and protective or life saving irrigation from harvested runoff/drainage water in farm pond should be advocated.

It could be seen from the analysis of annual maximum time series of precipitation and dry spell, on the one

hand there is a tremendous scope for harvesting rain water at Arnej (Table 3) whereas on the other hand the situation actually calls for judicious and timely recycling of harvested water in the dry spells during monsoon period, to help the crop during their critical stages and increases the productivity.

- (C) Early withdrawal of monsoon : As indicated above, there is a possibility of harvesting runoff water and recycle as life saving irrigation for *kharif* crops during early termination of monsoon. The harvested runoff water can also be

used for irrigation *rabi* crops viz., wheat and gram. The experimental finding at Agricultural Research Station, Arnej showed that the application of one irrigation (5.0 cm) from harvested run-off water to wheat at maximum tillering stage increased grain yield by 30-35 per cent and also at maximum branching in gram. In the case of early

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 termination of monsoon semi *rabi* crops viz., sesamum variety "Purva" and "Tejpur 5", Sunflower variety "Morden" and "SUF 3" (pre *rabi*), Safflower variety "Bhima" and "IC 11842-4" and Mustard variety "Varuna" or "GM-1" (*rabi*) are suggested in place of *rabi* crops like wheat and gram.

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Analysis of Rainfall Data for Crop Planning Under Dryland Agriculture at Rajkot

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Water is the most limiting factor and has to be made available at most crucial time for getting high yields. Rainfall which is the only source of water in dryland farming is generally characterised as scanty and erratic with large seasonal as well as annual variation. The coefficient of variation of annual rainfall is 43 per cent. Analysis of seasonal, monthly and weekly rainfall was carried out for Rajkot. In this region, the drought year is expected once in five years. About 80.5 per cent of annual average rainfall is received in the months of June, July and August. The rainfall exceeds potential evapo-transpiration in only four weeks throughout the rainy season. It is not more than 10 and 20 mm at 80 per cent probability in any week. The probability of $R/P > 0.34$ (ratio of rainfall to evapo-transpiration exceeding 0.34) never exceeded 80 per cent. Therefore, any crop planning schedule can only be made on the basis of watershed improvement aimed at moisture conservation and water harvesting. The potential of water harvesting occurs starting middle of June, to middle of August.

The philosophy of dryland farming revolves around the principle that water is the limiting factor and has to be made available at times which are most crucial for getting high yields. The rainfall which is the only source of water in such regions is however, scanty and erratic with large seasonal and annual differences. Therefore, the rain water utilization in the country has been very low and is estimated to be only 6 per cent on an average for the whole country. Even in the arid region of Rajasthan, under average rainfall conditions, the rain water use efficiency is hardly 50-55 per cent (Mann *et al.*, 1981; Gupta and Pandey, 1979). Wastage of nearly half of the rain water is due to unscientific management of rain water. It is however, now realized that management of rain water through moisture conservation and water harvesting is the only approach to increase its utilization to more than 90 per cent. It naturally leads to increased yield in rainfall agriculture. The realization of this twin goals of improved rain water utilization and increased yields can be achieved by proper crop planning as supported by the statistical analysis of the rainfall data (Gupta 1987).

Collection of data

Weekly rainfall data for the last 14 years, covering the period 1971 to 1984 were collected from the meteorological observatory at Targhadia Farm in Rajkot district. The farm is located at latitude $20^{\circ} - 17.6' N$ and longitude $70^{\circ} - 46' E$ and has an altitude of 133 m above

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mean sea level. Rajkot district is an important district of the North Saurashtra region in Gujarat and has an area of 11821 sq. km. of which 94 per cent is confined to the semi arid zone and the remaining portion as arid. Agriculture is mainly sustained through dry farming and by and large, depends upon the rainfall. The annual average potential evapo transpiration is 2145 mm which is far in excess of the average annual rainfall (642.6 mm). The moisture and aridity index worked out to be 34.5 and 59.5, respectively. This shows that the observatory falls in the pre-dominant semi-arid zone. Large coefficient of variation (43 per cent) worked out for the series of annual rainfall data of 14 years indicates that statistically the length of record is insufficient to draw conclusions with an expected error of 10 per cent. However, the average annual rainfall of the 14 years included in this study is 102.8 per cent of the mean annual rainfall of the last 28 years, thereby indicating that conclusions drawn from this analysis could be fairly valid. Moreover, as the planning process is more of site specific nature, it is considered justifiable to use shorter length of records to get site specific and valuable information than to use the long record of data from a nearby place to overcome this shortcoming.

Analytical procedure

In agricultural planning, seasonal rainfall is more important than the annual average, because of the large seasonal variations and the general characteristic of the monsoonal rainfall, that the lion's share of rainfall occurs in a few scattered days followed by long dry spells. It supports the hypothesis that analysis should be based on durations than a season. Therefore, in this paper, analysis was carried out on the basis of annual, seasonal monthly and weekly rainfall and was supported by limited data on daily rainfall

Annual rainfall analysis

The average annual rainfall in the region is 642.6 mm with a coefficient of variation of 43 per cent which is quite large compared that for many stations in semi-arid zones falling within this range of annual average rainfall. On the basis of a drought and an abnormal year defined as the year with rainfall one standard deviation less and more than the average annual rainfall of the region, respectively, Fig. 1 presents the drought abnormal and normal years in this region. This shows that drought years occur with a probability of 21.44 per cent whereas abnormal years occur only at a probability of 7.1 per cent. Thus, in this region a drought year can be expected once in five years suggesting that several alternative crop planning schemes have to be made for the area. Maximum rainfall received in a year during the 14 years period is 213.2 per cent of the average with 6 years receiving rainfall above the normal. The minimum rainfall received in a year during the period under study is 44.6 per cent of the average and 8 years received rainfall below the average. This means that the annual rainfall series is skewed and usually a wet year raises the average more than an unusually dry year lowers it.

Seasonal and monthly rainfall analysis

The amount of rainfall that occurs during a cropping season is indeed more important than the annual average. The analysis on seasonal and monthly basis reveal some very important aspects of rain water management.

(i) The rainfall in the monsoon season (June-September) is 91.9 per cent of the total annual average rainfall. Even in the first three months of June, July and August, the rainfall is 80.5 per cent of the annual average. Moreover, this is the only season with a large potential

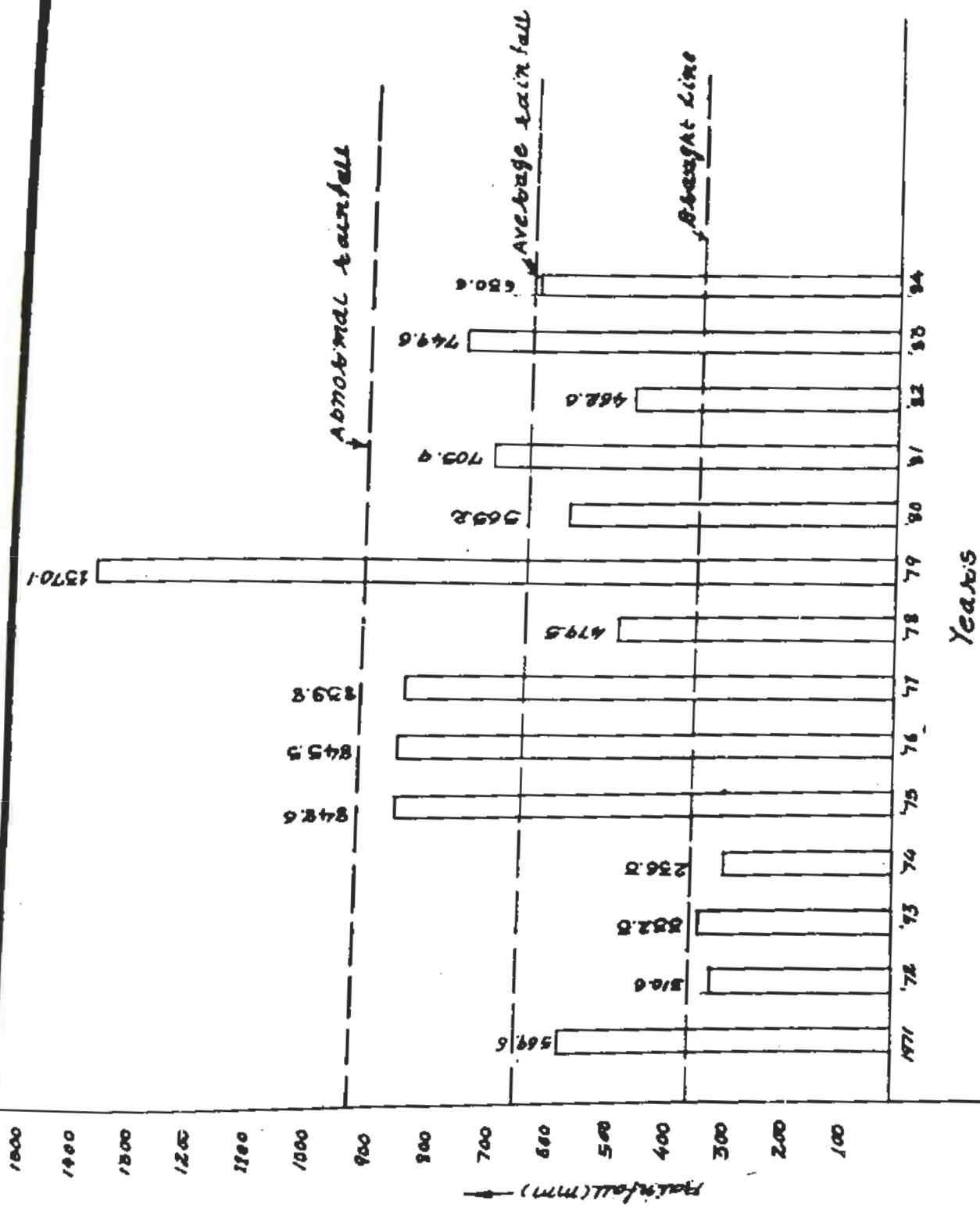


Fig. 1 Distribution of annual rainfall at D.F.R.S. Tabaghadia (Rajkot).

of water harvesting. Even during this season, the continuous dry spells at a probability of 20 per cent could exceed one month. Thus, crop may suffer from moisture stress even in this season.

(ii) In the *rabi* season, the rainfall occurs only in the month of November with the remaining months (Dec.-April) being completely dry. The rainfall in the month of November is also quite erratic and, in the 14 years under consideration, the rainfall varied from 0 mm to 322.2 mm. Therefore, the only source of water for dryland agriculture in this region could be through moisture conservation or water harvested during the *kharif* season.

The monthly distribution of rainfall is also quite revealing. The month of July is the wettest

TABLE 1

Seasonal and monthly distribution of rainfall at Targhadia (Rajkot).

Rainfall season/month	Average rainfall (mm)	Drought season/month rainfall (mm)	Probability (per cent)
June-September (Monsoon season)	607	303.5	13.33
June	136	68.0	33.00
July	191.5	95.8	13.33
August	192	86.0	33.33
September	667.7	33.9	46.66
October	21.7	10.9	53.33

Weekly rainfall analysis

With emphasis on profitable crop production in dryland agriculture, weekly rainfall appears to be the most suitable basis for judicious utilization of soil moisture and harvested water. Even this analysis will not reflect on dry-spells as large as 12 days but it is presumed that crops are hardy enough to withstand such dry spells.

month with an average rainfall of 225 mm. It is also the month of maximum potential for rain water harvesting thereby ensuring water for the long dry spell expected in the season later on. The probability of rain water harvesting in the succeeding months is in the order of August-September-October. However, the water harvested due to low probability spells of rain ensures refilling of the storage structures and thus allow water to be kept for use in the *rabi* season. The quantity of water however, may vary depending upon the rainfall, its distribution and management inputs used in the catchment. The probability of drought for the season as well as for each of the months of 14 monsoon seasons is presented in Table-1.

Weekly rainfall at a probability of 50 per cent for each standard week and average potential evapotranspiration in each week estimated based on pan evaporation data are furnished in Fig. 2. The rainfall exceeded the potential evapotranspiration in 28th, 29th, 32nd and 33rd weeks during the rainy season which showed the potential of rain water harvesting. At still lower probabilities and for duration

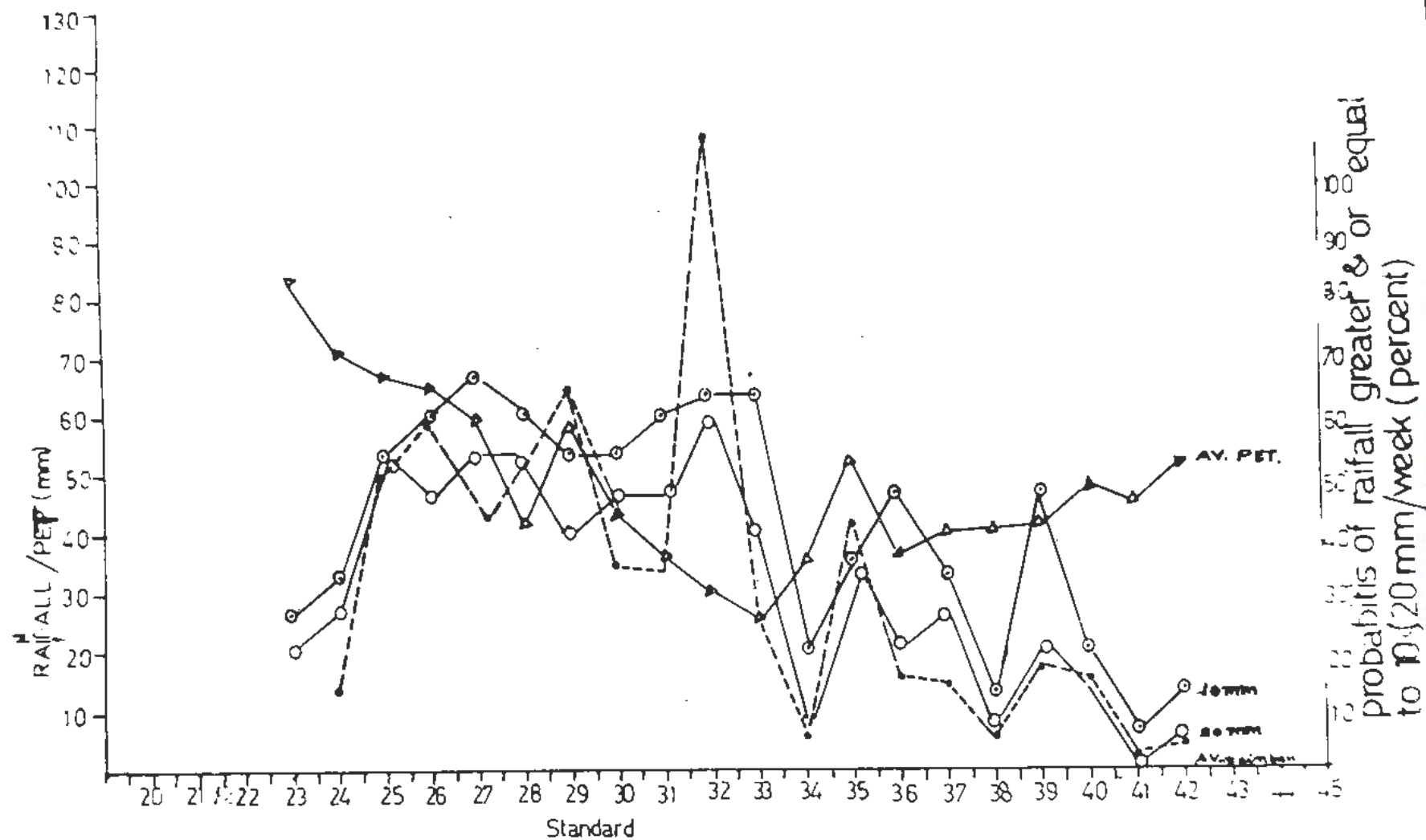


FIG.2. Weekly rainfall & potential evapo-transpiration at D.F.R.S. Targhadia (Rajkot)

less than a week, there are several spells of rain in that week as well as in other weeks during which water can be harvested and stored for irrigating crops during dry spells and/or *rabi* season. Analysis however, reveals that on weekly basis and at 75 per cent confidence, surplus rainfall is not available which indicates flexible planning that can be moulded as and when situation warrants.

The probability of occurring 10 mm and 20 mm rainfall in a week from 20th week to 42nd week is shown in Fig. 2. Data showed that rainfall is not more than 10 mm and 20 mm at 80 per cent probability in any week. Thus, the planning of dryland crops can be started in 25th week when rainfall exceeds 20 mm with probability more than 50 per cent. The risk is less than or equal to 50 per cent, but from agricultural point of view, it is considered on a lower side as the event of rainfall occurs with a probability of ≥ 0.75 (75%) is considered to be dependable (Virmani *et al.*, 1982). However, in this region, it appears to be the only alternative as rainfall with 80 per cent confidence is very rare and only occurs late in the season. The risk, however, can be reduced by choosing crops which can be sown within the range of more than a week so that, if rains fail in that week, the sowing can be carried out in the following weeks. Moreover, the probability of onset of south-west monsoon by the middle of 25th week is 62 per cent and it increases to 86 per cent by the end of 26th week. This also indicates the appropriate period for crop sowing in the region. It is clear that probability is almost similar or increased beyond this week before it starts falling again. A crop which is more tolerant to water stress during the later stages of growth is useful as probability of rainfall

decreases towards the end of the growing season of the crop.

Dryland farming is considered to be a successful venture in weeks where the ratio of rainfall to potential evapo-transpiration equals or exceeds 0.34 ($R/P \geq 0.34$) (Virmani *et al.*, 1982). Probability of $R/P \geq 0.34$ for selected weeks is shown in Fig. 3. This again shows that kharif crop can be planted successfully in the 25th week though the sowing can be started as early as in 23rd week and could prolong upto 26th week. Here again it can be seen that probability of $R/P \geq 0.34$ never exceeds 80 per cent. Therefore, in this region, during monsoon, crop planting/sowing has to be done at a higher risk level.

The probability of $R/P \geq 0.34$ is extremely low in the months of October/November and abnormal years have a probability of 7.1 per cent only. In fact crop planning is difficult at these levels of probability. Therefore, crop planning schedule can be made only on the basis of watershed improvement aimed at moisture conservation and water harvesting.

Water harvesting potential

Utility of water harvesting in a region has to be adjusted mainly on two grounds. Firstly, the potential of water harvested in raising the yields of crops and secondly the actual potential of rainfall for water harvesting. A good review on the potential of water harvested in raising crop yields has been reported by Gajjar *et al.*, (1982). It is reported that a single irrigation over control (unirrigated) results in increase in the yield of major dryland crops. For example, yield of wheat increases from 31 to 81 per cent and barley from 32 to 55 per cent. Maximum increase in yield is

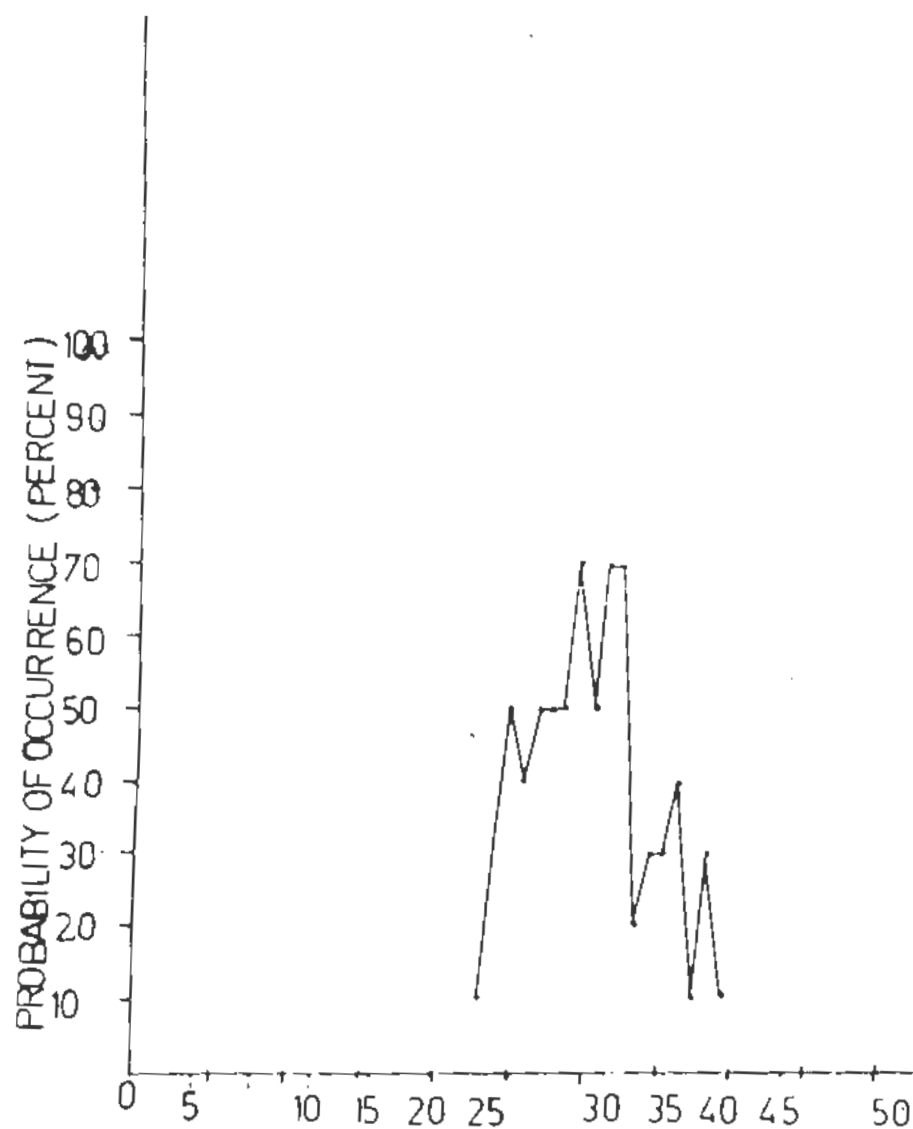


FIG.3. PLOT OF PROBABILITIES OF $R_p > 0.34$ AGAINST STANDARD WEEK AT RAJKOT.

for rapeseed (141 per cent) followed by safflower (123 per cent). Thus, there is evidence that even if the water is harvested to provide one lift-saving irrigation to the crop, it will be useful. However, the time at which this water should be applied needs be determined in respect of each crop grown in this agro-climatic zone. Such an experiment on supplemental (life-saving) irrigation to bunch type groundnut

at different growing stages was conducted during 1979 at Targhadia farm (Table 2) (Parmar *et al.* 1983). The results showed that maximum increase in the yield of groundnut was observed with application of two irrigations viz., at flowering and pegging stages of the crop. An application of one irrigation at peg formation stage was also beneficial as compared to control (no irrigation).

TABLE 2

Effect of supplemental irrigation on yield of groundnut GAU-G-1, at different growth stages (1979).

Sr. No.	Treatment	Date of irrigation	pod yield t/ha.
1.	Control	—	5.40
2.	One irrigation at flowering stage	23.7.79	5.40
3.	One irrigation at pegging stage	26.8.79	7.00
4.	Two irrigations one at flowering and second at pegging stage.	23.7.79 26.8.79	8.5

A scrutiny of daily rainfall data of many stations in the semi arid zones including Targhadia, revealed that the probability of rainwater harvesting is maximum in the weeks with rainfall exceeding 100 mm, though there could be many other spells of rain which can also be harvested (Narayana *et al.*, 1978). The probability of standard weeks with cumulative rainfall exceeding 100 mm is given in Table 3. This shows that major potential of water harvesting occurs starting from middle of June to middle of August. At low probabilities, some replenishment is possible in the 35th and 40th week. The water harvested in the month of June, can be utilized to provide flexibility to crop sowing. The replenishments later in the

season should help in conserving water for the rabi crop. For example, there is a 50 per cent chance that there could be 9 runoff producing spell of rain at least once in the month of Sept. Even in the month of November, the chance of water harvesting is estimated at 10 per cent. Thus, on both accounts i.e., on the basis of increased crop yield and probable occurrences of water of rainfall, water harvesting is possible and useful in this region. A more detailed analysis based on daily rainfall to work out storage space etc., can lead to more useful conclusions in this regard. On consideration of the above analysis of the rainfall data of the last 14 years, the following crops could be successfully adopted under the arid dry-farming region of Rajkot.

TABLE 3

Probability of cumulative rainfall exceeding 100 mm in selected weeks.

Standard week	Period with dates and months	Probability (per cent)
22	28-3 June	0
23	4-10	0
24	11-17	0
25	18-24	20.0
26	25-1 July	20.0
27	2-8	6.7
28	9-15	13.3
29	16-22	26.7
30	23-29	6.7
31	30-5 August	6.7
32	6-12	26.7
33	13-17	0
34	20-26	0
35	27-2 Sept.	13.3
36	3-9	0
37	10-16	0
38	17-23	0
39	24-30	0
40	1-7 Oct.	6.7
41	8-14	0
42	15-21	0

1. Food grains Pearl millet (GHB-30, 32); Sorghum (CHS-5, CSH-1)

2. Oilseeds Groundnut (GG-2, JL-24); Castor (GAU-CH-2 and 4); Sesamum (Gujarat Sesamum-1)

3. Pulses Mung (G-2, K-851); Urd (T-9); Pigeonpea (UPS-120)

4. Fibre crops Cotton (Deshi-Hybrid, V-797, G.Cot.11,13).

However, there is a wide scope for studying the details about adopting crop varieties as per the occurrence of rainfall and adoption of suitable cropping patterns.

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Studies on Pre-emergence Applied Herbicides Residues in Soil and Onion Plant

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A field study, to estimate the residues of pendimethalin and fluchloralin in soil as well as in onion (var. Pusa Red) was conducted at Agronomy Farm, Gujarat Agricultural University, Anand Campus, Anand, during the *rabi* season of 1987-88. Pendimethalin was applied at 0.75, 1.0, 1.25, 1.5 and 2.0 kg/ha and fluchloralin at 1.0 kg/ha as pre-emergence spray 5 days after transplanting the onion seedlings. The soil samples for residue analysis were collected at 0, 10, 30 and 50 days after application and at harvest (115 DAS). The soil

of the experimental plot was deep, alluvial and well drained loamy sand locally known as *goradu* soil. The method of extraction and estimation of pendimethalin and fluchloralin residues from soil and plant samples were as described by Zimdahl *et al.*, (1984) and Beste *et al.*, (1983) respectively.

The residues detected in soil at harvest with all rates of pendimethalin application were well below the permissible limit of 0.1 ppm (Anonymous, 1981) except 1.5 and 2.0 kg/ha. Residues detected from onion plant at harvest were also below the tolerance level at 1.0 kg/ha but was above in case of 2.0 kg/ha pendimethalin.

Fluchloralin residues detected in soil as well as in onion plant were below the tolerance limit of 1.0 ppm prescribed for oil seed crops (Yaduraju *et al.*, 1980).

TABLE 1

Residues of pendimethalin and fluchloralin in soil (kg/ha).

Treatment	Dose kg/ha	Sampling intervals (days after spraying)				
		0	10	30	50	At harvest (115)
Pendimethalin	0.75	0.401	0.168	0.094	0.092	0.072
Pendimethalin	1.00	0.777	0.206	0.179	0.146	0.076
Pendimethalin	1.25	1.326	0.289	0.269	0.244	0.087
Pendimethalin	1.50	4.039	0.517	0.417	0.385	0.181
Pendimethalin	2.0	4.569	0.694	0.555	0.508	0.259
Fluchloralin	1.0	0.452	0.217	0.047	0.047	0.040

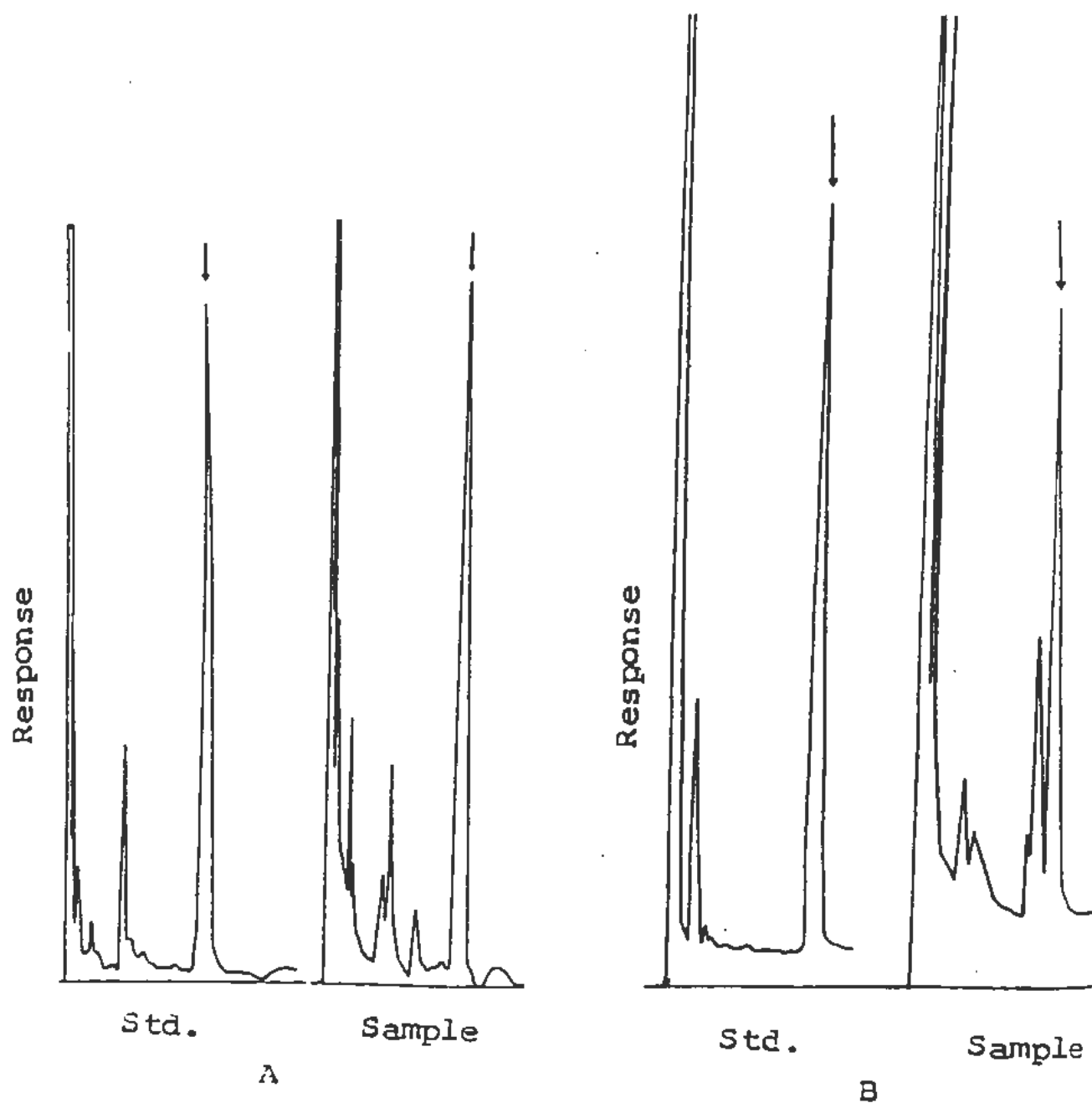


Fig. 1

CHROMATOGRAPHIC PATTERN

A RESIDUES OF PENDIMETHALIN

B RESIDUES OF FLUCHLORALIN

TABLE 2
Residues of pendimethalin and fluchloralin in onion (ppm).

Treatments	Dose kg/ha	Sampling intervals (days after spraying)	
		70	At harvest
Pendimethalin	1.0	0.312	0.056
Pendimethalin	2.0	0.552	0.103
Fluchloralin	1.0	0.634	0.126

The data of terminal residues of both the herbicides in soil as well as plant have been presented in Tables 1 and 2. The chromatographic pattern obtained for the residues of both the herbicides are depicted in Fig. 1.

By considering these tolerance levels, residues estimated below 0.1 and 1.0 ppm

for pendimethalin and fluchloralin respectively, appeared to be safe in soil and plant.

It could, therefore, be concluded from the present study that pre-emergence application @ 1.0 kg/ha pendimethalin and 1 kg/ha fluchloralin could be recommended for weed control in onion.

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Nitrogen Utilization by Wheat Varieties Grown on Vertisols with Different Sowing Methods

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In rice-wheat rotation, drilling method of sowing wheat is time wasting because of vertisol characteristics of soils of South Gujarat. By changing the plant geometry through sowing method, plant growth, yield attributes, yield and nutrients utilization pattern may be affected. Keeping this in view, a field experiment was conducted in Rabi 1981 to know the response of three cultivars (Lok-1 Swati and Kalyansona in main plot) of wheat to four N levels (30, 60, 90 and 120 kg/ha in sub-sub plot) and two methods of sowing (drilling and broadcasting in sub plot) in double split plot design with four replications at Agricultural College Farm, Navsari on vertisol with Jalalpur series. The soil was clayey in texture having pH (1:2.5) 7.9, EC, (1:2.5) 0.41 mm hos/cm low in total N (0.052%), marginal in available P_2O_5 (24 kg/ha) and high in available K_2O (368 kg/ha).

The N was applied in three splits as 50% at sowing and remaining in two equal splits at tillering and penicle initiation stages of growth in the form of urea. Sixty kg P_2O_5 /ha in the form of SSP was applied at sowing. The basal

dose was broadcasted and mixed in the in broadcasting method while in drilling placement was followed. No potash applied. The plant samples were analysed for N, P and K content and their uptake macro-kjeldahl's, colourimetry and Flame photometry methods, respectively.

From the data (table-1), it is observed that the effects of methods of sowing on yield of wheat grain as well as straw were significant. Similarly, non-significant effects of methods of sowing on yield was observed by Jakasaniya (1980), while Singh et al., (1978) Patel (1978) and Nakrani (1982) observed significantly higher yield when wheat was sown by drilling method over broadcasting method. In contrast to this significantly higher yield were also observed when sowing was done by conventional method than drilling method (Sharma and Singh, 1971 and Dhaliwal and Kler, 1978).

The effects of methods of sowing on N content in grain and total N uptake were significant. The broadcasting method proved superior over drilling method in respect of N content and uptake. The total N uptake was 8% higher over drill method. The superiority of broadcasting method might be due to the growth of plants as compared to drilling method. Seed rate in both the methods was equal. Equality of the seed rate in drilling method gave more number of plants per unit furrow length. The higher intensity of plants was

TABLE 1

Wheat yield, content and uptake of N, P₂O₅ and K₂O as affected by methods of sowing.

Methods of sowing	Yield (kg/ha)		N content (%)		P ₂ O ₅ content (%)		K ₂ O content (%)		Total uptake (kg/ha)		
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	N	P ₂ O ₅	K ₂ O
Drilling	3747	5174	2.058	0.533	0.582	0.076	0.322	2.042	105.94	26.03	119.05
Broad-casting	3798	5503	2.142	0.571	0.595	0.076	0.316	2.068	114.40	26.87	127.11
S. Em. ±	86	116	0.026	0.013	0.022	1.31	0.006	0.029	2.34	0.86	3.50
CD at 5% ±	NS	NS	0.082	NS	NS	NS	NS	NS	7.58	NS	NS

TABLE 2

Grain yield, total N uptake and nitrogen use efficiency as affected by variety x methods of sowing.

Variety	Methods of sowing								
	Drilling			Broadcasting			Average		
	Yield kg/ha	Uptake kg/ha	NUE N kg/100 kg grain production	yield kg/ha	Up take kg/ha	NUE kg N/100 kg grain production	Yield kg/ha	Up take kg/ha	NUE N kg/100 kg grain production
Lok — 1	3979	109.05	2.74	3976	114.23	2.87	3978	111.65	2.81
Swati	3766	100.91	2.68	3885	122.76	3.16	3826	111.84	2.92
Kalyansona	3496	107.84	3.09	3532	106.22	3.01	3514	107.03	3.05
Average	3747	105.93	2.83	3798	114.40	3.01	3773	110.17	2.92
		S. Em.	C. D.						
Method		2.34	7.58						
Variety		1.61	NS						
Variety x Method		4.13	NS						

affect adversely the growth of different components i. e. the leaves, stems and roots. This would not be the case in broadcasting method as the equal number of seeds would be distributed uniformly and this uniform distribution would give more scope for development of plants including their components. Thus, the high growth of plants under broadcasting method of sowing would result in higher concentration of nitrogen per unit weight i.e. the content and total uptake. Mahanta (1967) observed non-significant differences in respect to protein content of wheat eventhough the values were higher in dibbling method than the line sowing and transplanting method.

The N use efficiency of different varieties tried under these methods was also worked out (table-2). The variety Lok-1 proved to be the most efficient variety in respect of N utiliza-

tion (2.81 kg N for 100 kg grain production), followed by Swati (2.92) while Kalyansona was less efficient (3.05). The N use efficiency of sowing methods was also computed. Accordingly broadcasting method proved less efficient as compared to drill method in respect to grain and total biomass production.

The effect of methods of sowing on content and uptake of phosphorus and potash was also not significant. The non-significant effect might be due to variation in method of phosphorus application.

By and large, it can be inferred that both the methods of sowing wheat are equally good. Nitrogen concentration in grain and total N uptake by wheat were significantly higher under broadcasting method. Nitrogen use efficiency was relatively higher under drilling method.

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Accumulation of Dry Matter and Nutrients at Various Growth Stages in Groundnut (*Arachis hypogaea* Linn.)

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The cultivation of groundnut (*Arachis hypogaea* Linn.) in summer has been increasing gradually in Saurashtra region of Gujarat due to high remunerative returns as the average yield of the summer crop is more than double to that of the rainfed one. The higher dry matter production in summer under irrigated and controlled supply of water needs more nutrients. The information on the accumulation of dry matter and mineral nutrients, especially of micronutrients at various growth stages of most commonly summer sown groundnut 'GAUG 1' is scanty (Patel and Zalawadia, 1982). Hence the experiment was conducted to generate the information on dry matter and nutrient accumulation at 40, 75 and 110 days (maturity) in this cultivar of groundnut.

The crop was sown on 11 February, 1981 on the university farm at Junagadh, keeping 45 and 10 cm row to row and plant to plant distance, respectively. The soil of the experimental plot is highly calcareous (38% CaCO_3), clayey in texture and moderately alkaline in reaction (pH 7.9). Taxonomically, this soil has been classified as Ustochrepts.

It contained 0.63% organic carbon, 8.3 kg/ha Olsen's P and 1 N ammonium acetate extractable 315 kg K/ha. All micronutrient cations as extracted by DTPA were adequately supplied. The crop was uniformly fertilized with a dose of 25 kg N and 50 kg P_2O_5 /ha as diammonium phosphate and urea. Two interculturing operations, three weedings and two sprays of dimecron for protection against aphids were carried out. As per the schedule, the crop was given 13 irrigations.

Forty plants at 40 days and 20 plants each at 75 days and at harvest were randomly collected from the experimental area cutting them from the base. They were washed with tap water followed by double distilled water. For the first sampling, the dry matter yield was recorded for entire plant, whereas it was recorded separately haulm and pods at 75 days and harvesting stages.

Nitrogen from the powdered plant samples was determined by the Kjeldahl's method. Similarly P by vanadomolybdophosphoric yellow colour method, K by flame-photometrically, Ca and Mg by EDTA and S by turbidometrically (Jackson, 1967) and micronutrient cations were estimated by Shimadzu atomic absorption spectrophotometer model AA-640-13 from the diacid extract.

From the data (Table 1), it is clearly evident that out of the total production (5590 kg/ha), hardly 7.7 per cent dry matter was

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TABLE 1

Cummulative and per cent accumulation of dry matter and nutrients at various growth stages of groundnut.

Particular	Cumulative and per cent accumulation at					Total	Per cent distribution at maturity	
	40 days	75 days		110 days			Haulm	Pod
	Haulm	Haulm	Pod	Haulm	Pod			
Dry matter	429 (7.7)	2131 (30.5)	429 (7.7)	3298 (21.0)	2292 (33.3)	5590	59.0	41.0
N	14.49 (10.0)	62.16 (32.8)	12.42 (8.5)	74.45 (8.5)	70.82 (40.2)	145.27	51.3	48.7
P	1.07 (7.9)	5.05 (29.6)	1.05 (7.8)	7.26 (16.4)	6.21 (38.3)	13.47	53.9	46.1
K	14.21 (16.6)	61.84 (55.9)	3.54 (4.1)	70.09 (9.7)	15.19 (13.7)	85.28	82.2	17.8
Ca	4.82 (10.9)	36.85 (72.2)	0.86 (1.9)	40.56 (8.4)	3.69 (6.4)	44.25	91.7	8.3
Mg	2.03 (7.9)	17.65 (60.4)	1.19 (4.6)	20.68 (11.7)	5.16 (15.4)	25.84	80.0	20.0
S	0.64 (7.3)	4.11 (39.7)	0.65 (7.4)	5.39 (14.6)	3.36 (31.0)	8.75	61.6	37.4
	g/ha							
Fe	156.4 (6.6)	826.8 (28.1)	181.6 (7.6)	1530.3 (29.5)	885.3 (28.2)	2385.3	64.2	35.8
Cu	9.5 (7.6)	40.4 (24.8)	17.19 (14.4)	52.7 (9.9)	71.8 (43.3)	124.5	42.3	57.7
Mn	35.9 (8.3)	272.1 (54.3)	12.3 (2.8)	379.3 (24.6)	56.0 (10.0)	453.3	87.1	12.9
Zn	39.5 (11.0)	165.9 (35.3)	36.4 (10.2)	201.2 (9.8)	157.4 (33.7)	358.6	56.1	43.9

Figures in the parentheses indicate per cent accumulation of total dry matter and nutrients.

accumulated during the first 40 days, whereas during the second and remaining 35 days, it was 38.2 and 54.3 per cent, respectively. The average growth rate was 10.7, 60.9 and 86.6 kg/ha/day for 40, 75 and 110 days, respectively, which indicated slow growth rate in the

beginning, moderate at the second and vigorously at the harvesting stages. These results are in agreement with those of Baynes and Walmsley (1974) and Patel and Zalawadia (1982). The former observed the most rapid accumulation between 48 to 78 days and the

latter between 60 to 108 days after sowing. Although, the total dry matter production upto harvest was greater than that given by Bunting and Anderson (1960) the percentage in pod was much less (33.3) in 'GAUG 1' groundnut as compared with 50 to 60 per cent observed by these workers. This variation could be attributed to varietal difference and climatic conditions because, more soil nutrients are required to produce equivalent weight of pods.

The rate of accumulation of N, K, Ca and Zn was much higher than that of the dry matter (7.7%), but that of P, Mg, S, Fe, Cu and Mn closely followed the pattern of dry matter accumulation at 40 days. However, the pattern of absorption of these nutrients varied greatly in the latter stages in relation to dry matter production. Maximum accumulation (37 to 74%) of these nutrients was between 40 to 75 days, whereas that of dry matter accumulation was 38 per cent. During this period, the absorption of Ca and Mg was

comparatively higher (65 to 75%) than that of the rest of the nutrients. At 110 days, N, P, S, Cu and Zn accumulation pattern followed the similar trend to that of dry matter production, but most of them accumulated in pod than in haulm, indicating translocation of these nutrients from vegetative parts to fruits. These results with respect to dry matter accumulation and nutrient absorption pattern at various growth stages, in general, are in conformity with those of Baynes and Walmsley (1974) and Patel and Zalawadia (1982).

At maturity, N, P, S, Fe and Zn followed the per cent distribution pattern of dry matter. K, Ca, Mg and Mn also followed the same trend but their proportion was high in haulm than in pod, indicating practically no translocation of these nutrients. The reverse was true for Cu. These observations are in direct line with those of Baynes and Walmsley (1974) Bunting and Anderson (1960) and Patel and Zalawadia (1982).

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Note on Combining Ability Analysis for Yield and its Components Over Environments in Grain Sorghum

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Studies on combining ability pooled over environments for 7 characters involving 8 genetically diverse elite lines of grain sorghum were undertaken.

The material comprising of 36 entries including 8 parents and 28 F_1 S were sown in the randomised block design with 3 replications at 2 locations mainly Navsari and Jagudan with 2 environments, high fertility level of 100 kg N + 50 kg P/ha and low fertility level of 50 kg N + 25 kg P/ha at each of the locations during kharif, 1987. The row to row and plant to plant distances were 45 to 15 cm respectively. Each entry was represented by single row plot. The observations on 5 randomly selected plants from each entry were recorded on days to 50% flowering, plant height (cm), earhead length (cm), number of primaries, 100 grain weight (g), number of grains per plant and grain yield per plant (g). The combining ability analysis was estimated following Griffing (1956a) method 2 model 1.

The mean squares due to both general combining ability (gca) and specific combining ability (sca) were highly significant for all the characters (Table-1). This showed that both

the additive and non-additive gene action were important for these traits. However, the estimates of the mean squares due to gca were higher in magnitude than those of the sca for the characters under study indicated that major part of genetic variation was additive in nature. Almost similar observations were reported by Monpara and Singh 1982; and Nayeem and Bapat, 1984.

The mean squares due to gca x environments were significant for all the characters except panicle length and number of primaries indicating that the parents were sensitive in different environments. The mean squares due to sca x environments interaction showed that sca effects of the crosses for majority of the traits were not consistent over environments except for panicle length and number of primaries. It may therefore be suggested that for unbiased estimates of combining ability, the studies must be carried out over a range of environments. The general combining ability effect of the parents revealed that the parents 'M 51' for earliness, '296 B' and 'M 34' for number of primaries, 'M 49' and '296 B' for grain weight and '2077 B' and 'M 35' for grain yield and for number of grains per plant were good general combiners. High gca effects mostly contributed to additive gene effects or additive x additive interaction effects (Griffing 1956b).

The best crosses as indicated by the sca effects were '2077 B x M 35', '2077 B x M 34', '296 B x M 35' for grain yield, number

TABLE 1

Mean squares for combining ability in sorghum.

<i>Sources of variation</i>	<i>Days to 50% flowering</i>	<i>Plant height</i>	<i>Panicle length</i>	<i>No. of primaries</i>	<i>100 grain weight</i>	<i>No. of grains per plant</i>	<i>Grain yield per plant</i>
gca	95.4**	10272.2**	73.5**	437.4**	0.9**	426695.7**	5195.5**
sca	17.9**	2507.2**	23.5**	229.2**	0.0**	154464.2**	2154.2**
gca x environment	1.4**	279.6**	2.2	13.6	0.0**	63500.0**	91.0**
sca x environment	1.3**	301.3*	2.0	17.7	0.0*	91811.8**	117.0**
Error	0.4	133.2	1.1	15.2	0.0	19107.5	19.5
6 ² gca/6 ² sca	5.3	4.1	3.1	1.9	35.0	0.3	2.4

* Significant at P = 0.05

** Significant at P = 0.01

of grains per plant and panicle length; '296 B x M 51' for earliness and '296 B x M 35' and '296 B x M 34' for dwarfness. Further, results indicated that most of these crosses involved high x high or high x poor general combiners.

Thus, the present study indicated the importance of both additive and non-additive gene effects in the inheritance of the traits. However, the additive gene effects were predominant and hence, pedigree system would be most efficient method for obtaining desirable genotypes.

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Variability Studies on Yield Components in Castor (*Ricinus communis* L.)

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Assessment of variability is a pre-requisite for any breeding programme of specific breeding objectives. As information on genetic variability for yield and yield components in castor is limited, it was thought worth-while to collect information on variation and related genetic parameters of oil and yield components in 14 divergent stable homozygous genotypes grown at main castor research station, GAU, Sardar Krushinagar.

Fourteen diverse entries of castor chosen out of a large collection of castor germplasm maintained at Main Castor Research Station, Sardar Krushinagar (Gujarat) were grown in randomized block design replicated thrice during kharif 1986. Each plot comprised of 3 rows (7.2 m length) accomodating 36 plants. Five competitive plants from each plot were selected and observations were recorded on seed yield, days to 50 per cent flowering, no. of nodes upto primary raceme, plant height (cm), no. of branches, no. of effective branches per plant, length of primary raceme (cm), no. of capsules on primary raceme, 100 seed weight (gm) and oil content (%). Genetic coefficient of variation, heritability in broad

sense and genetic advance were calculated according to Burton (1951), Johnson et al (1955) and Lush (1949), respectively.

The analysis of variance revealed highly significant differences among the genotypes for all the 10 characters studied as reported earlier by Singh and Shrivastava (1978). It was observed that wide range of variability existed for various characters studied except oil content as evidenced by ranges (Table-1).

The highest genotypic coefficient of variability (GCV) was observed for plant height followed by length of primary raceme, seed yield, no. of capsules on primary raceme and 100 seed weight indicating presence of wide genetic variability for these traits and chances for improvement in these traits are fairly high. These results are in confirmity with the results reported by Muthian et al., (1982) and Patel et al., (1985). These characters also revealed high phenotypic coefficient of variability heritability and high genetic advance expressed as percentage of mean (Table-1) and are in confirmity with the results reported by Patel and Jaimini (1988). High heritability with high genetic advance expressed as percentage of mean was exhibited for 100 seed weight, plant height, length of primary raceme and seed yield indicating that these characters are under the control of additive gene action and selection for these traits would be highly effective (Table-1) as reported earlier by Patel et al. (1985).

TABLE 1

Genetic parameters of 10 characters in castor.

Sr. No.	Characters	Mean	Range	GCV	PCV	h^2	G. A. as % of mean
1.	Seed yield kg/ha	1756.33	1143.75-2402.50	21.20	24.64	73.98	37.56
2.	Days to 50% flowering	48.77	41.75-55.25	7.72	8.79	77.03	13.96
3.	Number of nodes upto primary raceme	14.80	12.80-19.10	11.56	12.56	84.70	21.78
4.	Plant height (cm)	60.45	28.80-93.10	26.69	28.65	86.80	51.22
5.	No. of branches/plant	9.31	7.60-11.60	11.49	19.96	49.87	28.14
6.	No. of effective branches/plant	6.65	5.30-8.10	12.02	18.14	43.86	16.63
7.	Length of primary raceme (cm)	42.67	32.10-71.00	24.06	26.58	81.96	44.88
8.	No. of capsules on primary raceme	59.17	32.40-77.55	19.34	27.39	49.87	28.14
9.	100 seed weight/(gm)	24.38	16.15-31.98	18.21	18.65	95.37	36.64
10.	Oil content (%)	48.30	45.70-50.00	2.53	2.81	81.60	4.72

High heritability with low genetic advance observed for oil content could be probably due to non-additive gene effects as reported

earlier by Panse (1957) and Liang and Walter (1968).

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Effect of Spacing and Sowing Time on the Yield of Irrigated Castor Under North Gujarat Conditions

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In North Gujarat, castor is extensively cultivated under irrigated condition. Sowing time and spacing for planting castor plays an important role in boosting the yields. The time of sowing varies from place to place depending upon agro climatic conditions. The spacing requirement varies with varieties and optimum spacing for castor hybrids needs to be worked out. Narain and Amarnath (1962) indicated that early sowing (1st July in *kharif* and 1st October in *rabi*) tended to give higher yield than subsequent sowings. Though there was no significant difference due to different dates of sowing. Kumar (1979) advocated the row width of 60 cm under irrigated condition. However, there is a need to assess the performance of castor (GAUCH-1) in North Gujarat. An experiment, therefore, was conducted at Regional Research Station, G.A.U., Sardar Kushinagar to find out optimum spacing and date of sowing for cultivation of hybrid castor GAUCH-1 in North Gujarat region.

The experiment was conducted during the years 1981-82 to 1983-84. The soil is loamy sand with pH 7.7 to 8.1, low in organic carbon and available nitrogen; phosphorus with medium to high and high in available potash.

The experiment was laid out in splitplot with 24 different treatment combinations comprising of four dates of sowing (1st July, 16th July, 31st July and 15th August) and six spacings (60 x 30 cm, 60 x 45 cm, 60 x 60 cm, 90 x 30 cm, 90 x 45 cm and 90 x 60 cm) with dates of sowing on main plot and spacing to sub-plot, repeated four times. The recommended dose of 25 kg N/ha and 50 kg P₂O₅/ha as basal and 25 kg N/ha as top dressing was applied using urea and DAP. The crop received 519 mm, 548 mm and 473 mm rain in 31, 20 and 29 rainy days in the year 1981-82, 1982-83 and 1983-84, respectively. The crop was irrigated 4 times in the years 1981-82 and 1983-84; and 3 times in the year 1982-83.

The data indicated that (Table 1) the date of sowing had no significant effect on the castor seed yield during 1981-82, 82-83 and in pooled. During 1983-84, differences due to D₁, D₂ and D₃ were nonsignificant but D₄ gave significantly less yield. Narain and Amarnath (1962) obtained similar results. In general, sowing of castor any time between 1st July to 15th August can be followed for irrigated hybrid castor GAUCH-1.

As seen from Table 1, there were no differences in seed yields due to spacings in all the years and in pooled analysis. Thus inter row spacing of 60 or 90 cm and intra row spacing of 30, 45 or 60 cm can be adopted.

It was found that interaction of sowing date x spacing was nonsignificant in all the

TABLE 1

Seed yield of castor (GAUCH-1) as affected by dates of sowing and spacings.

Treatments	Seed yield kg/ha			Pooled
	1981-82	1982-83	1983-84	
Date of sowing				
D ₁ -1st July	1073	2073	1930	1692
D ₂ -16th July	1265	1780	2103	1716
D ₃ -31st July	1417	1764	2023	1735
D ₄ -15th August	1268	1865	1554	1562
S. Em.	85	96	102	55
C. D. at 5%	NS	NS	325	NS
C. V. %	33.00	25	26.16	28
Spacing				
S ₁ -60 x 30 cm	1189	1808	1877	1658
S ₂ -60 x 45 cm	1286	1880	1814	1660
S ₃ -60 x 60 cm	1271	1781	2024	1692
S ₄ -90 x 30 cm	1345	1853	1762	1653
S ₅ -90 x 45 cm	1206	1892	1988	1695
S ₆ -90 x 60 cm	1238	2008	1850	1699
S. Em.	52	82	156	61
C. D. at 5%	NS	NS	NS	NS
C. V. %	16.60	17.64	32.75	25.33
Interaction (D X S)				
S. Em.	104	165	311	122
C. D. at 5%	NS	NS	NS	NS
C. V. %	16.60	17.64	32.75	25.33
Interaction (D x Y)				
S. Em.				94
C. D. at 5%				272
Interaction (Y x D x S)				
S. Em.				212
C. D. at 5%				586
Interaction (Y x S)				
S. Em.				106
C. D. at 5%				NS

years and in pooled analysis. Whereas date of sowing x year and year x date of sowing x spacing were found to be significant.

The results indicate that for higher yield of irrigated hybrid castor (GAUCH-1) under

North Gujarat conditions sowing can be done at any time during the period of 1st July to 15th August with an intra row spacing of 60 or 90 cm and inter row spacing of 30, 45 or 60 cm.

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Tolerance of Ber (*Ziziphus mauritiana* Mill) to Salinity Levels in Soil

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Ber is one of the hardiest fruit crops which can be grown over a wide range of soil types. The Marathwada region in Maharashtra is getting increased irrigation through different projects. The soil salinity problem is also increasing. There is no scientific data available highlighting the tolerance of Ber (*Ziziphus mauritiana* Mill) to the exact level of salinity in the vertisol. As this information is essential for assessing the suitability of such marginal land for growing so called salinity tolerant crop ber, the studies were made to determine the effect of salinity on the growth and mineral nutrition of ber.

The experiment was conducted at Department of Horticulture, Marathwada Agricultural University, Parbhani. The medium black vertisol (44% clay, 30% silt and 21% sand) used for experimentation was non-saline, non-alkali soil with 8.5 pH (1:2 soil water ratio), 0.35 mmhos/cm E_ce and 60% moisture at saturation point. The soil was filled in the earthen pots of 25 litre capacity. The inner side and bottom of each pot were covered over with a polythelene sheet in order to avoid loss of soluble salt through drainage. Each pot was provided with a false bottom having 5 cm layer of gravel to facilitate drainage.

Salt concentrations of 20, 30, 40, 50 and 60 meq/l of saturation extract were considered to raise the conductivity of 2, 3, 4, 5 and 6 mmhos/cm respectively. The relative proportion of various cations (Na^+ , Ca^{++} and Mg^{++}) and anions (Cl^- , SO_4 and HCO_3^-) selected for building soil salinity represented in general the salt content of different soil profiles in the affected region.

Wighed amounts of NaCl, NaHCO₃, Na₂SO₄, CaCl₂ and MgSO₄ salts were dissolved in so much quantity of water which after application made the soil in the pots saturated and brought out the graded conductivity levels (2, 3, 4 and 6 mmhos/cm) in the saturation extract.

Uniform budded plants of about six months age of Umrani variety of ber were planted in each pot on May 15, 1978. Four pots of each species with each salinity level including control were placed in completely randomised design.

Five months after planting it was observed that there were no significant differences in plant growth in different salinity treatments. So the levels were doubled by dissolving proportionate salts in water and applying same to each pot. Now the graded conductivity levels were 4, 6, 8, 10 and 12 mmhos/cm with 3 mmhos/cm variation in the saturation extract of the soil.

The adverse effect of salinity was evident from the various types of symptoms

on the plants. The following key was used to assess the extent of mortality.

Symptoms	per cent mortality
Leaf burning from margin	25
Severe defoliation, drying of shoot tip	50
Dying back from mainstem	75
Complete death of plant	100

The plants were grown in different salinity treatments for 19 months and then they were uprooted taking due care to avoid damage to the root system. The roots were cleansed of the adhering soil by washing them with water and then the fresh weight of whole plants was recorded. The root portion of the plants was cut at the root collar and fresh weights of root and top were separately recorded. Dry weights of the root and top were also recorded after drying the samples to a constant weight in an electric oven at 60°C temperature. Maximum length of main root of each plant was recorded.

Plant analysis was conducted by adopting standard methods.

Effect on the growth

It is evident from the data (Table 1) that plant mortality started at conductivity of 8 mmhos/cm and increased with increasing salinity. The spread of plants and length of root decreased significantly at 10 mmhos/cm and above salinity levels.

There was decrease in fresh weight of whole plant, fresh and dry weight of root and length of root and the leaf area with the increasing salinity. A significant decrease in

fresh weight of whole plant, fresh and dry weight of root and top and leaf area was noted at 8 mmhos/cm conductivity level and above. According to Oganessian (1954) *Ziziphus jujube* and pomegranate were most resistant to salts.

Dahiya (1979) concluded that per seedlings could be grown satisfactorily up to 9.75 mmhos/cm.

Dahiya (1979) reported that soil salinity decreased the plant height, stem diameter, leaf area, shoot dry matter and yield of ber at the conductivity of 14.20 mmhos/cm. Patil and Bhambota (1978) reported the adverse effect of salinity increase on the various growth parameters in citrus.

Effect on the chemical composition

It is evident from the data in Table 2 that there was a significant decrease in leaf chlorophyll, N, P, Ca, Mg, Zn and Fe content of leaves and roots at higher levels of salinity was recorded. Most of these nutrients decreased significantly at conductivity level of 8 mmhos/cm and above. Na content of leaves and roots however, increased with the increase in salinity levels. Mn and Cu content of leaves did not differ significantly but Mn and Cu content of root was significantly low at higher levels on salinity (10 and 12 mmhos/cm) than at low levels. Similar decrease in chlorophyll, K, Mg and Zn due to high soil salinity has been reported in different fruit crops by Bhambota (1965), Desai and Singh (1979), Pearson et al. (1957) and Patil (1976), respectively. Similarly increased Na contents in different fruit plants due to high soil salinity have been reported by several workers (Divate, 1974; Desai and Singh, 1979 and Patil and Bhambota, 1980).

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TABLE 1

Effect of salinity on the growth of ber plants.

<i>Salinity mmhos cm</i>	<i>Spread of plant (m)</i>	<i>Fresh Wt. of whole (g)</i>	<i>Fresh Wt of root (g)</i>	<i>Fresh Wt. of top (g)</i>	<i>Dry Wt. of root (g)</i>	<i>Dry Wt. of top (g)</i>	<i>Length of root (cm)</i>	<i>Total leaf area (mm)</i>	<i>Per cent mortality (cm)</i>
0.35	33.5	162.5	71.0	91.5	32.1	36.5	49.7	1617.2	0
4	32.5	160.0	69.7	90.2	31.1	36.7	47.7	1572.5	0
6	31.2	153.4	66.7	86.7	29.7	34.7	45.5	1491.2	0
8	28.5	128.2	58.5	69.7	26.2	28.2	44.5	1116.0	12.5
10	17.0	64.0	28.0	36.0	12.5	15.0	30.0	440.0	62.5
12	9.5	18.5	4.5	14.0	2.2	7.0	11.0	70.4	62.5
S. E. $\pm$	3.0	9.1	3.9	5.4	1.8	2.3	5.1	52.8	—
C.D.	9.3	27.5	11.8	16.4	5.4	7.0	15.3	159.3	—

TABLE 2

Effect of salinity on chlorophyll content (mg/g) of leaves and nutrient contents (percentage) of leaves and roots of ber.

Salinity mmhos cm	Chloro- phyll	N	P	K	Ca	Mg	Na	Zn	Fe	Mn	Cu
Leaves											
0.35	0.99	1.75	0.20	1.53	2.88	0.54	0.46	105.50	723.25	99.50	30.00
4	1.00	1.64	0.19	1.51	2.62	0.57	0.47	107.50	735.00	104.00	29.25
6	0.96	1.41	0.19	1.46	2.43	0.56	0.47	111.00	710.00	99.00	26.50
8	0.85	1.44	0.18	1.41	2.36	0.48	0.62	98.00	685.00	96.50	29.00
10	0.72	1.44	0.17	1.28	1.75	0.48	0.82	87.00	635.00	93.50	27.50
12	0.49	1.31	0.17	1.04	1.56	0.28	0.87	73.50	554.75	89.00	24.50
S. E. $\pm$	0.02	0.09	0.009	0.03	0.11	0.03	0.03	3.53	19.28	3.28	1.92
C. D.	0.07	0.27	0.027	0.09	0.34	0.09	0.11	10.65	58.09	N.S.	N.S.
Roots											
0.35		2.93	0.14	0.95	1.80	0.88	0.51	142.50	1774.75	129.00	36.25
4		2.88	0.14	0.91	1.63	0.85	0.59	134.50	1775.00	125.00	37.25
6		2.88	0.15	0.83	1.55	0.76	0.62	142.00	1693.25	127.50	36.25
8		2.81	0.12	0.75	1.58	0.65	0.68	114.50	1613.25	127.00	34.75
10		2.74	0.12	0.57	1.39	0.55	0.69	106.50	1625.75	102.00	31.00
12		2.50	0.12	0.46	1.36	0.53	0.73	100.00	1391.50	97.00	27.00
S. E. $\pm$		0.10	0.005	0.04	0.07	0.02	0.01	5.38	38.63	3.99	1.26
C.D.		0.32	0.015	0.14	0.21	0.08	0.05	16.25	116.42	12.04	3.81

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Note on Aldicarb Residues in Okra Fruits*

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Aldicarb is very effective for controlling the major sucking pests and mite (Eswaramoorthy *et al.*, 1976; Ramamohana Rao and Ayyana, 1977; Sarma and Ranga Rao, 1978 and Patel *et al.*, 1980) and has been reported to check yellow vein mosaic virus disease and stimulate the growth of plants (Palanyswamy *et al.*, 1974; Sarma, 1979 and Patel *et al.*, 1980).

A field experiment was conducted during rabi season, 1984 at College Farm of Gujarat

Agril. University, Navsari. The okra crop (cv. N-5) was side dressed after germination with aldicarb (TEMIK) 10 G @ 0.75 kg a.i./ha. once (Aldicarb-0), twice (Aldicarb-0 + 15) and thrice (Aldicarb-0 + 15 + 30). The initial application was given immediately after germination while subsequent applications were given at 15 days interval. The treatments were replicated eight times with all normal manurial, cultural and irrigation practices. The fruit samples each first and second pickings taken randomly were chopped finely and analysed as per the procedure of Johnson and Stansbury (1966) and Romine (1973). Aldicarb, aldicarb sulphoxide and aldicarb sulphone were determined as total toxic aldicarb residues by first oxidising aldicarb and it sulphoxide to sulphone with a mixture of hydrogen peroxide : glacial acetic acid (2:1).

TABLE 1
Residues of aldicarb in okra fruits.

Sr. No.	Treatments	Days after last application		Residues (ppm)	
		First picking	Second picking	First picking	Second picking
1.	Aldicarb-0	42	49	BDL	BDL
2.	Aldicarb-0 + 15	26	33	0.04	BDL (100.0)
3.	Aldicarb-0 + 15 + 30	11	18	0.29	0.19 (34.48)

1. BDL : Below detectable level.

2. Figures in parantheses are per cent reduction of residues in second picking over first picking.

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The extraction and cleanup of sample was carried out following the method used by Singh *et al.*, (1983). The method was validated by fortifying the untreated fruit samples with aldicarb sulphone at 0.5 to 1.00 ppm. The method sensitivity was 0.02 ppm. The average aldicarb sulphone recovery was 92.99% and a correction factor was applied for 100%.

The treatments of aldicarb-0 and aldicarb-0 + 15 were found to be safer as the residues detected (BDL to 0.04 ppm) in okra fruits of first and second picking were below the tolerance limit of 0.2 ppm prescribed by FAO/WHO (Anonymous, 1980) for fruits (Table 1). However, the third treatment of aldicarb-0 + 15 + 30 was found not advisable to use for plant protection work on okra as the toxic residue (0.29 ppm) was above the tolerance limit (0.2 ppm) at first picking, however it was (0.19 ppm) below the tolerance limit at second picking. Ali *et al.* (1976) and Rajukkannu *et al.* (1977) have

reported aldicarb residues at below tolerance limit of 0.2 ppm in the first harvest of okra fruits when it was applied at the rate of 0.5 and 1.0 kg a.i./ha. The present finding of less than 0.2 ppm residue in okra fruits of first harvest from the treatment of aldicarb-0 is almost in agreement with them.

Thus, on the basis of present finding it is suggested that the treatments of aldicarb-0 + 15 G to be applied once @ 0.75 kg a.i./ha in soil as side dressing after germination or twice at the same rate to be applied after germination and 15 days latter can safely be used for the plant protection work on okra as to avoid health hazard problem to human being.

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Natural Enemies of *Agrotis* spp. From Gujarat

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The cutworms, *Agrotis* spp. have been reported as serious pests of various economical crops from India and also parts of world (Panchabhavi et al., 1972; Singh, 1982; Genchev, 1971; Napiorkowska-Kowalik, 1973 and Kravchenko, 1976). In order to develop biological control of these pests, surveys were conducted in potato fields at Anand to record natural enemies associated with *Agrotis* spp. Three distinct species viz., *A. ipsilon* (Hafnagel), *A. segetum* (Schiff) and *A. spinifera* (Hubner) are known to occur in this part of the State. A total of 500 larvae of these species was collected covering about 10 hectares of potato fields during January, 1986 and reared further in the laboratory. The host larvae yielded 15 *Enicospilus merdarius* Gravenhorst

(Ichneumonidae), 11 *Macrocentrus* sp., *Apanteles* sp. (Both Braconidae) and 2 unidentified dipterans (Tachinidae), which accounted for a maximum of 3.00, 2.20, 0.80 and 0.40 per cent parasitisation. In addition to these 1.6 per cent of the larvae were found infected with a green muscardine fungus, *Metarhizium anisopliae* Metschn. The parasites reported on *Agrotis* spp. from other parts of India are *Turanogonia chinensis* (Wiedemann), *Macrocentrus collaris* (Spin), *Coelichneumon truncatulus* (Thoms), *Periscepsia carbonaria* (Panz.), *Apanteles ruficrus* (Hal.), *Enicospilus* sp., *Neoaplectana* sp. and *Xestia c-nigrum* *Microplitis similis* and *Microgaster* sp., (Dutt, 1919; Kalra, 1984; Lyle, 1921; Singh, 1982).

Of the natural enemies recorded in the present studies, *Enicospilus* sp. appeared to be of some importance and warrants further studies. This species has been reported from larvae of *Heliothis armigera* (Achan et al., 1968) and Yadav, 1978).

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Relative Efficacy of Some Dust Formulations Against Jassids and Thrips of Hybrid-4 Cotton*

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A field experiment was carried out at College Farm, College of Agriculture, Gujarat Agricultural University, Junagadh Campus, Junagadh during the year 1977-78. Experiment was laid out in randomized block design with five replications. Six different dust formulations as per detail mentioned in table-1 were evaluated against sucking pests of hybrid-4 cotton. Crop was sown with a spacing of 1.2 M between rows and 0.6 M between plants with a plant stand of 33 in the net plot and 75 in the gross plot. Dusting was applied at fortnightly intervals with a hand rotary duster.

Observations of population counts 24 hours before and 48 hours after treatment were recorded from five randomly selected plants on three leaves viz., upper, middle and lower. Observations of aphid (*Aphis gossypii* Glover), Jassids (*Amrasca bigutula bigutula* Ishida), Thrips (*Thrips tabaci* Lind) and white fly (*Bemisia tabaci* Lind) were recorded from each treatment plot. Population of aphid and white fly was considerably low and so they were deleted for analysis. Mortality percentage of jassids and thrips were worked out on the

basis of pre and post count of the treatment. The data obtained were statistically analysed and results are presented in Table-1.

Data presented in Table-1 revealed all the treatment showed appreciable reduction in the population of jassid. Average mortality percentage ranged from 79.85 per cent in quinalphos 1.5 per cent dust @ 20 kg/ha to 95.32 per cent in carbaryl 10 per cent dust @ 15 kg/ha. The treatment carbaryl alone was found to be statistically significantly superior to rest of the treatment, and recorded highest average mortality percentage of jassid i.e., 95.32 per cent.

In the case of thrips also all the formulations tested so far, were found effective in reducing the thrips population. The average mortality percentage among the various treatments ranged from 95.45 per cent in quinalphos 1.5 per cent @ 20 kg/ha to 98.95 per cent in carbaryl 10 per cent @ 15 kg/ha. In the case of thrips also, the treatment of carbaryl 10 per cent dust @ 15 kg/ha recorded the highest mortality and found statistically significantly superior to rest of the treatments and at par with schedule proposed which was followed by quinalphos @ 25 kg/ha and methyl parathion 2 per cent dust @ 18 kg/ha.

So far as yield is concerned the treatment of endosulfan 4 per cent dust @ 20 kg/ha registered the highest yield and found

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TABLE 1

Statement showing the relative mortality percentage of jassids (*Amrasca bigutula bigutula* Ishida), and thrips (*Thrips tabaci* Lind) along with yield data in kg/ha.

Sr. No.	Treatments	Dose kg/ha	Average jassids population counts		Av. mortality percentage	Av. thrips population counts		Av. mortality percentage	Yield kg/ha
			Before	After		Before	After		
			24 hrs	48 hrs		24 hrs	48 hrs		
1	Quinaphos 1.5% dust	20	69*	14	63.33 (79.85)**	144	7	77.66 (95.45)	1498
2	Quinalphos 1.5 % dust	25	70	12	64.54 (81.50)	170	4	81.32 (97.75)	1465
3	Endosulfan 4% dust	20	49	8	66.06 (83.67)	146	5	78.55 (96.05)	1716
4	Carbaryl 10% dust	15	53	2	77.51 (95.32)	187	2	84.16 (98.95)	1618
5	M. Parathion 2% dust	18	57	10	65.96 (83.40)	167	4	81.03 (97.60)	1213
6	Schedule proposed ^a	—	47	7	64.93 (82.05)	197	4	81.62 (97.87)	1662
	S. Em.	—	—	—	2.22	—	—	1.26	89.98
	C. D. at 5%	—	—	—	6.53	—	—	3.70	264.54
	C. V. %	—	—	—	6.72	—	—	3.49	13.16

* Population sampled on five plants per three leaves.

** Figures in paranthesis are retransformed value.

^a Detail treatment are given in separate table-2.

TABLE 2

Details of different dust and spray insecticides used in schedule proposed in dust experiment.

<i>Date of application</i>	<i>Insecticides used</i>	<i>Formulation product used</i>	<i>Quantity of insecticides ltr/kg/ha</i>
20th July '77	Monocrotophos	Nuvacron 40 E. C.	0.463 Lt
3rd August '77	"	"	"
17th August '77	Quinlphos	Ekalux 1.5% dust	13.320 kg.
2nd Sept. '77	Methyl Parathion	Methyl parathion 25 E.C.	0.527 Lt.
16th Sept. '77	"	"	"
1st October '77	Quinolphos	Ekalux 1.5% dust	25.00 kg.
16th Oct. '77	Endosulfan	Thiodan 4% dust	22.25 kg.
31st Oct. '77	Carbaryl	Hexavin 10% dust	26.00 kg.
15th Nov. '77	Endsulfan	Thiodan 4% dust	24.00 kg.
30th Nov. '77	Carbaryl	Hexavin 10% dust	26.00 kg.
15th Dec. '77	Quinlphos	Ekalux 1.5% dust	26.00 kg

tically significantly superior to rest of the treatment and was at par with schedule proposed, followed by carbaryl, @ 18 kg/ha, quinalphos @ 20 kg/ha, and quinalphos @ 25 kg/ha. The lowest yield was recorded in the treatment of methyl parathion 2 per cent dust @ 18 kg/ha. Thus over all performance in reduction of pest population the treatment of carbaryl 10 per cent dust recorded the highest mortality percentage of jassids and thrips. While in case of yield, the treatment of endosulfan 4 per cent dust @ 20 kg/ha recorded the highest yield of seed cotton.

These findings are in agreement with those of Butani and Sahni (1970) and

Rangarajan *et al.* (1970) who indicated that dusting of carbaryl 10 per cent was found the most effective against sucking pest of cotton. While testing the efficacy of some E. C. formulations Singh and Singh (1982) reported that vemidothion 0.06% proved best against jassid. Similarly monocrotophos 0.06 per cent was more effective against white fly. The insecticides viz., monocrotophos, dimethoate and vemidothion 0.06 per cent gave very high kill of thrips on cotton crop. Visvanathan and Kareem (1983) found monocrotophos, methyl demeton and endosulfan equally effective for the control of jassids of cotton crop. Mundiwale *et al.* (1983) reported that fenvalrate, methamidophos, methomyl,

phosalone, alone and each in combination with D D T (except fenvalrate) effectively controlled aphid upto 7 days. Good control of jassids and thrips upto 7 days was obtained with fenvalrate, methamedophos, methomyl. phosalone, alone and in combination of D D T.

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Relative Susceptibility of Different Wheat Varieties to Pink Stem Borer, *Sesamia inferens* Walker*

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Wheat *Triticum aestivum* L., is one of the important food crops. It's value in human diet, both as a source of carbohydrate and protein, makes it more important as a human food as compared to other cereals. In Gujarat State, the crop occupies an area of 4.31 lakh hectares producing 7.83 lakh tonnes of grains. Thus, the State occupies third position in respect of yield per hectare (Anonymous, 1986).

Earlier, Pal (1966) studied the relative susceptibility of some exotic and indigenous wheat varieties to *S. inferens* and reported that the indigenous varieties viz., Sukharai Pissi, Punjab type-9, NP-6 and Lal Kusrwala were comparatively resistant to this pest. Saxena *et al.* (1972) also tested several wheat varieties for their susceptibility to this pest in Rajasthan, Kalyan Sona was found more susceptible showing 11.01 per cent infestation. An attempt was made to test the recommended and promising varieties for their relative susceptibility against the wheat stem borer.

The susceptibility test of different varieties (Table 1) was carried out under field condition at Wheat Research Farm, GAU, Junagadh Campus, Junagadh during the year 1985-86. The varieties were divided in normal and late

sown groups. Each variety was grown in a strip of 10 m x 5 m with recommended cultivation practices. Observations on total number of plants and damaged plants were recorded from randomly selected five spots (one metre row length) at fortnightly intervals. The data thus obtained were converted to per cent dead heart and subjected to statistical analysis for relative susceptibility of the varieties under test and presented in Table-1.

Normal sown varieties

Ten wheat varieties (Table 1) were screened against this pest. The data on per cent infestation revealed that the pest infestation started in first fortnight of January 1986 but it was very low. During this period var. Lok-1 showed the lowest (0.20%) damage. The highest incidence (0.78%) was observed in variety J-24 and was at par with Raj-1555, WH-147 and GW-89.

The infestation increased with time and ranged from 1.63 to 3.56 per cent in different varieties during the second fortnight of January, 1986. The data clearly indicated that the infestation was at peak during the month of February 1986. During this period the lowest infestation (2.40 to 3.22%) was recorded in the variety Lok-1 and differed significantly from other varieties. The pest infestation was comparatively low in varieties J-1-7, J-40 and GW-89 during the first and second fortnight of February, 1986. The highest damage (5.45 to 7.65%) was recorded in the variety J-24 followed by Kalyan Sona.

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TABLE 1

Incidence of *S. inferens* in different wheat varieties during 1985-86.

Sr. No.	Varieties	Per cent dead heart in different wheat varieties at different dates				
		4th Jan.	18th Jan.	1st Feb.	15th Feb.	1st March
Normal sown group (Date of sowing 7-12-1985)						
1.	Kalyan sona	3.99 (0.48)	10.74 (3.47)	12.61 (4.76)	15.52 (7.18)	
2.	J-1-7	4.34 (0.57)	8.87 (2.34)	10.04 (3.04)	12.14 (4.42)	
3.	J-24	5.08 (0.78)	10.88 (3.56)	13.51 (4.45)	16.05 (7.65)	
4.	J-40	4.02 (0.49)	9.05 (2.47)	10.54 (3.34)	11.68 (4.10)	
5.	Lok-1	2.54 (0.20)	9.02 (2.46)	8.92 (2.40)	10.35 (3.22)	
6.	GW-89	4.58 (0.64)	7.33 (1.63)	11.54 (3.87)	12.21 (4.47)	
7.	HD-2236	4.23 (0.54)	8.91 (2.40)	11.56 (4.01)	13.05 (5.10)	
8.	WH-147	4.85 (0.72)	9.92 (2.96)	11.80 (4.18)	13.47 (5.42)	
9.	Raj-1555	4.96 (0.75)	10.35 (3.23)	12.76 (4.88)	13.87 (5.75)	
10.	HD-4530	4.38 (0.58)	9.95 (2.97)	12.03 (4.34)	13.23 (5.25)	
S.E.m. $\pm$			0.38	0.19	0.22	
C. D. at 5 %			1.08	0.54	0.62	
C. V. %			9.09	3.66	3.68	
Late sown group (Date of sowing 21-12-1985)						
11.	Sonalika		8.4 (0.98)	5.68 (1.22)	6.33 (1.47)	6.97
12.	GW-18			8.94 (2.47)	10.03 (3.03)	11.14 (3.73)

1.	2.	3.	4.	5.	6.	7.
13.	Lok-1	—	4.49 (0.61)	6.40 (1.24)	7.86 (1.87)	9.45 (2.70)
14.	GW-405	—	5.60 (0.95)	9.57 (2.76)	10.40 (3.25)	11.72 (4.13)
15.	GW-120	—	4.40 (0.59)	9.35 (2.64)	9.99 (3.01)	11.22 (3.79)
	S. Em. $\pm$	—	0.27	0.23	0.15	0.51
	C. D. at 5 %	—	0.79	0.68	0.45	1.51
	C. V. %	—	14.48	6.49	3.83	11.35

Thus in normal sown group, variety Lok-1 was found to be the least susceptible followed by J-40, J-1-7 and GW-89, whereas varieties J-24, Kalyan Sona and Raj-1555 were comparatively more susceptible to this pest. In similar studies Saxena *et al.* (1972) observed that Kalyan Sona was more susceptible to this pest in Rajasthan. Similar observations were also reported by various workers (Judal, 1978 and Anonymous, 1980 and 1983) for the varieties J-24 and Lok-1 in Gujarat State.

Late sown varieties

In late sown wheat varieties, the incidence started in the second fortnight of January, 1986. During this period the lowest incidence of the borer was observed in the varieties Sonalika and GW-18 followed by GW-120 and Lok-1, which ranged from 0.25 to 0.61 per cent. The variety GW-405 showed comparatively more incidence (0.95%) during the second fortnight of January, 1986.

During first fortnight of February, 1986 the incidence increased in all the varieties. A close perusal of the data (Table 1) indicates that the lowest incidence (0.98%) was observed in the variety Sonalika which was

Lok-1 and GW-18. The highest incidence (2.76%) was observed in variety GW-405. During second fortnight of February and first fortnight of March, 1986 Sonalika showed the lowest borer incidence (1.22%) followed by Lok-1 (1.87 %). However, the maximum incidence was recorded in the varieties GW-120, GW-18 and GW-405 which ranged from 3.01 to 3.25 per cent.

Thus in late sown varieties, Sonalika and Lok-1 proved to be the least susceptible to the stem borer as compared to the remaining varieties under test. These results are in confirmation with the work carried out by various workers (Judal, 1978, Anonymous, 1980 and 1983).

From the results, it can be concluded that among the normal sown varieties, Lok-1 showed the lowest incidence (0.98%) followed by J-40, J-1-7 and GW-89. In late sown varieties, Sonalika showed the lowest incidence (0.98%) followed by Lok-1 and GW-18. The highest incidence (4.13%) was observed in variety GW-405.

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Intensity and Damage of *Earias vittella* Fab. on Various Cultivar of Bhendi

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Shoot-and-fruit borer, *Earias vittella* Fab. is an important insect pest of *bhendi*, *Abelmoschus esculentus* Linn. larvae bore the growing shoots before fruits formation and

TABLE 1

Damage of shoot-and-fruit borer, *E. vittella* Fab. on various *bhendi* cultivars and their yield (pooled kharif 1987 and 1988).

Cultivar	Per cent shoot infested plants	Per cent infested fruits		Yield (tonnes/ha)
		Number basis	Weight basis	
Parbhani	12.64*	28.91	27.41	1.55
Kranti	(4.80)	(23.34)	(21.20)	
Gujarat	14.27	27.90	27.10	2.44
Okra-1	(6.20)	(21.90)	(20.78)	
Padra 18-6	13.48	33.48	31.35	2.15
	(5.45)	(30.45)	(27.01)	
Selection-2	10.00	28.31	27.49	1.95
	(3.00)	(22.50)	(21.30)	
Punjab	12.72	28.96	29.73	1.73
Padmini	(4.80)	(23.45)	(24.60)	
Pusa	12.07	33.93	32.95	1.71
Sawani	(4.35)	(31.12)	(29.60)	
S. Em. $\pm$	0.76	1.42	1.28	1.96
CD (P 0.05)	2.29	4.08	3.70	—
CV (%)	12.12	13.33	12.14	17.14

* Arcsine $\sqrt{\text{percentage}}$ transformed values.

Figures in parentheses are retransformed values.

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with the availability of fruits start damaging the fruits and make the fruits unmarketable. The study was conducted to find out the extent of damage in different cultivars of *bhendi* to *Earias* in Gujarat condition.

The field experiment of six *bhendi* cultivars was laid out in randomized block design with 4 replications at Anand during kharif 1987 and 1988. Net plot size was 5.4 m x 2.25 m. The damage to shoots was

recorded 15 days of germination at 1 week intervals till fruit formation by counting the total number of shoot infested plants from all the 90 plants in the net plot. Observations on fruits were recorded on the basis of number and weight of healthy and infested fruits at each picking. The data were subjected to analysis of variance.

The infestation of *E. vittella* (Table 1) on shoots of *bhendi* Selection-2 was significantly less than Parbhani Kranti, Padra 18-6, Gujarat Okra-1 and Punjab Padmini, whereas fruit damage by *E. vittella* was significantly less in varieties Gujarat Okra-1, Selection-2, Parbhani Kranti and Punjab Padmini as compared to Pusa Sawani and Padra 18-6. Thus it reveals from this study that *bhendi* variety Selection-2 had minimum infestation of

E. vittella to shoots as well as fruits. Whereas, the infestation of *E. vittella* on shoots of Gujarat Okra-1 was maximum, even though, its population buildup during fruit formation was comparatively low than Padra 18-6 and Pusa Sawani. Ratanpara (1987) has also reported similar observation from Saurashtra for Gujarat Okra-1.

The pooled data on fruit yield (Table 1) showed non-significant difference among the various *bhendi* cultivars. However, Gujarat Okra-1 yielded maximum (2.44 tonnes/ha) fruit yield.

Considering the damage caused by *E. vittella* and marketable fruit yield the cultivation of *bhendi* Gujarat Okra-1 is preferable in the agro climatic condition of Gujarat.

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A Note on Effect of Age of Animal on Fleece Yield in Patanwadi and its Halfbreeds with Rambouillet and Russian Merino

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Information on the effect of an animals age on it's production trait is desirable for determining the optimal structure of the flock (Brown *et al.*, 1966). Many workers have estimated the effect of such maternal handicaps on several economic traits and have concluded that the greasy or clean wool yield decreases with increasing age.

The efforts have been made to determine the influence of an animal's age on fleece yield (washed) in two crossbred groups and its contemporary native Patanwadi. The data collected on ewe lambs born during the period 1979-85 at All India Co-ordinated Research Project on Sheep Breeding for Fine Wool, Dantiwada Unit (Gujarat) were utilised for present study. The data were analysed over the years, with the assumption that the year effect is random, using standard statistical procedures as described by Snedecor and Cochran (1968). All the animals were reared and managed under uniform managerial conditions.

Age groupwise and breed groupwise mean and total yield (washed) along with the per cent improvement over the first year as well as over the native at each age is furnished in Table-1. The breed group differences and age group differences within breed group were significant (Table-2). Both the halfbreeds produced more greasy fleece yield than Patanwadi. During the life span of seven years Rambouillet x Patanwadi and Russian Merino x Patanwadi halfbreeds produced 3.41 and 3.96 kg i.e. 47.0 and 54.5 per cent, respectively, more wool than Patanwadi.

With regards the effect of age on fleece yield in Patanwadi, it was observed that fleece production increased upto the age of three years and declining consistantly thereafter upto seven years age. The highest yield obtained at the age of three years did not differ significantly from that of second, fourth and fifth year. The increase in wool production varied from 4.5 to 21.3 per cent at various ages over that of first year.

In case of Rambouillet x Patanwadi halfbreeds the wool production increased initially and was highest at the age of three years and remained stable from fourth to sixth year of age. The fleece yield was significantly, low at the age of seven years, which was not different from that of first year. The increase was to the tune of 12.8 per cent and decline was to the extent of 7.9 per cent over the first year's fleece yield.

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TABLE 1

Fleece yield (washed) along with the per cent improvement at different ages in Patanwadi and it's crosses with Rambouillet and Russian Merino (kg)*.

Age in Years	Breed groups				
	Patanwadi Mean $\pm$ S. E.	Ramb. x Pat. Mean $\pm$ S. E.	Improvement over Pat. (%)	R. Merino x Patanwadi Mean $\pm$ S. E.	Improvement over Pat. (%)
One	0.950 ^b $\pm$ 0.018 (138)	1.461 ^{bc} $\pm$ 0.023 (233)	53.82	1.558 ^{bc} $\pm$ 0.023 (201)	64.04
Two	1.031 ^{ab} $\pm$ 0.015 (127, 8.61)	1.533 ^b $\pm$ 0.018 (217, 4.93)	48.62	1.611 ^{ab} $\pm$ 0.022 (190, 3.41)	56.19
Three	1.152 ^a $\pm$ 0.023 (114, 21.33)	1.648 ^a $\pm$ 0.020 (209, 12.80)	43.01	1.667 ^a $\pm$ 0.030 (166, 7.03)	44.70
Four	1.058 ^{ab} $\pm$ 0.020 (97, 11.42)	1.511 ^b $\pm$ 0.024 (176, 3.45)	42.83	1.674 ^a $\pm$ 0.030 (143, 7.46)	58.22
Five	1.060 ^{ab} $\pm$ 0.023 (64, 11.66)	1.513 ^b $\pm$ 0.026 (122, 3.56)	42.67	1.585 ^{ab} $\pm$ 0.038 (95, 1.77)	49.52
Six	1.021 ^b $\pm$ 0.039 (44, 7.47)	1.527 ^b $\pm$ 0.043 (76, 4.56)	49.66	1.453 $\pm$ 0.054 (48, -6.74)	42.35
Seven	0.993 ^b $\pm$ 0.050 (28, 4.54)	1.346 ^c $\pm$ 0.04 (50, -7.86)	45.96	1.371 $\pm$ 0.070 (21, -11.97)	48.60
Total yield	7.260	10.674	47.02	11.220	54.54
Average yield	1.040 $\pm$ 0.090	1.525 $\pm$ 0.095	—	1.603 $\pm$ 0.012	—

*Note :- (1) Figures in parenthesis are of number of observations and per cent improvement over first year yield within the breed.

(2) Values bearing same superscript in the column do not differ significantly.

The R. Merino x Patanwadi halfbreds achieved the peak in the production at the age of four years which did not differ from that of second, third and fifth year. The wool production has increasing trend up to the age of four years, declining thereafter. At the sixth

and seventh year of age the wool yield did not differ significantly from each other. The increase in production over the first year production was to the tune of 7.46 per cent only, while the decline was to the extent of 12.0 per cent.

TABLE 2

Analysis of variance for fleece yield.

Source	d.f.	M.S.
Between breeds	2	64.962**
Between ages within breeds	20	0.644**
Error	2536	0.143
Total	2558	—

**P < 0.01

Significant age group and breed group differences in Indian breeds and its crosses with exotic breeds have been reported by Gupta *et al.* (1976) and Tomar (1980). While significant effect of age on wool production have been reported by Tomar (1978), Kishor *et al.*, (1982) and Koratkar and Patil (1983) in Nali, Avivastra and Deccani sheep respectively. The present findings are in confirmation with the findings of above workers.

Both the halfbred groups produced significantly heavier fleece than Patanwadi at all the ages, leading to conclude that comparison

of different genetic groups among the contemporary animals would be possible. Further, it is also evident that wool yield increases up to three to four years of age and then decreases thereafter. The possible rise in wool production with increasing age might be due to increase in body size and body weight of the animal up to particular age (Tomar, 1978). Whereas the diminishing effect might be due to ewe's own environmental handicaps like, pregnancy, lactation, ageing, number of lambs born and reared, etc.

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Saponin (Mowrin) Content in *Mahuva* (*Madhuca indica*) Seed Cake as Estimated by Different Methods

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Mahuva seed cake contains saponin like substances which are collectively called as mowrin. Different workers reported varying levels of mowrin in *Mahuva* seed cake from 4.0 to 21.3% by adopting different saponin estimation methods (Mulky and Gandhi, 1977; Varma, 1977; Vyas, 1981; Dorothy and David, 1983 and Joshi *et al.*, 1984). The qualitative

method of I.S.I. (1975) is also not specific for detection of adulteration of *Mahuva* seed cake in feed samples. Therefore, three different methods were tried for quantitative estimation of saponins. The methods used to estimate mowrin in *Mahuva* seed cakes and concentrate mixture containing *Mahuva* seed cake were Heywood and Kon (1940), Van atta *et al.* (1961) and Yosioka *et al.* (1974). Mowrin content by these methods was estimated in four samples of *Mahuva* seed cake collected from different sources and concentrate mixtures containing 0, 10 and 20% levels of *Mahuva* seed cake. The values of Mowrin obtained by different methods are presented in Table 1.

The values of saponin (Mowrin) in different samples obtained by the method of Yosioka

TABLE 1
Saponins (Mowrin) content as estimated by different methods (% on as such basis).

Feed samples	Yosioka <i>et al.</i> (1974)	Heywood & Kon (1940)	Van atta <i>et al.</i> (1961)
<i>Mahuva</i> seed cake — 1	27.49 ± 8.41	19.77 ± 0.38	12.20 ± 2.03
<i>Mahuva</i> seed cake — 2	24.59 ± 8.55	18.73 ± 0.82	11.60 ± 0.51
<i>Mahuva</i> seed cake — 3	26.23 ± 6.39	25.10 ± 0.70	9.80 ± 2.69
<i>Mahuva</i> seed cake — 4	26.34 ± 9.83	16.47 ± 1.46	6.87 ± 1.82
Concentrate mixture (Devoid of <i>Mahuva</i> seed cake)	14.18 ± 3.07	5.09 ± 0.32	1.27 ± 0.53
Concentrate mixture (10% <i>Mahuva</i> seed cake)	22.46 ± 3.95	7.18 ± 0.56	8.83 ± 4.86
Concentrate mixture (20% <i>Mahuva</i> seed cake)	15.13 ± 0.29	11.40 ± 0.44	5.23 ± 1.35

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et al. (1974) were the highest followed by Heywood and Kon (1940) and the least by Van atta *et al.* (1961). Thus, wide variation in the values of Mowrin was obtained by different methods. Further, Mowrin values obtained in concentrate mixture did not reveal consistent trend though the mixtures contained graded level of *Mahuva* seed cake (i.e. 10

and 20%). Even the mixture devoid of *Mahuva* seed cake gave positive values for saponin. Thus, all the three methods tried are not very precise for estimation of saponins (Mowrin). Therefore, it is suggested to develop foolproof method of estimation of saponins (Mowrin) in *Mahuva* seed cake.

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Abstracts of Ph. D. Thesis

Studies on the Effect of Different Levels of Moisture Regime and Nutrient on Growth, Yield and Quality of Sapota [*Manilkara achras* (Mill.) Fosberg] Cultivar Kalipatti Under South Gujarat Conditions

Submitted to Gujarat Agricultural University

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Major Guide

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Sapota or Sapodila or Chiku [*Manilkara achras* (Mill.) Fosberg] is one of the most popular tropical fruit crop highly suited to humid tropical climate. The fruit is mainly consumed in a fresh state. Sapota occupies an area of 4100 ha in Gujarat State of which 3600 ha. area is in South Gujarat. Out of this, 3300 ha. area is in Valsad district only which comes to 80 per cent area of the State. The 'Kalipatti' cultivar is the main choice of the cultivators and more than 99 per cent of area under sapota in Gujarat is of this cultivar, which amounts to monoculture. Even though sapota crop was introduced in South Gujarat decades ago but it is extensively planted and adopted in this region. The irrigational and nutritional requirements of this crop are yet not worked out. The present investigation was therefore aimed to assess the water and nutritional needs of sapota crop based on the more reliable approach on IW/CPE ratio, which possibly could be translated in terms of the number of irrigations and its frequency for the use of orchardists, canal authorities as well as horticulturists working with sapota.

The studies were carried out at the orchard of Gujarat Agricultural University, Navsari Campus, Navsari during the year 1982-83 and 1983-84. The soil of the experimental field was clayey in texture with 61.33% clay, 22.17% silt, 16.60% sand, pH 7.5 and EC 0.8

mmhos/cm at 25°C. Field capacity, bulk density and permanent wilting point were determined in the field itself and average values were noted as 32.0%, 18.0% and 1.43 g/cc, respectively. Uniform sapota grafts raised on khirnee (*Manilkara hexandra* L.) rootstocks were planted in July, 1970 at 9 m x 9 m spacing. The experiment was laidout randomised block design with three replications. These were twelve treatment combinations comprised of three irrigation schedule based on IW/CPE ratios viz., 0.25 (low), 0.50 (medium) and 0.75 (high) alongwith one control (No irrigation) and three levels of fertilizer viz., F_1 — 500 g N + 250 g P_2O_5 + 250 g K_2O (low), F_2 —1000 g N + 500 g P_2O_5 + 500 g K_2O (medium) and F_3 — 1500 g N + 750 g P_2O_5 + 750 g K_2O (high) per tree. The irrigation was scheduled as per the CPE values calculated from evaporation data obtained from a U. S. Class-A pan evaporimeter installed in the meteorological observatory of the college farm located near the experimental plot. At each irrigation, 80 mm water was applied with the help of 6" Parshall flume. The canopy volume of tree was calculated in cubic meter by using the formula $M^3 = \frac{(\text{width})^2 \times \text{ht}}{4}$ (where, width = spread of tree in meter and ht. = height of tree in meter). The fruits were harvested as and when they were ready and were categorised into three grades having fruit diameter 5 cm and above in first grade, 4.9 to 4 cm diameter in second grade and 3.9 cm diameter and below in third grade.

Conclusion

The important findings are briefly presented here as below

The moisture regime of 0.50 IW/CPE ratio which comes to 10 to 11 irrigations at an interval of 32 days in winter and 18 days in summer found beneficial for maximum fruit production (162.93 kg/tree) with larger fruit size and better quality fruits in sapota, where is

among different fertilizer treatments, F_3 (1000 g N + 500 g P_2O_5 + 500 g K_2O) appeared optimum for maximum fruit production (151.54 kg/tree) with better quality fruits. The increase in moisture level and fertilizer dose beyond the optimum levels failed to increase the fruit yield significantly.

The tree spread, circumference, twig growth, canopy volume and fruit production per m^3 of tree volume were found effective and ideal under soil moisture regime of 0.50 IW/CPE ratio and F_2 fertilizer level. Beyond these levels tree growth was found luxuriant and it was not beneficial for fruit production. In respect of quality of fruit, the total soluble solids, total sugars, non-reducing sugars and first grade fruits were found significantly higher in the fruits from the soil moisture regimes of 0.50 IW/CPE ratio and F_2 fertilizer level.

Sapota tree made maximum use of soil moisture to the extent of 66.16 per cent from 0 to 75 cm depth, followed by 33.84 per cent at 75 to 150 cm depth. The percentage of moisture extraction decreased with the increase in depth of the soil. The maximum feeding

roots to the extent of 82.3 per cent were found from 0 to 75 cm depth, while 79.1 per cent were found in 200 cm radial distance from the trunk and they found decreased with the increase in depth and distance. It indicates that 0 to 75 cm depth and 200 cm radial distance were optimum for the application of nutrients and irrigation for sapota crop.

The total consumptive use of water by sapota tree was increased with the increase in moisture regime and fertilizer levels. Whereas, the water use efficiency was decreased with the increase in soil moisture regime but it showed an increasing pattern with the increase in fertilizer levels.

The studies further revealed that the soil moisture regime 0.50 IW/CPE ratio and F_2 fertilizer level gave the highest net ICBR values of 1:11.20 and 1:11.12 respectively. Beyond these levels ICBR showed negative values.

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**Gross and Histological Study of
Superficial Regional Lymph Nodes as
Well as Lymphatics in Young and Adult
Surti Buffalo (*Bubalus bubalis*)**

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Present work on eight superficial regional lymph
nodes viz., parotid, mandibular, atlantal, preescapular,
axillary, pectoral, popliteal and superficial inguinal;
tracheal lymph duct and thoracic duct and counting of
total lymph nodes per animal, was carried out in six
young and six adult Surti buffaloes.

Gross study of lymph nodes comprised of total
number of lymph nodes, morphology, relationship,
drainage area as well as biometry i.e., length, width,
breadth, weight and volume.

Histomorphological study of lymph nodes was
carried out on paraffin sections. They were stained with
Harris' Haematoxylin and Eosin for general histomor-
phological observations and micrometry, Hart's stain
for elastic fibres, Masson's trichrome stain for connec-
tive tissue and smooth muscles, Snook's method for
reticular fibres, Methyl green-pyronin for plasma cells
and Unna's stain for mast cells. Micrometry was done
for the measurement of thickness of capsule and
trabeculae as well as diameter of lymph nodule and
germinal centre of lymph nodes.

Gross study on major lymphatic ducts like
tracheal lymph duct and thoracic duct was carried by
dissection and lymphography to know their normal
course and measure their length and diameter. Their
histological study was carried out by taking transverse

and longitudinal sections stained by above mentioned
staining methods used for lymph nodes.

In general, the total number of lymph nodes in
various regions like head, neck, thoracic cavity along
with thoracic limb, abdominal cavity, pelvic cavity with
pelvic limb had more number of lymph nodes in adult
buffaloes than those of buffalo calves. The total number
of lymph nodes in the whole body were 308.17 ± 6.01
in buffalo calves and 341.33 ± 8.37 in adult buffaloes.

All the superficial lymph nodes studied, were
smaller in size with varying in shape in buffalo calves
than those of adult buffaloes. The relationship and
drainage area were found to be same in both the age
group. Haemal nodes were found in the vicinity of su-
perficial lymph nodes and along the large blood vessels.
Further they were more in number along the dorsal
aspect of preescapular lymph node. Almost all the three
dimensions studied, length showed significantly greater
increased compared to width and breadth of all the
superficial lymph nodes of young and adult Surti buf-
faloes. All the eight superficial lymph nodes showed
significantly increase in weight and volume in both the
group. In young and adult buffaloes, the preescapular
lymph node was larger while axillary and mandibular
lymph nodes were smaller in young and adult buffaloes
respectively amongst all superficial lymph nodes
studied.

The larger lymphatic duct like tracheal duct and
thoracic lymph duct showed normal course as described
in the ox, while cisterna chyli was piercing the right crus
of the diaphragm, and entered the right side of the
thoracic cavity. The thoracic duct opened into left
jugular vein at a distance of 1 cm and 2.5 cm from
the anterior border of first rib in young and adult buf-
faloes respectively.

The length of the right and left tracheal lymph
ducts was 31.17 ± 0.41 and 34.25 ± 0.25 cm respectively
in young buffalo while it was 50.92 ± 0.27 and $53.58 \pm$

0.44 cm, respectively in adult buffaloes. The length of the left tracheal duct was significantly more than that of right tracheal ducts in both the age groups. The diameter of tracheal duct was found to be 1-2 mm 3.0 mm in young and adult buffaloes, respectively.

The length and diameter of the thoracic duct was found to be 35.67 ± 0.60 cm and 3-4 mm in young buffaloes and 76.67 ± 0.56 cm and 5-6 mm in adult buffalo respectively.

The direct method of lymphography was useful for tracing the course easily and typical beaded appearance was revealed in tracheal lymph duct and thoracic duct by lymphography.

In general histomorphological appearance of lymph nodes was similar to that of the ox. Amongst various regional lymph nodes studied, the superficial inguinal lymph node showed slight lobulation microscopically. The bicuspid valves were present in afferent and efferent lymph vessels. The capsule and trabeculae of lymph nodes were prominent and well developed. Few scattered elastic fibres and smooth muscles were present in connective tissue capsule. The frame work of lymph nodes was composed of reticular cells and fibres. Cell population of lymph node was formed by large number of lymphocytes followed by macrophages and plasma cells. Mast cells were present along the course of blood vessels in the capsule and trabeculae. The lymph capillaries were abundant in connective tissue surrounding the lymph nodes and they were larger than the blood capillaries.

The hemal node showed well developed capsule but trabeculae were not observed. Cortex and medullary regions were not distinguishable. Afferent and efferent lymph vessels were not observed.

There were three poorly demarcated layers in large lymphatic ducts. Tunica media was made up of one to two layers of circularly arranged smooth muscle bundles and they were seen interrupted longitudinally. Valves were absent in large lymphatic ducts.

The capsule was significantly thicker in adult as compared to that in young animals. The maximum thickness of capsule was found in prescapular and prefemoral lymph nodes ($104.76 \pm 7.13 \mu\text{m}$) and minimum was found in popliteal lymph nodes ($69.84 \pm 7.13 \mu\text{m}$) in young animals. In case of adult animals, maximum thickness of capsule was found in prefemoral lymph nodes ($232.80 \pm 20.57 \mu\text{m}$) and minimum was found in axillary lymph nodes ($64.02 \pm 5.82 \mu\text{m}$).

The maximum thickness of trabeculae was found to be $122.22 \pm 10.89 \mu\text{m}$ in prescapular lymph node and minimum was found to be $64.02 \pm 10.89 \mu\text{m}$ in atlantal in young animals. In case of adult buffaloes, maximum thickness of trabeculae was found in prefemoral lymph node ($215.34 \pm 25.36 \mu\text{m}$) while minimum was in axillary lymph nodes ($64.026 \pm 5.82 \mu\text{m}$). The diameter of lymph nodule was significantly smaller in young animals than that of adult buffaloes. Occasionally some lymph nodes of young animals showed larger diameter of lymph nodules than that of adult animals. The maximum diameter of lymph nodules was $378.30 \pm 20.58 \mu\text{m}$ in prescapular lymph nodes and minimum was $267.72 \pm 14.26 \mu\text{m}$ in popliteal lymph nodes in young animals. In case of adult animals maximum diameter was $616.92 \pm 29.67 \mu\text{m}$ in parotid lymph nodes and minimum was $221.4 \pm 21.77 \mu\text{m}$ in mandibular lymph nodes.

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**Effect of Different Levels
of Phosphorus on the Growth,
Yield and Quality of Premonsoon
Groundnut (*Arachis hypogaea* L.)
Under Integrated Weed Control**

**Submitted to the Marathwada Agricultural
University, Parbhani**

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A field investigation was conducted on clayey soil of College Farm, Marathwada Agricultural University, Parbhani to evolve suitable integrated weed management practice along with optimum dose of phosphorus in premonsoon of 1986 and 1987.

The experiment was laid out in split plot design with 24 treatments comprising of 6 weed management practices (higher levels of fluchloralin (1.2 l a.i./ha) and pendimethalin (1.0 l a.i./ha) as well as their lower levels (0.90 and 0.75 l a.i./ha, respectively) each supplemented with one hoeing at 5 WAS along with the local practice and unweeded control in main plots and 4 levels of phosphorus (P_0 , P_{20} , P_{40} and P_{60}) in sub plots which were replicated thrice.

The results revealed that significantly higher values of growth parameters viz., number of leaves and branches, leaf area, plant spread, nodule number and weight. Growth constants like AGR, RGR, CGR, LAI and LAD as well as yield attributes viz., number of pods and developed pods, weight of pods, seed index, shelling per cent were recorded under (F_2 , PM_2 and LP) lower levels of fluchloralin (F_2) and pendimethalin (PM_2) supplemented with one hoeing at 5 WAS and also in the local practice (LP) at most of the stages. These treatments found superior in keeping down the weed count and weed biomass with higher weed control and

phosphorus use efficiency. The uptake of NPK was low by weeds and high by crop under these treatments.

Minimum severity of rust and leaf spot was also noticed in F_2 , PM_2 and LP. High pod, haulm and kernel yield as well energy output was also recorded under F_2 , PM_2 and LP.

Maximum net returns per rupee invested accrued were under F_2 followed by PM_2 and LP. There was no adverse effect of both the herbicides on succeeding crops of wheat, bengal gram and safflower.

As regards phosphorus application, high values of growth and yield attributes as well as growth constants were recorded under P_{40} and P_{60} levels of phosphorus.

Density of grasses and broad leaved weeds as well as dry weight of weeds and weed control efficiency were high under high levels of phosphorus. However, severity of leaf spot and rust was negatively influenced with P application. Pod, haulm and kernel yield per hectare was materially high upto 40 kg P_2O_5 /ha only. Energy equivalent, harvest index, seed index, shelling per cent, oil and protein content as well as its output increased with P level. NPK uptake by crop and weeds, residual P present in soil and P use efficiency were also influenced by increased P application.

Significant associations and regression coefficients were observed between pod yield/plant and yield attributes like total dry matter, haulm yield, weed control efficiency, seed index, leaf and branch number, leaf area, pod number, shelling percentage and total dry matter. Pod and leaf number exhibited pronounced direct effects towards pod yield/plant.

High net realization/rupee invested was noticed upto 20 kg P_2O_5 /ha.

Test crops were not substantially altered due to P application in residue studies.

Combined effect of weed control x P levels was not significant in most of the cases, except pod yield/ha in 1986.

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