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Yield, Nutrient Content and Uptake by Indian Mustard (*Brassica juncea* (L.) Czernj and Cossonj as Influenced by FYM, Nitrogen and Source of Fertilizer

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ABSTRACT

An experiment was conducted at Anand during winter season of 1992-93 and 1993-94 to study the effect of FYM, nitrogen and source of fertilizer on yield and nutrient uptake in mustard crop. P-content in stover, S-content in seed and stover and N-uptake during 1993-94, P and S-uptake as well as seed and stover yields in both the years were significantly higher in FYM applied either @ 10 or 20 tonnes ha^{-1}. Increasing the rate of N progressively raised the N and S-contents in both seed and stover and N, P and S uptake as well as seed and stover yields in both the years of study. S carrying source (S_2) gave significantly higher N, P and S contents in seed and stover and their uptake, by crop, seed and stover yields as compared to sulphur free fertilizer source (S_1) during both the years. The N and S content in seed and stover and uptake of N, P and S by crop were strongly associated with seed yield in mustard.

(Received on 17th May, 1997)

INTRODUCTION

The concentration of plant nutrients in a crop and the amount of nutrients being removed by a particular crop from the soil may be helpful guide for formation of a sound fertilizer management programme (Tandon, 1989). Also, nutrient translocation from vegetative parts (source) to the grain (sink) during grain filling has been considered to be an important factor that influences the yield. Studies on direct effect of FYM, nitrogen and source of fertilizer on the content and uptake of nutrients by crops have been found to be helpful in economizing the fertilizer use without any adverse effect on soil fertility.

MATERIALS AND METHODS

A field experiment was conducted during the winter of 1992-93 and 1993-94 at College Farm, B. A. College of Agriculture, Anand Campus, Anand on loamy sand soil containing 0.36 per cent organic matter, 0.036 per cent total nitrogen, 42.5 kg available P_2O_5, 274.8 kg available K_2O and 10 ppm S ha^{-1} with a pH of 7.9. Mustard cv. GM-1 was sown at 45 cm x 15 cm spacing. Treatments consisted of three levels of FYM (0, 10 and 20 tonnes ha^{-1}) as main plots and combinations of three N-levels (25, 50 and 75 kg ha^{-1}) and two sources of fertilizers (S-free source : Urea + DAP and S-carrying

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source : AS + SSP) as sub-plots. The treatments were replicated six times in a split-plot design. Entire quantity of FYM and 50 per cent of N were applied as basal and remaining N was top dressed 45 DAS in respective treatments. The whole quantity of N (basal + top dressed) and recommended dose of phosphorus (50 kg ha^{-1}) were applied through two sources viz., Urea + DAP (S-free fertilizers) and AS + SSP (S-carrying fertilizers).

Mustard seed and stover samples collected were analysed for N, P and S contents. N was estimated by microkjeldahl method (Jackson, 1973), P by Vanadate method colorimetrically (Jackson, 1973) and S turbidimetrically (Chopra and Kanwar, 1976). Uptake of nutrients was calculated by multiplying the yield with per cent content of the respective nutrient and converted in kg ha^{-1} for each nutrient. All data thus obtained were processed statistically.

RESULTS AND DISCUSSION

Seed and stover yield

The data on seed yield (Table 1) indicated that FYM application (10 and 20 tonnes ha^{-1}) significantly increased the seed yield of mustard over no application in individual years as well as in pooled results too. The magnitude of mean increase in seed

TABLE 1

Seed and stover yields of mustard as influenced by varying levels of FYM, nitrogen and source of fertilizer.

Treatment	Seed (kg ha^{-1})			Stover (kg ha^{-1})		
	1992-93	1993-94	Pooled Mean	1992-93	1993-94	Pooled Mean
FYM (tonnes ha^{-1})						
F_0	2510	2508	2509	5319	5858	5589
F_{10}	2681	2761	2721	5674	6099	5887
F_{20}	2767	2831	2799	5713	6604	6159
C. D. (P = 0.05)	110	144	85	187	290	NS
Nitrogen (kg ha^{-1})						
N_{25}	2360	2489	2424	5109	5669	5539
N_{50}	2709	2764	2737	5733	6294	6013
N_{75}	2889	2847	2868	5864	6299	6082
C. D. (P = 0.05)	108	146	89	279	270	191
Source of fertilizer						
Urea + DAP (S_1)	2549	2564	2556	5357	6056	5707
AS + SSP (S_2)	2756	2836	2796	5781	6319	6050
C. D. (P=0.05)	88	119	73	227	220	155

TABLE 2

Nitrogen content in seed and stover of mustard and nitrogen uptake by plant as influenced by varying levels of FYM, nitrogen and source of fertilizer.

Treatment	N content (%)						N uptake (kg ha^{-1})		
	Seed			Stover					
	1992-93	1993-94	Pooled Mean	1992-93	1993-94	Pooled Mean	1992-93	1993-94	Pooled Mean
FYM (tonne ha^{-1})									
F_0	3.75	3.64	3.69	0.40	1.00	0.70	115.80	150.76	133.28
F_{10}	3.66	3.69	3.68	0.42	1.12	0.77	124.08	175.08	149.58
F_{20}	3.73	3.50	3.62	0.40	1.07	0.73	126.47	172.57	149.52
C. D. (P = 0.05)	NS	NS	NS	NS	NS	0.48	NS	12.05	7.49
Nitrogen (kg ha^{-1})									
N_{25}	3.54	3.50	3.52	0.39	0.99	0.69	104.14	145.74	124.94
N_{50}	3.64	3.65	3.65	0.40	1.04	0.72	121.81	171.71	146.76
N_{75}	3.96	3.69	3.82	0.42	1.17	0.80	140.40	180.96	160.68
C. D. (P = 0.05)	0.185	0.137	NS	0.026	0.037	NS	7.90	9.11	5.94
Source of fertilizer									
Urea + DAP (S_1)	3.60	3.47	3.54	0.39	1.00	0.70	114.02	152.06	133.04
AS + SSP (S_2)	3.82	3.75	3.79	0.42	1.13	0.78	130.22	180.21	155.21
C. D. (P = 0.05)	0.151	0.112	0.093	0.021	0.030	NS	6.47	7.44	NS

yield with 10 and 20 tonnes ha^{-1} was 11.6 and 8.5 per cent, respectively over no application. The results confirm the findings of Khurana *et al.*, (1991). The stover yield when pooled however, was not affected by FYM application.

The results further indicated that graded increase in levels of N significantly increased the seed yield in 1992-93 and in pooled analysis, whereas during 1993-94, N_{50} and N_{75} being at par, significantly increased the seed yield over N_{25}. The stover yield of mustard was significantly increased upto 50 kg N ha^{-1} during both the years and in pooled analysis.

Sulphur carrying source of fertilizer (AS + SSP) significantly produced higher seed and stover yields than S-free source of fertilizer (Urea + DAP) individual years as well as in pooled analysis.

N-concentration and uptake

The N-content of seed and stover was not improved significantly due to FYM application in both the years (Table 2). However, pooled data showed the significant improvement in N-content of stover, wherein FYM @ 10 tonnes ha^{-1} registered the maximum N-content. The data of 1993-94 and of pooled analysis also indicated significant increase in N-uptake at 10 tonnes FYM ha^{-1} over no FYM application. Similar results were obtained by Sharma *et al.* (1993) and Sardana and Sidhu (1994).

The N-content of seed as well as stover was significantly increased by N-levels. Application of N @ 75 kg ha^{-1} recorded significantly the highest N-content in seed and stover during 1992-93 and 1993-94. Similar results were obtained by Joshi *et al.*, 1991. N-uptake was also significantly increased with increased level of applied N (Table 2). The higher uptake due to N fertilization was also recorded by Nepalia (1991).

The S-containing fertilizer significantly increased N-content of seed and stover during both the years. However, it was higher in seed than stover (Table 2). Such an increase of N-content in seed and stover might be due to synergistic effect of both N and S which were supplied through S-containing fertilizers (Aulakh and Pasricha, 1983). The N-uptake by mustard crop increased significantly with the use of source S_2 (AS + SSP) during both the years, which might be due to the cumulative effect of increased seed and stover yields as well as increased N-content in both seed and stover. Similar positive effects on increase in N-content of seed and stover as well as N-uptake were recorded at Junagadh (Anon., 1992).

P-concentration and uptake

Application of FYM @ 20 tonnes ha^{-1} significantly increased the P-content of seed over no application but it was at par with 10 tonnes FYM ha^{-1} on pooled basis (Table 3). The differences in P-content in stover due to FYM treatment were found significant only in 1993-94 wherein 20 tonnes FYM ha^{-1} recorded significantly the highest P-content. It was further observed that the P-uptake by plant was increased significantly with each successive increase in FYM levels during 1993-94 and in pooled analysis. The highest P-uptake noted with 20 tonnes ha^{-1} which increased the P- uptake to the tune of 11.8, 25.9 and 18.4 per cent over no FYM in 1992-93, 1993-94 and in pooled data, respectively, FYM helps in increasing P utilization on account of organic compounds

TABLE 3

Phosphorus content in seed and stover of mustard and phosphorus uptake by plant as influenced by varying levels of FYM, nitrogen and source of fertilizer.

Treatment	P content (%)						P uptake (kg ha^{-1})		
	Seed			Stover					
	1992-93	1993-94	Pooled Mean	1992-93	1993-94	Pooled Mean	1992-93	1993-94	Pooled Mean
FYM (tonnes ha^{-1})									
F_0	0.83	0.64	0.73	0.07	0.09	0.083	24.63	21.51	23.07
F_{10}	0.85	0.66	0.75	0.07	0.09	0.082	27.06	24.36	25.71
F_{20}	0.85	0.68	0.76	0.07	0.11	0.092	27.54	27.09	27.31
C. D. (P = 0.05)	NS	NS	0.020	NS	0.009	NS	1.86	2.19	1.28
Nitrogen (kg ha^{-1})									
N_{25}	0.84	0.67	0.75	0.07	0.09	0.080	23.22	22.14	22.68
N_{50}	0.84	0.65	0.75	0.07	0.10	0.085	23.62	25.06	25.84
N_{75}	0.85	0.66	0.75	0.08	0.10	0.092	29.38	25.78	27.58
C. D. (P = 0.05)	NS	NS	NS	0.009	NS	0.007	1.38	1.47	NS
Source of fertilizer									
Urea + DAP (S_1)	0.85	0.68	0.77	0.08	0.11	0.091	25.93	24.28	25.11
AS + SSP (S_2)	0.83	0.64	0.74	0.07	0.09	0.080	26.88	24.37	25.63
C. D. (P = 0.05)	0.015	0.010	0.010	NS	0.010	0.006	NS	NS	NS

TABLE 4

Sulphur content in seed and stover of mustard and sulphur uptake by plant as influenced by varying levels of FYM, nitrogen and source of fertilizer.

Treatment	*S content (%)*						*S uptake (kg ha^{-1})*		
	Seed			*Stover*					
	1992-93	*1993-94*	*Pooled Mean*	*1992-93*	*1993-94*	*Pooled Mean*	*1992-93*	*1993-94*	*Pooled Mean*
FYM (tonnes ha^{-1})									
F_0	1.63	1.28	1.46	0.34	0.65	0.50	59.58	70.42	65.00
F_{10}	1.78	1.57	1.68	0.34	0.76	0.55	68.11	92.64	80.37
F_{20}	1.79	1.59	1.69	0.35	0.80	0.57	69.81	99.69	84.75
C. D. (P = 0.05)	NS	0.224	0.13	NS	0.049	NS	7.82	4.16	NS
Nitrogen (kg ha^{-1})									
N_{25}	1.63	1.37	1.50	0.31	0.67	0.49	54.72	74.05	64.39
N_{50}	1.80	1.45	1.62	0.35	0.77	0.56	69.27	90.78	80.03
N_{75}	1.77	1.63	1.70	0.36	0.78	0.57	73.49	97.93	85.71
C. D. (P = 0.05)	0.101	0.165	0.10	0.032	0.049	0.029	4.05	5.86	3.51
Source of fertilizer									
Urea + DAP (S_1)	1.64	1.39	1.51	0.29	0.58	0.44	58.13	72.30	65.21
AS + SSP (S_2)	1.83	1.58	1.70	0.39	0.89	0.64	73.53	102.87	88.20
C. D. (P = 0.05)	0.0083	0.135	0.08	0.026	0.039	NS	3.31	4.78	NS

present in it which are capable of chelating cations like Al and Fe, thus preventing them to become insoluble as Al and Fe phosphates (Lal and Dravid, 1993). This was clearly evident from the results of present study on P-uptake. P-content of seed remained unchanged due to N-fertilization. However, P-content of stover was significantly increased in 1992-93 and in pooled results, wherein the highest level of N (75 kg ha^{-1}) showed maximum P-content. The differences in P-uptake by crop were found significant due to different N-treatments and maximum P-uptake was recorded in N applied @ 75 kg ha^{-1} during both the years of study. Similar, significant response to N-fertilization was for P content of stover observed in earlier work (Prasad and Shukla, 1991).

S-free source (Table 3) helped in increasing the P-content of seed (during both the years) and stover during 1993-94 and in pooled analysis. The relatively lower P-concentration in seed and stover under S_2 could be due to simple dilution effect. Aulakh *et al.* (1977) also reported similar findings. However, the P-uaptake under both the sources of N and P fertilizers remained unaltered.

S-concentration and uptake

Application of FYM @ 20 tonnes ha^{-1} significantly increased the S-content of seed and stover over no application during 1993-94 (Table 4). The addition of FYM besides improving physical and biological properties of soil, supplies macro, secondary and micro-nutrients and improves root proliferation which might have helped in increasing sulphur absorption (Lal and Dravid, 1993). The data further revealed that S-uptake was significantly increased by FYM application upto 10 tonnes ha^{-1} during 1992-93 and 20 tonnes ha^{-1} in 1993-94. Dhillon and Dhillon (1991) also obtained similar effect of FYM on S-uptake.

The highest level of N (75 kg ha^{-1}) showed significantly the highest S-content in seed and stover during both the years and in pooled analysis. It was further observed that the S-uptake by crop was increased significantly with every increased level of applied N. On an average N_{25}, N_{50} and N_{75} removed 64.39, 80.03 and 85.71 kg S ha^{-1}, respectively. N application is known to increase the root cation - exchange capacity which may improve the absorption of P and S ions through synergistic effect of N on these ions (Aulakh and Pasricha, 1983). This was well elucidated by significantly improved uptake of P and S due to N- fertilization as observed in the present study.

TABLE 5

Correlation coefficient (r) between seed yield and nutrients content and uptake.

Sr. No.	*Characters*	*Correlation coefficient (on pooled basis)*
1.	N–content in seed (%)	0.63*
2.	N–content in stover (%)	0.83*
3.	P -content in seed (%)	-0.04
4.	P -content in stover (%)	0.22
5.	S - content in seed (%)	0.84*
6.	S - content in stover(%)	0.78*
7.	N - uptake (kg ha^{-1})	0.96*
8.	P - uptake (kg ha^{-1})	0.91*
9.	S - uptake (kg ha^{-1})	0.93*

Critical value at 5%, 0.47

* Significant at 5% level.

The source having S significantly increased S-content of both seed and stover over S-free source. This may be due to the fact that S-source (AS) not only increases the availability of S from applied fertilizer but also the availability of native S of soil as reported by Dhillon and Dev (1980). The highest uptake of S was also observed in favour of S_2 source during both the years. The increased uptake of S by mustard crop with S-containing source seems to be partly due to increased content of this element in seed and stover (Table 4) and partly due to higher yield with source carrying sulphur.

Correlation study

The nutrients content (N and S) and uptake (N, P and S) have indicated significant positive correlation with seed yield, while P-content in seed and stover did not show any significant association with seed yield of mustard.

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Preliminary N, P and K Diagnostic Norms for Wheat (*Triticum aestivum*) Using DRIS

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ABSTRACT

The N, P and K foliar diagnostic preliminary norms for wheat (*Triticum aestivum*) were developed by using the Diagnostic and Recommendation Integrated System (DRIS) approach. These norms were developed from data sets on N, P and K composition in wheat plant samples and corresponding grain yields. The degree of nutrient imbalance in the plant was expressed in forms of a DRIS index, which measured the extent to which a particular nutrient deviated from the established norms. The DRIS assesses the nutrient balance in plant tissue and identifies not only the most limiting-element, but also the order in which other elements would become limiting. The diagnosis could be made for the deficiency of nutrients in the order of their requirements.

(Received on 2nd Aug., 1996)

INTRODUCTION

Critical values for diagnostic purpose determined through regression relationship between soil and plant analysis and crop yield, are specific to the conditions unique to the experiments involved and often do not hold under different agro-climatic conditions. The Diagnosis and Recommendation Integrated System- (DRIS) developed by Beaufils (1973), has been proved useful in the interpretations of plant analysis using nutrient concentration ratios (Summer, 1979). The approach has been found reliable in diagnosing nutrient requirement for short duration crops like soybean, sugarcane and potato (Summer, 1977a; Summer, 1979; Elwali and Gascho, 1984; Sharma, 1991). The DRIS identifies not only the most limiting element, but also the order in which other elements would become limiting and was able to diagnose plant nutrient needs early in the life of the crops than sufficiency range method (Beverly *et al.*, 1986). This paper reports the N, P and K foliar diagnostic preliminary norms developed from their composition in plant samples of wheat crop grown under different fertility condition.

MATERIALS AND METHODS

Preliminary foliar diagnostic norms for wheat were formulated by using data sets from the experiments conducted at College Agronomy Farm, G.A.U., Anand during 1991-93. Total 505 plant samples (3rd leaf) of different growth period (six to eight weeks after

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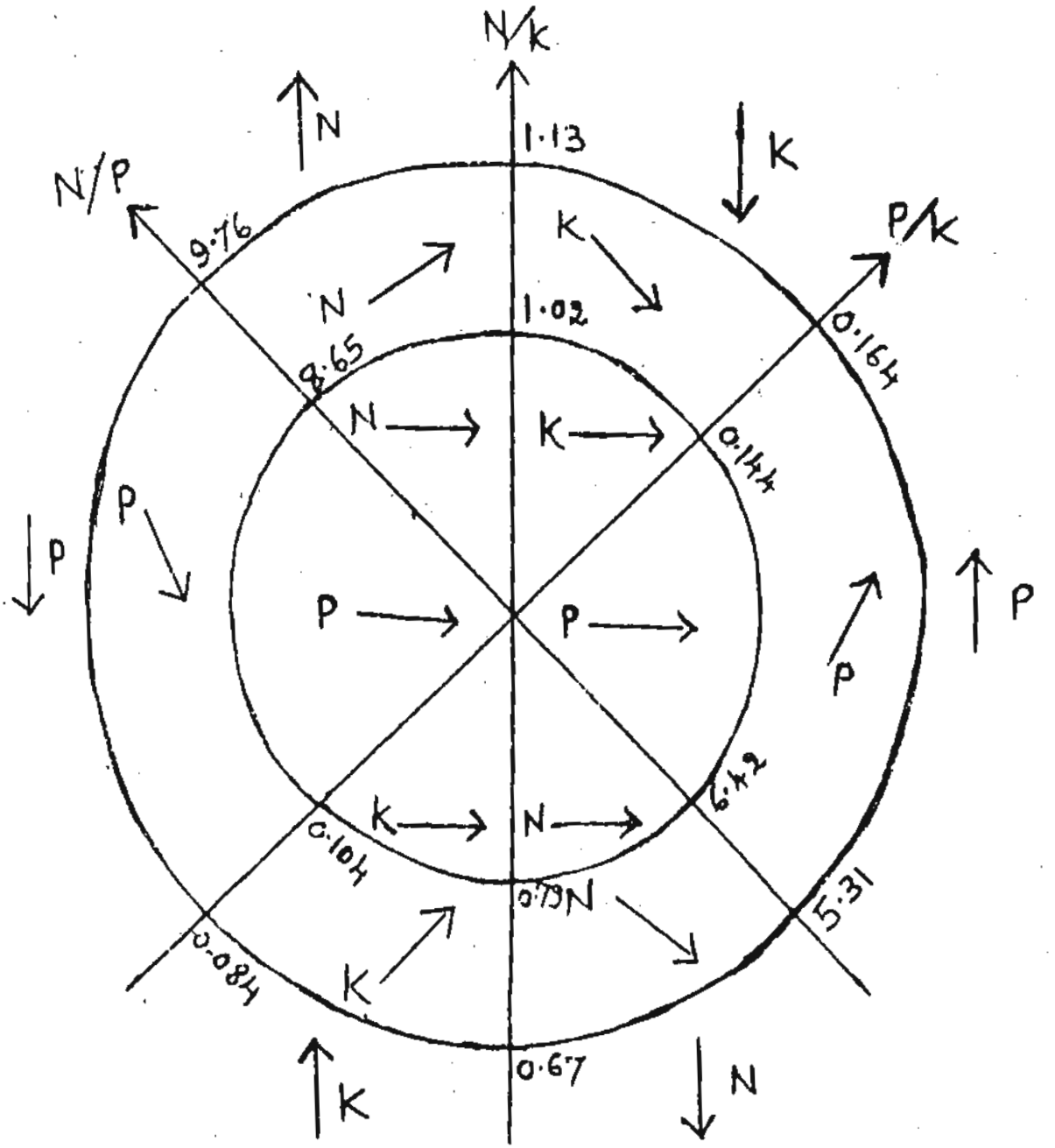
TABLE 1

Statistical parameters for different forms of wheat plant N, P and K expressions.

Paremeter	Forms of Expression								
	N	*P*	*K*	*N/P*	*N/K*	*K/P*	*K/N*	*P/N*	*P/K*
	-(% in dry matter)-								
					Low yielding population (A)+				
Mean	2.25	0.28	2.18	8.39	1.07	8.23	1.02	0.127	0.131
S.D.	0.50	0.08	0.43	2.20	0.33	2.32	0.34	0.031	0.035
C.V. %	22.36	28.44	19.81	26.20	30.35	28.15	32.80	24.18	26.46
Variance									
S_A	0.25	0.01	0.19	4.83	0.11	5.36	0.11	0.001	0.001
					High yielding population (B)+				
Mean	2.30	0.32	2.60	7.54	0.90	8.56	1.15	0.140	0.124
S.D.	0.26	0.07	0.35	1.67	0.17	2.23	0.22	0.034	0.031
C. V. %	11.53	21.27	13.40	22.17	19.12	26.02	18.86	23.98	24.76
Variance									
S_B	0.07	0.01	0.12	2.79	0.03	4.96	0.05	0.001	0.001
S_A/S_B	3.62*	1.40*	1.54*	1.73*	3.57*	1.08	2.40*	0.83	1.42*

+ Number of observations were 257 in A and 248 in B.



	$\bar{X}$	SD	CV%
N/P	7.54	1.67	22.17
N/K	0.90	0.17	19.12
P/K	0.12	0.03	24.76

Fig. 1. : DRIS chart for obtaining the qualitative order of requirement for N, P and K in wheat. Mean of significant expressions ((value at origin in chart) are : N/P = 7.54, N/K = 0.902, P/K = 0.124.

sowing) were collected and analysed for total N, P and K contents. The ground plant samples were analysed for N contents by wet digetion with H_2SO_4 following macro kjeldahl method and total P in the di-acid digested samples were estimated by phosphovanado-molybdate yellow colour method in HNO_3 system (Jackson, 1973); whereas total K was determined flame-photometrically.

Corresponding grain yield data were collected and the population was divided into two sub-population on the basis of yield : sub-population A, in which all yield exceeded more than 70 per cent of the maximum yield and sub-population B, with yields lower than this level. Each element in the plant sample was expressed as shown in Table 1. For each population, the mean, Standard Deviation (SD), Coefficient of Variation (CV%) and Variance (S) for each form of expression were computed. Expressions N/P, N/K and P/K were retained as being discriminatory since their variance ratio (SA/SB) was significant and their mean values for two sub-populations were nearly the same. These forms of expression were then interrelated in a three coordinate DRIS chart (Fig. 1). The point of origin in the centre of chart represents the mean of each expression N/P, N/K and P/K for the population of high yielding plants. The diameter of the inner and outer circles are 4 SD/3 and 8 SD/3 as has been dealt by Beaufils (1973) which takes care of the variability in the population.

The plant sample composition falling within the inner circle would be considered to be relatively balanced as is denoted by horizontal arrow (→). Away from the central zone along the axis, the degrees of imbalance between the two elements increases. This zone of imbalance is divided into two sub-zones, the first being slight to moderate imbalance which is denoted by an arrows at 45 degrees to the horizontal (↘) (↗), while the zone of marked imbalance beyond this circle, being either too high or too low is denoted by vertical arrows (↑), (↓) respectively. The DRIS indices were calculated for quantitative evaluations of the relative degree of imbalance of the nutrients using following equations :

$$\text{N Index} = + \left[\frac{f(N/P) + f(N/K)}{2} \right]$$

$$\text{P Index} = + \left[\frac{f(P/K) - f(N/P)}{2} \right]$$

$$\text{K Index} = - \left[\frac{f(N/K) + f(P/K)}{2} \right]$$

Where f (N/P) = 100 [(N/P/7.54)-1] 10/CV, when the value of N/P is > 7.54 and N/P = 100 [1-(7.54/N/P)] 10/CV when central value of N/P is < 7.54. In this case 7.54 is the mean. CV = coefficient of variation for high yielding sub-population. The other forms viz., N/K and P/K were derived in a similar way using the mean 0.902 for N/K and 0.124 for P/K. These indices have positive and negative values which always sum to zero as they measure the relative balance among N, P and K. The order of plant requirement is given by the most negative index being the most required and the most positive, the least. The diagnostic norms computed above were tested against independent data collected during 1992-93 from an ongoing long term fertilizer experiment at College Agronomy Farm, GAU, Anand. The

details of the treatments are shown in Table 2. This was done by selecting a particular treatment of interested element which is the nutrient most required by the plant and then satisfying the requirement by selecting another treatment in which that particular element is applied.

TABLE 2

Treatment details of long term fertilizer experiment at Anand.

Treatment	*Fertilizer application (kg/ha)*		
	N	*P*	*K*
T_1	0	0	0
T_2	FYM @ 25 t ha^{-1}	Every 3rd year	
T_3	60	0	0
T_4	60	30	0
T_5	60	30	60
T_6	120	0	0
T_7	120	60	0
T_8	120	60	120
T_9	135	65	0
T_{10}	135	65	135

RESULTS AND DISCUSSION

The results of the example for the ongoing experiment have been presented in Table 3. First treatment shows N as the most limiting when it was not applied to the wheat crop. The limitation of N goes on decreasing with increase in the rate of N application upto 120 kg ha^{-1} or when the N was applied as per soil test value i.e. 135 kg N ha^{-1} and its requirement was satisfied. Phosphorus becomes limiting followed by N and K when N rate is increased to 120 kg ha^{-1} or as per soil test value. The requirement of P gets satisfied at 60 kg P_2O_5 ha^{-1} or as per soil test value i.e. 65 kg P_2O_5 ha^{-1} when applied in combination with N application @ 120 kg ha^{-1} or 135 kg ha^{-1}. At this rate K becomes most limiting, but further increase in K applications (120-60-120 or 135-65-135 kg ha^{-1}) shows P as the most limiting one. Thus, the imbalance between elements goes on increasing at higher rates. So, while selecting the dose of nutrients, balance has to be struck somewhere when negative value of element (S) index is minimum. Since the sum total of index values is zero, the most desired balance would be when DRIS index is zero for all the elements. To obtain such an index value is rather rare, therefore, the balanced treatments are the one which give plant composition yielding DRIS indices having minimum negative values.

TABLE 3

Effect of fertilizer treatments on plant composition, DRIS indices and yield of wheat.

Treatment	Plant composition (%)			DRIS indices			Nutrient requirement	Grain yield (t/ha)
	N	P	K	N	P	K		
T_1	1.34	0.196	2.13	-16.11	-6.35	22.46	N>P>K	1.24
T_2	1.39	0.191	2.29	-13.47	-9.00	22.48	N>P>K	1.75
T_3	1.46	0.197	1.90	- 4.92	-3.58	8.50	N>P>K	2.09
T_4	1.53	0.210	1.50	2.65	3.38	-6.03	K>N>P	2.07
T_5	1.60	0.200	2.10	-3.42	-7.49	10.91	P>N>K	2.66
T_6	1.79	0.180	1.62	13.18	-9.64	-3.55	P>K>N	2.44
T_7	1.52	0.204	1.65	0.27	0.21	-0.48	K>P>N	2.83
T_8	1.39	0.168	2.49	-14.05	-19.03	33.08	P>N>K	2.94
T_9	1.75	0.165	1.29	22.32	-8.51	-13.81	K>P>N	2.36
T_{10}	1.43	0.182	2.29	-10.54	-12.54	22.82	P>N>K	3.08

S. Em. +/- = 0.23
C. D. (P= 0.05) = 0.66
C. V. (%) = 19.30

In the above example, the maximum yield (3.08 t ha^{-1}) was obtained with 135-65-135 treatment which was also comparable with 120-60-120 (2.94 t ha^{-1}) and 120-60-0 (2.83 t ha^{-1}) treatments. However, the yield of 2.83 t ha^{-1} was recorded upto the point when the negative values of DRIS indices were minimum under 120-60-0 treatment which is a recommended dose of wheat. It would be possible that with further increase in the application of particular element, the imbalance may increase to an extent causing a decrease in the yield or in other words that particular element may be toxic. Thus, the application of DRIS norms to the data show that the diagnosis that result in yield responses can be made as explained by Summer (1981). Comprehensive DRIS norms for major and secondary nutrients in case of corn and wheat (Summer, 1976; Summer, 1977b; Summer, 1981), soybean (Beverly *et al.*, 1986), potato (for N, P, K : Sharma, 1991) and litchi (for micronutrients : Hundal and Arora, 1996) have also been tested and their validity established.

Reading the chart

The use of chart (Fig. 1) to make a diagnosis is illustrated by an example (Table 2, treatment-1). The N, P and K concentration in wheat plant sample on dry matter basis are 1.34, 0.196 and 2.13 per cent, respectively which give : N/P = 6.84, N/K = 0.63 and P/K = 0.09. The nutrient insufficiencies are recorded by convention for the purpose of diagnosis which is done stepwise for each function. The value of N/P lies within the inner circle in the zone of balance situation (i) NPK. The value of N/K lies outside the outer circle in the zone of N deficiency, (ii) N ↓ PK ↑ and that of P/K lies inbetween two the circles i.e. the zone of moderate P deficiency, (iii) NP ↘ K. ↗. After reading the three functions, the remaining element is assigned a horizontal arrow. The final reading then becomes : (iv) N ↓ P ↘ K ↑ , which gives the order of requirements of N, P and K in terms of limiting importance on yield as N > P > K. The order of nutrient requirement matched with chart readings as well as DRIS indices.

Thus, critical value approach to diagnose would not achieve the same success as the DRIS system. The application of most limiting nutrient could result in a yield increase, it usually means that the element is present at an insufficient level in the soil as well. Sometime, situation could arise, where application of most limiting nutrient dose not result in yield increase. This is usually the case when some other factors viz., soil salinity, pH, $CaCO_3$, scarcity of water, unfavourable climate etc. are limiting the uptake of the particular element. Therefore, in making useful recommendations having the highest chances of increasing yield, both soil and plant parameters as well as the modifying influence of weather and cultural practices should be taken into consideration (Beaufils, 1973; Summer, 1977b).

Preliminary DRIS norms for N, P and K in wheat leaves have been found to be useful in diagnosing and ranking the most limiting and excessive major nutrients.

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Estimation of Inter-Generation Parameters in Various Selection Schemes in Four Cowpea Crosses

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ABSTRACT

Estimates of inter-generation parameters indicated that the heritability values calculated from the regression of F_5 lines on F_4 lines using conventional and standard unit procedures were significant in PS (EF) and PS (Hy) in all the four crosses for seed yield per plant. The values of observed and predicted selection differential and response to selection were comparable in PS (EF) in cross 1 and PS (Hy) in cross 4 only. PS (EF) and PS (Hy) of cross 1 showed high estimate of realized heritability. Phenotypic correlations between F_4 and F_5 lines for seed yield per plant were significant only in PS (EF) and PS (Hy) in all the four crosses.

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INTRODUCTION

The most important function of heritability in the genetic studies of metric traits is its predictive role, expressing the reliability of the phenotypic values as a guide of its breeding value which ultimately determines its influence on the next generation. Estimates of heritability in narrow sense and genetic gain in early segregating generations provide basic information for designing an efficient and effective breeding strategy. With this view, the present study was conducted to estimate the heritability by various procedures and to compare the observed and predicted selection differential as well as response to selection.

MATERIALS AND METHODS

Five selection procedures viz., pedigree selection for early flowering [PS(EF)], pedigree selection for high yield [PS(Hy)], mass selection [MS], single seed descent [SSD] and random bulk population [RBP] were applied in F_2 (Summer, 1991), F_3 (*kharif* 1991) and F_4 (Summer 1992) generating in four cowpea crosses (Table 1). PS (EF), PS(Hy) and MS were conducted by selecting 80 superior plants from F_2 to F_4. One seed from each plant taken and bulked under SSD. Seeds from remaining plants were bulked for RBP. Plants to progenies of PS(EF) and PS (Hy) in F_3 and F_4 were evaluated in augmented design with seven parental checks, whereas, populations

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PS (EF) : Pedigree Selection for early flowering.
PS (Hy) - Pedigree Selection for high yield.

(SSD, MS and RBP) were grown in separate block with parents of cross as check. A total of 500 plants to progenies (25 plants selected in each F_4 for each of the five selection schemes) were evaluated in F_5 (*kharif*, 1992) alongwith F_2 and standard checks in Compact Family Block Design with two replications. The plot size was single row of 5.25 m length for progenies and checks and seven rows for F_2. Seeds were dibbled at 0.45 x 0.15 m spacing.

Heritability values were calculated from the regression of F_5 lines on F_4 lines using both the conventional procedure and the standard unit procedure of Frey and Horner (1957). The standard errors of the heritability estimates were obtained following the procedure described by Pesek and Baker (1971). The realized heritability and observed selectrion differential and response to selection were calculated according to the formula suggested by Falconer (1960). The predicted selection differential was calculated as the product of constant (K = 1.12 at 32 per cent selection intensity) and the phenotypic standard deviation of F_4 generation. The predicted response to selection was estimated following the procedure used by O'Brien *et al.* (1978) in which predicted respnse is the product of selection differential and the estimate of heritability from regression of progenies on parents by conventional procedure. The standard error of predicted and observed response were obtained using methods described by Pesek and Baker (1971). Simple phenotypic correlation coefficients by between different segregating generations were calculated in all the selection procedures of four crosses for seed yield per plant.

RESULTS AND DISCUSSION

There are two alternative methods open to the breeder for improving the rate of response to selecttion, one by increasing the heritability and other by reducing the proportion of selected genotypes and to increase the intensity of selection. The heritability can be increased only by reducing environmental variation. Reducing the proportion of the individual selected, seems at first sight to be straight forward means of improving the response but there are several factors to be considered which set a limit to wheat the breeder can do in this way (Falconer, 1960). In the present study, both conventional and standard unit procedures were adopted to calculate heritability values from the regression of F_5 lines on F_4 lines for seed yield per plant and were significant in PS (EF) and PS (Hy) methods in all the four crosses (Table 1). The two methods gave fairly similar values of heritability in PS (EF) of cross 2 and 3 and in PS (Hy) of cross 1, 2 and 4. This indicated that environment did not cause an expansion or contraction of the phenotypic variability present in a population (Frey and Horner, 1957). In general, the standard unit method gave the higher estimates of heritability than the conventional procedures in both the selection methods of cross 1, 2 and 4.

Differences in the ranges and variances between F_4 and F_5 generations within a cross was mainly responsible for the higher estimates of standard unit method of heritability. Similar results were also reported by Frey and Horner (1957). The standard unit method for calculating heritability is useful only when a certain type of scaling factor is operating and have two advantages over the conventional

TABLE 1

Estimates of heritability by parent-off spring regression (F_5 lines on F_4 lines) method, selection differential, response to selection and realised heritability for seed yield per plant in four cowpea crosses.

Selection procedures	Heritability		Selection differential		Response to selection		Realized heritability
	Conventional procedure	Standard procedure	Observd	Expected	Observed	Expected	
			Pusa falguni x V 269 (cross 1)				
PS (EF)	0.44** ± 0.09	0.71** ± 0.15	8.31	8.33	4.33** ± 1.07	3.66** ± 0.78	0.52
PS (HY)	0.39* ± 0.18	0.40* ± 0.19	5.08	3.65	3.01** ± 0.74	1.42* ± 0.68	0.59
			GC 1 x RC 8 (cross 2)				
PS (EF)	0.41** ± 0.12	0.57** ± 0.17	1.74	5.03	0.80 ± 0.79	2.06** ± 0.63	0.46
PS (HY)	0.53** ± 0.12	0.67** ± 0.15	8.05	6.36	1.63 ± 1.06	3.37** ± 0.79	0.20
			GC 2 x V 16 (cross 3)				
PS (EF)	0.50* ± 0.22	0.43* ± 0.19	6.27	4.95	0.01 ± 0.97	2.48* ± 1.13	0.002
PS (HY)	0.84** ± 0.28	0.52** ± 0.18	6.38	3.45	2.07 ± 1.09	2.90** ± 0.99	0.32
			GC 2 x V 240 (cross 4)				
PS (EF)	0.52** ± 0.09	0.76** ± 0.13	3.69	6.37	-1.22 ± 0.96	3.31** ± 0.91	-0.33
PS (HY)	0.40** ± 0.13	0.55** ± 0.17	6.60	6.84	2.18* ± 1.09	2.74** ± 0.92	0.21

*, ** Significant at P = 0.05 and P = 0.01 levels, respectively.

method. First, the ceiling for heritability value is 100 per cent, while in conventional method the ceillings of heritability changes with each set of data. Until the ceilling is known, it is difficult to interpret a value as high, medium or low. Secondly, the standard unit method eliminates the unrealistic values of over 100 per cent and also eliminates the environmental effects of different years which increase or decrease the range of the progenies relative to that of the parents.

The values of observed and expected selection differential were comparable in PS (EF) of cross 1 and PS (Hy) of cross 4. The expected selection differential was higher than the observed differential in PS (EF) of cross 1, 2 and 4 as well as in PS (Hy) of cross 4. This indicated that phenotypic standard deviation may be high and mean phenotypic values of the selected lines close to that of the base population. So it may give lower values of the observed selection differential.

The predicted genetic gain was lower than the realized gain in both the selection methods in cross 1. The observed and expected response to selection was comparable with each other only in PS (EF) of cross 1 and PS (Hy) of cross 4. In rest of the cases, the actual gain, however, did not agree with the estimates of the expected gain. Such lack of the relationship between expected and actual genetic gains has been attributed to heterozygosity of the selected plants at some of the loci and high genotype x environment interaction (Singh and Sharma, 1976).

TABLE 2

Phenotypic correlation coefficients between generations for seed yield per plant in different selection procedures of four cowpea crosses.

Selection procedures	*Generations*	*Pusa Falguni x V 269 (Cross 1)*	*GC 1 x RC 8 (cross 2)*	*GC 2 x V 16 (cross 3)*	*GC z x V 240 (cross 4)*
PS (EF)	F_2 and F_3	-0.12	0.09	0.15	0.15
	F_3 and F_4	-0.05	0.002	0.03	0.14
	F_4 and F_5	0.71**	0.57**	0.43*	0.76**
PS (Hy)	F_2 and F_3	0.18	0.03	0.09	-0.19
	F_3 and F_4	-0.02	0.005	0.08	-0.19
	F_4 and F_5	0.40*	0.67**	0.52**	0.55**
SSD	F_3 and F_4	0.22	0.03	-0.17	0.16
	F_4 and F_5	0.15	-0.20	0.02	-0.06
MS	F_3 and F_4	0.06	0.007	0.06	0.05
	F_4 and F_5	0.11	0.06	-0.02	-0.27
RBP	F_3 and F_4	0.06	-0.05	-0.04	0.01
	F_4 and F_5	-0.25	0.26	-0.14	-0.27

*, ** Significant at P = 0.05 and P = 0.01 levels, respectively.

The realized heritability estimates may vary from generation to generation for the same population and also with a varying magnitude of genotype x environment interaction (Bisen *et al.*, 1985). There was no consistent trend for increase of decrease in heritability estimates in different crosses from F_4 to F_5 generations. In general, both the pedigree methods of selection of cross 1 showed high estimate of realized heritability whereas, the estimate were quite inconsistent in PS (EF) of cross 3 and 4. This showed high genotype x environment interactions playing an important role in the expression of seed yield in these populations. As it is known that the yield is a complex character influenced by several factors, it is possible to get varying estimates of heritability for seed yield of the same cross in different populations created through selection. Similar findings were reported by Tee and Qualset (1975) that heritability values in wheat were changing with breeding procedures and the hybrid material.

Estimates of correlation between yields of different generations have been used as a measure of the effectiveness of selection procedures. In the present study, significant phenotypic correlation coefficients between F_4 and F_5 lines were obtained for seed yield per plant in PS (EF) and PS (Hy) procedures of all the four crosses (Table 2) thereby, indicating that selection in the F_4 generation had a greater role to play on the performance of subsequent generations. The high correlation could be due to the fact that F_4 generation had large number of near homozygous genotypes. Knott and Kumar (1975) suggested the use of later generation for yield in wheat since it attains a reasonable degree of homozygosity. However, non-significant phenotypic correlations were obtained in other generations in PS (EF) and PS (Hy) as well as in all the generation in SSD, MS and RBP of all the four crosses. The observed inconsistency in performance of different generations of cowpea crosses may have been caused by high genotype x environment interactions, as the different generations were studied in different seasons. Breaking of genetic linkages might have caused changes in performance and genetic shift in the various populations during their production cycles might have added to the inconsistency (Bejiga *et al.*, 1991). Non-significant or inconsistent correlations among different generations have also been reported by Virupakshappa (1984) in cowpea. Genotype x environment interaction tends to reduce the correlation between generations, especially when one is evaluating early generation material for seed yield (O'Brien *et al.*, 1978).

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Genetic Variability and Correlation in Early Maturing Genotypes of Pigeonpea

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ABSTRACT

Drymatter per plant, plant height and pods per plant showed a wide range of phenotypic variation. The genotypic and phenotypic coefficient of variation were higher for drymatter per plant, harvest index, pods per plant and grain yield per plant. Heritability estimates were higher for all the characters studied. However, high genetic advance was obtained only for drymatter per plant followed by pods per plant and plant height. High heritability coupled with high genetic advance for these traits indicated that additive gene effects were probably more important in the inheritance of these traits. Grain yield was significantly and positively correlated with pods per plant and drymatter per plant indicating that selection on the basis of these traits would be effective for yield improvement.

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INTRODUCTION

Improvement over existing varieties is a continuous process in plant breeding. One of the important considerations in any crop improvement programme is the detailed study of genetic variability. The estimates of heritable and non-heritable variation give a clue to improvement possible in the trait under study. Knowledge about interrelationship among yield components and their influence on yield is important for a fruitful selection. The present investigation was, therefore, carried out to estimate the phehotypic and genotypic variation, heritability, expected genetic advance and interrelationship among the traits in germplasm collection of pigeonpea, keeping the view for selection of supeior genotypes.

MATERIALS AND METHODS

The experimental material comprised 20 early maturing genotypes of pigeonpea laid out in a randomized block design with four replications at Instructional Farm, GAU, Junagadh during 1990-91. Each genotype was grown in a single row of 5 m length with 60 cm spacing between rows and 30 cm between plants within the rows. Five competitive plants were selected randomly for each genotype in every replication to record observations on yield and 10 related traits (Table 1). Phenotypic and genotypic coefficients of variation, heritability and genetic advance were worked out as per the procedure given by Johnson *et al.* (1955). Correlation coefficients were worked out for all possible combinations

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TABLE 1

Variability, heritability and genetic advance for different characters in early maturing genotypes of pigeonpea.

Character	*Range*	*Mean ± SE*	*GCV (%)*	*PCV (%)*	*Heritability (%)*	*Genetic advance (%)*
Days to flowering	81.50 (ICPL-87) – 108.75 (GAUT-82-55)	95.80 ± 1.99	7.60	8.66	77.09	13.17
Branches/plant	8.95 (GAUT-82-104) – 16.45 (GAUT-82-137)	11.93 ± 0.59	13.73	16.68	67.72	2.78
Plant height (cm)	112.70 (ICPL-312) – 207.50 (ICPL-151)	152.03 ± 1.98	14.59	14.83	96.90	44.99
Days to maturity	128.00 (ICPL-87) – 164.50 (GAUT-85-7)	145.58 ± 1.49	6.70	7.00	91.49	19.21
Pods/plant	45.55 (GAUT-85-7) – 119.10 (GAUT-82-137)	81.27 ± 3.77	28.55	30.02	90.44	45.45
Pod length (cm)	3.24 (GAUT-83-18) – 5.00 (ICPL-312)	4.40 ± 0.07	9.55	10.80	91.11	0.83
Grains/pod	3.10 (GAUT-84-13) – 4.84 (GAUT-85-7)	3.80 ± 0.10	11.51	12.73	81.75	0.82
100-grain weight (g)	9.83 (GAUT-84-2) – 13.60 (GAUT-85-7)	11.86 ± 0.17	12.90	13.22	95.24	3.08
Drymatter/plant (g)	30.22 (ICPL-312) – 194.49 (GAUT-82-137)	93.32 ± 2.90	38.55	39.05	97.47	73.17
Harvest Index	19.40 (GAUT-82-91) – 52.41 (ICPL-312)	28.24 ± 1.98	26.89	30.33	78.57	13.87
Grain yield/plant (g)	21.60 (GAUT-82-56) – 58.77 (GAUT-82-137)	34.52 ± 2.63	25.12	29.37	73.18	15.28

TABLE 2

Genotypic (r_G) and phenotypic (r_P) correlation coefficients various characters in early maturing genotypes of pigeonpea.

Character		Branches/ plant	Plant height	Days to maturity	Pods/ plant	Pod length	Grains/ pod	100-grain weight	Drymatter/ plant	Harvest index	Grain yield/ plant
Days to flowering	r_G	0.472**	0.587**	0.763**	0.090	-0.359	-0.428	0.146	0.139	-0.230	-0.086
	r_P	0.355	0.498	0.635**	0.066	-0.314	-0.341	0.150	0.120	-0.200	-0.066
Branches/plant	r_G		0.207	0.289	0.504*	-0.319	-0.402	-0.027	0.544*	-0.227	0.454*
	r_P		0.171	0.194	0.416	-0.275	-0.271	-0.024	0.424	-0.116	0.348
Plant height	r_G			0.553*	0.182	-0.188	-0.241	0.126	0.250	-0.371	0.083
	r_P			0.528*	0.173	-0.175	-0.242	0.111	0.244	-0.319	0.069
Days to maturity	r_G				-0.065	-0.067	-0.184	0.367	0.173	-0.345	-0.079
	r_P				-0.064	-0.035	-0.177	0.339	0.171	-0.281	-0.041
Pods/plant	r_G					-0.406	-0.512*	-0.362	0.611**	-0.030	0.867**
	r_P					-0.382	-0.446	-0.310	0.564**	-0.046	0.669**
Pod length	r_G						0.782**	0.319	-0.307	0.469*	0.037
	r_P						0.687**	0.293	-0.286	0.415	0.065
Grains/pod	r_G							0.135	-0.489*	0.527*	-0.162
	r_P							0.127	-0.428	0.401	-0.138
100-grain weight	r_G								0.242	-0.231	0.154
	r_P								0.231	-0.201	0.136
Drymatter/plant	r_G									-0.676**	0.699**
	r_P									-0.628**	0.573**
Harvest index	r_G										0.001
	r_P										0.214

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

of characters as per the procedure outlined by Panse and Sukhatme (1961).

RESULTS AND DISCUSSION

Analysis of variance revealed highly significant differences among genotypes for all the characters which proved adequacy of material chosen for the study. Estimates of genetic parameters of variation, heritability and expected genetic advance are given in Table 1. Phenotypic range was higher for drymatter per plant, followed by pods per plant and plant height. Among the genotypes studied, GAUT 82-137 exhibited highest grain yield per plant alongwith branches per plant, pods per plant and drymatter per plant while days to maturity, grains per pod and 100-grain weight were highest for GAUT 85-7. The genotype ICPL 312 was found to be superior in pod length and harvest index. Among all the genotypes, ICPL 87 was earliest in maturity. The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were found higher for drymatter per plant followed by pods per plant, harvest index and yield per plant. In general, the values of GCV were close to corresponding values of PCV for almost all the characters indicating least influence of environment on the expression of the characters. Godawat *et al.* (1980) also found high GCV for grain yield per plant and harvest index.

The estimates of heritability were higher for all the characters studied. Similar results were also noted by Sidhu *et al.* (1985) and Raman Kapur *et al.* (1988). Genetic advance was higher for drymatter per plant, pods per plant height. Thus, these three traits had high heritability copuled with high genetic advance. Sidhu *et al.* (1985) also observed high heritability and high genetic advance for pods per plant. High heritability coupled with high genetic advance indicates that these traits are controlled by the additive gene action, hence, phenotypic selection could be effective for the improvement of such traits.

The genotypic and phenotypic correlation coefficients among various characters studied are presented in Table 2. The grain yield was significantly and positively correlated with pods per plant and drymatter per plant at both genotypic as well as phenotypic levels, while its correlation with branches per plant was significant and positive only at genotypic level. These results are in agreement with the earlier findings of Bhopalsingh and Pawankumar (1987) and Marekar and Nerkar (1987). Amongst the components, significant and positive association was observed between days to flowering and days to maturity, pod length and seeds per pod and pods per plant and drymatter per plant at both the levels, while correlation coefficient of days to flowering with branches per plant and plant height; harvest index with pod length and grains per pod; and branches per plant with pods per plant and drymatter per plant was found positive and significant only at genotypic level. Hence, pods per plant appeared to be the most important selection criterion for the grain yield in pigeonpea. Gartan (1990) also reported the similar findings in pigeonpea.

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Combining Ability for Vegetative Characters Over Environments in Upland Cotton (*G. hirsutum* L.)

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ABSTRACT

In an 8 x 8 diallel cross of *G. hirsutum* L. evaluated in three environments, additive type of gene action was preponderant for monopodial, sympodial branches and plant height. Interaction effects of GCA and SCA with locations were highly significant for all the traits. The variaces due to GCA were higher in magnitude than SCA for all the characters. H 777 was found to be a good general combiner for all the three characters. The cross combinations G.Cot.10 x DCI 108, Sharda x S. D. registered high SCA effects for monopodial braches while H 777 x S. D. and LRK 516 x B. N. recorded high SCA effects for sympodial branches and plant height, respectively.

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INTRODUCTION

The vegetative characters like plant height, number and nature of branching have special significance in a multiflowered crop like cotton. Sympodial branches are preferable to monopodial branches, as they induce early maturity.

The decision on the choice of a suitable breeding approach for the improvement of any character depends upon the genetic control of a character. As environment plays an important role in the expression of a character and greatly influences the combining ability estimates. The study in a single environment may not provide reliable information. Therefore, three environments created by different date of sowing. An attempt has been made to know the general and specific combining ability effects and their interactions with environment variation so that an appropriate breeding methodology could be developed.

MATERIALS AND METHODS

Eight parental lines, viz., G.Cot. 10, H. 777, Sharda, DCT-108, G. 2360, LRK-516, Bikaneri Narma (B. N.) and Surat Dwarf (S. D.) and their 28 F_1s were grown during *kharif*, 1993 at Junagadh in a randomized block design, replicated thrice in three dates of owing (end of May, end of June and end of July). Each entry had a single-row plot of ten plants, spaced at 90 x 60 cm. The normal agronomical and plant protection practices were followed from time-to-time. Observations were recorded for three characters viz., number of monopodia per plant, number of sympodia per plant and

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plant height on five randomly tagged plants in each replication in each environment. The data were analysed following Griffing (1956) as extended by Singh (1973, 1979) using Model-1, Method-2.

RESULTS AND DISCUSSION

The pooled analysis revealed significance of both general combining ability (GCA) and specific combining ability (SCA) variances for all the traits which indicated that both the variances were important in the inheritance of the characters. Significant GCA variances were also observed by Marani (1964), Bhandari (1980) for plant height and sympodial branches by Pavasia *et al.* (1990). It was further observed that, the variances due to environments were significant for all the characters. The interactions of GCA x environment were highly significant for all the characters. The magnitude of former was greater than latter in all the characters suggesting greater influence of environment on GCA variance than SCA variances.

GCA Effects

In order to incorporate various traits in true breeding varieties, crosses involving both parents showing high GCA effects would be very useful, as this will provide additive x additive type of gene effects. which are fixable, H. 777 and Sharda were the most parents, contributing favourable genes for number of monopodial branches, while for sympodial branches, H 777 and B. N. exhibited high GCA effects. For plant height, H. 777, B. N., G. Cot.-10 and Sharda were most useful.

Gupta and Singh (1974) and Singh *et al.* (1988) reported significant relationship the *per se* performance and GCA effects of the parents in upland cotton. In the present study, it was also found that most of parents having

TABLE 1

Anova for combining ability over environments in upland cotton.

Sources	*d.f.*	*Number of monopodia/ plant*	*M.S.S. Number of sympodia/ plant*	*Plant height*
GCA	7	1.344**	9.999**	445.918**
SCA	28	0.594**	8.642**	308.525**
ENV (E)	2	20.898**	87.201**	20507.593**
GCA x E	14	0.812**	8.484**	149.923**
SCA x E	56	0.602*	4.586**	110.099**
Error	210	0.042	0.371	10.341

*Significant at 5% level.

** Significant at 1% level.

TABLE 2

Estimates of general combining ability effects in upland cotton, pooled over environments.

Parents	*Monopodia/plant*		*Sympodia/plant*		*Plant height (cm))*	
	Mean	*gca effect*	*Mean*	*gca effect*	*Mean*	*gca effect*
G Cot. 10	1.89	0.05	18.67	-0.08	108.89	1.88**
H 777	2.44	0.24**	18.22	0.89**	110.56	4.26**
Sharda	1.89	0.25**	18.22	-0.01	101.11	1.82**
DCI-108	1.11	-0.23**	17.22	-0.33**	98.89	0.38
G. 2360	1.00	-0.37**	17.78	-0.57**	95.00	-2.79**
LRK-516	2.67	0.03	16.56	-0.11	92.78	-0.35
B. N.	1.56	0.00	16.78	0.83**	89.44	2.76**
S. D.	1.33	0.02	14.56	-0.63**	78.33	-7.96**
S.E. [gi] ±		0.0035		0.104		0.549
S.E. [gi - gi] ±		0.053		0.157		0.830

*Significant at 5% level.

** Significant at 1% level.

high mean performance had high GCA effects for monopodial and sympodial branches and plant height.

SCA effects

The best specific crosses for monopodial branches in order were G. Cot.-10 x DCI-108, Shrada x S. D., G. Cot.-10 x Sharda, G. Cot.-100 x G. 2360, H. 777 x B. N. and Sharda x DCI-108, while for the sympodial branches the best specific crosses were H. 777 x S. D., LRK-516 x B. N., H. 777 x LRK 516, H. 777 x DCI-108 and DCI-108 x B. N. Among these crosses, LRK-516 x B. N., H. 777 x S. D, and DCI-108 x B. N. also showed high SCA effects for plant height (Table 3). These hybrids involving high x high general combiners for these traits, represented additive x additive type of interactions. Such crosses may yield transgressive segregants in latter generations. Marked negative effects in crosses between good x good and good x average combiners could be attributed to the lack of coadaptation between favourable alleles of the parents

TABLE 3

Estimates of specific combining ability effects in upland cotton pooled over environment.

			Monopodia/ plant	*Sympodia/ plant*	*Plant height*
G. Cot. 10	x	H 777	– 0.54**	– 1.46**	– 10.72**
	x	Sharda	0.56**	– 0.23	1.72
	x	DCI-108	0.59**	– 0.79*	– 4.06
	x	G. 2360	0.51**	– 0.33	6.33**
	x	LRK-516	– 3.33**	0.43	– 3.89*
	x	B. N.	– 0.41	0.83**	5.22**
	X	S. D.	– 0.10	1.17**	8.72**
H 777	x	Sharda	0.26*	– 0.76**	– 1.78
	x	DCI-108	– 0.27**	1.56**	4.67**
	x	G. 2360	0.21*	0.92**	8.39**
	x	LRK-516	– 0.63**	1.79**	0.94
	x	B. N.	0.51**	– 0.93**	– 4.94**
	x	S. D.	0.38**	3.31**	13.00**
Sharda	x	DCI-108	0.50**	– 0.87**	– 1.22
	x	G. 2360	– 0.24*	0.60*	11.39**
	x	LRK-516	– 0.53**	1.35**	5.06**
	x	B. N.	– 0.06	0.97**	9.72**
	x	S. D.	0.59**	– 0.24	– 6.22**
DCI-108	x	G. 2360	0.01	1.83**	0.61
	x	LRK-516	– 0.06	– 0.88**	5.39**
	x	B. N.	0.20	1.52**	11.17**
	x	S.D.	– 0.27**	– 0.03	0.78
G-2360	x	LRK-516	– 0.13	– 2.75**	–13.11**
	x	B. N.	0.23	0.76*	4.89**
	x	S. D.	– 0.23*	– 0.78*	– 6.06**
LRK-516	x	B. N.	– 0.17	2.74**	18.56**
	x	S. D.	– 0.48**	1.09**	13.72**
B. N.	x	S. D.	0.40**	1.15**	1.17
SE (Sij) ±			0.107	0.319	1.684
SE (Sij-Sik) ±			0.159	0.472	2.491

* Significant at 5% probability level

** Significant at 1% probability level

B. N. = Bikaneri Narma

S. D. = Surat Dwarf.

involved. Whereas marked positive effects in crosses between poor x poor, average x average or average x poor combiners could be ascribed to better complementation between favourable alleles of the parents involved. Thus, combining ability study is a good guide for selection of parents for improvement of all these traits.

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Reaction of Pigeonpea Genotypes Against Improtant Insect Pests*

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ABSTRACT

Field screening of twenty genotypes of *Cajanus cajan* (L.) Millsp. in North Gujarat conditions during 1991-92 revealed that six early maturing genotypes *viz.*, ICPL 85014, ICPL 9008, ICPL 87, ICPL 151, ICPL 88027 and ICPL 9007 were highly promising against *Empoasca kerri* Pruthi as they gained 5 or less resistance rank. Only Guj. Tur-1 from early maturity group and GAUT 85035 and BDN 2 from mid-late maturity group showed remarkable resistance against all the three pod borers *viz.*, *Heliothis armigera* (Hubner), *Exelastis atomosa* Walsingham and *Melanagromyza obtusa* Malloch. The Hy. 3C was the only genotype found to be resistant against jassid as well as pod borers and as such may be included in breeding programme to develop a cultivar with multiple resistance against these pests.

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INTRODUCTION

Pigeonpea, *Cajanus cajan* (L.) Millsp. is attacked by several insect pests right from seedling stage till pod formation stage (Ghosh, 1981). Chemical pesticides alone does not help to suppress pests below economic injury level and therefore, Integrated Pest Management approach should be adopted. Host plant resistance is one of its important tools. Therefore varietal reaction of promising genotypes of pigeonpea was studied against aphid, *Aphis craccivora* Koch; jassid, *E kerri; H. armigera;* tur plume moth, *E. atomosa* and tur pod fly, *M. obtusa.*

MATERIALS AND METHODS

Field screening of ten early maturing and ten mid-late maturing genotypes of pigeonpea was done in Randomised Block Design at Puleses Research Station, GAU, Sardar Krushinagar, Dist. Banaskantha, during 1991-92. Each genotype was sown at 0.6 x 0.3 m spacing in 5 x 12 m plot (Gross). Pest populations were counted from five randomly tagged plants from each plot. Number of aphid nymphs and adults were counted from the whole plant, whereas, jassid nymphs were counted and recorded from three trifoliate leaves, one each from top, middle and bottom

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portion at a week interval. Observations on pod borers were recorded on the basis of damage symptoms of each borer separately, from 250 pods collected randomly from each plot at maturity stage. Data were statistically analysed after necessary transformation.

Cut off values were worked out by using the formulae suggested by Rana *et al.* (1975) and Bapat and Mote (1982) and presented in Table 2. However, neither of these satisfactorily served the purpose. The mean value of incidence or damage of a pest which was intermediate to the cut off value derived by using formulae suggested by earlier workers and as such adopted as cut off value. The genotypes which registered less damage or incidence of a pest than its mean values were designated as resistant (R) and those showing higher damage or incidence were grouped as susceptible (S).

The resistant genotype (R) with least value of damage or incidence of a pest was assigned numerical rank 1 and the remaining genotypes were ranked in ascending order of damage or pest population. Mean rank of resistance was worked out for only those genotypes which proved resistant against all the pod borers by addition of the resistance ranks secured by a genotype against different pod borers and then dividing the total rank value by 3. Combined rank of resistance against jassid as well as all pod borers was computed for the genotype that proved resistant against all these pests by summing up the ranks of resistance gained by a genotype and dividing the value so arrived by 4. Smaller value of mean rank combined rank of resistance indicated greater degree of resistance against the pests.

RESULTS AND DISCUSSION

The results presented in Table 1 showed that the pigeonpea genotypes differed significantly with respect to their reaction to all the pests except aphid. The aphid population varied from 5.2 to 6.2 (Av. 5.62) per plant. The jassid population was minimum in ICPL 85014 and maximum in GAUT 82-90. Most of the early maturing genotypes *viz.,* ICPL 87, ICPL 151, ICPL 85014, ICPL 9007 and ICPL 9001 proved resistant against jassid, whereas only Hy 3C and ICPH 8 from mid-late maturity group exhibited resistrance against this pest.

The results also indicated that *Heliothis* damage varied from 2.5 to 14.3 per cent (Av. 7.5%). Only four early maturing genotypes *viz.,* ICPL 88027, Guj. Tur-1, ICPL 85014 and ICPL 85-4, all except GAUT 88-18 and ICPH 8 in the mid-late maturity group proved resistant to *H. armigera.* Earlier to this, Bhosale and Navale (1983) reported that gram pod borer damage was more in early maturing genotypes than mid-late genotypes supporting the present findings.

The damage of *E. atomosa* ranged between 3.6 and 15.4 (av. 7.5) per cent in the pods. Two early maturing genotypes such as GAUT 85-4 and Guj. Tur 1 proved highly promising, whereas all the mid-late maturing genotypes except GAUT-88-18 showed resistance against tur plume moth. Among these, GAUT 85-35, GAUT 82-90 and BDN 2 were highly promising against this pod borer since they registered less than five per cent damage. Contrasting to this, Khokhar and Singh (1984) reported higher incidence of *E. atomosa* in late maturing varieties of pigeonpea.

TABLE 1

Reaction of pigeonpea genotypes to important insect pests.

Genotype	No. of sucking pests		Mean pod damage (%)		
	Aphid/plant[1]	Jassid/Leaf[2]	H. armigera	E. atomosa	M. obtusa
Early maturity group					
ICPL 87	5.67	8.33	11.1 (19.4)*	10.5 (18.7)	19.4 (23.6)
ICPL 151	5.20	8.33	9.6 (17.9)	5.5 (13.5)	16.3 (23.6)
ICPL 9001	5.33	10.73	12.2 (20.5)	11.7 (19.8)	31.8 (33.9)
ICPL 9006	5.33	9.73	12.1 (20.3)	8.8 (17.2)	29.9 (33.1)
ICPL 9007	5.73	8.93	11.8 (20.1)	13.0 (20.9)	19.9 (26.5)
ICPL 9008	5.47	8.20	14.3 (22.2)	15.4 (22.9)	21.9 (27.3)
ICPL 85014	5.53	8.00	7.2 (15.5)	8.1 (16.4)	12.3 (20.5)
ICPL 88027	6.00	8.80	6.4 (14.7)	8.9 (17.3)	9.8 (18.3)
Guj. tur 1	6.00	13.40	6.5 (14.3)	3.8 (11.0)	6.2 (14.4)
GAUT 85-4	5.33	12.07	7.3 (15.6)	3.6 (11.0)	17.4 (24.6)
Mid-late maturity group					
GAUT 82-58	5.60	12.60	2.5 (9.0)	7.1 (15.4)	34.9 (36.2)
GAUT 82-90	5.33	14.53	2.9 (9.7)	4.3 (12.0)	15.5 (23.1)
GAUT 85-19	6.00	12.67	4.2 (11.8)	7.2 (15.5)	13.5 (21.1)
GAUT 85-35	5.73	14.07	3.4 (10.5)	4.2 (11.7)	11.2 (19.5)
GAUT 88--18	5.47	12.40	8.5 (16.9)	9.9 (18.0)	9.1 (17.5)
GAUT 88-19	5.73	12.27	6.4 (14.6)	5.7 (13.7)	9.2 (17.6)
Hy 3C	5.67	9.87	5.8 (14.0)	6.7 (14.9)	12.6 (20.8)
ICPH 8	5.53	10.53	7.7 (16.1)	7.0 (15.3)	11.3 (19.6)
BDN 2	6.20	11.93	6.9 (15.2)	4.6 (12.4)	4.3 (11.9)
T 15-15	5.40	12.07	3.1 (11.0)	5.1 (13.1)	23.1 (26.4)
Mean	5.62	10.96	7.5 –	7.5 –	16.5 –
C. D. at 5%	NS	2.15	2.53	3.74	6.74
C. V. %	15.11	11.00	9.91	14.55	17.67

1. Based on four observations 2. Based on ten observations.

* Figures in parenthesis are sin $\sqrt{\ }$ per cent transformed values.

The pod fly damage varied from 4.3 to 34.9 (Av. 16.5) per cent (Table 1). Four early maturing genotypes *viz.*, Guj. Tur 1, ICPL 88027, ICPL 88014 and ICPL 151 and all except GAUT 82-58 and T 15-15 from mid-late maturity group exhibited resistance against pod fly damage. Patel and Patel (1983) reported Baroda 12 as resistant against tur pod fly.

The varietal differences for aphid were non-significant and as such resisance rank was assigned only for jassid and pod borers. It was clearly evident that only Guj Tur 1 from the early maturity group and six genotypes from mid-late maturity group viz., GAUT 85-35, BDN 2, GAUT 82-90, GAUT 88-19, Hy 3C and GAUT 85-19 exhibited resistance against all the three pod borers (Table 2).

TABLE 2

Ranking of pigeonpea genotypes for resistance against jassid and pod borers.

Genotypes	*Jassid*	*H. armigera*	*F. atomosa*	*M. obtusa*	*Rank for pod borers*	*Combined rank for jassid and pod borers*
Early maturity group						
ICPL 87	8.33 R_3	11.1$_S$	100.5$_S$	19.4$_S$	–	–
ICPL 151	8.33 R_3	9.6$_S$	5.5 R_6	16.3 R_{12}	–	–
ICPL 9001	1073 R_9	12.2$_S$	11.7$_S$	31.8$_S$	–	–
ICPL 9006	9.73 R_6	12.1$_S$	8.8$_S$	29.9$_S$	–	–
ICPL 9007	8.93 R_5	11.8$_S$	13.0$_S$	19.9$_S$	–	–
ICPL 9008	8.20 R_2	14.3$_S$	15.4$_S$	21.9$_S$	–	–
ICPL 85014	8.00 R_1	7.2 R_{10}	8.1$_S$	12.3 R_8	–	–
ICPL 88027	8.80 R_4	6.4 R_7	8.9$_S$	8.9 R_5	–	–
Guj Tur 1	13.40$_S$	6.5 R_8	3.8 R_2	6.2 R_2	4.0	–
GAUT 85-4	12.07$_S$	7.3 R_{11}	3.6 R_1	17.4$_S$	–	–
Mid-late maturity group						
GAUT 82-58	12.60$_S$	2.5 R_1	7.1 R_{10}	34.9$_S$	–	–
GAUT 82-90	14.53$_S$	2.9 R_2	4.3 R_3	15.5 R_{11}	5.3	–
GAUT 85-19	12.67$_S$	4.2 R_5	7.2 R_{11}	13.5 R_{10}	8.6	–
GAUT 85-35	14.07$_S$	3.4 R_4	4.2 R_{11}	11.2 R_6	4.0	–

1.	2.	3.	4.	5.	6.	7.
GAUT 88-18	12.40_S	8.5_S	9.9_S	9.1 R_1	–	–
GAUT 88-19	12.27_S	6.4 R_7	5.7 R_7	9.2 R_4	6.0	–
Hy 3C	9.87 R_7	5.9 R_6	6.7 R_8	12.6 R_9	7.6	7.3
ICPH 8	10.53 R_8	7.7_S	7.0 R_9	11.3 R_7	–	–
BDN 2	11.93_S	6.9 R_{10}	4.6 R_4	4.3 R_1	5.0	–
T 15-15	12.07_S	3.1 R_3	5.1 R_S	23.1_S	–	–
C. D.	2.09	3.45	3.26	8.43	–	–
Criterion for computing cut off value for grouping genotypes in resistant (R) and susceptible (S) category :						
1. Mean incidence/ damage	10.96	7.5	7.5	16.5	–	–
2. Mote and Bapat (1982) formula : Max. demage / 2	11.26 Min. damage	8.4 Min. damage	9.5	19.6	–	–
3. Rana *et al.* (1975) formula : Mean-S.D.	8.87	4.05	4.24	8.07	–	–
4. R = Resistant, S = Susceptible.						

From the overall results, it can be inferred that out of 20 genotypes screened, six early maturing genotypes and one midlate maturing genotypes proved highly promising against jassid as they recorded less than 10 jassid per leaf and gained 1 to 7 rank of resistance. On the other hand, only one genotype from early maturity group and two genotypes from mid-late maturity group showed remarkable degree of resistance against all the three pod borers as these recorded less than 4 mean rank of resistance against all the pod borers. Thus, ICPL 85014, ICPL 9008, ICPL 84, ICPL 151, ICPL 88027 and Hy 3C may be used as source of resistance against *E. kerri*. Similaly, GAUT 85-35 and BDN 2 may be incorporated in resistance breeding for pod borers. A single genotype Hy 3C showed combined resistance against jassid as well as three pod bores and as such it can be utilized for developing cultivar having multiple resistance against all these pests.

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Population Dynamics of Groundnut Leafminer in Relation to Weather Parameters

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ABSTRACT

Groundnut leafminer, *Aproaerema modicella* Deventer (Gelechiidae : Lepidoptera) is one of the major pest attacking groundnut in both *kharif* and summer seasons. Among the various weather factors, maximum temperature showed positive significant influence on leafminer infestation during summer season. In rainy season, relative humidity and rainy days showed significant positive correlation, while maximum temperature and sunshine hours exhibited significant negative correlation with leafminer population. Multiple regression studies indicated that an increase in one per cent relative humidity resulted in decrease of leafminer by 0.141 larvae per plant in summer, while in rainy season R^2 value (0.912) indicated that seven weather parameters jointly contributed 91.2 per cent of the total variation in the density of leafminer population per plant.

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INTRODUCTION

Groundnut is the important oilseeds crop of semi-arid tropics in general and Saurashtra region of Gujarat in particulars. It is attacked by number of pests from germination to harvest. Among the various pests, groundnut leafminer, *Aproaerema modicella* Deventer (Gelechiidae : Lepidoptera) is one of the major pest. The climatic factors play an important role in the biology of any pest. It is rather difficult to find a direct cause and effects relationship between any single factor and pest activity, because the impact of weather elements on pest is usually confounded (Parker, 1946; Banerjee, 1972). However, temerature, rainfall, relative humidity, sunshine hours and wind speed are the chief weather parameters that largely direct the activity of a given species of insect. The present study deals with the population dynamics of groundnut leafminer in relation to these abiotic factors.

MATERIALS AND METHODS

Field experiments were conducted at Sagdividi Farm, Gujarat Agricultural University, Junagadh to determine the influence of abiotic factors on the population dynamics of *A. modicella* in GG 4 variety of groundnut during summer 1996 and *kharif* 1996. The crop was grown in an isolated plot size of 10 x 4.5 m^2 with 45 cm spacing in both the seasons. All the recommended agronomic practices were followed. The plots of this experiment were

TABLE 1

Meteorological data recorded during *kharif* 1996 at Junagadh.

Week after sowing	*Standard week No.*	*Temperature °C*		*Relative humidity (%)*	*Mean bright sunshine hours*	*Rain fall (mm)*	*Rainy days*	*Wind speed km/hr*
		Maximum X1	*Minimum X2*	*X3*	*X4*	*X5*	*X6*	*X7*
	1996	*1996*	*1996*	1996	*1996*	*1996*	*1996*	*1996*
1.	25	32.4	25.6	81.5	2.8	205.6	2	17.6
2.	26	34.8	26.1	71.0	7.1	0.5	0	15.7
3	27	35.3	26.3	69.0	6.8	1.0	0	13.4
4	28	32.1	25.4	87.0	2.9	21.6	4	7.0
5	29	30.8	25.5	94.0	1.2	188.2	5	6.1
6	30	28.9	24.8	92.0	0.3	90.2	4	8.4
7	31	29.5	25.2	88.5	2.0	25.4	3	8.5
8	32	29.0	24.8	87.5	0.5	6.6	1	8.6
9	33	28.9	24.1	89.0	1.0	19.0	3	5.9
10	34	29.7	23.9	87.0	3.8	20.8	3	9.2
11	35	30.2	23.7	84.5	2.0	18.6	2	4.9
12	36	31.2	23.8	78.0	3.1	0.5	0	4.7
13	37	32.7	23.7	74.5	4.7	0.4	0	4.8
14	38	33.3	23.0	70.0	7.0	0.0	0	6.1
15	39	34.7	23.1	64.5	8.6	0.0	0	5.6

kept unsprayed throughout the season. Ten quadrates each consisting of 10 plants were observed at weekly interval to record incidence of leaf- miner, starting from first week after sowing (WAS) till harvest of the crop. To determine the leafminer population; larval counts were made and mean incidence was worked out. Meteorological data for different standard weeks were obtained from the agro-meteorological observatory of Junagadh (Table 1 and 2). In order to study the influence of different meteorological parameters on leafminer incidence, correlation and regression analysis were carried out.

TABLE 2

Meteorological data recorded during summer 1996 at Junagadh.

Week after sowing	*Stanard week No.*	*Temperature °C*		*Relative humidity (%)*	*Mean bright sunshine hours*	*Wind speed km/hr*
		Maximum	*Minimum*			
		X1	*X2*	*X3*	*X4*	*X5*
1	5	31.3	8.7	42.0	9.5	6.2
2	6	32.6	13.3	41.5	9.3	5.6
3	7	31.8	12.9	44.5	9.5	6.6
4	8	33.9	17.9	53.0	8.9	6.7
5	9	33.5	15.5	39.5	9.9	7.4
6	10	38.2	19.1	42.5	10.2	6.1
7	11	38.9	22.5	40.0	8.3	8.8
8	12	36.8	21.4	40.0	10.5	8.7
9	13.	38.1	19.4	41.0	10.6	8.9
10	14	39.1	20.2	41.5	10.8	7.8
11	15	39.3	20.6	47.5	10.1	7.8
12	16	38.9	22.7	56.5	10.0	8.5
13	17	38.7	24.1	60.0	10.7	9.8
14	18	39.8	23.6	52.0	10.6	9.7
15	19	39.5	24.6	63.5	10.4	10.6

RESULTS AND DISCUSSION

The results (Table 3) revealed that *A. modicella* began to infest the groundnut from 2nd WAS (1st week of February) during summer season and remained active up to the harvest. The population growth range from 0.3 to 4.9 larvae per plant with a mean population of 2.51 larvae per plant. Two distint peaks were observed during summer

TABLE 3

Weekly observation on seasonal incidence of *A. modicella* on groundnut.

Week after sowing	Standard week No.	Population per plant Summer Date	1996	Standard week	Mean larval Date	1996
1	5	28-1	0.0	25	22-6	0.4
2	6	5-2	0.3	26	29-6	1.8
3	7	12-2	1.2	27	6-7	2.6
4	8	19-2	1.8	28	13-7	7.7
5	9	26-2	2.2	29	20-7	8.9
6	10	5-3	3.3	30	27-7	8.7
7	11	12-3	4.1	31	3-8	6.4
8	12	19-3	3.9	32	10-8	5.1
9	13	26-3	4.8	33	17-8	4.8
10	14	2-4	4.9	34	24-8	3.7
11	15	9-4	4.0	35	31-8	2.1
12	16	16-4	3.5	36	7-9	1.9
13	17	23-4	1.8	37	14-9	1.2
14	18	30-4	1.0	38	21-9	0.8
15	19	7-5	0.8	39	28-9	0.6
Mean			2.51			3.78

season. The first peak (4.1 larvae/plant) was recorded during 2nd week of March (7th WAS) and the second (4.9 larvae/plant) was observed during 1st week of April i.e. 10th WAS. The results of *kharif* season indicated that infestation of leafminer commenced from 1st WAS (3rd week of June) and its incidence continued in a variable density till harvest of the crop. The population varied from 0.4 to 8.9 larvae per plant with an average of 3.78 larvae per plant. The peak activity of 8.9 larvae/plant was observed during 3rd week of July (5th WAS). The activity of leafminer was higher in *kharif* as compared to summer season.

Upadhyay (1984) and Vyas (1989) also reported that leafminer infestation remained active on groundnut throughout the crop period during both *kharif* and summer season under Junagadh condition on GAUG - 10 groundnut variety.

Correlation studies between *A. modicella* and weather parameters

The results (Table 4) indicated that during summer season significantly positive correlation of leafminer was observed only with maximum temperature. But other weather parameters were non- significantly associated.

TABLE 4

Correlation coefficient between larval population of *A. modicella* and weather parameters.

Season	Year	Temperature °C		Relative humidity (%)	Mean bright sunshine hours	Rainfall (mm)	Rainy days	Wind speed km/hr
		Maximum	Minimum					
		X1	X2	X3	X4	X5	X6	X7
Summer	1996	0.566*	0.435	-0.324	0.224	—	—	0.200
Kharif	1996	-0.588*	0.375	0.806*	-0.678*	0.312	0.846*	-0.195

* Significant at 0.05 level (r = 0.512) (n = 15).

TABLE 5

Multiple regression analysis between larval population of *A. modicella* and weather parameters.

Season Year	A value	Temperature °C		Relative humidity (%)	Mean bright sunshine hours	Rainfall (mm)	Rainy days	Wind speed km/hr	R^2
		Maximum	Minimum						
		X1	X2	X3	X4	X5	X6	X7	
Summer 1996	-2.842	0.251	0.202	-0.141*	0.119	—	—	-0.284	0.695
Kharif 1996	-08.095	-1.291	2.876*	-0.216	0.431	0.002	1.205	-0.524*	0.912

* Significant at 0.05 level.

** Significant at 0.01 level.

In *kharif*, relative humidity and rainy days showed significant positive correlation, while maximum temperature and sunshine hours exhibited significant negative correlation with leafminer population. Similar trend was observed in *kharif* season by Upadhyay (1984) and Vyas (1989).

Multiple regression studies of *A. modicela* with weather parameters

The data presented in Table 5 indicated that only relative humidity showed significant negative efffect on leafminer population during summer season. It indicated that an increase in one per cent relative humidity resulted in decrease of leafminer population by 0.141 larvae per plant. The R^2 value of 0.695 revealed that five weather parameters jointly contributed 69.5 per cent of the total variation in the density of leafminer per plant in summer groundnut.

In *kharif* season, the partial regression coefficient of leafminer population on minimum temperature showed significant positive effect, whereas wind speed exhibited significant negative correlation. The R^2 value (0.912) indicated that seven weather parameters jointly contributed 91.2 per cent of the total variation in the density of leafminer population per plant in *kharif* groundnut. Vyas (1989) also observed highly significant positive effect with relative humidity, while significant negative effects with minimum temperature on leafminer population during *kharif*.

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Life Table of Gram Podborer, *Helicoverpa armigera* (Hubner) on Lucerne*

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ABSTRACT

Studies on the intrinsic rate of multiplication of *Helicoverpa armigera* (Hubner) were carried out at a constant temperature of 26 + 1 °C on lucerne. The maximum duration of egg, larva and pupa were observed 3, 17 and 15 days, respectively. The net reproductive rate (Ro) representing the total female births was 206.35. The population increased with an infinitesimal rate (rm) of 0.1272 and finite rate (λ) 1.136 females per female per day. The mean generation time (TC) was 42.34 days. It was estimated that on reaching stable age distribution, the population of *H. armigera* would comprise 41.34 per cent eggs, 52.67 per cent larvae, 5.37 per cent pupae and 0.63 per cent adults. The expectation of further life at the age interval of 10 to 15 days was reduced to 13.29 days from 16.54 days in the beginning.

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INTRODUCTION

The gram podborer, *Helicoverpa armigera* (Hubner) Hardwick is a polyphagous pest causing severe damage to many cultivated crops. Life table is a concise summary of certain vital statistics of insect population. It is a useful technique in the study of population dynamics and provides a formate for recording and accounting for all population changes in the life cycle of a species in its natural environment. The present paper deals with the rate of multiplication in the population of *H. armigera* on lucerne.

The pest survive on lucerne during summer season in Gujarat and information is lacking on population buildup of this pest in next generation when reared on lucerne therefore, present study was undertaken.

MATERIALS AND METHODS

In order to construct the facundity life-table of females, laboratory culture of *H. armigera* reared on lucerne for two consecutive generations at a constant temperature of 26 + 1°C., Five adult pairs were released for egg laying in 45 x 45 x 60 cm wooden cages. Eggs laid on white muslin cloth were collected by wet camel hair brush and 100 eggs were kept for hatching in the batches of 10 each. Immediately after hatching, the

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larvae were transferred on lucerne leaves kept in plastic containers (5.0 x 5.5 cm). Fresh food was provided daily in the morning. Observations on hatching, larval development, formation of purpae, successful adult emergence and fecundity were recorded daily which provide the values for the life-table (1x). Age specific mortality in different developmental stages like eggs, larvae, pupae and adults were recorded. With a view to determine the age specific facundity of females, total number of adults emerged on the same day were caged for oviposition. The fecundity of the females on subsequent days were noted till all the females died. The number of eggs laid per female was divided by two (sex ratio 1:1) to get the number of female births (mx). Life tables were constructed according to the method of Birch (1948). Howe (1953) and Atwal and Bains (1974). Stable age distribution (per cent distribution of various stages) was worked out by observing the population schedule of birth rate and death rate (mx and lx) when grown in limited space. Life expectancy was computed by using the method reported by Deevey (1947) and Atwal and Bains (1974).

RESULTS AND DISCUSSION

The maximum duration of egg, larva and pupa were recorded 3, 17 and 15 days, respectively. The number that survived from egg to adult emergence was 78 individuals (Table 1). The data on life fecundity and age specific fecundity are presented in Table-2 and Fig. 1. It is evident from the data that first female mortality occurred on 9th day after emergence which increased on subsequent days. The net reproductive rate which

TABLE 1

Survival of different stages of *H. armigera* during development on lucerne.

No. of eggs	*Numbers survived*		
	Egg stage (0 to 3 days)	*Larval stage (4 to 20 days)*	*Pupal stage (21 to 35 days)*
10	10	9	8
10	10	9	8
10	10	8	7
10	10	9	8
10	10	9	8
10	10	9	8
10	10	9	8
10	10	9	8
10	10	8	7
10	10	9	8
100	100	88	78

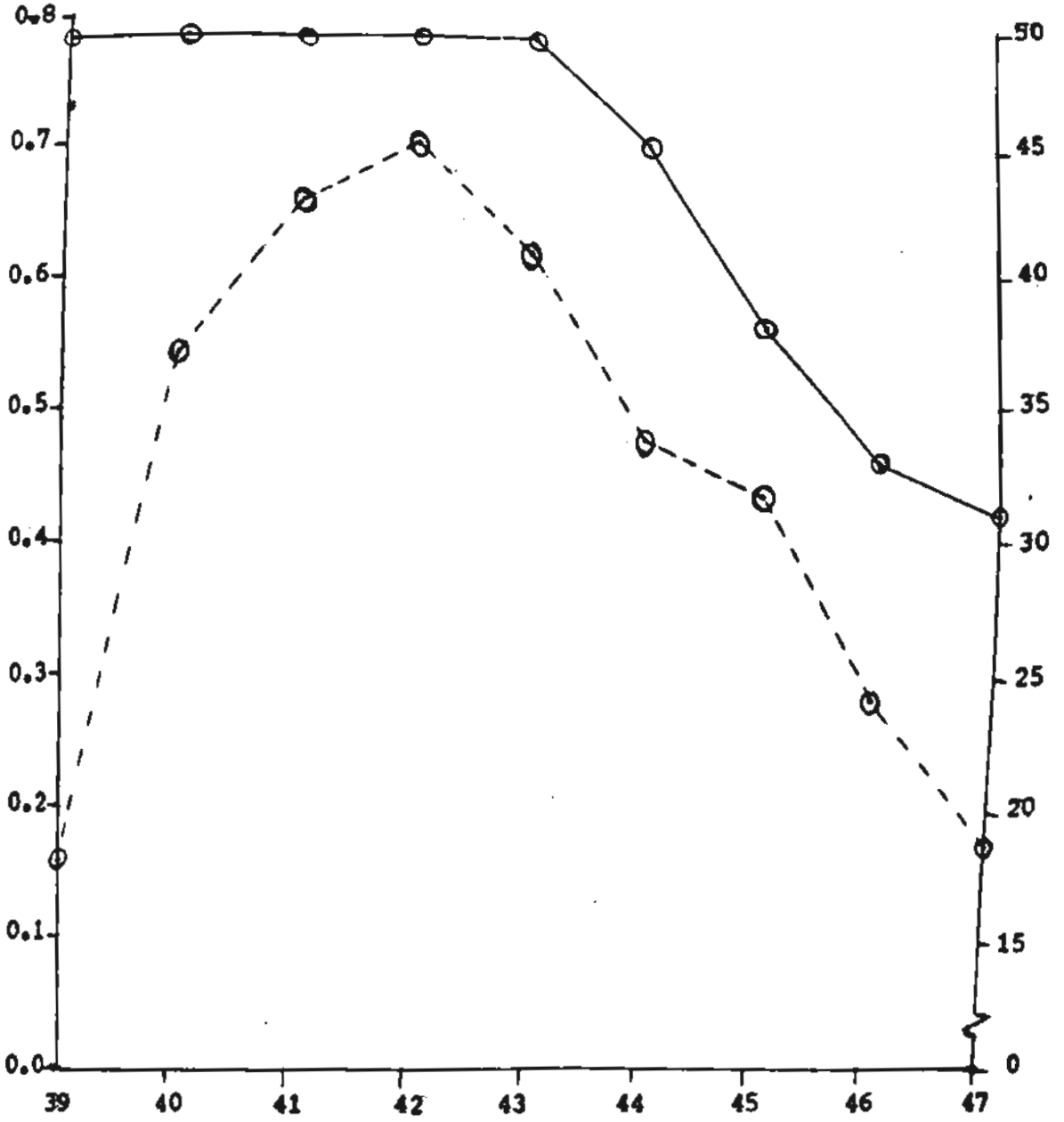

Fig. 1 : Daily age-specific survival and fecundity of *H. armigera* on lucerne.

TABLE 2

Life table (for female) and age-specific fecundity for *H. armigera* on lucerne.

Pivotal age in days x	*Survival of female at different age interval* lx	*Age schedule for female birth* mx	lxmx	xlxmx
0 – 35	0.78	–	–	Immature
36	0.78	–	0.78	28.08
37	0.78	–	0.78	28.86
38	0.78	–	0.78	29.64
39	0.78	18.00	14.08	547.56
40	0.78	37.37	29.15	1165.94
41	0.78	42.69	33.30	1365.23
42	0.78	45.09	35.17	1477.15
43	0.78	40.89	31.89	1371.45
44	0.70	33.85	23.70	1042.58
45	0.56	31.72	17.76	799.34
46	0.46	24.17	11.12	511.52
47	0.42	18.75	7.88	370.13
48	0.40	0.00	0.00	0.00

$\sum$ lxmx = 206.35 $\sum$ xlxmx = 8737.48

indicates total female births per generation was recorded to the tune of 206.35. The oviposition period lasted for 9th days and reached a peak (mx = 45.09 females per female per day) on the 42nd day of pivotal age and then declined slowly.

The mean time required to complete the generation (TC) was 41.90 days (Table-3). The innate capacity (rm) and finite rate (λ) for increase in numbers was calculated 0.1259 and 1.136 females per female per day, respectively. The population was capable to multiply 2.436 times per week. The hypothetical female population in F_2 generation was 42733.16.

TABLE 3

Mean length of generation, innate capacity for increase in numbers and finite rate of increase in numbers of *H. armigera* on lucerne.

Sr. No.	*Population growth statistics*	*Formula*	*Calculated values*
1.	Net reproductive rate	$Ro = \sum lxmx$	206.35
2.	Mean length of generation	$TC = \frac{\sum x lxmx}{Ro}$	42.34 days
3.	Innate capacity for increase in numbers	$rm = \frac{\log_e Ro}{TC}$	0.1259 Females/ female/day
4.	Arbitarary 'rm' (rc)	0.12 and 0.13	
5.	Corrected 'rm'	$\sum e^{7-rmx} lxmx$	0.1272 Females/ female/ day
6.	Corrected generation time	$T = \frac{\log_e Ro}{rm}$	41.90 days
7.	Finite rate of increase in number	$= \text{antilig } e^{rm}$	1.136 Females/ female/ day
8.	Weekly multiplication of population	$(\lambda)7$	2.436 Times
9.	Hypothetical F_2	$(Ro)^7$	42733.16

The contribution of different developmental stages towards the stable age-distribution was determined and results obtained are presented in Table-4. It is seen that on reaching the stable age-distribution, the population in its various stages viz., egg, larva, pupa and adult contributed to the tune of 41.34, 52.67, 5.37 and 0.63 per cent, respectively.

The data on life expectancy (Table-5) indicated that the life expectancy of newly deposited eggs was only 16.54 days. The mortality rate was comparatively high at the age of 10 to 15 days, when the expectancy of life was reduced to 13.29 days from 16.54 days in the beginning.

TABLE 4

Age-specific distribution of *H. armigera* on lucerne (rm = 0.1272).

Pivotal age (days) x	*Lx*	$e^{-rm\ (x\ +\ 1)}$	$Lx.e^{-rm\ (x\ +\ 1)}$	*Per cent contribution*
1.	*2.*	*3.*	*4.*	*5.*
0	1.00	0.8806	0.8806	12.3822
1	1.00	0.7754	0.7754	10.9030
2	1.00	0.6828	0.6828	9.6009
3	1.00	0.6012	0.6012	8.4536
				41.3397
4	1.00	0.5294	0.5294	7.4440
5	0.99	0.4662	0.4615	6.4892
6	0.98	0.4105	0.4023	5.6568
7	0.98	0.3615	0.3542	4.9805
8	0.96	0.3183	0.3056	4.2971
9	0.95	0.2803	0.2663	3.7445
10	0.95	0.2468	0.2345	3.2973
11	0.95	0.2173	0.2064	2.9022
12	0.95	0.1914	0.1818	2.5563
13	0.93	0.1685	0.1567	2.2033
14	0.90	0.1484	0.1335	1.8772
15	0.88	0.1307	0.1150	1.6170
16	0.88	0.1150	0.1012	1.4230
17	0.88	0.1013	0.0891	1.2528
18	0.88	0.0892	0.0785	1.1038
19	0.88	0.0785	0.0691	0.9716
20	0.88	0.0692	0.0609	0.8563
				52.6729
21	0.88	0.0609	0.0536	0.7537

1.	2.	3.	4.	5.
22	0.88	0.0536	0.0472	0.6637
23	0.88	0.0472	0.0416	0.5849
24	0.88	0.0416	0.0366	0.5146
25	0.88	0.0366	0.0322	0.4528
26	0.88	0.0322	0.0284	0.3993
27	0.88	0.0284	0.0250	0.3515
28	0.88	0.0250	0.0220	0.3093
29	0.88	0.0220	0.0194	0.2728
30	0.88	0.0192	0.0171	0.2404
31	0.88	0.0171	0.0150	0.2109
32	0.88	0.0150	0.0132	0.1856
33	0.88	0.0132	0.0116	0.1631
34	0.88	0.0117	0.0103	0.1448
35	0.83	0.0103	0.0085	0.1195
				5.3669
36	0.78	0.0090	0.0070	0.0984
37	0.78	0.0080	0.0062	0.0872
38	0.78	0.0070	0.0055	0.0773
39	0.78	0.0062	0.0048	0.0675
40	0.78	0.0054	0.0042	0.0591
41	0.78	0.0048	0.0038	0.0534
42	0.78	0.0042	0.0033	0.0464
43	0.78	0.0037	0.0029	0.0408
44	0.70	0.0033	0.0023	0.0323
45	0.56	0.0029	0.0016	0.0225
46	0.46	0.0025	0.0012	0.0169
47	0.42	0.0022	0.0009	0.0127
48	0.40	0.0020	0.0008	0.0112
				0.6257

TABLE 5

Life table for computing life expectancy of *H. armigera* reared on lucerne.

Pivotal age (days) (x)	Numbers surviving to the beginning of age interval (lx)	Number dying during x (dx)	Mortality rate per hundred alive at beginning of age interval $\frac{(dx.100)}{lx}$ (100 qx)	Alive between age x and x + 1 $\frac{l\,x + (l\,x + 1)}{2}$ (Lx)	Numbers of the individual's life days beyond x (Tx)	Expectation of further life $\frac{Tx}{lX} \times 2$ (ex)
0 — 5	100	2	2.00	99.00	827.00	16.54
5 — 10	98	3	3.06	96.50	728.00	14.86
10 — 15	95	7	7.37	91.50	631.50	13.29
15 — 20	88	0	0.00	88.00	540.00	12.27
20 — 25	88	0	0.00	88.00	452.00	10.27
25 — 30	88	0	0.00	88.00	364.00	8.27
30 — 35	88	0	0.00	83.00	276.00	6.27
35 — 40	78	10	12.82	78.00	193.00	4.95
40 — 45	78	22	28.21	67.00	115.00	2.95
45 — 50	56	16	28.57	48.00	48.00	1.71

Similar type of life table studies of *H. armigera* have been computed on lucerne and it was found that net reproductive rate was 185.69, whereas mean length of generation was 46.12 days. The innate capacity for increase in numbers and finite rate of increase were 0.1132 and 1.12 females per female per days (Bilapate *et al.* 1977). These observations are more or less similar to the present findings.

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Biology of Fruit Fly, *Dacus ciliatus* Loew (Tephritidae : Diptera) Infesting Little Gourd, *Coccinia indica* W. & A*

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ABSTRACT

Studies were conducted on the bionomics of *Dacus ciliatus* Loew using little gourd as host in the laboratory of Department of Entomology, N. M. College of Agriculture, GAU, Navsari during Aug., '92 to May '93 (Aug.-Sept., Dec-Jan., April- May). The life history, brief description of various stages, sex difference and sex ratio are given. There are three larval instars. The larval period was 4.40 ± 0.55, 6.80 ± 0.89 and 3.75 ± 0.95 days while, pupal period was 9.03 ± 0.82, 13.50 ± 1.13 and 7.05 ± 0.78 days during August-September, December-January and April-May, respectively. The average longevity of male was 13.41 ± 5.03, 24.80 ± 8.67 and 12.15 ± 3.84 days whereas that of female was 15.12 ± 6.27, 26.76 ± 10.05 and 14.35 ± 4.35 days. The duration of total life span (egg to death of adult) for male was 19.05 ± 1.43, 31.58 ± 4.07 and 16.50 ± 1.13 days while, for female was 19.98 ± 2.00, 33.84 ± 4.82 and 18.48 ± 1.79 days during August-September, December-January and April-May, respectively. The average number of eggs laid by female was 25.79 ± 13.30, 19.33 ± 12.28 and 35.32 ± 16.94. The hatching percentage of eggs was 85.50 ± 4.60, 83.02 ± 3.46 and 88.20 ± 6.19. The preoviposition, oviposition and post-oviposition periods were 6.96 ± 1.74, 4.87 ± 2.28 and 4.52 ± 1.68 days, 8.00 ± 2.05, 5.29 ± 2.28 and 4.38 ± 2.44 days and 4.53 ± 1.17, 3.89 ± 1.41 and 3.58 ± 1.74 days, respectively. The sex ratio of male : female was 1 : 0.98.

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INTRODUCTION

Among the different gourds, little gourd, *C. indica* is widely cultivated in central America, China, Ceylon, India, Malaya & Tropical Africa as a vegetable. Little gourd has its own importance as a human food because of good source of nutritional components. The roots, stems and leaves are also used to cure skin diseases, bronchitis and diabetes.

Little gourd is attacked by a number of insect pests during different growth stage of crop. Out of which, fruit fly, *D. ciliatus* has been observed to cause serious damage to little gourd fruits. The female fruit flies puncture the soft and tender fruits of *C. indica* with their stout and hard ovipositor and lay eggs below the epidermis of fruits. The maggots feed inside on the pulp of fruits. The punctures may also serve as a site of secondary infection by pathogens causing rotting and premature falling. The damage was estimated to the tune of 3 to 100 per cent on *C. Indica* in Gujarat (Patel, 1976). Keeping this in view, the

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bionomics of *D. ciliatus* was carried out at Department of Entomology, N. M. College of Agriculture, Navsari during Aug. '92 to May '93.

MATERIALS AND METHODS

Initial culture of fruit fly, *D. ciliatus* was raised by collecting infested fruits of *C. indica*. The infested fruits were kept vertically in the rearing jars (11 x 15 cm) on a 5 cm, thick layer of Sieved moist soil, at bottom to facilitate pupation. Top of the jar was covered with clean white muslin cloth to prevent the escape of maggots. When, all the full grown maggots entered the soil for pupation, the rotten fruits were removed from the jar. After 4 to 5 days, the soil in the jar was sieved to collect pupae. The pupae were then transferred in clean glass tubes (1.5 x 7.5 cm), individually. The tubes were plugged with cotton lint to prevent the escaping of adult flies when emerged. To raise the laboratory culture, freshly emerged adults (males and females) were confined in round iron bar cage (30 x 45 cm) lined with white muslin bag. Top of the cloth bag was kept open which was tightened with rubber band after releasing adults in the cage.

Enzymatic yeast hydrolysate was provided as a food to the adults by smearing 1 gram of it on the lid (4 x 1 cm) of plastic bottle and placing the lid at the bottom of the iron cage. The tender unifested fruits of little gourd were hung inside the iron cage with thread for oviposition. Fresh fruits were replaced daily for oviposition and food was also given every day in the morning till the adults died. The fruit with eggs, laid on it, was kept in glass jar with the layer of soil for further studies.

The studies on the colour, shape, size and periods of eggs, Maggots, pupa and adults were studied. The preoviposition, oviposition and post-oviposition periods, sex ratio and longevity of adults were also studied.

RESULTS AND DISCUSSION

Egg

Freshly laid eggs were shiny, translucent and whitish in colour. They were cylindrical in shape, slightly curved and narrow at one end. The average length and breadth of eggs was 0.98 ± 0.03 and 0.20 ± 0.02 mm, respectively (Table 1).

Maggot

The maggot passed through three instars. Freshly emerged first instar maggots were translucent and white in colour while second instar maggots were translucent, elongate, ellipsoidal in shape and creamy white or pale white in colour with pointed cephalic end and blunt at posterior end and had peculiar habit of jumping. The first, second and third instar maggots were measured on an average 1.31 ± 0.22, 4.51 ± 0.28 and 8.27 ± 0 .49 mm in length and 0.31 ± 0.05, 1.26 ± 0.12 and 2.03 ± 0.13 mm in breadth, respectively, (Table 1). The average duration of first, second and third instar maggots was 1.75 ± 0.50, 1.33 ± 0.56 and 2.33 ± 0.58 days, 2.16 ± 0.41, 2.33 ± 0.52 and 3.25 ± 0.50 days and 1.25 ± 0.50, 1.33 ± 0.58 and 1.50 ± 0.58 days at the temperatures of 29.78 ± 1.94°C, 26.60 ± 145°C and 32.34 ± 1.24 °C and relative humidity of 83.35 ± 3.27, 65.86 ± 6.84 and 77.43 ± 2.69 per cent respectively (Table 2).

TABLE 1

Measurement of different stages of *D. ciliatus*.

Stage	*Number observed*	*Length (mm)*			*Breadth (mm)*		
		Min.	*Max.*	*Av. ± S.D.*	*Min.*	*Max.*	*Av. ± S.D.*
Egg	50	0.94	1.03	0.98 ± 0.03	0.17	0.23	0.20 ± 0.02
Maggot							
I instar	50	1.00	1.72	1.31 ± 0.22	0.22	0.39	0.31 ± 0.05
II instar	50	4.06	4.94	4.51 ± 0.28	1.06	1.44	1.26 ± 0.12
III instar	50	7.50	9.25	8.27 ± 0.49	1.81	2.19	2.03 ± 0.13
Prepupa	50	6.50	7.31	6.97 ± 0.28	2.06	2.44	2.25 ± 0.13
Pupa	50	3.75	5.44	4.68 ± 0.44	1.50	2.38	1.95 ± 0.27
Adult							
Male	25	6.75	7.81	7.32 ± 0.35	9.25	10.31	9.82 ± 0.35
Female	25	7.81	8.93	8.40 ± 0.35	9.56	10.68	10.35 ± 0.35

TABLE 2

Life cycle of *D. ciliatus* on little gourd.

Sr. No.	*Particulars*	*Aug.-Sept., '02 Range*	*Dec.-Jan. '92-93 Range*	*Apri. May '93 Range*
1.	Egg period (days)	2-3 (2.50 ± 0.55)	2-5 (3.30 ± 0.95)	1-2 (1.50 ± 0.55)
2.	Maggot period (days)			
	I instar	1-2 (1.75 ± 0.50)	2–3 (2.16 ± 0.41)	1-2 (1.25 ± 0.50)
	II instar	1-2 (2.33 ± 0.58)	2-3 (2.33 ± 0.52)	1-2 (1.33 ± 0.58)
	III instar	2-3 (2.33 ± 0.58)	3-4 (3.25 ± 0.50)	1-2 (1.50 ± 0.58)
	Total maggot period	4-5 (4.40 ± 0.55)	6-8 (6.80 ± 0.89)	3-5 (3.75 ± 0.95)
3.	Prepupal period (days)	0.5-1 (0.75 ± 0.27)	1-2 (1.50 ± 0.55)	0.5-1 (0.63 ± 0.25)
4.	Pupal period (days)	8-10 (9.03 ± 0.82)	12-15 (13.50 ± 1.13)	6-8 (7.05 ± 0.78)
5.	Adult period (days)			
	Male	6-24 (13.41 ± 5.03)	7-38 (24.80 ± 8.67)	5-18 (12.15 ± 3.84)
	Female	6-25 (15.12 ± 6.27)	6-42 (26.76 ± 10.05)	6-21 (14.35 ± 4.35)
6.	Total life period (days)			
	Male	17-21 (19.05 ± 1.43)	25-38 (31.58 ± 4.07)	15-18 (16.50 ± 1.13)
	Female	17-23 (19.98 ± 2.00)	26-42 (33.84 ± 4.82)	16-21 (18.48 ± 1.79)
7.	Temperature (°C)	27.00 – 32.00 (29.78 ± 1.94)	22.50 – 29.00 (26.60 ± 1.45)	30.00 – 34.00 (32.34 ± 1.24)
8.	Relative humidity (%)	78 – 86 (83.35 ± 3.27)	55–83 (65.86 ± 6.84)	73 -79 (77.43 ± 2.69)

Figures in parenthses are average values ± S.D.

Prepupa

In this stage, the full grown maggot was slightly bent in position, became sluggish and stopped feeding. The size of prepupa was measured on an average 6.97 ± 0.28 mm in length and 2.25 ± 0.13 mm in breadth (Table 1). The average duration of prepupal stage was 0.75 ± 0.27, 1.50 ± 0.55 and 0.63 ± 0.25 days during August-September, December-January and April-May, respectively (Table 2).

Pupa

The freshly formed pupa was of cream coloured which turned to dark yellow within 4-5 hours. Lateron, the colour changed to brownish to ochraceous. The pupae were barrel shaped with single black dot on posterior portion. The average length and breadth of pupae were 4.68 ± 0.44 and 1.95 ± 0.27 mm, respectively (Table 1). The average duration of pupal stage was 9.03 ± 0.82, 13.50 ± 1.13 and 7.05 ± 0.78 days at an average temperatures of 29.78 ± 1.94, 26.60 ± 1.45 and 32.34 ± 1.24°C and relative humidity of 83.35 ± 3.27, 65.86 ± 6.84 and 77.43 ± 2.69 per cent respectively (Table 2).

Adult

The maximum number of adults were found to be emerged from the pupae between 8.00 to 10.00 a.m. The eclosion time varied from 3 to 40 (Av. 16.52 ± 7.75) minutes. The freshly emerged adult flies were less active, pale yellow with wings attached to body. The files attained its normal bright brown or ferrugineous brown colour after 2-3 hours. Two lemon yellow coloured markings were observed either side on dorsum of prothorax, one at the anterior side and other at posterior side. Another large sized marking of same colour was observed at mid dorsum of metathorax. Two round dark brown spots were present on dorsal side of fourth abdominal segment. The average length and breadth (with expanded wings) of male was 7.32 ± 0.35 and 9.82 ± 0.35 mm, respectively. Whereas, the female measured on an average 8.40 ± 0.35 mm in length and 10.35 ± 0.35 mm breadth (with expanded wings) indicating the males being smaller in size than females (Table 1).

The average number of eggs laid by a female was 25.79 ± 13.30, 19.33 ± 12.28 and 35.32 ± 16.94 at an average temperatures of 28.75 ± 1.83, 26.61 ± 1.42 and 32.63 ± 1.30°C and relative humidity of 83.90 ± 2.13, 67.78 ± 5.50 and 76.13 ± 6.62 per cent, respectively (Table 3). The fecundity was lower with lower temperature and vice versa.

The hatching percentage of eggs was 85.50 ± 4.60, 83.02 ± 3.46 and 88.20 ± 6.19 at an average fluctuating temperatures of 28.56 ± 1.86, 26.31 ± 1.66 and 32.54 ± 1.22°C and relative humidity of 83.75 ± 2.38, 70.50 ± 7.46 and 77.43 ± 5.93 per cent, respectively (Table 3).

The average longevity of male was 13.41 ± 5.03, 24.80 ± 8.67 and 12.15 ± 3.84 days whereas, that of female was 15.12 ± 6.27, 26.76 ± 10.05 and 14.35 ± 4.15 days at an average temperatures of 29.78 ± 1.94, 26.60 ± 1.45 and 32.34 ± 1.24°C and relative humidity of 83.35 ± 3.27, 65.86 ± 6.84 and 77.43 ± 2.69 per cent respectively (Table 2).

The female fruit fly preferred to lay eggs in proximal half part of the fruit at an average depth of 1.98 ± 0.45 mm.

TABLE 3

Pre oviposition, oviposition, post-oviposition periods, fecundity and hatching percentage of fruit fly, *D. ciliatus*.

Sr. No.	*Particulars*	*Temperature (°C)*	*Relative humidity (%)*
1.	Preoviposition period (days)	29.29 ± 1.92	83.47 ± 2.84
	6.96 ± 1.74	26.02 ± 1.79	64.78 ± 6.82
	8.00 ± 2.05	32.88 ± 1.82	73.92 ± 5.80
	4.53 ± 1.17		
2.	Oviposition period (days)	29.29 ± 1.92	83.47 ± 2.84
	4.87 ± 2.28	26.02 ± 1.79	64.78 ± 6.82
	5.29 ± 2.28	32.88 ± 1.82	73.92 ± 5.80
	3.89 ± 1.41		
3.	Postoviposition period (days)		
	4.52 ± 1.68	29.29 ± 1.92	83.47 ± 2.84
	4.38 ± 2.44	26.02 ± 1.79	64.78 ± 6.82
	3.58 ± 1.74	32.88 ± 1.82	73.92 ± 5.80
4.	Fecundity		
	25.79 ± 13.30	28.75 ± 1.83	83.90 ± 2.13
	19.33 ± 12.28	26.61 ± 1.42	67.78 ± 5.50
	35.32 ± 16.94	32.63 ± 1.30	76.13 ± 6.62
5.	Hatching percentage		
	85.50 ± 4.60	28.56 ± 1.86	83.75 ± 2.38
	83.02 ± 3.46	26.31 ± 1.66	70.50 ± 7.46
	88.20 ± 6.19	32.54 ± 1.22	77.43 ± 5.93

Duration of entire life span

The entire life span of *D. cillatus* from egg to the death of adult male was completed within on an average of 19.05 ± 1.43, 31.58 ± 4.07 and 16.50 ± 1.13 days whereas, that of female completed within on an average of 19.98 ± 2.00, 33.84 ± 4.82 and 18.48 ± 1.79 days at an average temperatures of 29.78 ± 1.94, 26.60 ± 1.45 and 32.34 ± 1.24°C and relative humidity of 83.35 ± 3.27, 65.86 ± 6.84 and 77.43 ± 2.69 per cent, respectively (Table 2).

Pre oviposition, oviposition and post-oviposition period

The average pre oviposition, oviposition and post oviposition periods were 6.96 ± 1.74, 4.87 ± 2.28 and 4.52 ± 1.68 days, 8.00 ± 2.05, 5.29 ± 2.28 and 4.38 ± 2.44 days and 4.53 ± 1.17, 3.89 ± 1.41 and 3.58 ± 1.74 days at temperatures of 29.29 ± 1.92, 26.02 ± 1.79 and 32.88 ± 1.82°C and relative humidity of 83.47 ± 2.84, 64.78 ± 6.82 and 73.92 ± 5.80 per cent, respectively (Table 3).

Sex ratio

The adults emerged from pupae were critically examined and sexed by observed presence or obsence of pointed ovipositor. Out of 399 adults observed, 202 were males and 197 were females indicating preponderance of male population over female. Thus, the sex ratio of male : female was found to be 1:0.98.

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Comparative Evaluation of Bio-Agents and Seed Dressing Fungicides Against *Aspergillus niger* Causing Collar Rot of Groundnut

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ABSTRACT

Nine biocontrol agents and four seed dressing fungicides were evaluated against collar rot (*Aspergillus niger* Van Teighem.) of groundnut under inoculated conditions for three seasons. The seed treatments of thiram, carbendazim mancozeb and captan each at @ 3.0 g/kg seed were found effective in controlling disease and improving the yield. The maximum net profit and ICBR were recorded in the treatment of thiram. Carbendazim and mancozeb were also found economical for disease control. Among biocontrol agents, *Bacillus* spp. *A. Pseudomonas fluorescens* and *Trichoderma harzianum* were found moderately effective as compared to fungicides.

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INTRODUCTION

Collar-rot (*Aspergillus niger* Van Teighem) is one of the important diseases, which causes heavy loss in pod and fodder yield of groundnut. The most of the cultivars of groundnut are susceptible to this disease. The disease is manifested in pre and post emergence phases. Many seed dressing fungicides are reported to be effective against collar rot of groundnut (Gangopadhyay, *et al.*, 1996, Karthikeyan, 1996) but limited work has been done on successful exploitation of biocontrol agents on management of the disease. It is highly needed to keep the disease below economic threshold level without damaging the agro-ecosystem in soil (Papavizas and Lewis, 1988). Keeping this in view, a study was initiated to investigate into the comparative efficacy of biocontrol agents and seed dressing fungicides against *Aspergillus niger* causing collar rot of groundnut.

MATERIALS AND METHODS

A field trial was conducted during *kharif* 1993, 1995 and 1996 at College Farm, Junagadh to evaluate antagonists and fungicides against collar rot disease. Experiment was laid out adopting randomized block design and replicated three times. The plot size was 3 x 2.7 m keeping 45 cm space between rows and 5 cm between the plants. The groundnut variety GG-2 was used.

Nine biocontrol agents viz., *Trichoderma harzianum T. viride, T. hamatum, T. longisporum,*

Note : These results are recommended to farmers in 26th Joint Agresco meeting held in April, 1997 at Junagdh.

T. koningii, *Pseudomonas fluorescens*, *Bacillus* spp. A, B and D were used @25 ml/kg seed. Spore strength was kept 10^6 cfu/ml for fungal bioagents while it was 10^9 cfu/ml for all bacterial antagonists. Four fungicides namely, carbendazim 25 DS at @2, 3 and 4 g, mancozeb 75% WP thiram (TMTD) 75% SD and captan 75% SD each at 3 g were used as seed treatment. The seeds were inoculated with *A. niger* before giving respective treatments of biocontrol agents and seed dressing fungicides. Seeds inoculated with spore suspension alone served as the check.

The observations on collar rot incidence were recorded upto 50 days after sowing and dry pod weight was also recorded after harvesting of the crop. The results were analysed statistically.

RESULTS AND DISCUSSION

The results presented in Table 1 revealed that all the seed dressing fungicides significantly reduced the collar rot incidence as compared to check. The lowest disease incidence (18.67%) and maximum disease control (52.38%) were recorded in seed treatment with thiram 75% SD @ 3.0 g/kg seed. However, carbendazim 25 DS (4.0 g/kg seed), captan 75% SD, carbendazim 25 DS and mancozeb 75% WP each @ 3.0 g/kg seed were also effective and were at par with thiram. They exhibited 19.34, 22.40, 22.67 and 23.65 per cent disease incidence and 50.67, 42.87, 42.18 and 39.68 per cent disease control as compared to check, respectively.

Maximum pod yield i.e. 1584 kg/ha was recorded in the plots where seeds were treated with thiram (3.0 g/kg seed) and it was significantly higher than check. The yields in the treatment of mancozeb, 75% WP, carbendazim 25% DS and captan 75% SD (at the rate of 3.0 g/kg seed) were 1437, 1432 and 1405 kg/ha respectively and these were at par with thiram (Table 2).

Maximum net return (Rs. 7086/ha) was obtained with highest Incrimental Cost Benefit Ratio (ICBR 1 : 79.73) in the treatment of thiram. Next best treatment was carbendazim (4.0 g/kg seeds) followed by mancozeb (3.0 g/kg seeds), which gave net profit of Rs. 6427 and Rs. 5317 per hectare, respectively. But the ICBR of mancozeb (1:56.96) was greater than carbendazim (1:35.74) due to low market price of the mancozeb (Table 2).

These results are in accordance to those of Karthikeyan, 1996, who achieved good control of collar rot of groundnut with carbendazim, thiram and *Trichoderma viride*. However, *T. viride* was comparatively less effective than *T harzianum* in present investigations and also in agreement of the results obtained by Lashin *et al.*, 1989. Effectiveness of carbendazim or captafol in controlling collar rot of groundnut has also been reported by Gangopadhyay in 1996. Pettit *et al.* (1969) reported association of *Bacillus subtilis* on freshy harvested or dried kernels of groundnut as an effective antagonist against *Aspergillus*.

TABLE 1

Effect of biocontrol agents and fungicides on incidence of collar rot (pooled).

Treatment	*Rate / kg seed*	*Mean disease incidence (%)*			*Pooled mean*	*Per cent disease control*
		1993-94	*1995-96*	*1996-97*		
Trichoderma harzianum	25 ml	41.99 (40.35)	27.54 (31.36)	23.55 (28.99)	31.02 (33.66)	20.88
T. viride	25 ml	47.67 (43.64)	29.85 (33.10)	24.90 (29.91)	34.13 (35.55)	12.95
T. hamatum	25 ml	48.88 (44.34)	26.96 (31.24)	30.18 (33.29)	35.34 (36.29)	09.86
T. longisporum	25 ml	45.63 (42.46)	31.70 (34.25)	29.07 (32.61)	35.46 (36.44)	09.56
T. koningii	25 ml	40.33 (39.40)	26.15 (30.74)	28.70 (32.35)	31.72 (34.16)	19.10
P. fluorescens	25 ml	40.99 (39.79)	27.88 (31.86)	23.79 (29.11)	30.88 (33.59)	21.24
Bacillus spp-A	25 ml	40.66 (39.59)	26.73 (31.11)	24.81 (29.79)	30.73 (33.50)	21.62
Bacillus spp-B	25 ml	36.45 (37.11)	30.66 (33.59)	28.33 (32.13)	31.81 (34.28)	18.87
Bacillus spp-D	25 ml	48.22 (43.96)	29.97 (33.16)	26.66 (31.03)	34.95 (36.05)	10.86
Carbendazim 25 DS	2.0 g	32.11 (34.50)	24.30 (29.52)	19.35 (26.06)	25.25 (30.02)	35.60
Carbendazim 25 DS	3.0 g	26.99 (31.28)	21.85 (27.85)	19.97 (26.44)	22.67 (28.52)	42.18
Carbendazim 25 DS	4.0 g	17.77 (24.76)	21.29 (27.46)	18.87 (25.72)	19.34 (25.99)	50.67
Mancozeb 75% WP	3.0 g	31.65 (34.19)	18.86 (25.70)	20.46 (26.87)	23.65 (28.92)	39.68
Thiram 75% S.D.	3.0 g	16.99 (24.21)	20.13 (26.64)	18.90 (25.73)	18.67 (25.53)	52.38
Captan 75% S.D.	3.0 g	22.25 (28.29)	22.20 (28.09)	22.75 (22.44)	22.40 (28.27)	42.87
Check		49.99 (44.97)	33.44 (30.70)	34.21 (29.64)	39.21 (39.68)	—
(Figures in paranthesis are transformed value)						
C. D. at 5%		(04.24)	(01.95)	(03.67)	(04.73)	

TABLE 2

Effect of biocontrol agents and fungicides on yield of groundnut (pooled).

Treatment	*Rate/kg seed*	*Mean yield kg/ha*			*Pooled yield kg/ha*	*Net return (Rs.)*	*ICBR*
		1993-94	*1995-96*	*1996-97*			
Trichoderma harzianum	25 ml	0972	1310	1390	1227	2777	1 : 25.14
T. viride	25 ml	1017	1273	1254	1182	2237	1 : 20.58
T. hamatum	25 ml	0925	1204	1294	1141	1745	1 : 16.17
T. longisporum	25 ml	0925	0972	1217	1038	0509	1 : 05.42
T. koningii	25 ml	0971	1088	1287	1115	1433	1 : 13.46
Pseudomonas fluorescens	25 ml	1063	1157	1303	1174	2141	1 : 19.61
Bacillus ssp-A	25 ml	0994	1157	1254	1135	1643	1 : 14.64
Bacillus ssp-B	25 ml	1132	1273	1296	1254	2861	1 : 25.87
Bacillus spp-D	25 ml	1064	1134	1271	1156	1925	1 : 17.73
Carbendazim 25 DS	2 g	1362	1226	1440	1342	4172	1 : 42.72
Carbendazim 25 DS	3 g	1389	1435	1472	1432	5209	1 : 37.42
Carbendazim 25 DS	4 g	1642	1504	1464	1537	6427	1 : 35.74
Mancozeb 75% WP	3 g	1179	1527	1604	1437	5317	1 : 56.96
Thiram 75% S.D.	3 g	1688	1643	1423	1584	7086	1 : 79.73
Captan 75% S.D.	3 g	1294	1481	1440	1405	4908	1 : 41.90
Check		0878	1209	0986	—		
C. D. at 5%		0157	0267	0167	0190		

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Effect of Paclobutrazol on Mango Seedling Quality

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ABSTRACT

Seeds from control trees produced only one main stem during germination and subsequent growth upto 60 days. However, mango seeds obtained from paclobutrazol (PBZ) treated trees produced more than 1 (2-5) shoots on each main stem. Multi-branching as a result of PBZ treatment was due to the death of apical shoot apices. Therefore, seedling deformed with increased number of primary and secondary branches.

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INTRODUCTION

Paclobutrazol is a triazole growth retardant not only regularized alternate bearing (Burondkar and Gunjate 1989; Kurian and Iyer, 1993) but it also affects on seedling quality. Paclobutrazol treated tree show reduced stem height, internodal length and leaf size with increased main stem thickness. Multibranching as a result of PBZ treatment was due to the death of apical shoot apices. The objective of these studies, therefore, was to determine the residue effect of PBZ in seed germination and seedling growth.

MATERIALS AND METHODS

The experiment was carried out during 1993-95 on 16-17 year old bearing mango tree of the cvs. Dasheri, Langra, Chausa and Fazri at H. R. C., Patherchatta of G.B.P. U.A. & T. Pantnagar, U.P. Paclobutrazol was applied on two different dates namely 15 September and 15 October 1993 and 1994 and 2.3 g PBZ per meter tree canopy radius in soil at the drip and mixed with 7 litre of water. One tree was taken under each treatment and each treatment was replicated thrice.

Seeds extracted from ripe fruits of each treatment were sown in seed bed soon after their extraction. Data on germinated seeds (stone) for their number of primary and secondary branches, number of dead or alive shoot-tips, height, internodal length, thickness of main stem, number and size of leaves on each seedling were recorded 60 days after seed sowing. The observations were subjected to statistical analysis by using Randomized Block Design.

RESULTS AND DISCUSSION

Data in Table 1 (ABC) show that out of 10 seeds sown in each treatment, 6-8 seeds germinated in all the cultivars in both the years

TABLE 1 (A)

Effects of time of paclobutrazol treatment on seed germination and seedling growth in mango.

Treatment	No. of germinated stones out of 10		% germination		No. of seedling having > 1 primary branches		% seedlings having > 1 prl. branches		No. of primary branches		No. of died main shoot tips		% of died main shoot tips	
	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995
Dashehari-Control	7.0	7.0	70.00 (56.99)	70.00 (56.99)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
Dashehari-15 Sept.	8.66	8.33	86.66 (68.85)	83.33 (66.14)	4.00	5.00	49.46 (44.69)	68.51 (56.57)	5.33	4.66	2.33	2.33	45.71 (42.52)	58.88 (50.16)
Dashehari-15 Oct.	7.66	7.33	76.66 (61.21)	73.33 (59.00)	3.33	3.33	43.45 (41.21)	58.92 (50.14)	4.00	4.33	1.66	2.00	46.66 (43.07)	61.10 (51.48)
Langra-Control	5.66	5.66	56.66 (48.84)	56.66 (48.84)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Langra-15 Sept.	7.66	7.66	76.66 (61.21)	76.66 (61.71)	3.66	4.00	47.61 (43.62)	68.45 (56.37)	5.33	6.00	1.33	1.66	46.66 (43.07)	43.33 (41.75)
Langra-15 Oct.	6.66	6.66	66.66 (54.78)	66.66 (54.78)	2.66	3.33	39.67 (39.01)	61.10 (51.96)	4.00	4.33	2.00	1.66	67.21 (55.16)	61.10 (51.48)
Chausa-Control	6.66	6.33	66.66 (54.78)	63.33 (52.85)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chausa-15 Sept.	7.66	8.00	76.66 (61.21)	80.00 (63.92)	3.33	4.66	43.45 (41.21)	66.85 (54.88)	4.66	4.66	2.00	1.33	62.22 (52.08)	38.88 (38.50)
Chausa-15 Oct.	6.66	6.66	66.66 (54.78)	66.66 (54.78)	2.66	3.66	39.67 (39.01)	65.87 (54.70)	3.66	3.66	2.00	1.00	70.00 (56.92)	38.88 (38.50)
Fazri-Control	5.66	5.33	56.66 (48.84)	53.33 (46.92)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fazri-15 Sept.	7.33	7.33	73.33 (59.00)	73.33 (59.00)	2.33	4.33	31.54 (34.12)	72.61 (58.45)	5.33	5.66	1.66	1.00	50.00 (44.99)	44.44 (41.75)
Fazri-15 Oct.	6.66	6.33	66.66 (54.78)	63.33 (52.77)	2.00	4.00	30.15 (33.29)	63.48 (53.33)	4.66	4.33	2.66	1.00	67.21 (55.16)	50.00 (44.91)
Treatment	0.578	0.720	3.400	4.740	0.464	0.570	2.543	6.755	0.603	0.623	0.396	0.309	3.142	3.141
C.D. at 5% cultivar	0.668	NS	3.926	5.473	0.535	NS	2.937	NS	NS	NS	NS	0.357	3.628	3.628
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	6.285	6.283

TABLE 1(B)

Effects of time of paclobutrazol treatment on seedling growth in mango.

Treatment	Main stem height (cm)		Height of seedling (cm) Healthy		Height of seedling (cm) Deformed		Internode length of main stem (cm)		Internode length of seedling (cm) Healthy		Internode length of seedling (cm) Deformed		Thickness of main stem (cm)	
	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995
Dashehari-Control	30.70	30.43	35.65	36.00	0.00	0.00	4.76	4.43	5.76	5.76	0.00	0.00	5.23	5.23
Dashehari-15 Sept.	25.20	25.13	27.66	27.33	16.66	15.33	3.90	3.26	4.16	4.13	3.16	3.33	6.26	6.86
Dashehari-15 Oct.	29.86	27.10	30.66	30.66	20.00	19.33	4.10	3.80	4.66	4.76	3.50	3.26	5.33	5.40
Langra-Control	33.20	33.00	36.33	36.00	0.00	0.00	5.00	4.90	5.69	5.66	0.00	0.00	5.46	5.50
Langra-15 Sept.	24.36	24.06	27.33	28.00	17.00	15.66	3.83	3.13	4.23	4.33	3.50	3.26	6.36	6.46
Langra-15 Oct.	28.26	27.70	23.66	31.66	21.00	20.00	4.36	3.70	4.90	4.80	3.76	3.83	6.23	6.30
Chausa-Control	32.33	31.66	33.33	35.66	0.00	0.00	4.76	4.93	5.23	5.16	0.00	0.00	5.96	6.00
Chausa-15 Sept.	25.73	24.63	26.66	26.00	16.33	15.33	3.33	3.46	4.46	4.40	3.76	3.43	6.50	6.73
Chausa-15 Oct.	28.83	28.86	30.00	29.33	19.00	19.00	4.06	3.80	4.70	4.83	4.06	3.90	6.40	6.60
Fazri-Control	31.63	31.96	32.66	37.66	0.00	0.00	4.83	4.90	5.06	5.10	0.00	0.00	5.76	5.70
Fazri-15 Sept.	22.16	22.06	25.66	24.66	16.33	17.00	3.36	3.26	4.26	4.26	3.70	3.56	7.13	7.30
Fazri-15 Oct.	26.10	25.40	29.66	30.66	21.00	18.33	3.80	3.70	4.70	4.80	4.36	4.23	6.93	7.03
Treatment	1.181	1.720	1.140	1.545	1.006	1.464	0.270	0.239	0.114	0.161	0.147	0.150	0.278	0.266
C.D. at 5% cultivar	1.364	1.353	1.317	NS	NS	NS	NS	NS	0.132	NS	0.170	0.174	0.321	0.308
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	0.228	0.322	NS	NS	NS	0.533

TABLE 1 (C)

Effects of time paclobutrazol treatment on seedling growth in mango.

Treatment	Number of leaves		No. of leaves in seedlings: Healthy		Deformed		Length of leaves (cm)		Length of leaves in seedling (cm): healthy		deformed		Width of leaves (cm)		Width of leaves in seedling (cm)			
	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995
Dashehari-Control	20.33	21.00	18.00	18.00	0.00	0.00	19.66	19.66	23.66	24.00	0.00	0.00	7.23	7.20	8.33	8.33	0.00	0.00
Dashehari-15 Sept.	27.66	28.66	21.66	23.33	31.00	31.00	14.66	15.00	17.00	16.33	7.19	7.19	5.60	5.46	4.36	7.46	4.36	4.30
Dashehari-15 Oct.	24.00	25.00	20.66	22.33	29.00	30.33	17.33	16.66	21.33	21.00	7.33	7.46	6.90	6.23	8.13	7.76	4.63	4.80
Langra-Control	22.33	22.00	20.33	20.66	0.00	0.00	23.00	23.33	26.33	26.00	0.00	0.00	7.10	7.13	8.79	8.80	0.00	0.00
Langra-15 Sept.	28.33	28.66	23.66	24.66	31.33	32.66	12.66	11.66	19.66	19.00	7.76	7.63	5.56	5.53	7.79	7.76	4.60	4.43
Langra-15 Oct.	26.33	24.66	22.00	24.00	28.66	31.33	15.66	15.00	24.00	22.00	8.26	7.90	6.06	6.10	8.43	8.13	5.26	4.80
Chausa-Control	19.66	20.33	17.33	18.00	0.00	0.00	21.33	21.66	26.33	26.33	0.00	0.00	7.80	7.53	8.76	8.76	0.00	0.00
Chausa-15 Sept.	27.66	27.66	24.00	24.33	31.00	31.66	13.66	13.33	19.33	19.00	7.40	7.30	6.80	5.96	8.09	7.93	4.86	4.66
Chausa-15 Oct.	24.33	24.33	20.33	21.33	27.33	29.00	17.33	16.66	23.66	22.00	7.76	7.63	6.66	6.56	8.53	8.20	5.40	5.13
Fazri-Control	20.66	20.33	17.66	17.66	0.00	0.00	21.66	20.66	29.33	30.00	0.00	0.00	8.03	8.00	9.23	9.10	0.00	0.00
Fazri-15 Sept.	28.66	28.66	23.33	24.33	31.66	35.00	16.00	16.33	24.33	23.00	8.06	7.86	6.40	6.10	8.53	7.83	5.16	5.26
Dazro-15 Oct.	25.66	24.33	21.33	21.66	29.00	31.66	17.33	17.00	25.66	24.33	8.43	8.13	7.13	6.80	8.76	8.30	5.09	5.60
Treatment	1.740	1.666	0.839	1.385	1.411	1.487	1.258	1.812	1.33	1.398	0.124	0.560	0.340	0.328	0.135	0.177	0.195	0.175
C. D. at 5% cultivar	NS	NS	0.968	1.600	NS	1.718	NS	NS	1.537	1.614	0.143	0.180	0.392	0.378	0.156	0.204	0.225	0.202
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

and parcentage of germination in cultivars was different. The time of PBZ application also affected germination. Seeds from control tree produced only one main stem during germination and subsequent growth whereas seeds obtained from PBZ treated trees produced more than 1 (2-5) shoot on each main stem. The effect of cultivars and time of application of PBZ affected branching of the main stem in 1994. However, in 1995 effect of cultivar was negligible and interaction between cultivars and time of application were non-significant in both the years. Similar was the result of PBZ on percentage of seeds having more than one branch on each main stem and as high as 50% seedling in 1994 and 73% seedling in 1995 possessed more than one secondary branches on each seedling. The number of primary branches on each main stem was also more than one and as high as 5.33 and 6.00 in 1994 and 1995, respectively. Multibranching as a result of PBZ treatment was due to death of 28-70% apical shoot apices in 1994 and 1995 respectively. The effect of time of PBZ application, cultivar and their interactions were significant in both the years. Therefore, seedling deformed with increased number primary and secondary branches which gave the appearance of malformation. Thus PBZ was capable of creating abnormal seedling having multibranching, restricted shoot growth, rusetting and smaller leaf size similar to that of malformation (Tripathi and Ram, 1994).

The height of seedling in different PBZ treatments varied depending upon the cultivar and date of application. Treatments of 15th September was most effective in reducing the height than 15 October. When data of healthy and deformed seedling under different treatment were analysed, cultivars effects were generally negligible and effects were similar in all the cultivars. However PBZ affected the height of healthy and deformed seedling significantly without any significant effect on cultivar and time of PBZ application suggesting major height reduction due to application of PBZ and similar effect of PBZ were seen on internodal length, thickless of seedling main stem and number of leaves on each seedling under different treatment. Paclobutrazol is also reported to reduce 11-80% tree height, 53-90% internodal length and 20-70% leaf area in mango (Kulkarni, 1988; Burondkar and Gunjate, 1989; Goguey, 1990; Khader, 1991; Kurian and Iyer, 1993).

Number of leaves in different PBZ treatments were increased but its length and width where reduced. Treatments of 15 September was most effective in increase the number of leaves with reduced leaf size than 15 October in both healthy and deformed seedling. Increase number of leaves were due to multibranching of seedling.

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A Study on the Entrepreneurial Behaviour of Dairy Women Among their Different Variables Categories

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ABSTRACT

Present study was carried out in three taluka of Mehsana district of Gujarat State during the *rabi* 1994-95. The sample size for the study was 225 dairy women on the basis of variability in population existing. The dependent i.e. entrepreneurial behaviour and twelve independent variables were selected for the study. One way analysis of variance test and critical difference were conducted. The results indicated that Dairy women who had high education, large size of family, joint type of family, large farm size, high category of fodder crops area, high dairy farming experience, large herd size, high infrastructural experience, high dairy income, high social participation and high milk yield were highly significantly different in their entrepreneurial behaviour.

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INTRODUCTION

To understand the intricacies of entrepreneurial behaviour, it is essential to learn about the concept of entrepreneur, entrepreneurial behaviour and entrepreneurship. The concept of entrepreneurship has been used in a variety of contexts to refer to different kinds of human phenomena. Entrepreneurship development is a process, and the entrepreneur as an individual is a significant factor in the process. It may be very useful to understand how the social set-up has been instrumental to the emergence of entrepreneurs from among the womenfolk. Therefore, dairy farming entrepreneurship can described as a creative and innovative response from dairy women to the environment, with the following objective :

1. to study the personal, socio-economic and situational characteristics of dairy women with reference to their entrepreneurial behaviour.

MATERIALS AND METHODS

In the present study was carried out during the *rabi* 1994-95 in Mehsana district of Gujarat State. The ex-post facto research design was selected for the study. The multistage random sampling method was adopted to select talukas, villages and respondents. The sample size decided for the study was 225 dairy women on the basis of variability in population existing. The research procedure consisted of dependent (entrepreneurial behaviour) and independent variables namely age, education, type of

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family, size of family, land holding, herd size, fodder crops area, social participation, dairy income, dairy experience, milk yield and infrastructural experience. The selected dairy women were personally interviewed with the help of interview schedule. The statistical tests like; analysis of variance was used to analyse the data.

RESULTS AND DISCUSSION

The one way analysis of variance test and critical difference, were conducted as

TABLE 1

Analysis of variance of entrepreneurial behaviour of dairy women in different variables categories.

N = 225

Sr. No.	*Category of variable*	*Frequency*	*Mean E.B. Index*	*Cal F.*
1.	**Age**			0.23 N.S.
2.	**Education**			6.75**
	College level	3	69.70	
	Higher secondary	6	66.62	
	Secondary	63	63.01	
	Middle	69	61.79	
	Primary	40	57.48	
	Illiterate	44	57.41	
	C.D. 6.22			
3.	**Type of family**			17.76**
	Joint family	116	62.76	
	Nuclear family	109	58.60	
	C. D. 1.94			
4.	**Size of family**			394.03**
	Large size	35	12.34	
	Middle size	146	6.32	
	Small size	44	3.50	
	C. D. 0.55			
5.	**Farm size/**			10.46**
	Big farmers	19	66.18	
	Medium farmers	57	63.80	
	Small farmers	65	59.41	
	Marginal farmers	84	58.48	
	C. D. 3.12			
6.	**Fodder crops area**			4.29**
	High	77	62.57	
	Medium	55	60.76	
	Low	92	58.94	
	No cultivation	1	54.07	
	C. D. 1.06			

1.	2.	3.	4.	5.
7.	**Dairy farming experience**			428.83**
	High	13	23.92	
	Medium	91	13.06	
	Low	121	7.48	
	C. D. 1.8			
8.	**Herd size**			619.00**
	Large	66	63.47	
	Medium	143	59.64	
	Small	16	59.34	
	C. D. 3.50			
9.	**Dairy farming income**			411.09**
	High	25	156.16	
	Medium	163	72.37	
	Low	37	29.08	
	C. D. 7.45			
10.	**Social participation**			4.40**
	High	1	76.35	
	Medium	15	65.99	
	Low	96	60.80	
	No participation	113	59.86	
	C. D. 10.84			
11.	**Milk yield**			436.09**
	High	25	1308.00	
	Medium	161	601.24	
	Low	39	238.21	
	C. D. 60.89			
12.	**Infrastructural experience**			"14.34**
	High	33	64.13	
	Medium	159	61.23	
	Low	33	54.99	
	C. D. 3.00			

E.B. = Entrepreneurial behaviour. C. D. = Critical difference at 5% level.
N. S. = Non-significant. ** = Significant at 1 per cent level.

recommended by Ferguson (1966). The computed F ratio was found highly significant. It is quite obvious from Table-1 that, all the independent variables except age and dependent variable : entrepreneurial behaviour of the dairy women significantly different with a high degree of non-significance. Where as in age group the computed F ratio was now non-significant. Thus, there was non significant difference in the entrepreneurial behaviour of respondents belonging to different age groups.

The present study is in line with the finding reported by Nandapurkar (1982).

Further, in Table-1, showed that the value of C. D. was calculated to know the difference between the entrepreneurial behaviour of the dairy women and all the independent variables except age. It was found at five per cent level of significance.

The probable reasons and conclusions of all the variables for this finding is nerated as under :

(1) Education

in College level education of dairy women was significantly superior over the remaining education level, but the entrepreneurial behaviour of dairy women were identical in college and higher secondairy education level.

This finding is similar to the finding reported by Nandapurkar (1982).

(2) Type of family

The joint family sustem is still dominant in village and there is a strong willing of co-operation and co-ordination spirit, amongst the family members.

(3) Size of family

The entrepreneurial behaviour of the respondents belonging to large size family was significantly superior over middle and small size family. The probability of this finding is very interesting because the large size family was found in joint and rice versa. The same result conformed the superiority of joint family.

(4) Farm size

The big and medium farmers have higher entrepreneurial behaviour than small and marginal farmers.

This might be due to the fact big and medium farmers have excellent infrastructural facilities.

(5) Fodder crops area

The entrepreneurial behaviour of high fodder crops area group was superior over the medium, medium over to low. Very poor entrepreneurial behaviour was observed in no cultivation group.

The results seemed to be quite natural because of the fact that fodder crops are the heart of dairy farming business and respondents have realized the importance of green fodder in increasing the milk production.

(6) Dairy farming experience

The entrepreneurial behaviour depended on experience, thus the respondents have high experience leading to high entrepreneurial behaviour and vice versa.

This might be due to the fact that experience plays significant role in all the aspects of dairy farming business.

(7) Herd size

The large herd size provided income throughout the year and respondents exercised better managerial ability to regulated the income from the herd and this led to maximum profit.

(8) Dairy farming income

Income is the principal factor for the success of any business, who had earned then entrepreneurial behaviour of the respondents will be higher due to higher income and vice versa.

This finding is in line with the finding of Nandapurkar (1982).

(9) Social participation

Dairy women were hasitate to take part in other activities, due to our old customs and male dominancy. Further, they devoted most of their time for the dairy farming management and household work.

This finding is similar to that of Nandapurkar (1982).

(10) Milk yield

High milk yield provided more income and business become more profitable. Thus, led to higher entrepreneurial behaviour of the dairy women and vice versa.

(11) Infrastructural experience

The entrepreneurial behaviour of high and medium infrastructural experience groups was found at par but it was superior over the low infrastructural experience, respondents have very poor entrepreneurial behaviour in low infrastructural experience category.

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Job Related and Socio-Psychological Factors Affecting Research Management Ability of the Heads in Gujarat Agricultural University

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ABSTRACT

Research management ability of the heads play crucial role in fruitful research work. Socio-psychological and job related characteristics of the heads are important factors which affect the research management ability of the heads differently. Therefore, this study was undertaken. The results indicated that image of heads, personality (extrovert), attitude towards delegation of authority, job involvement and style of supervision (developmental) of heads had positive and highly significant relationship with their research management ability.

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INTRODUCTION

Fruitful research work needs better research management ability (RMAI) of the heads. Therefore, it is the matter of great importance to study the factors affecting the research management ability, their extent and manner. Keeping in view, it is seen that socio-psychological and job related characteristics are the most important factors which affect the research management ability of the heads. Keeping the above said facts in view the present investigation was carried out to know the factors affecting the research management ability of the heads in Gujarat Agricultural University in 1993.

MATERIALS AND METHODS

In the present study research management ability of the head has been operationalised as the ability of the head to apply the basic principles of management in running the department/station/project/scheme for agricultural research work.

The study was conducted in Gujarat Agricultural University. All the independently working heads of the agricultural research department/station/project/scheme of the University were selected for the study purpose. For measuring research management ability of the selected heads two immediate subordinates of each head were randomly

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selected from respective department/ station/project/scheme. Thus in all 69 research heads and 138 their subordinates were selected. Two questionnaires were prepared for the study, one for the heads and the another for their subordinates. The respective questionnaire to the heads and subordinates were separately mailed to each person. Finally 86.95% responses were received.

Computing the research management ability index (RMAI) of the research head the scale developed for the purpose was used. To measure the research management ability of the research heads, the research management ability scale was applied to the two immediate subordinates of each head and RMAI from the subordinates were calculated. The final RMAI of the head was determined by averaging the RMAI get from both the subordinates of respective head. Coefficient of correlation were computed to findout the relationship between each of the independent variable and depedent variable by employing formula.

RESULTS AND DISCUSSION

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

A : Socio psychological characteristics

The nine variables i.e. (1) image of the head (2) personality (extrovert/introvert) (3) attitude towards delegation of authority (4) perceived workload (5) attitude towards research work (6) job involvement (7) job stress (8) achievement motivation and (9) styles of supervision were studies in relation to the RMAI of the heads. The data are presented in Table-1.

TABLE 1

Correlation coefficient between socio-psychological characteristics of heads and their RMAI.

Sr. No.	*Name of Variable*	*'r' value*
1.	Image (characteristics) of the head	.8159**
2.	Personality (extrovert/introvert)	0.3843**
3.	Attitude towards delegation of authority	0.5726**
4.	Perceived workload	-0.0773 NS
5.	Attitude towards research work	0.0712 NS
6.	Job involvement	0.3324**
7.	Job stress	0.160 NS
8.	Achievement motivation	0.0549 NS
9.	Styles of supervision	@0.4901**

NS = Non-significant at 0.05 level.

** = Significant at 0.01 level.

@ = Analysis was made on the basis of only 26 respondents.

In case of socio-psychological characteristics, image, personality, attitude towards delegation of authority, job involvement and styles of supervision had positive significant relationship RMAI of the heads. While perceived workload had negative non-significant relationship with RMAI of the heads and attitude towards research work, job stress and achievement motivation had non-signifcant but positive relationship with RMAI of the heads these might be due to following reasons :

1. Management is an art and also depends on invididuals characteristics therefore the positive image of the heads may increase their RMAI and vice versa.

2. Extrovert heads are more social, quickly react to situations, more interpersonal communicators and many other characters suitable for best management and therefore the extrovert personality increases their RMAI.

3. The favourable attitude of the heads towards delegation of authority will initiate him to delegate required authority among working individuals and as a result effective management may be achieved.

4. Job involved head considered the work as an important part of his life and he has affinity with whole job situation which resulted in better RMAI.

5. Self dispensing style of supervision has confidence in his subordinates and they are free to work both independently and interdependently with their colleagues which leads to the effective management.

B : Job related characteristics

The five job related variables like cadre, total experience, experience as a research head, training received and absence at headquarters were studied in relation to RMAI of the heads. Such data are presented in Table 2.

TABLE 2

Correlation coefficient between job related characteristics of heads and their RMAI.

N = 60

Sr. No.	*Name of Variable*	*'r' value*
1.	Cadre	0.0791 NS
2.	Total experience	0.1504 NS
3.	Experience as a research head	0.1420 NS
4.	Training received	-0.0914 NS
5.	Absence at headquarters	-0.1372 NS

NS = Non-significant at 0.05 level.

Data presented in Table 2 stated that cadre, total experience and experience as a research head had non-significant but positive relationship with RMAI of the heads. It means as the cadre, total experience and experience as a research head increases the RMAI of heads increases. This findings were in confirmity with the findings of Khare *et al.* (1987), Sakaria (1988), G. Rani (1985).

It is also seen from Table 2 that training received and absence at headquarters had negative but nonsignificant relationsjhip with RMAI of heads. This may be because of most of the training received by the heads were technological and very few were of management aspects. While the

absence of the head at headquarters leads to be poor management.

Implication

Among all the characteristics image of the head, personality (extrovert), attitude towards delegation of authority and job involvement were found correlated with research management ability of the heads. Therefore, the efforts should be made to get the favourable effects of the said characteristics to improve research management such as :

(i) The person with a extrovert personality and good image should be selected for the post of head of research station.

(ii) More powers should be delegated to heads so that he may be able to delegate the power to his subordinates and improve his research management.

(iii) More benefits may be provided to increase the job involvement of the head.

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Variability Analysis in Field Experiments on Maize - A Case Study of Godhra Farm

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ABSTRACT

The present study, being location as well as crop specific, was initiated to study the experimental factors responsible for high variability in field experiments on maize crop conducted at Godhra Farm. The variability estimated through coefficient of variation for grain yield data revealed that plot size, number of treatments and number of replications were responsible factors for high variability in field experiments.

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INTRODUCTION

Reliability of the results of any field experiment depends on the amount of experimental error which is usually expressed in terms of coefficient of variation (CV). Soil fertility variation is a prime source of experimental error (Federer, 1955) which is also influenced by the experimental factors such as size and shape of experimental units (plots), block size, number of replications, number of treatments, experimental designs etc. (Panse and Sukhatme, 1978). It has been reported that CV is considerably higher (> 20 per cent) in case of field experiments on pulse crops, maize, drilled paddy and bidi tobacco [Anon. (1993), Patel (1994) and Patel *et al.* (1995)]. The findings based on such experiments are not reproducible. It puzzles the scientists because they have to repeat the same experiment over space and time to arrive at some definite conclusion.

In Gujarat State, research work on maize crop is being carried out at Godhra (Dist. Pachmahals). This crop is raised as rainfed crop during *kharif* season showing large variation (CV per cent > 20). Besides climatic factors, soil factors are also responsible for large variation in experimental results. Soil factors are location specific. The soil of the research station is very shallow, sandy in texture, which moves with water easily, poor in moisture retention, as well as in organic matter and nutrient content. Large variation in maize experiments being conducted at Godhra (Gujarat State) has, therefore, become a base for initiating present investigation to study the

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experimental factors responsible for high variability in the field experiments on maize crop.

MATERIALS AND METHODS

Data collection

The grain yield data (secondary data) of 231 field experiments on maize crop, conducted during the years 1983 to 1992 at the Maize Research Station, Gujarat Agricultural University, Godhra were collected to study experimental factors influencing variability in those experiments. During the year 1984, there was no experiment because of severe drought condition in the Gujarat State. The information on the year of experiment, plot size, number of replications, number of treatments etc. of each experiment was also recorded.

Statistical analysis

The data on maize experiments were subjected to statistical analysis using analysis of variance technique (Das and Giri, 1985). Coefficient of variation in per cent (hereafter referred as CV) for yield data of each experiment was worked out using following relation.

$$CV = [\{(\hat{\sigma e})^2\}^{0.5} / \bar{Y}] \, 100$$

$$= \left[\frac{(\text{Error Mean Square})^{0.5}}{\text{Overall Experimental Mean}}\right] 100$$

where $\hat{\sigma e}^2$ = Error mean square from analysis of variance

$\bar{Y} = (Y... / r\,t)$ = Overall experimental mean (Simple Arithmetic mean)

$Y..$ = sum of all the observations (values)

r = number of replications

t = number of treatments

The estimated CV of each field experiment was classified to study the experimental factors responsible for high variation in experimental data. Factors studied were year of experiments, plot size, number of replications and number of treatments. Since 96 per cent of the field experiments (231) were conducted in Randomized Block Design (RBD), the design factor was not included in the study.

RESULTS AND DISCUSSION

The CV of 231 field experiments on maize were grouped in summary form in Table 3.1.

TABLE 3.1

Frequency distribution of CV.

Class	*Frequency*	*Class*	*Frequency*	*Class*	*Frequency*
< 9	0	29 - 33	28	53 - 57	7
9 - 13	9	33 - 37	27	57 - 61	3
13 - 17	14	37 - 41	17	61 - 65	3
17 - 21	24	41 - 45	15	65 - 69	0
21 - 25	31	45 - 49	12	69 - 73	4
25 - 29	30	49 - 53	5	≥ 73	2

Scrutiny of the results indicated that CV ranged from 9.70 per cent to 74.52 per cent with a mean of 31.98 per cent. Only 10 per cent of the total experiments, i.e., 23 experiments (Table 3.1) have CV between 9 to 17 per cent which is the acceptable range of variation (Panse and Sukhatme, 1978).

About 66 per cent of the total experiments had a high CV, i.e., 25 per cent and above.

The CVs were further analyzed to study the influence of experimental factors, viz., plot size, number of treatments, (i.e., block size) and replication on the experimental variability (CV). The factor-wise distribution of mean CV are presented in Tables 3.2 through 3.5. The standard statistical techniques of analyzing the data of many classifications with unequal numbers in each class/group/cell are not directly applicable. Therefore, test of significance was not attempted.

The information furnished in Table 3.2 indicated that the mean CV varied from 21.72 per cent in 1983 to 54.85 per cent in 1987 due to seasonal variation.

The data presented in Table 3.3 revealed that the smallest plot size (3-6 sq.m) had the highest variation (CV = 39.13) in the experimental data. The lowest CV (18.10) was observed with 9-12 sq.m plot size, but for this size, there was only one experiment. Increase in plot size from 3-6 sq.m to 6-9 sq.m showed a decrease in CV from 39.13 to 29.80. There was slight increase in CV (31.22) with the plot of 12-15 sq.m size, thereafter decreasing trend in CV, though not consistent, was observed. It is interesting to note that CV stabilized around 28 per cent when plot size was of 15 sq.m or more. Results indicated that the plot of 6 to 12 sq.m size appeared to be optimum for the field experiments. There was no gain after 12 sq.m size because decrease in CV was not proportional to the area added. The results confirmed that the plots of smaller size showed larger variation than optimum plot size (Katyal and Rajput, 1978. Binas *et al.*, 1983 and Kaushik *et al.*, 1989). It could be inferred that the plot size was a responsible factor influencing variability in experimental data.

TABLE 3.2

Year-wise distribution of CV.

Year	*No. of experiments*	*Mean CV*
1983	10	21.72
1985	11	27.35
1986	27	32.56
1987	2	54.85
1988	36	34.32
1989	39	27.65
1990	55	37.16
1991	34	27.70
1992	17	34.22
Total	231	31.98

The results in Table 3.4 showed that 81.39 per cent of the experiments were conducted with 5 to 29 treatments. The maximum mean CV (45.75) was noticed for the treatment group having 50-54 treatments whereas the lowest mean CV (25.88) was observed for the treatment group having 5-9 treatments. CV increased with the increase in number of treatments (with slight deviation in-between) per experiment (except treatment group < 5 treatments). The findings thus

TABLE 3.3

CV as influenced by plot size and number of treatments.

Plot size (sq.m.)	*Treatment*							
	< 5	*5-9*	*10-14*	*15-19*	*20-24*	*25-29*	*≥ 30*	*Mean CV*
3-6	—	37.89 (2)	41.34 (9)	46.81 (22)	38.02 (4)	31.18 (4)	33.95 (29)	39.13 (70)
6-9	—	25.30 (9)	25.99 (14)	31.02 (16)	36.35 (14)	28.45 (11)	29.49 (8)	29.80 (72)
9-12	—	—	—	18.10 (1)	—	—	—	18.10 (1)
12-15	—	34.44 (2)	32.16 (8)	24.20 (2)	—	—	—	31.22 (12)
15-18	29.23 (4)	25.52 (24)	31.82 (5)	30.45 (4)	36.60 (1)	—	—	27.55 (38)
18-21	—	24.79 (9)	40.07 (3)	—	—	—	—	28.61 (12)
21-24	28.89 (2)	24.94 (19)	37.70 (5)	—	—	—	—	27.70 (26)
Mean	29.11 (6)	25.88 (65)	33.20 (44)	38.10 (45)	36.73 (19)	29.18 (15)	32.98 (37)	31.98 (231)

supported the influence of number of treatments on experimental variability (Federer, 1955). These results are deviating from the results reported by Patel (1994) where he did not get any contribution of number of treatments in pulse crop on the experimental variability.

TABLE 3.4

Treatment-wise distribution of CV.

Treatment	*No. of experiments*	*Mean CV*
< 5	6	29.11
5 - 9	65	25.88
10 - 14	44	33.20
15 - 19	45	38.10
20 - 24	19	36.73
25 - 29	15	29.18
30 - 34	6	36.23
35 - 39	13	32.86
40 - 44	5	32.63
45 - 49	11	29.19
50 - 54	2	45.75
Total	231	31.98

The two-way distribution of CV (Table 3.3) indicated that the block of 5-9 treatments coupled with plot of 6-9 sq.m area per treatment appeared to be optimum combination for field experiments at Godhra Farm. This combination had an mean CV of 25.30 per cent, with the same treatment group, the plot sizes 18-21 and 21-24 sq.m had slightly lower CV. The decrease in CV was not proportional to the increase in plot size. A combination of plot size 9-12 sq.m and treatment group 15-19 had the lowest mean CV (18.10), but this combination had only one experiment. Therefore, it could not be considered reliable for generating the results. Similar was the case with the combination of plot size 12-15 and treatment group 15-19.

The Replication-wise data are presented In Table 3.5.

TABLE 3.5

Replication-wise distribution of CV.

Replication	*No. of experiments*	*Mean CV*
2	73	37.82
3	13	26.45
4	136	29.76
5	1	20.08
6	8	26.91
Total	231	31.98

The results in Table 3.5 reveals that 58.88 per cent of experiments were conducted with 4 replications and 31.60 per cent with 2 replications. There was one experiment conducted in 5 replications and 13 experiments with 3 replications. The highest mean CV as 37.82 per cent was observed when experiment was with 2 replications and the least mean CV as 20.08 per cent was observed in designs with 5 replications. Though, there was a decreasing trend in mean CV, the rate of reduction in mean CV was inconsistent with an increase in number of replications. Results indicated that number of replications had a vital role in controlling the variability in the field experimentation.

Conclusion

The present study leads to the conclusion that the factors responsible for high variability in field experimentation with maize

crop at Godhra farm was influenced by the experimental plot size, number of treatments and number of replications. It indicates a need to generate information on plot techniques for field experiments on maize crop and to evaluate statistical approaches to minimize the experimental error.

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Trends of Crop Productivity in Long Term Experiment

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ABSTRACT

The yield data from a long term experiment conducted at two different locations of Gujarat Agricultural University were utilized for the period 1979 to 1992. Two crop sequences tried were specific to the respective regions. Curve fitting approach was used to study the trend in crop yield. In all, 24 different equations were tried using original treatment means and three years moving averages. Use of moving average values reduced the seasonal/irregular fluctuations in the data effectively and gave better fit as compared to that of original set of data. The best fitted equation for defining the trend in yield due to treatments within a crop differed, except in case of groundnut. In majority of the cases, polynomial equations with varying degree and bases defined the trend of productivity of the crops.

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INTRODUCTION

Long term field experiments help in studying the changes in the productivity of the soil over the time alongwith direct, residual and cumulative effects of fertilizer application. In all the long term experiments, time is a quantitative factor, hence a common practice is to partition time into components associated with orthogonal polynomials (Gomez and Gomez, 1984). In most of the cases, a simple linear trend either positive or negative may be sufficient to describe a long term trend. However, in the case, where the yield fluctuates substantially over the time, the trend may not be easily described. The method of adjustment of such fluctuations in statistical analysis can be studied using time series analysis. Keeping this in view, an attempt has been made in the present investigation to examine the possibility of adjustment of such fluctuations in statistical analysis using time series (moving average) analysis and to explore the trend in yield due to various fertilizer treatments in different crops through curve fitting approach.

MATERIALS AND METHODS

The data for the present study were collected from a long term experiment conducted by the Department of Agricultural Chemistry in collaboration with the Department of Agronomy, at two different locations of Gujarat Agricultural University, for the period 1979 to 1992. The crop sequences tried were specific to the respective region.

In order to explore the possibility of adjustment of climatic/irregular fluctuations and

identifying the trend equations for various treatments over the period of time, 24 different equations were tried (Table 1) using curve fitting approach (i) using original treatment mean and (ii) using three years moving average.

TABLE 1

List of equations.

	Equation number and form	*Equation name*
1.	Y = A + B*X	Straight line
2.	Y = B* X	Line through origin
3.	Y = A + B* X^ .5 +C*X	2nd deg. poly. with X^.5 as base
4.	Y = A + B/X^. 5 + C/X	2nd deg. poly. with 1/X^.5 as base
5.	Y = A + B*X + C/X	Linear and reciprocal
6.	Y = A + B/X	Hyperbola
7.	Y = X / (A* X + B)	Reciprocal hyperbola
8.	Y = A + B*X^.5 + CX + D*X^ 1.5	3rd deg. poly. with X^ .5 as base
9.	Y = A + B / X + C / X^ 2	2nd order hyperbola
10.	Y = A + B* X + C* X^ 2	Parabola
11.	Y = A + B* X + C / X^ 2	Mod. parabola
12.	Y + A + B* X + C* X^ 2 + D* X^ 3	3rd deg. polynomial
13.	Y = A + B / X + C / X^ 2 + D / X^ 3	Reciprocal 3rd deg. polynomial
14.	Y = A + B / X^ .5 + C / X + D / X^ 1.5	3rd deg. poly. with 1/X^.5 as base
15.	Y = A * X^ B	Power function
16.	Y = A* B^ X	Mod. power function
17.	Y = B^ (1/X)	Root function
18.	Y = A* X^ (B*X)	Super geometric
19.	Y = A* X^ (B/X)	Mod. geometric
20.	Y = A* e^ (B*X)	Exponential
21.	Y = A* e^ (B/X)	Mod. exponential
22.	Y = A + B* ln (X)	Logarithmic
23.	Y = 1 / [A + B* ln (X)]	Reciprocal logarithmic
24.	Y = A*B^ X*X^ C	Hoerl function

Using original treatment means the respective equations for each of the treatments for various crops were fitted and the best fitted equation was identified as the one having the

TABLE 2

Comparison of coefficients of determination for the best fitted trend equations fitted through original data and moving average values in various treatments.

Crop	*Groundnut*		*Wheat (J)*		*Sorghum*		*Bajra*		*Wheat (A)*	
Treatment	R^2	R^2	R^2	R^2	R^2	R^2	R^2	R^2	R^2	R^2
Control	-0.04	0.78	0.72	0.97	0.72	0.98	-0.15	0.34	-0.26	0.08
FYM	-0.06	0.82	0.63	0.65	0.38	0.89	-0.10	0.30	0.04	0.35
N50	-0.05	0.78	0.86	0.99	0.80	0.99	-0.17	0.33	0.54	0.66
NP50	-0.04	0.74	0.33	0.86	0.60	0.96	-0.22	0.31	0.54	0.69
NPK50	-0.04	0.71	0.38	0.83	0.50	0.96	-0.19	0.30	0.22	0.68
N100	-0.05	0.78	0.89	0.96	0.80	0.98	-0.24	0.20	0.70	0.89
NP100	-0.03	0.78	-0.03	0.54	0.69	0.97	-0.24	-0.09	0.45	0.63
NPK100	0.02	0.77	0.41	0.85	0.33	0.97	-0.15	0.29	0.01	0.70
NsPs	-0.09	0.73	0.38	0.81	0.75	0.96	-0.25	0.37	0.70	0.83
NsPsKs	0.03	0.79	0.52	0.87	0.39	0.95	-0.12	0.49	0.45	0.68

Note : R^2 = Adj. R^2 of the best fitted equation using original data R^2 = Adj. R^2 of the best fitted equation using moving average.

highest adjusted coefficient of determination (R^2). In the second approach taking first year of the experiment as the base year, three years moving average values of the original treatment means were obtained and using these values, the best fitted equation was identified from the equations tried for each treatrment of the crops under study.

RESULTS AND DISCUSSION

The best fitted trend equations by both the methods are presented in Table 2. The results indicated that the use of moving average values reduced the seasonal/irregular fluctuations in the data remarkably and gave better fit (adjusted R^2) as compared to original treatment mean equations.

The results presented in Table 3 revealed that best fitted equation for various treatments for a crop differed, indicating that the quantum, form and combinations of the nutrients affected the trend in crop productivity. However, in case of groundnut, which require quite low level of nutrients, a consistent behaviour was noticed, while for the rest of the crops various degree of polynomial with different bases explained the trend in yield over the time.

TABLE 3

Best fitted trend equation for different treatments in different crops.

Treatment	*Crops*				
	Groundnut	*Wheat (J)*	*Sorghum*	*Bajra*	*Wheat (A)*
Control	8	8	9	8	14
FYM	8	7	12	10	4
N50	8	8	9	8	6
NP50	8	8	1	8	6
NPK50	8	12	4	8	9
N100	8	8	9	8	3
NP100	8	8	1	12	3
NPK100	8	8	4	8	10
NsPs	8	4	1	8	6
NsPsKs	8	12	4	12	9

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Feasibility of Utilization of *Prosopis juliflora* Pods in Broiler Ration

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ABSTRACT

An experiment was conducted on 240 'Vencobb' broiler chicks raised in deep litter system and randomly allotted to three dietery treatments (80 in each) viz., (1) 0 per cent (2) 5 per cent and (3) 10 per cent levels of *Prosopis juliflora* pods respectively in broiler starter and broiler finisher ration. The weight gain at 6 and 8 weeks of age was at par in all the treatments. Feed intake of birds were not affected by dieatary treatments which resulted in non-significant differences in feed efficiency amongst them. The dressing percentage and other carcass traits also followed the same trend alongwith that of cost of feed. The results suggested that the *Prosopis juliflora* pods can be incorporated in broiler starter and broiler finisher upto 10% level without any adverse effects on performance of broiler.

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INTRODUCTION

The growth rate of birds has excelled over all other livestock species in the last decade along with the escalation of broiler production from 30 million to 200 million between 1980-1990 (Singh *et al.* 1991). But this has been associated with the rise in demand of feed which is estimated to be 11 million tonnes by 2000 AD (Chadha, 1991). To meet this demand and to reduce the feed cost, it is essential to incorporate unconventional feeds in the poultry ration. Many unconventional feeds have been tried as poultry ration but very little information is available on the use of *Prosopis juliflora* pods in poultry diet. *Prosopis juliflora* pods are very good source of enery (75% TDN) with 7.0% DCP, and good palatability (Talpada *et al.* 1979). It's availability is *2.00 lakh* M.T.Year in Gujarat and *10.00 lakh* M.T./Year in India (Anon. 1992-93). Hence present study was undertaken to know feasible and economic level of incorporation of *Prosopis juliflora* pods in broiler starter and finisher ration.

MATERIALS AND METHODS

240 straight run day old 'Vencobb' chicks of same hatch were randomly allotted to three treatments with 80 chicks in each. Each treatment had four replications. The treatments were as follows :

T_1 : Control 0 per cent level of *Prosopis juliflora* pods.
T_2 : 5 per cent level of *Prosopis juliflora* pods.
T_3 : 10 per cent level of *Prosopis juliflora* pods.

Details regarding proportions of feed ingredients used are given Table 1. Feeding

TABLE 1

Formulation and chemical composition of experimental diets.

Sr. No.	Ingredient	Proportion (per cent)						*Prosopis juliflora* pods
		Broiler starter			Broiler finisher			
		T_1	T_2	T_3	T_1	T_2	T_3	
1.	Maize	45	44	42.5	50	52	49.5	
2.	Maize gluten	18	18	18	15	17	19.5	
3.	Rice polish	10	6	2	12	5	2	
4.	*Prosopis juloflora* pods	0	5	10	0	5	10	
5.	Deoiled groundnut cake	10	10	10	7	5	2	
6.	Fish meal	11	11	11	9	9	9	
7.	Tallow	3	3	3.5	4	4	5	
8.	Mineral mixture	3	3	3	3	3	3	
	Chemical composition (% on DM basis) for three experimental groups							
	C. Protein	22.60	22.09	21.96	21.71	22.12	21.06	13.71
	E. Extract	9.50	10.57	11.36	12.12	12.94	12.58	3.64
	C. fibre	4.66	4.56	3.68	4.43	3.76	3.66	15.99
	NFE	51.20	51.54	51.94	50.67	50.34	52.07	60.49
	Ash	12.04	11.24	11.06	11.07	10.84	10.63	6.17
	Silica	3.34	2.89	1.93	3.32	2.97	1.99	1.11
	P	0.41	0.31	0.31	0.43	0.36	0.40	0.13
	Ca	1.06	0.76	1.07	1.06	0.95	1.03	0.49
	Calculated CP (%)	22.46	22.46	22.41	18.99	19.09	18.96	
	Calculated ME (Kcal/kg)	2881.60	2846.60	2832.60	2995.40	2961.40	2995.90	
	Cost (Rs./100 kg)	444.30	433.03	429.21	449.46	439.05	446.21	

standards (ISI, 1979) were followed to meet the energy and protein requirements of the birds reared under starter and finisher phase. All the treatment feeds were fortified with adequate vitamin supplement and coccidiostate.

The birds were raised in deep-litter system with 1.32 sq. ft. floor space per bird. The pens were properly sterilized before conducting the experiment. *Bajra* husk was used as litter material. In each pen, 100 watt electric bulb was provided to maintain brooding temperature ground 35°C. till it reaches at the end of 4th week. Light was provided 24 hours to achieve maximum feed consumption in linear feeder trough with 2.5 cms linear space per bird for first 3 weeks, 4.4 cms linear space per bird from 4 to 6 weeks and 13.5 cms linear space per bird during 7 and 8 weeks. Plastic water trough were provided at the rate of 0.5 and 1.0 cm linear space for the first two weeks and 3 to 8 weeks, respectively.

During the 8 weeks of experimental period, the body weight were recorded at weekly interval. The feed intake was recorded daily by weighing in the morning and evening feed in feeders. Fortyeight birds (sixteen in each treatment) were slaughtered by 'Halal' method to study the carcass traits. The data were analysed statistically as per procedure of Snedecor and Cochran, (1987).

RESULTS AND DISCUSSION

The chemical composition of feeds are given in Table 1. The *Prosopis juliflora* pods contained 13.71% CP and 15.99% CF. The ME content was 2200 kcal/kg. Thus, it is a good source of energy.

Effect of weight gain

The average total body weight gain during the experiment is presented in Table 2. It was 1553.56, 1552.62 and 1498.23 g with corresponding values of 27.74, 27.72 and 26.75 g daily gain in weight under T_1, T_2 and T_3 respectively. Weight gain (g/d) was found slightly lower as compared to BIS (1992) standards. Slight reduction in daily weight gain has been reported in broiler fed unconventional cake mixture (Haque *et al.* 1991) and unconventional feed mixture with penicillium mycellium residue (Gianchand, 1969).

Feed intake and feed efficiency

Feed consumption during starter and finisher phase was observed at par with the average total intake of 2784.36, 2885.59 and 2787.56 g of starter mash and 1746.69, 1763.87 and 1707.20 g of finisher mash per bird respectively under T_1, T_2 and T_3 groups. The total feed intake was 4531.05, 4649.26 and 4494.76 g per bird in T_1, T_2 and T_3, respectively with the corresponding values of 80.94, 83.12 and 81.44 g per bird of average daily feed intake. The birds under T_2 consumed more feed compared to T_1 and T_3 but the difference was non significant. The results suggested that *Prosopis juliflora* pods are quite palatable and it has no adverse effect on feed intake.

Gianchand (1969) reported lower feed consumption in broilers fed mango seed kernel or mixture of unconventional feeds. But Patel (1995) observed non-significant effect of corn steep liquor on feed intake by broilers. The average feed efficiency (kg feed/kg gain) were recorded to be 2.92, 2.99 and 3.01 during starter phase and

TABLE 2

Average weight gain, feed intake, feed efficiency and carcass characteristics of birds under study.

Particulars	Treatments		
	T_1	T_2	T_3
Av. Body weight (g)			
Initial	48.08 ± 0.41	47.29 ± 0.31	48.89 ± 0.51
Final	1601.64 ± 14.92	1599.91 ± 17.64	1547.12 ± 28.58
Gain in weight	1553.56 ± 26.04	1552.62 ± 22.37	1498.23 ± 24.66
Daily weight gain	27.74 ± 0.30	27.72 ± 0.31	26.75 ± 0.50
Av. Feed intake (g)			
0-8 weeks	4531.05 ± 66.78	4649.26 ± 49.51	4494.76 ± 61.72
Daily intake (g/d)	80.94 ± 1.17	83.12 ± 00.94	81.44 ± 1.13
Feed efficiency (kg feed/kg gain)			
0-8 weeks	2.92 ± 0.02	3.01 ± 0.04	3.04 ± 0.04
Carcass characteristics			
Av. carcass wt. (g)	1273.50 ± 45.79	1288.88 ± 47.90	1331.12 ± 40.77
Dressing %	64.70	65.07	64.63
Av. dressed wt. (g) with giblet	1077.72	1084.87	1123.06
Wt. of heart (g)	8.22	7.72	8.59
Wt. of spleen (g)	2.81	2.59	3.00
Wt. of liver (g)	39.44	40.62	42.33
Wt. of Gizzard (g) with lining	36.38	34.81	36.72
Economics of feeding Feed Cost (Rs.)			
0-6 weeks	12.37	12.50	11.96
0-8 weeks	20.22	20.24	19.58
Rs. per kg gain (0-8 weeks)	13.02	13.04	13.33
Av. return over feed Cost Rs.	15.02	14.98	14.45

2.88, 2.98 and 2.94 during finisher phase with the overall average of 2.92, 3.1 and 3.04 under T_1, T_2 and T_3, respectively. The treatment differences were non-significant. Similar results (2.69 to 3.06) have been reported by Singh *et al.* (1991) in broiler chicks raised on mixture of unconventional cakes.

Carcass characteristics

The carcass study revealed non significant treatment differences for all the traits. The average carcass weight was 1273.50, 1288.88 and 1331.12 g whereas the values for dressing percantage were 64.70, 65.07 and 64.63 in treatment groups T_1, T_2 and T_3, respectively. The values were at par which suggested that *Prosopis juliflora* pods are not having any adverse effect on dressing percentage upto 10 per cent level. The weights of different edible organs were also non significantly different amongst the treatments. Haque *et al.* (1991) and Patel (1995) also reported non-significant effect of unconventional cake mixture and corn steep liquor, respectively on dressing percentage of broilers which supports the present findings.

Economics of feeding

The average cost of feeding broilers was found to be Rs. 12.37, 12.50 and 11.96 during starter phase and Rs. 20.22, 20.24 and 19.58 for the entire rearing period (0-8 weeks under T_1, T_2 and T_3, respectively. The cost of feed (Rs./kg gain) was realised to be Rs. 13.02, 13.04 and 13.33 whereas the cost of meat was Rs. 18.52, 18.66 and 17.79 per kg meat respectively under T_1, T_2 and T_3. The economics of raising the broiler chicks upto 8 weeks revealed non significant treatment differences. The net returns overfeed cost were found to be Rs. 15.02, 14.98 and 14.45 in T_1, T_2 and T_3, respectively and treartment differences were non significant. However, Jadhao *et al.* (1994) observed higher values and Vala *et al.* (1996) found lower values than the values observed under the present study for net return over feed cost with different levels of sand in broiler and corn steep liquor in chicks, respectively.

The present results indicated that *Prosopis juloiflora* pods can be incorporated upto 10% level in the ration of broilers without any adverse effect on weight gain and carcass characteristics.

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Short Communications

Crop Diversification for Conservation and Sustainable Production on Marginal Lands of Mahi River in Gujarat

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Marginal lands, which are slopy (2 to 6%) table lands, 6 to 60 m away from gully rim and very sensitive to erosion and extending from about one to six kilometers along the banks of Mahi river, suffer from accelerated erosion because of dominace (more than 80% area) of row crop like Tobacco. Problem of erosion is aggravated when in the *kharif* season fields are left fallow during intense monsoon and before taking of Tabacco crop and tillage and cultural practices are performed along the slope.

To overcome the problem on such lands, a package of conservation agronomic practices (Singh *et al.* 1995) with a diversified cropping system was transferred to the farmers' field under Lab to Land Programme. Castor and Castor based intercropping systems and contour cultivation alongwith conservation agronomic practices were introduced in the area where surface cover is more to reduce the soil erosion, more conservation of rain-water in the soil profile. Farmers' adoption of the various systems were spread over three different years, viz., 1988-89, 1989-90 and 1990-91 at different locations and observations on farmers' cultivation practices were taken regularly. The observations were recorded from plot size of 0.2 ha and the physical input-output data were analysed. Farmers were advocated the recommended doses of fertilizers but they used fertilizer according to their choice, availability and buying capacity. The results were compared on the basis of yield and net returns on per cent basis. The economics of various intercropping systems was worked out at 1995-96 prices. Considering phosphorus application, its fixation and availability in a cropping system over a period, out of the total crop response to phosphate 60 per cent was utilized to the first crop and balanced 40 per cent carried over to the next crop and is reflected in the crop yield (Tondon and Tondon, 1995).

Castor (*Ricinus communis*)) crop is intercropped with legunimous crop like Cowpea (*Vigna unguiculata*), Cluster bean (*Cyamospsis tetragonoloba*) and Sesamum (*Sesamum indicum*). Castor intercropped with above crops have given higher yield of castor than the pure Castor crop without much extra inputs (Table 1). This is due to better utilisation of interspaces and moisture conserved due to lesser runoff and erosion in intercropping

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system as compared to pure crop. There is more moisture intake, absorption and conservation due to lesser soil loss and run off as compared to the sole crop (Prasad *et al.*, 1993). Cowpea is harvested in early stage and hence there may not be much compition with Castor crop. Cluster bean, though, is harvested at later stage but due to fast growth it has competed with base crop, reducing the yield of castor. Sesamum has not suppresed the base crop, Castor and has given higher yield.

When the two intercropping systems are compared, it is observed that almost similar castor equivalent yield and, therefore, net returns are realized. However, it is relevent to note that there is much variation in applied in N and P_2O_5 doses. While Castor + Cowpea (1:2) intercropping system was applied 58 kg and 35 kg per ha of N and P_2O_5, respectively, Castor + Sesamum (1:3) was applied 97 kg and 50 kg per ha of N and P_2O_5, respectively. This may be due to the legume effect enhancing the soil fertility and productivity.

TABLE 1

Performance of castor Intercrops on farmers' field.

Sr. No.	Cropping systems	Fertilizers N-P-K (kg/ha)	Yield (kg/ha)*			Net returns (Rs./ha)	
			Castor Tobacco	Intercrop (green pod/ grain)	Castor equivalent	I	II
1.	Castor pure (7)	49-29-0	701	—	701	4816	4663
2.	Castor + Cowpea (1:2) (8)	58-35-0	822	783	1399	11292	10939
3.	Castor + Cluster bean (1:3) (2)	45-42-0	618	276	807	7210	6839
4.	Castor + Sesamum (1:3) (2)	97-50-0	1028	121	1346	11191	10659
5.	Tobacco i) Improved (42)	174-0-0	2058	—	—	—	10268
	ii) Traditional (14)	139-0-0	1682	—	—	—	7572

*Average of 3 years.

Figures in parentheses indicate number of farmers.

I 60% P benefit credited to first crop and 40% to next crop.,

II 100% P benefit to first crop.

As compared to monocropping system of Tobacco cultivation, Castor + Cowpea (1:2) and Castor + Sesamum (1:3) intercropping systems realized 10 per cent higher net returns as compared with improved system and 49 per cent as compared with traditional system, respectively.

The Castor based systems (Castor + Cowpea and Castor + Sesamum), thus, performed better than the improved Tobacco cultivation on demonstration plots. Since Tobacco is erosion permitting crop and affect the soil productivity and fertility on longer period of crop cultivation specially on slopy lands. Hence traditional monocropping system of Tobacco may be replaced with Castor + Cowpea (1:2) and Castor + Sesamum (1:3) intercropping system on slopy marginal lands of Mahi ravines.

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Correlation Studies in Sunflower*

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The improvement in productivity and quality of sunflower is governed by many factors. The mutual association of growth and yield contributing parameters can particularly provide useful information to understand thoroughly the relationship between yield and yield attributes under a given situation. With this view, a field experiment was conducted during *rabi* seasons of 1993-94 and 1994-95 with three levels each of irrigation schedule (0.6, 0.8 and 1.0 IW/CPE ratios), nitrogen (60, 80 and 100 kg ha^{-1}) and phosphorus (30, 40 and 50 kg ha^{-1}) in a split plot design at College Farm, Navsari (Gujarat). Observations were recorded on different random plants in respect of growth (plant height, leaf area index and stem girth) and yield (number of seed, filled seed per cent, head diameter, seed yield per head and seed index) attributes.

Correlation coefficient (r) between the seed yield and growth and yield contributing characters (independent variables) were studied on the linear regression $Y = a + bX$, where Y = expected seed yield for the level of any other factor 'X' (Croxton and Cowden, 1964).

It has been observed that an appreciable positive significant correlation was found between seed yield and all the growth and yield attributing characters (Table 1) during both the years.

Optimum moisture regime and nitrogen level leads to favourable effect on seed weight per head by increasing the number of seeds and seed index. In the present study, seed weight per head (r = 0.9783 in 1994 and 0.9809 in 1995), seed index (r = 0.9732 in 1994 and 0.9728 in 1995) and number of seeds (r = 0.9727 in 1994 and 0.9816 in 1995) established highly significant positive correlation with seed yield during both the years.

Plant height, stem girth and leaf area index gave an indication of better growth and development of crop plants, which ultimately strengthened the yield attributes and consequently resulted in higher seed yield. All the three growth characters exhibited higher positive correlation with seed yield during both the years of present investigation.

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

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TABLE 1

Constants of regression line of the yield 'Y' on other individual yield attributes and coefficient of correlation and regression equation during 1993-94 and 1994-95.

Character	1993-94				1994-95			
	a	b	r	100 R^2	a	b	r	100 R^2
Plant height	-1188.610	17.825	0.8936	79.86	-10081.401	16.698	0.9040	81.73
LAI	311.190	480.807	0.9575	91.68	301.592	421.868	0.9663	93.36
Stem girth	82.176	337.368	0.9317	86.81	179.866	308.928	0.9280	86.13
Head diameter	75.103	137.835	0.9496	90.18	158.819	131.804	0.9240	85.38
No. of seeds/head	-661.692	3.741	0.9727	94.62	-281.627	3.298	0.9816	96.36
Filled seed (%)	-1053.825	43.853	0.9073	82.31	-1192.067	39.786	0.9430	88.92
Seed index	-2098.304	71.456	0.9732	94.71	-1580.694	64.363	0.9728	94.63
Seed weight/head (g)	672.899	49.026	0.9783	95.70	697.223	45.089	0.9809	96.22

Note : r value signifcant at 1 per cent level of probability in all cases.

Head diameter and filled seeds per cent also indicated significant positive correlation with seed yield during both the years as they have direct impact on number of seeds and seed index, and ultimately on seed yield/head. These findings are in comformity with Sindhu and Bains (1980) and Pathak *et al.* (1983).

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Drip Irrigation in Summer Groundnut (*Arachis hypogaea* L.)*

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Groundnut is the most important oilseed crop grown in India. It is mostly grown in *kharif* season, although it performs very well during summer. Because of high potentiality and high productivity the yield is two to three folds more as compared to *kharif* cultivation. Among the various factors determining the crop yield, water and nutrient management are the two major inputs which are becoming scare and costly day-by-day. The information on how these costly resources can effectively be used is scare for this region. Therefore, an attempt has been made to study the economic feasibility of drip irrigation in summer groundnut.

A field experiment was conducted during the summer season of 1994-95 at the Instructional Farm, Gujarat Agricultural University, Junagadh. The experiment comprising of nine treatment combinations was laid out in split plot design with four replications on medium black clayey soil with medium in available nitrogen and low in available phosphorus. Three main plot treatments viz., surface irrigation (1.0 CPE) with fertilizer applied in soil, drip irrigation (0.8 CPE) with fertilizer applied in soil and drip irrigation (0.8 CPE) with fertilizer applied through drip and three sub plot treatments viz., 100% of recommended dose of N and P, 75% of recommended dose of N and P and 50% of recommended dose of N and P. Irrigation of 50 mm depth was applied at 1.0 CPE (100% of CPE) in surface irrigation method at an interval of 8-10 days. In case of drip irrigation the required quantity of water was applied at 0.8 fraction of CPE (80% of CPE) on alternate day. The groundnut CV. GG-2 was sown on 4th February, 1994 using recommended seed rate of 125 kg kernel ha^{-1} keeping inter and intra row spacing of 30 and 10 cm respectively. The lateral pipes were laid out in plot at 60 cm distance. The drippers were fitted on lateral line at the distance of 45 cm. Normal operating pressure was maintained at 1.2 kg/cm^2.

Perusal of data (Table 1) revealed that treatment drip irrigation with fertigation (1_3) produced significantly higher plant height (14.35 cm), plant spread (26.67 cm), shelling percentage (72.03%) and test weight (33.40 g) over their respective surface irrigation method. The direct application of fertilizer to root zone through fertigation might have promoted physiological processes and nutrients uptake, that might have

*Part of M. S. (Agri.) thesis submitted by senior author to the Gujarat Agricultural University.

TABLE 1

Growth and yield attributes of summer groundnut as influenced by methods of irrigation and fertilizer application under varying levels of N and P.

Treatment	Plant height 90 DAS (cm)	Plant spread 90 DAS (cm)	Shelling (%)	Test weight (g)	Water required (mm)	Saving of water (%)	Pod yield (q ha^{-1})	Haulm yield (q ha^{-1})	Net realization (Rs ha^{-1})
[I] Methods of irrigation									
I_1 = Surface irrigation (Ferti. applied in soil)	10.05	19.12	69.81	32.33	700	—	17.50	34.80	14624
I_2 = Drip irrigation (Ferti. applied in soil)	14.20	26.02	70.93	33.30	600	14.28	21.77	45.17	15876
I_3 = Drip irrigation (Ferti. applied through drip)	14.35	26.67	72.03	33.40	600	14.28	24.18	47.97	19067
C. D. (P = 0.05)	**1.11**	**0.91**	**1.22**	**0.84**	—	—	**3.48**	**1.52**	—
[F] Levels of N and P (kg ha^{-1})									
F_1 = 25.00 + 50.00	13.62	25.77	71.27	33.07	—	—	21.80	46.36	17352
F_2 = 18.75 + 37.50	12.96	23.87	71.16	32.97	—	—	21.24	42.64	16632
F_3 = 12.50 + 25.00	12.02	22.17	70.35	33.00	—	—	20.41	38.94	15595
C. D (P = 0.05)	**0.85**	**0.58**	**0.65**	**N.S.**	—	—	**N.S.**	**4.07**	—

ultimately resulted in higher plant growth. Similar results were also reported by Anon. (1994). The maximum pod yield (24.18 q ha^{-1}) and haulm yield (47.97 q ha^{-1}) were recorded under the treatment of drip irrigation with fertigation which were significantly higher over their respective surface irrigation method with fertilizer applied in soil (I_1). The magnitude of increase in pod and haulm yield due to drip irrigation with fertigation over surface method of irrigation were 13.81 and 13.78 per cent respectively. The higher pod and haulm yield under drip irrigation with fertigation could be attributed to the readily available nitrogen and phosphorus fertilizers in the vicinity of the root zone due to fertigation treatment, resulting in more efficient utilization of applied fertilizers than placement or band method (Hapase, 1993). The maximum net realization of Rs 19067 ha^{-1} was secured under drip irrigation with fertigation. The lowest net realization of Rs. 14624 ha^{-1} was realized with surface method of irrigation (I_1). A critical examination of data (Table 1) revealed that application of 100 per cent of recommended dose (25 N + 50 P_2O_5 kg ha^{-1}) of nitrogen and phosphorus tended to be advantageous for attaining higher plant height (13.62 cm), plant spread (25.77 cm), shelling percentage (71.27 %) and haulm yield (46.36 q ha^{-1}) over 50 per cent recommended dose of nitrogen and phosphorus. However, the application of 100 per cent of recommended dose of nitrogen and phosphorus was remained at par with 75 per cent of recommended dose of nitrogen and phosphorus in all the parameters except plant spread. The similar trends was also observed by Bhalerao *et al.* (1993). The test weight and pod yield of summer groundnut remained unaffected due to various levels of nitrogen and phosphorus. The maximum net realization of Rs. 17352 ha^{-1} was recorded with the treatment of 100 per cent recommended dose of N and P. It was found higher by 720 and 1757 Rs ha^{-1} over 75 and 50 per cent recommended dose of N and P respectively.

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Distribution of Micronutrients and Sulphur in Profiles of Some Soil Series in Amdavad District

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Periodical assessment for the micronutrient contents in the soils of Gujarat revealed an overall improvement in their status over the years (Dangarwala *et al.* 1994). It was also observed that among different districts, the Amdavad soils exhibited a considerable increase in available Fe, Mn and Cu contents, besides showing a decline in Zn deficiency. Hence, it was thought worthwhile to see the vertical distribution of these micronutrients and also sulphur in these soils. The information on serieswise distribution of micronutrient and sulphur contents in most of the soils of Gujarat to series level is quite meagre. Hence, the present investigation reports a depthwise distribution of micronutrient cations and sulphur in six representative soil profiles from the prominent series occurring in the district.

Six typical pedons of soil series viz., Kathlal (*Ktl*), Oganaj (*Ogn*), Silaj (*Slj*), Ranodar (*Rnd*)), Rakhiyal (*Rkl*) and Dehgam (*Dgm*) in Daskroi and Dehgam talukas were sampled in collaboration with the Soil Survey Division, Department of Agricultural, Nadiad. The soils of different series belong to the order of inceptisols except those of *Ogn*, which are Entisols. Soils of *Ktl, Dgm, Rkl* and *Rnd* are members of deep fine loamy mixed hyperthermic Fluventic Ustochrepts. They have been developed over mixed alluvium which is baseltic and sedimentary in nature. The *Ogn* pedon is a member of deep coarse loamy, mixed (calcareous) hyperthermic family of Typic Ustifluvents, whereas soils of *Slj* are members of deep fine loamy mixed hyperthermic family of Typic Ustochrepts. The soils of *Ogn* series exhibit sandy loam texture throughout the profile.

Soil samples of < 2 mm size were used for various laboratory determinations. The salient physico-chemical properties of the soils were determined by adopting standard procedures and their mechanical fractions according to International Pipette method. The available micronutirent cations, viz., Fe, Mn, Zn and Cu were extracted with DTPA-$CaCl_2$ solution (Lindsay & Norvell, 1978) and determined by using Atomic Absorption Spectrophotometer. The available sulphur, phosphorus and potassium contents were determined by extracting the soil with 0.15% $CaCl_2$, 0.05 M $NaHCO_3$ and neutral 1 N NH_4OAc, respectively. Earlier studies have

indicated that soils poor in organic C, available P_2O_5 and K_2O contents with high soil pH are relatively more prone to Zn deficiency. Similarly the deficiency of S is felt to a greater extent when the soils are having poor status with respect to available phosphate, available potash and organic C contents as well as when the pH of the soils was of the low order. The pH of all the soils barring those of *Slj* series irrespective of the depth was slightly alkaline in range (around 8.0), whereas those of exceptions were near neutrality. Similarly, almost all the soils were found to be having low soluble salts except those belonging to *Rnd.* series, wherein EC varied between 0.62 and 1.15 mmhos/cm. The contents of organic C in soils of different layers of profiles of *Ktl, Ogn, Slj,* and *Rnd* series varied narrowly between 0.08 and 0.24 per cent, while those of *Rkl* and *Dgm* series had around 0.3 to 0.5 per cent. The availability of phosphate in soils was low to high (12.8 to 67.9 kg/ha), while that of potash was generally medium (220 to 324 kg/ha).

Sulphur availability in soils of different profile-layers did not show any definite trend; and most of them could be rated as deficient according to the critical concentration of 12 mg kg^{-1} soil. The available S content ranged from 4.3 to 30.1 mg kg^{-1} in surface soils (Table 1). Significant correlation observed between available S and EC ($r = 0.76^{**}$) indicates that sulphate ions contribute to the extent of nearly 58 per cent of the accumulation of soluble salts. Likewise, generally most of the soils under investigation showed marginal status with respect to available Zn and Fe, whereas availability of Mn and Cu could be rated as fairly adequate (Table 1).

A perusal of data given in Table 1 also indicated that in general, the DTPA-Zn showed declining trend with increase in the soil depth. Almost, identical trends were noticed for DTPA-extractable Fe and Mn, while such consistency was not found in case of Cu. However, exceptionally high or low values of the element at some depth from that of the normal trend might be due to either irregular distribution of the nutrient for some inexplicable reasons or unknown contamination of the respective samples. The results also revealed that soils belonging to *RKl* and *Ktl* series could be considered as moderate in available Fe content based on critical concentration of DTPA-Fe (5.0 mg kg^{-1} soil), whereas rest of the soils of different series as deficient to marginal.

It appears that DTPA-Fe is negatively influenced by the content of soil organic carbon ($r = -0.37^{**}$). Organic matter influences nutrient availability of a soil either due to fixation or release through solubilization. Hence, positive and negative associations are encountered between the two depending upon other soil parameters. In general, it gives negative correlation, as little excessive quantity of organic matter may reduce temporarily the availability of nutrients especially of trace elements. The soils of *Slj* series throughout the profile had shown very high DTPA-Mn content (Table 1). The higher Mn availability of the soils of this series could be attributed to nearly neutral reaction of those soils (pH 7.2 to 7.4), as the DTPA-Mn had shown negative and highly significant correlation ($r = -0.57^{**}$) with soil pH. Similar results also have been reported by several workers (Tripathi *et al.,* 1994, Kumar *et al.,* 1994).

TABLE 1

Physico-chemical properties of soil series of Amdavad district.

Sr. No.	Name of series	Depth (cm)	Textural class	Particle size distribution (%)				pH (1:2)	EC dSm^{-1}	Org. C (%)	Av. P_2O_5 kg ha^{-1}	Av. K_2O (kg ha^{-1}	Av. S (ppm)	Micronutrient cations (ppm)			
				Clay	Silt	Coarse sand	Fine sand							Fe	Mn	Zn	Cu
1.	Kathlal (Ktl)	0-18	Ls	12.8	15.4	70.9	0.9	8.1	0.45	0.17	43.2	220	4.3	2.9	4.9	1.80	1.1
		18-39	Sl	18.2	26.0	54.6	1.2	8.0	0.24	0.24	11.8	201	11.5	6.6	19.8	0.50	1.6
		39-75	Sl	17.7	23.9	55.5	2.9	7.8	0.11	0.11	17.3	182	7.4	6.3	16.6	1.40	1.4
		75-112	Sl	18.8	25.0	55.2	0.8	7.8	0.13	0.13	14.8	191	2.7	6.6	21.5	0.14	1.2
		112-150	Sl	19.8	20.2	54.9	4.5	7.8	0.08	0.08	17.1	191	5.5	5.8	13.2	0.34	1.2
2.	Rakhiyal (Rkl)	0-20	Sl	27.6	21.2	48.7	2.4	7.7	0.30	0.42	32.2	324	9.1	6.5	10.8	0.94	2.2
		20.78	Scl	23.5	25.6	49.2	1.8	7.8	0.14	0.21	34.5	157	3.7	9.2	24.7	0.70	1.0
		78-116	Scl	24.2	21.0	2.1	2.7	7.9	0.19	0.44	18.4	132	4.3	9.3	8.5	0.08	0.9
		116-150	Scl	17.6	17.1	63.0	2.4	8.1	0.18	0.46	18.4	128	5.9	6.1	6.5	0.06	0.7
3.	Dehgam (Dgm)	0-20	Sl	18.8	17.7	60.3	3.3	7.6	0.42	0.50	27.6	302	11.5	6.0	7.2	0.50	0.8
		20-44	Cl	29.6	22.6	45.8	2.1	7.7	0.36	0.34	18.4	236	11.1	6.0	14.6	1.24	1.5
		44-80	Cl	35.5	26.3	35.0	3.2	8.1	0.44	0.35	16.1	216	15.6	6.2	16.5	0.28	1.4
		80-124	Cl	38.8	24.9	34.2	2.1	7.5	0.21	0.30	16.1	201	9.1	5.4	8.3	0.56	1.0
		124-150	Cl	39.0	26.8	31.0	3.2	7.6	0.20	0.21	16.1	186	10.9	5.9	14.8	0.36	1.1
4.	Oganaj (Ogn)	0-18	Sl	17.8	20.1	60.5	1.6	8.1	0.37	0.17	67.9	221	7.3	6.3	6.7	0.98	0.8
		18-46	Sl	19.3	22.7	56.6	1.4	8.2	0.41	0.15	42.1	152	1.3	4.8	10.3	0.40	1.0
		46-73	Sl	17.1	23.9	56.4	2.7	8.3	0.34	0.20	42.1	118	2.0	5.4	8.7	0.24	0.7
		73-105	Sl	16.9	23.9	55.9	3.3	8.1	0.35	0.12	30.6	113	11.5	5.7	8.8	0.16	0.7
		105-150	Sl	16.8	25.2	56.4	1.6	8.0	0.37	0.13	76.7	123	14.5	3.6	6.2	0.36	0.8
5.	Silaj (Slj)	0-15	Sl	19.9	23.0	54.9	2.2	7.3	0.40	0.16	23.1	275	10.0	6.9	75.2	0.80	1.5
		15-50	Sl	23.9	22.3	50.1	4.3	7.2	0.30	0.14	29.2	201	3.7	5.2	66.5	0.36	1.6
		50-87	Scl	25.3	23.2	49.6	1.9	7.4	0.33	0.12	14.4	201	1.1	3.9	38.2	0.56	1.1
		87-115	Scl	26.3	25.8	44.7	3.2	7.2	0.26	0.11	49.3	201	5.5	5.2	36.7	0.50	1.1
		115-150	Scl	28.6	25.4	45.9	1.0	7.4	0.26	0.10	46.8	211	4.9	3.4	41.1	0.38	0.9
6.	Ranodar (Rnd)	0-20	Scl	25.0	23.9	46.8	4.4	8.0	1.15	0.13	12.8	294	30.1	5.1	15.9	0.78	1.3
		20-48	Scl	28.2	23.9	45.6	2.3	8.0	0.62	0.15	18.0	191	11.5	4.8	7.6	0.48	1.5
		48-73	Cl	27.6	30.1	32.8	7.5	7.9	0.73	0.12	49.8	211	19.9	3.9	8.1	0.78	1.5
		73-114	Cl	30.9	35.2	31.4	2.5	7.8	1.05	0.17	42.8	206	24.5	4.2	7.4	0.60	1.9
		114-150	Cl	32.7	37.5	26.9	2.9	7.5	1.00	0.11	55.6	191	20.2	4.0	5.7	0.45	1.0

Ls = Laomy sand; Sl = Sandy loam; Scl = Sandy clay loam; Cl = Clayey.

The results confirmed the earlier reports by Dangarwala *et al.* (1994). However, the available contents of Fe and Zn were not under sufficiency range in all the soils. Moreover, subsequence soils were also by and large deficient to marginal in Zn and Fe. Besides, the micronutrients, the soils were found deficient in available S also. The results, therefore, suggest relatively greater need of sulphur fertilization for crops especially oilseeds grown on these soils to obtain higher yields. Further, the crops might also exhibit deficiency symptoms of Fe and Zn, if not properly managed by making judicious use of Fe and Zn fertilizers. Deficiencies of Mn and Cu are not likely in these soils. Liberal addition of organic matter is desirable.

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Interrelationship of Seed Yield With its Components in F_5 Generation of Cowpea

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The phenotypic and genotypic correlation coefficients were estimated in respect of 180 paired combinations of nine characters in five selection procedures of four cowpea crosses and are appended in Table 1. Five selection procedures viz., pedigree selection for early flowering [PS(EF)], pedigree selection for high yield [PS(HY)], mass selection [MS], single seed descent [SSD] and random bulk population [RBP] applied in F_2 (Summer, 1991), F_3 (*kharif*, 1991) and F_4 (Summer, 1992) generations in four cowpea crosses. PS (EF), PS (HY) and MS were conducted by selecting 80 superior plants from F_2 to F_4. One seed from each plant taken and bulked under SSD. Seeds from remaining plants were bulked for RBP. A total of 500 plant to progenies (25 plants selected in each F_4 for each of the five selection procedures) were evaluated in F_5 (*Kharif*, 1992) in Compact Family Block Design with two replications. The plot size was single row of 5.25 m length for progenies at 45 x 15 cm spacing. Observations were recorded in five randomly selected plants in each progeny per replication in respect of yield and its component traits (Table 1). Correlation coefficients at genotypic and phenotypic levels were computed according to Al-Jibouri *et al.* (1958).

The results indicated that in general the values of genotypic correlation were slightly higher than the corresponding phenotypic correlation counterparts between seed yield and its components in most of the selection procedures of four crosses. These results are in agreement with the findings of Jambukia (1987) and Solanki (1991) in cowpea. Cheverud (1988) suggested that these observations of high genotypic correlaton may partly be due to the bias towards high integration of the correlation matrix inherent in the method of estimating the genetic covariance matrix. In a few cases, however, the phenotypic correlations were slightly higher than their genotypic correlations which suggested that non-genetic causes inflated the values of genotypic correlation.

The main usefulness of genotypic correlation is to strengthen the interpretations based on phenotypic correlation (Pandey and Gritton, 1975). In the present study, seed yield per plant exhibited strong and positive association at genotypic as well as significant

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TABLE 1

Correlation coefficients of various characters with seed yield per plant in F5 generation of cowpea.

Selection procedures		*Days to 50% flowering*	*Days to maturity*	*Plant height*	*Branches per plant*	*Clusters per plant*	*Pods per plant*	*Pod length*	*Seeds per pod*
				Pusa Falguni x V 269 (cross 1)					
PS (EF)	G	0.23	0.43	0.16	0.89	0.41	0.90	0.14	0.20
	P	0.08	0.16	0.11	0.85**	0.41*	0.87**	0.41*	0.09
PS (HY)	G	-0.01	0.17	0.46	0.65	0.48	0.87	0.25	0.22
	P	-0.02	0.01	0.45*	0.64**	.0.47*	00.86**	-0.26	0.15
SSD	G	0.16	-0.18	-0.28	0.92	0.73	0.98	-0.09	0.06
	P	0.08	-0.08	-0.16	0.86**	0.67**	0.95**	-0.04	0.06
MS	G	-0.32	-0.06	0.28	0.88	0.82	0.96	-0.20	-0.30
	P	-0.15	-0.03	0.10	0.84**	0.77**	0.94**	-0.11	.-0.28
RBP	G	-0.12	0.47	0.38	0.91	0.66	0.94	0.34	0.34
	P	-0.14	0.17	0.21	0.88**	0.65**	0.94**	0.23	0.21
				GC 1 x RC 8 (cross 2)					
PS (EF)	G	-0.10	-0.43	0.38	0.84	0.81	0.93	0.14	0.13
	P	-0.10	-0.19	0.27	0.82**	0.75**	0.85**	0.07	0.03
PS (HY)	G	0.06	0.19	0.20	0.93	0.81	1.03	-0.22	-0.02
	P	-0.05	0.04	0.12	0.91**	0.78**	0.93**	-0.18	-0.02
SSD	G	0.14	0.35	-0.08	0.98	0.98	0.96	0.03	0.19
	P	0.17	0.25	-0.03	0.95**	0.93**	0.95**	0.04	0.13
MS	G	0.62	-0.05	0.06	0.96	0.79	0.99	-0.10	0.01
	P	0.42*	0.03	0.05	0.93**	0.78**	0.93**	-0.02	0.04
RBP	G	-0.28	-0.10	-0.04	0.81	0.85	0.89	-0.22	-0.06
	P	-0.14	0.10	-0.16	0.79**	0.73**	0.91**	-0.07	0.01

1.		2.	3.	4.	5.	6.	7.	8.	9.
GC 2 x V 16 (cross 3)									
PS (EF)	G	2.56	0.34	-0.04	0.91	0.80	0.98	0.19	-0.15
	P	0.31	0.13	0.06	0.90**	0.75**	0.94**	0.08	-0.01
PS (HY)	G	0.32	0.29	0.30	0.92	0.90	0.99	0.40	0.02
	P	0.28	0.25	0.27	0.90**	0.85**	0.97**	0.31	0.02
SSD	G	0.20	-0.17	-0.12	0.94	0.91	0.96	0.04	0.29
	P	0.13	-0.17	-0.02	0.91**	0.84**	0.95**	0.00	0.16
MS	G	0.28	0.27	0.16	0.82	0.76	0.87	-0.33	0.13
	P	0.26	0.19	0.06	0.81**	0.73**	0.81**	-0.22	0.09
RBP	G	0.01	0.14	0.03	0.60	0.61	0.83	0.05	0.28
	P	-0.02	-0.04	0.03	0.67**	0.60**	0.85**	0.07	0.24
GC 2 x V 240 (cross 4)									
PS (EF)	G	-0.30	-0.31	-0.35	0.87	0.82	0.98	-0.28	-0.24
	P	-0.28	-0.23	-0.30	0.86**	0.77**	0.93**	-0.21	-0.21
PS (HY)	G	-0.06	0.22	0.07	0.96	0.90	0.98	0.53	-0.27
	P	-0.05	0.22	0.07	0.95**	0.87**	0.94**	0.37	-0.13
SSD	G	0.06	0.04	-0.28	0.94	0.91	0.95	-0.01	-0.42
	P	0.05	-0.01	-0.20	0.91**	0.87**	0.92**	0.08	-0.25
MS	G	0.03	0.07	-0.23	0.94	0.92	0.96	0.11	-0.09
	P	-0.01	0.05	-0.23	0.89**	0.87**	0.94**	0.05	0.03
RBP	G	-0.02	-0.39	-0.38	0.82	0.74	0.97	0.17	0.42
	P	-0.08	-0.11	-0.24	0.84**	0.74**	0.93**	0.22	0.11

*, ** Significant at P = 0.05 and P = 0.01 levels, respectively.
G and P indicates genotypic and phenotypic correlation, respectively.

and positive association at phenotypic levels with branches per plant, clusters per plant and pods per plant in all the five selection procedures of all the four crosses. This indicated that functionally related traits tend to be highly integrated morphologically and their phenotypic correlation structure confirms to the functional relationship structure (Cheverud, 1982). In addition to these associations, significant and positive relationship of seed yield with pod length on PS (EF) and plant height in PS (HY) were observed in cross 1 and with days to 5 per cent flowering in MS method of cross 2. The rest of the phenotypic associations of seed yield with other traits were non-significant.

Considering the interrelationship of various component characters with seed yield, it would be possible to develop an ideal plant type of cowpea having large number of pods with profused branching and bearing more bundles of pods per plant. Due weightage should be given to these traits in selection schemes in order to improve yield potential of cowpea.

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Reaction of Some Pre-Release Cultures to Paddy Pests and its Yield Potential

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Although good progress has been made to develop varieties resistant/tolerant to pests, use of insecticides in a limited way would continue as one of the components of pest control (Kalode, *et al.* 1977). Host plant resistant and need based chemical control are the two major components of IPM. Gangawar and Dasgupta (1986) also opined that routine chemical protection was uneconomic, whereas supervised control based on need has been recommended. Therefore, it is highly essential to generate information on the cultures towards reaction to insect pests and yield potential prior to their release. Keeping this view in mind the present study was carried out to evaluate the level of resistance in some of the pre-release cultures against major paddy pests which ultimately determine the degree of protection to be offered for achieving maximum yield.

For the purpose, a field trial was laid-out in split plot design with four replications at the Main Rice Research Station, Gujarat Agricultural University, Nawagam (Gujarat).

TABLE 1

Details of cultures/varieties used in study.

Culture/variety	*Cross*	*Grain type*
IET-12875	Swarnadhan x RP-2579-37	LB
IET-11768	Ratna x ARC 5984	LS
IET-13998	IET-5656 x RP-1579-37	LS
IET-12769	IET-7302 x IET-6262	LS
IET-12537	Ratna x ARC 10654	LS
Narmada	T. N. 1 x Basmati 370	LS
Jaya	T. N. 1 x T. 141	LB
GR-11	Z-31 x IR-8-246	LS

LB = Long and bold LS = Long and slender

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during *kharif* 1996. Need based plant protection (P_1) and no protection (P_2) throughout the crop period were the main plot treatments. The sub-plot treatments comprised of six pre-release (Table 1) cultures/varieties alongwith Jaya as susceptible check and GR-11 a local high yielding variety (susceptible check) were also included for comparison. Gross and net plot size were 5.0 x 4.95 and 3.8 x 3.75 m, respectively. Seedlings were transplanted at 20 x 15 cm spacing during first week of August 1996. Need based application of carbofuran 3G (0.75 kg a.i./ha) and monocrotophos 36 WSc (0.75 kg a.i./ha) were given on 23rd September and 8th October 1996, respectively.

TABLE 2

Incidence of leaf folder and white backed plant hopper in different cultures/varieties of paddy.

Treatments	*% leaves damaged by LF*	*Mean No. of WBPH/ hill*	*Yield (kg/ha)*	
			Grain	*Fodder*
Main plots				
P_1 = Protected	3.60	13.89	3327	5272
P_2 = Unprotected	10.35	19.41	2054	4921
S. Em. ±	0.24	1.65	65.18	118.5
C. D. at 5%	1.06	MS	293.30	NS
C. V. (%)	19.18	17.57	13.71	13.19
Sub-plots				
IET-12875	6.34	24.46	0899	2789
IET-11768	6.47	22.26	2311	4000
IET-13998	6.70	8.15	3689	6026
IET-12769	6.44	10.35	4136	6921
IET-12537	7.00	8.96	3987	7175
Narmada	3.94	8.24	3895	6474
Jaya (Check)	9.60	26.19	1373	3624
GR-11 (Check)	9.33	24.60	1232	3772
S. Em. ±	0.55	2.18	120.8	230.3
C. D. at 5%	1.58	6.59	344.9	657.6
C. V. (%)	22.43	17.28	12.70	12.78

NS = Not Significant.

Incidence of leaf fodder (LF), *Cnaphalocrocis medinalis* Guen and white backed plant hopper (WBPH), *Sogatella furcifera* (Horv.) were observed during the season. Observations on LF and WBPH were recorded when the incidence was at peak level. For the purpose, total number of leaves and LF damaged leaves were counted in 10 hills selected randomly from net plot. Similarly, WBPH populations were recorded from 10 hills in net plot area. The crop was harvested during first week of November. At harvest, grain and fodder yields were recorded separately from each net plot. Data obtained were statistically analyzed and presented in Table 2.

Results (Table 2) revealed that the incidence of LF was significantly reduced due to need based plant protection over unprotected plots. Similarly, hopper population was lowered in the former treatment than the latter, however, the difference was not enough to prove the superiority of the chemical treatments. Anonymous (1996) also reported that the need based protection lowered the population of WBPH in all the test entries. Pest incidence differed significantly amongst the cultures evaluated. Significantly least (3.94%) damage of LF was noticed in variety Narmada. Both the susceptible check (Jaya and GR-11) exhibited highest (9.33 to 9.60%) incidence of the pest. Remaining cultures showed damage ranging from 6.34 to 7.0% incidence. The differences among cultures/varieties with regard to WBPH population were significant. Significantly low (8.15 to 10.35 hopper /hill)population of WBPH recorded in the cultures of IET-13998, Narmada, IET-12537 and IET-12769 than the susceptible checks (24.46 to 24.60 hoppers/hill).

Grain yield was significantly enhanced due to need based application of plant protection treatments, however, it did not influenced fodder yield. Increase in grain yield Irrespective of cultures owing to chemical treatments was about 12.73 q/ha (61.97%). Increase in yield from 16.74 to 31.32 q/ha with chemical protection as compared to that of without protection reported by Yein and Rahman (1984) supports the present findings. Significantly highest (4136 kg/ha) grain yield was registered in culture IET-12769 followed by IET-12537, Narmada and IET-13998. More or less similar trend was noticed in case of fodder yield. As per the report of Anonymous (1996), the IET-12769 followed by IET-13998 under protected and IET-13998 followed by IET-12769 under unprotected conditions were the best yielder, are in accordance with present results. The culture IET-12875 produced lowest grain and fodder yields.

Based on pest incidence and yield potential, it can be concluded that the cultures IET-12769, IET-12537 and IET-13998 could be judged as promising pre-release cultures. These cultures can be used as donors for generating resistant breeding lines for crop improvement programme.

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In *vitro* Evaluation of Phytoextracts Against *Drechslera hawaiiensis* Bougn

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Nineteen phytoextracts were evaluated *in vitro* by paper disc method against *Drechslera hawaiiensis*. Results on inhibition zone recorded after 24, 48, 72 and 96 hr. of incubation revealed that extracts of garlic, eucalyptus, datura, soapnut and oinion bulb inhibited the growth of the *Drechslera hawaiiensis* as compared to control. However, garlic recorded maximum inhibition zone followed by eucalyptus, datura and soapnut.

In order to exploit the phytoextracts as non-chemical approach for management of *Drechslera hawaiiensis* causing leaf blight of papaya, nineteen various phytoextracts (Table 1) were evaluated *in vitro* by paper disc method (Thornberry, 1950).

Healthy 100 g leaves or rhizomes were washed thoroughly, cut into pieces and homogenised in a blender for 3-5 minutes in the sterile distilled water in 1 : 1 (w/v) ratio. It was filtered through double layered sterilized muslin cloth and stored in retrigerator. The extracts thus prepared were considered 1 : 1 extracts. The conidial suspension of *Drechslera hawaiiensis* having 125-150 conidia per low power microscopic field (100 x) was aseptically added to the autoclaved PDA supplemented with 200 ppm streptocyclin for avoiding becterial contamination. Thus PDA seeded with conidia of *Drechslera* sp. was poured into sterile petriplates and was allowed to solidify. On this medium four sterilized paper discs (5 mm diameter) each were placed aseptically at equidistance after dipping in each phytoextract. Paper discs dipped in sterile distilled water served as control. Eight replications of each treatment were maintained. The plates were incubated at ambient temperature (27 ± 2°C) for the growth and development of the fungus. Diameter of the inhibition zone in each case was periodically recorded and average inhibition zones computed.

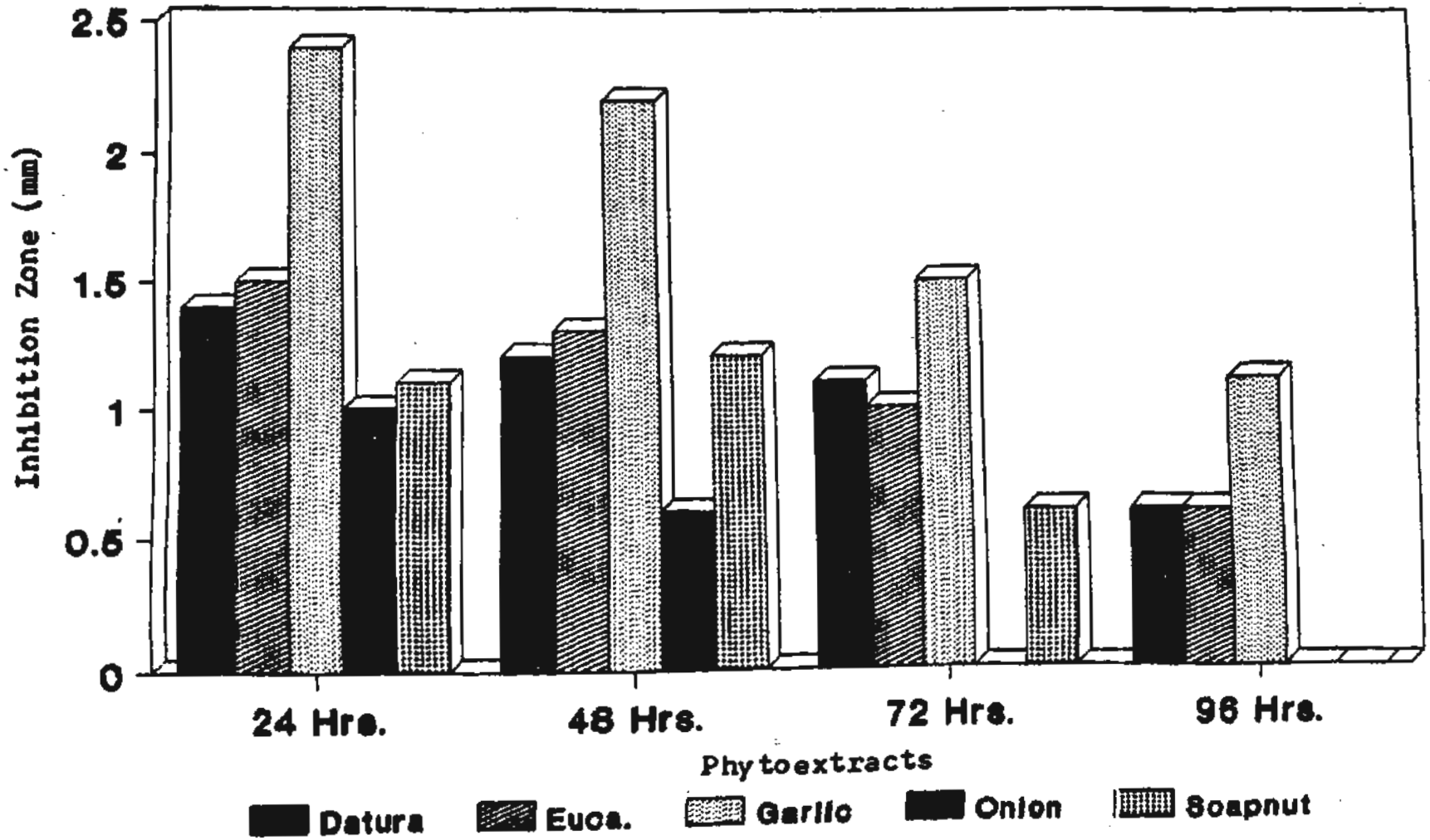
The results (Table-1) indicated that out of 19 phyto-extracts belonging to five families, extracts of five plants namely garlic, eucalyptus, datura, soapunt and onion bulb inhibited the growth of the *Drechslera hawaiiensis* as compared to control.The phytoextract of garlic produced maximum inhibition zone followed by eucalyptus, datura and soapunt while phyto-extract of onion bulb produced least inhibition zone and proved comparatively less inhibitory. No inhibitory

TABLE 1

Effect of various phytoextracts on the growth of *D. hawaiiensis*.

Sr. No.	Phytoextracts	Inhibition Zone (mm) 24 hr	48 hr	72 hr	96 her	Av.
1.	Ardusi (*Adathoda vesica* Nees)	0.0	0.0	0.0	0.0	0.0
2.	Barmasi (*Vinca rosea* L.)	0.0	0.0	0.0	0.0	0.0
3.	Bhoyringni (*Solanum xanthocarpum* Schd.)	0.0	0.0	0.0	0.0	0.0
4.	Black-tulsi (*Ocimum sanctum* L.)	0.0.	0.0	0.0	0.0	0.0
5.	Castor (*Ricinus communis* L.)	0.0	0.0	0.0	0.0	0.0
6.	Datura (*Datura stramonium* L.)	1.4	1.2	1.1	0.8	1.07
7.	Eucalyptus (*Eucalyptus citriodora* Hook)	1.5	1.3	1.0	0.8	1.10
8.	Garlic (*Allium sativum* L.)	2.4	2.2	1.5	1.1	1.82
9.	Garmalo (*Cassia fistula* L.)	0.0	0.0	0.0	0.0	0.0
10.	Ginger (*Zingiber officinales* Roscoe)	0.0	0.0	0.0	0.0	0.0
11.	Lantana (*Lantana camera* L.)	0.0	0.0	0.0	0.0	0.0
12.	Cnahendi (*Lawsonia inermis* L. ex. choisy)	0.0	0.0	0.0	0.0	0.0
13.	Nafatia (*Ipomoes fistulosa* Mart ex. choisy)	0.0	0.0	0.0	0.0	0.0

Fig. 1 : Effect of various phytoextracts on the growth of *D. hawaiiensis.*



1.	2.	3.	4.	5.	6.	7.
14.	Neem (*Azadirachta indica* Juss)	0.0	0.0	0.0	0.0	0.0
15.	Onion (bulb) (*Allium cepa* L.)	1.0	0.6	0.0	0.0	0.4
16.	Onion (leaves) (*Allium cepa* L.)	0.0	0.0	0.0	0.0	0.0
17.	Soapnut (*Sapindus trifoliata* L.)	1.1	1.2	0.6	0.0	0.72
18.	Sweet - neem (*Marrraya koenigii* spreng)	0.0	0.0	0.0	0.0	0.0
19.	Turmeric (*Curcuma longa* L.)	0.0	0.0	0.0	0.0	0.0

effect on the growth of *D. hawaiiensis* was produced by the phytoextracts of remaining plants species.

The antifungal properties of garlic, datura and onion bulb on various fungi have been reported by Sheikh and Agnihotri (1972 and 1977) and Misra and Dixit (1976). Our findings for these three phytoextracts are in similar line, whereas the antifungal properties of the extracts of eucalyptus and soapnut against *D. hawaiiensis* reported here is new.

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Evaluation of Some Stain Removal Characteristics of Cotton Fabrics Used by Different Consumers and Its Economic Implications*

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One of the primary needs of mankind is clothing, proper care of which improves appearance and also increases the wearing ability. The care for garments and other products made of fabrics has always been a concern of consumers and is reflected in economy, the household budget, service-ability and appearance. Stain is a spot or mark of discolouration left on fabrics by the contact and absorption of some foreign substances. Moss (1961) and Lyle (1977) stated that prime importance in stain removal is identification of stain. Hingorani *et al.* (1983) suggested some basic concept of stain removal. The choice of the method used may vary amongst various consumers. Informations on these aspects are very meagre in Assam. Hence, the present investigation was carried out togather some useful informations on the stain removal characteristics of cotton fabrics by different consumers.

The present survey study was conducted at the Assam Agricultural University, Jorhat and nearby areas of the Jorhat city during 1992. Fifty respondents both housewives and students were selected for the survey. The data were collected through an interview schedule and were analysed for percentage of age group, community, educational qualification, marital status, family size, occupation, income, method used for stain removal and satisfaction of stain removal methods.

Results revealed that majority (52%) of respondents belonged to 25-40 years age group, most of which were Hindu (94%) with general caste (58%) having educational qualification graduates (58%). Percentage of married people were 66 with 62% having family of 3-5. Most of the respondents (42%) were wiithin the income group of Rs. 2001-3000 per month.

It was interesting to note that all the respondents were in favour of washing their clothes at home and most of them could identify stains on their clothes. About 62-72% respondents could assume the mud, *Sindur*, blood and milk tea stain whereas 44-50% could assume the coal tar and spittle stains, 24-40% ball pen ink and hair oil, pickle oil and mobil stain, 28-30% lipstick and grass stain. Only 12-18% respondents could assume cough syrup and rust stain.

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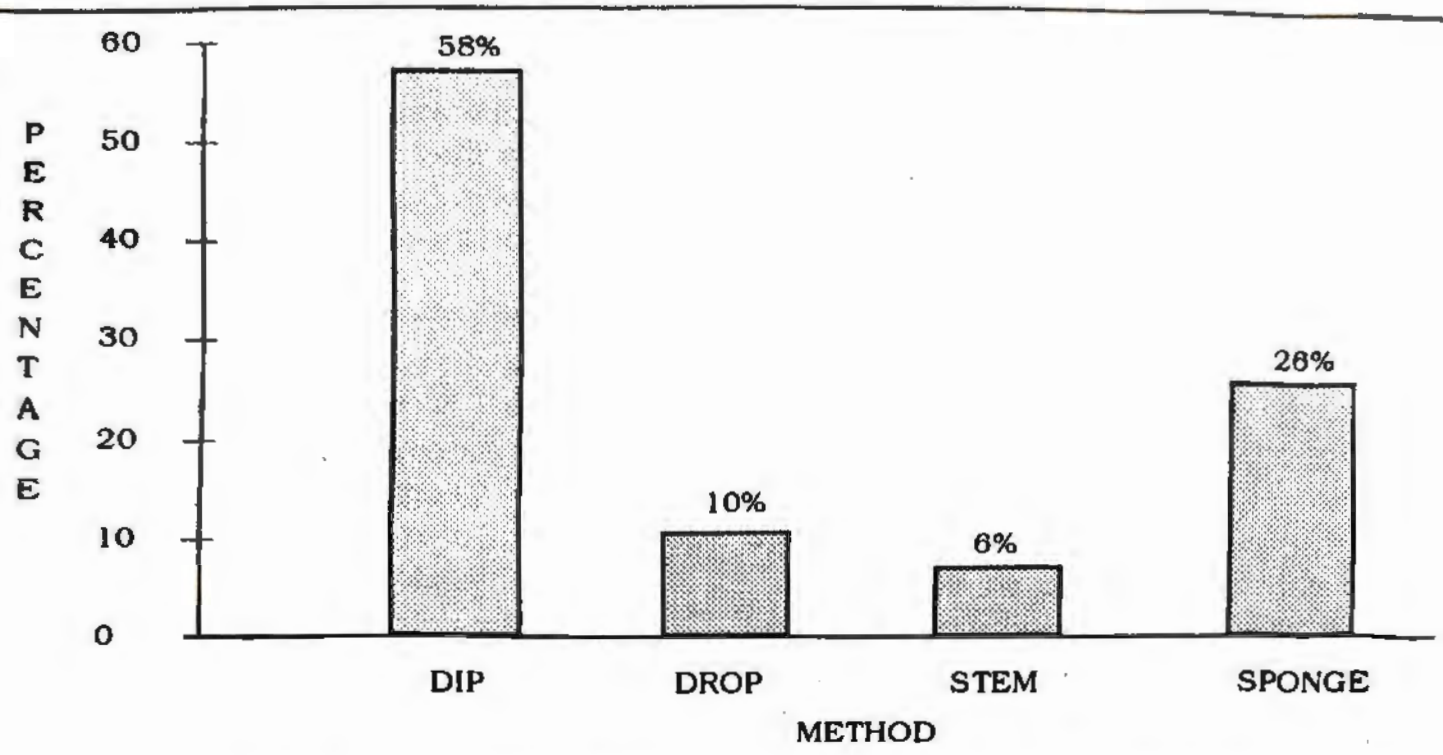

Fig. 1 : Percentage distribution of method used to remove the stain.

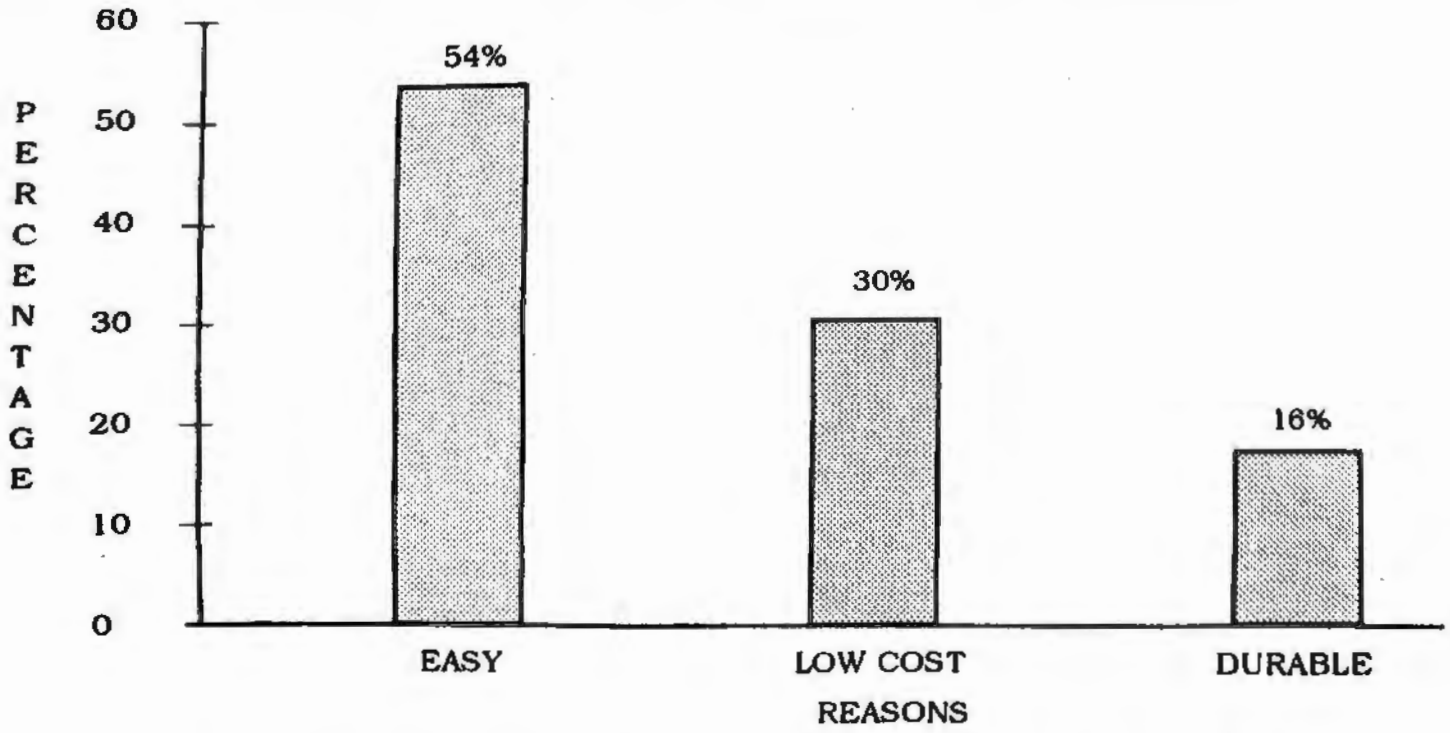

Fig. 2 : Percentage distribution of reasons which gave satisfaction for the method of stain removal.

Regarding removal of stains, it was noted that all the respondents knew only one treatment to remove stain. Majority (86%) remove stains from their clothes immediately and about 58% prefered to use dip method for removing the stain followed by sponge method (Fig. 1). For removal of blood, milk coffee, hair oil or pickle oil, lipstick, milk tea, spittle, cough syrup, grass, ball pen ink, rust and *sindur* stain, soap and water is used by 54.12, 36, 20, 8, 18, 10, 37, 14, 10 and 66% respondents, respectively. Lemon was used for removal of blood, milk coffee, milk tea, spittle, cough syrup, ball pen ink and rust stain by 4, 6, 10, 32, 2, 8 and 4% respondents, respectively. Kerosine oil was used by 44% respondents for coal tar and 4% used it for mobil stain. Only 10% respondents used salt and water for removal of blood stain. Out of the total population 54% were satisfied with the method they use, as they feel it was easy for them, 30% prefered to use the method because of low cost and 16% feel it to be durable (Fig. 2).

From the survey results it revealed that very few people knew different stain removal methods, the knowledge of which is very important in our day-to-day life. It is necessary to motivate people in a proper direction towards care of clothing to remove different stains from their clothes.

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