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Short Communications

Abstracts of Ph. D. Thesis

Response of Pearl-Millet Varieties to Improved Technology Under Rainfed Conditions

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ABSTRACT

A field experiment was conducted on medium black soil of Main Dry Farming Research Station, Targhadia during *kharif* season from 1984-85 to 1986-87 to evolve suitable technology towards boosting up pearlmillet production. The results revealed that significantly higher grain yield (15.9 q/ha) was recorded by using improved variety B. J. 104. The recommended fertilizer application of 75 kg N + 37.5 kg P_2O_5 / ha also yielded significantly higher grain (16.8 q/ha) over traditional method (15 kg N + 25 kg P_2O_5 / ba). Improved crop management did not exert significant influence on grain yield of pearlmillet. Increased benefit of Rs. 547 and 848 / ha was accrued by using improved variety and recommended dose of fertilizer, respectively over local variety of pearlmillet and traditional fertilizer dose.

(Received on 22nd Janu., 1993)

INTRODUCTION

Pearlmillet is one of the important food crops of the arid and semi-arid regions. The farmers still continue traditional production technique prevalent in the area which results in wide gap in the yield recorded at research centre and farmer's field. This is mainly due to differences in resource inputs and management practices. Use of dryland technology mainly involving the use of improved seeds, fertilizers, new methods of tillage and cultural practices have shown consistently higher production as compared to traditional farming practices. In order to generate the information on the effects of possible combinations of different steps of improved technology on crop yields and to work out efficiency of different production inputs the studies were initiated at Main Dry Farming Research Station, Targhadia.

MATERIALS AND METHODS

An experiment was conducted on medium black soil of clay texture during kharif seasons from 1984-85 to 1986-87 at Main Dry Farming Research Station, Targhadia. The soil of experimental plot was medium to low in available nitrogen and phosphorus and high in available potash having soil pH ranged from 7.7 to 8.2. The experiment was laid out in randomised block design with three replications. The eight treatments combinations comprised of two varieties viz., local (V_1) and improved B. J. 104 (V_2); two levels of fertilizer viz., traditional 15 kg N + 25 kg P_2O_5 / ha (F_1) and recommended

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dose 75 kg N +37.5 kg P_2O_5 / ha (F_2) and two crop management practices viz., local untreated seed, 5 kg/ha seedrate, 90 cm spacing and partial thinning (P_1) and improved treated seed, 3.75 kg/ha seedrate and 60 x 15 cm spacing (P_2). The gross and net plot size were 15.0 x 12.6 m and 13.0 x 10.0 m, respectively. The experiment was shown after sufficient rains received during all the seasons.

RESULTS AND DISCUSSION

The data on the effect of varieties, fertilizer and crop management on the yield of pearlmillet are presented in Table 1. The results on full graded technology are furnished in Table 2.

Contribution of varieties

Mean yield data based over a period of three years (Table 1) indicated that significantly higher grain yield was recorded in case of pearlmillet hybrid B.J.104 (15.9 q/ha) over local variety (12.5 q/ha). The magnitude of increase was 27.35 per cent by hybrid variety over local variety. Reddy and Reddy (1978) also observed higher grain yield with hybrid bajra as compared to prevalent variety.

Calculation of net ICBR of improved varieties v/s local variety showed that net amount of Rs. 31.18 can be realized by investing one rupee on seed of improved variety. Inherent genetic potential of hybrid variety is responsible for higher yield with B.J.104. The findings corroborate the reports of Sharma and Verma (1975) who also reported higher grain yield with hybrid variety of pearlmillet.

Contribution of fertilizer

Recommended application of fertilizer (75 kg N + 37.5 kg P_2O_5 /ha) out yielded the traditional application of fertilizer by recording significantly higher grain yield of 16.8 q/ha. An increase of 45.16 per cent in grain yield was recorded by recommended level over traditional level. The results also showed that use of recommended level of fertilizer is more remmunerative. The net Rs. 1.59 was realised by investing a rupee on the fertilizer. The hybrid varieties of pearlmillet are highly responsive to application of fertilizer which attributed to higher yield (Nirval and Upadhyay, 1979 and Gautam and Kaushik, 1981).

Contribution of crop management

Grain yield due to management was not significantly influenced. Reddy and Reddy (1978) found no significant affect on grain yield of bajra due to varying row spacing. However, marginal increase in grain yield was noted by adoption of improved management practices as compared to traditional practices.

Contribution of all the factors (full graded technology)

Data presented in Table 2 on grain as well as fodder yield showed that different combination of various important inputs responded in increasing the yields of pearlmillet crop. Maximum increase in average grain yield was recorded (97 per cent) due to application of all the three improved practices ($V_2 F_2 P_2$). However maximum net realization was recorded in treatment combination $V_2 F_1 P_1$ (1:20.55) followed by $V_2 F_1 P_2$ (1:10.14) and $V_2 F_2 P_2$ (1:3.13).

ACKNOWLEDGEMENTS

The authors are grateful to All India Co-Ordinated Research Project for Dry land Agriculture for providing facilities for research. Thanks are also due to Dr. M. R. Vaishnav and his colleague for statistical analysis of data.

TABLE 1

Yield of pearl millet under different production inputs with economics return.

Treatments	Yield (q / ha)						Pooled yield (q / ha)		Add. grain yield (q / ha)	Increased cost (Rs. / ha)	Increased benefit (Rs. / ha)	Gross ICBR over local	Net ICBR
	1984 - 85		1985 - 86		1986 - 87								
	Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover					
Variety													
V_1 (Local)	16.6	50.4	10.1	37.3	10.7	50.8	12.5	46.1	---	---	---	---	---
V_2 (Improved)	22.5	36.9	12.4	29.7	12.7	37.5	15.9	34.7	3.42	17.00	547.00	1 : 32.18	1 : 31 .18
CD 5 %	1.45	1.46	1.01	1.93	1.56	5.74	1.27	---	---	---	---	---	---
Fertilizer													
F_1 (Traditional)	16.1	41.9	10.1	30.1	8.4	35.2	11.6	35.7	---	---	---	---	---
F_2 (Recommended)	23.0	45.4	12.3	36.8	15.1	53.1	16.8	45.1	5.24	323.25	848.40	1 : 2.59	1 : 1.59
CD 5 %	1.45	1.46	1.01	1.93	1.56	5.74	1.27	---	---	---	---	---	---
Crop Management													
P_1 (Local)	19.0	42.6	10.2	32.8	11.6	41.3	13.6	38.9	---	---	---	---	---
P_2 (Improved)	20.1	44.6	12.3	34.2	11.9	47.0	14.8	41.9	---	---	---	---	---
CD 5 %	N.S.	1.46	0.01	N.S.	N.S.	N.S.	N.S.	---	---	---	---	---	---

N.S. = Not significant.

ICBR = Incremental Cost Benefit Ratio - Increased benefit divided by increased cost.

Note = None of the interaction was found significant.

TABLE 2

Yield of pearl millet under different treatments combination with economics return.

Treatments	*Average yield (q/ha)*		*Additional grain yield (q/ha)*	*Increased cost (Rs./ha)*	*Increased benefit (Rs./ha)*	*ICBR over local*	*Net ICBR*
	Grain	*Stover*					
$V_1F_1P_1$	9.99	38.87	---	---	---	---	---
$V_1F_1P_2$	10.38	42.20	0.39	37.00	62.40	1 : 1.88	1 : 0.88
$V_1F_2P_1$	14.34	52.35	4.35	323.25	696.00	1 : 2.15	1 : 1.15
$V_1F_2P_2$	15.32	50.23	5.33	360.25	852.80	1 : 2.36	1 : 1.36
$V_2F_1P_1$	12.28	27.12	2.29	17.00	366.40	1 :21.55	1 :20.55
$V_2F_1P_2$	13.75	33.81	3.76	54.00	601.60	1 :11.14	1 :10.14
$V_2F_2P_1$	17.94	37.35	7.95	340.25	1272.00	1 : 3.73	1 : 2.73
$V_2F_2P_2$	19.74	40.61	9.76	377.25	1560.00	1 : 4.13	1 : 3.13

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Seasonal Incidence and Effect of Minimum Temperature and Vapour Pressure on the Population of Mango Hopper *Amritodus atkinsoni* Leth in Middle Gujarat

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ABSTRACT

The mango hopper, *Amritodus atkinsoni* Leth. is an important and regularly occurring insect-pest of mango in middle Gujarat. It remains active throughout the year in the cracks and crevices of the mango trunk. However, maximum hopper population was found in the first fortnight of May during 1989 and 1990, second fortnight of September during 1988 and second fortnight of March during 1991.The population on twigs was found only during the period when young leaves and inflorescences were available.

The effect of various meteorological factors on population build up of mango hoppers revealed that only minimum temperature ($r^2 = 0.64$) and vapour pressure ($r^2 = 0.73$) showed positive correlation.

(Received on 9th July, 1993)

INTRODUCTION

The mango hopper, *Amritodus atkinsoni* Leth. is an important pest of mango in the middle Gujarat region. Twenty five to 60 per cent loss in yield has been reported due to this pest attack (Wadhi and Batra, 1964). The nymphs and adults suck the cell sap from the young mango leaves and inflorescences resulting shooty mould on leaves and prematured fruit dropping. The population of hoppers vary from season to season probably due to weather factors which is dynamic. No information on effect of abiotic factors is available for mango hopper and therefore studies were carried out in the orchard of the Gujarat Agricultural University, Campus Anand during 1988 to 1991 by recording data on ten year old mango trees of variety 'Hansraj'.

MATERIALS AND METHODS

Ten Hansraj mango trees which were planted at an inter and intra row spacing of 8 m were randomly selected for the study. No insecticide spray was given to these trees. The population of hopper was recorded at fortnightly intervals throughout the year both from the trunk as well as twigs during morning hours by taking 5 sweeps each with a hand net from each tree.

The meteorological data were recorded daily in the nearby Agrometeorological observatory. The vapour pressure was worked out by the following formula :

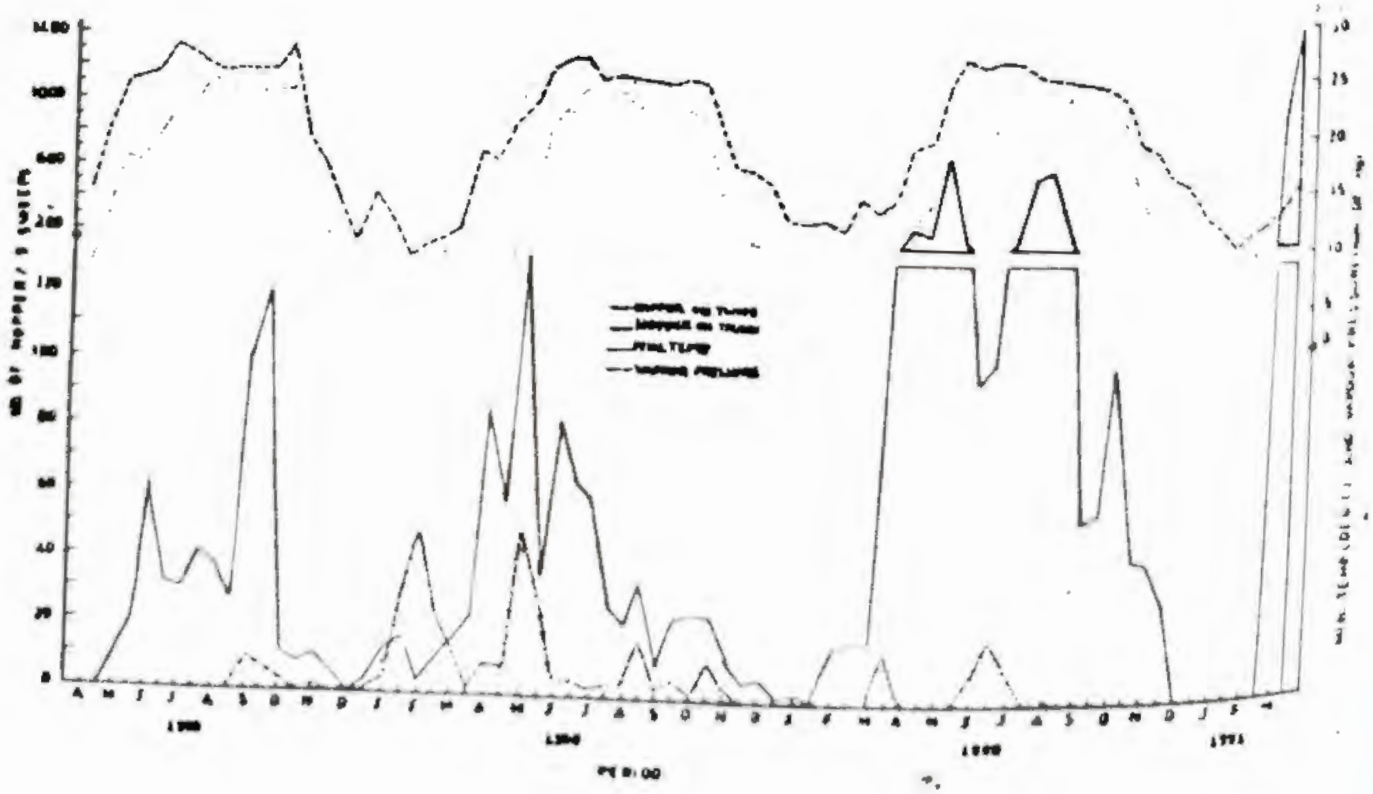
$$\text{Relative humidity (\%)} = \frac{\text{Actual vapour pressure}}{\text{Saturated vapour pressure}} \times 100$$

The simple graphical presentation were followed for analysis and statistical test for quantifying the effect of weather parameters on population of mango hopper.

RESULTS AND DISCUSSION

The activity of mango hopper, *A. atkinsoni* was observed throughout the year during the study period (Fig. 1). However, the maximum population on trunk was 120, 132, 680 and 1420 (hoppers/5 sweeps) during second fortnight of September in 1988, first fortnight of May in 1989 and 1990 and second fortnight of March in 1991 respectively, whereas, on twig it was 9, 50 and 20.5 during first fortnight of September in 1988, first fortnight of May in 1989 and second fortnight of June in 1990 respectively. Thus, it is clear from this study that even in the availability of leaves/inflorescences of mango the population build up of this pest was low may be due to weather effect. To find out relationship of abiot factors on *A. atkinsoni*, statistical analys was carried out with regression and correl tion technique. The correlationship of mir mum temperature and vapour pressure o population dynamics of mango hopper discussed below :

The correlation study revealed that a night became warmer the hopper popula tion started increasing. The higher hoppe population (75 per 5 sweeps) was observe during all the four years of study when minimum (20°C) temperature increased in association with increased vapour pres sure (21 to 25 mm of Hg), whereas, hopper population remained low (25 per 5 sweeps) at minimum temperature less than 15° C with 10 mm of Hg vapour pressure. To assess the effect of individual parameter on population build up of mango hopper differ ent mathematical relations were tried. The



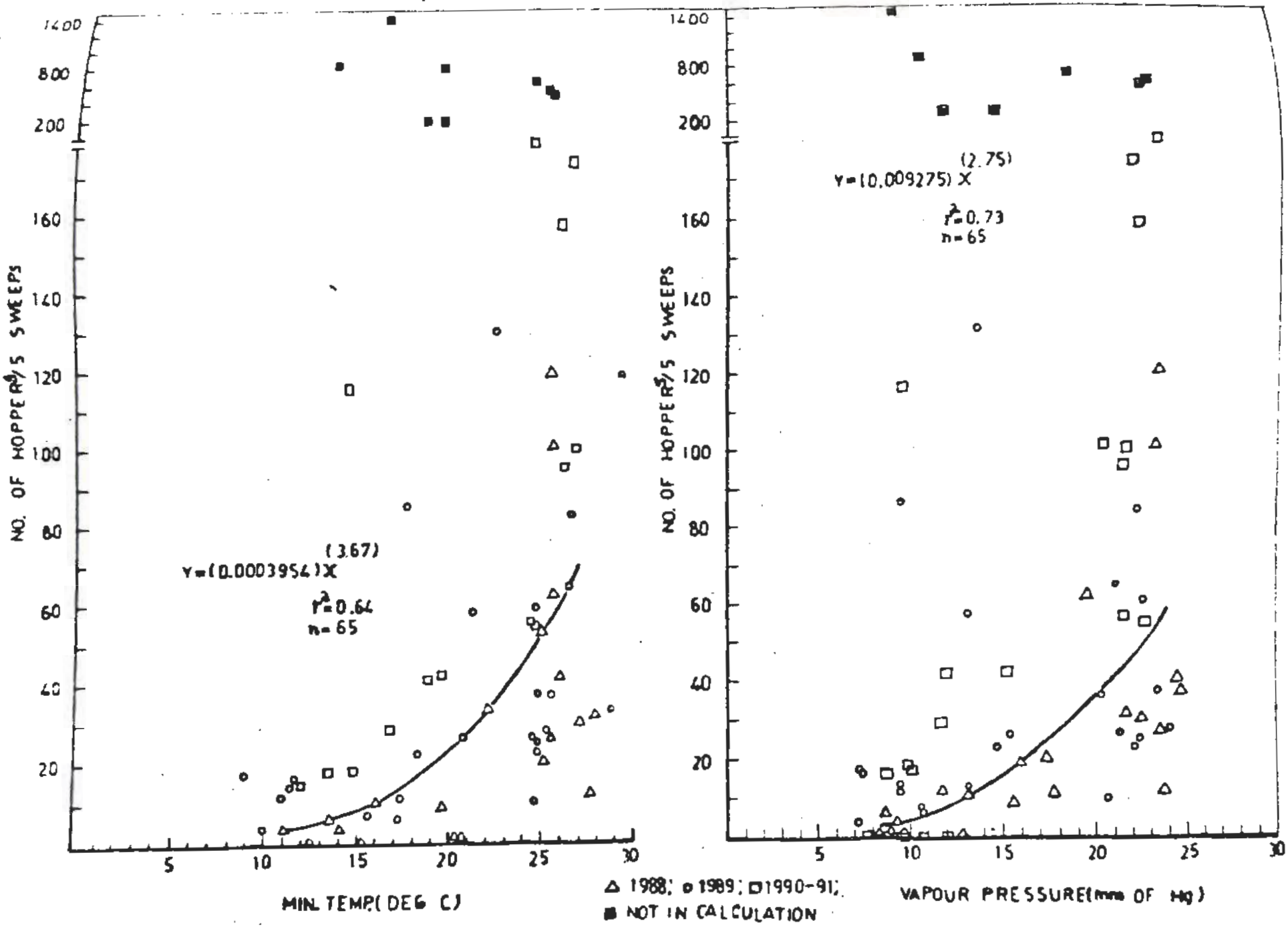


Fig. 2 : Effect of minimum temperature and vapour pressure on population build up of *A. atkinsoni*.

TABLE 1

Effect on minimum temperature and vapour pressure on *A atkinsoni.*

Minimum temperature (°C)	*Mean hoppers/5 sweeps/ trunk or twig* — *Vapour pressure (mm of Hg)*							*avarage*
	5 - 10		*11 - 15*		*16 - 20*		*21 -*	*25*
5-10	8	(4)+	-		-		-	8(4)
11-15	14	(15)	430	(2)	-		-	63(17)
16-20	502	(3)	50	(13)	-		-	135(16)
21-25	-		72	(3)	162	(5)	116(18)	119(26)
26-30	-		-		101	(1)	81(8)	84(9)
Average	80	(22)	96	(18)	152	(6)	105(26)	99(72)

\+ Number of observations.

following equations were obtained to estimate the mango hopper population based on minimum temperature and vapour pressure (Fig. 2.).

(i) $Y = (0.0003954) X^{(3.67)}$

(where $r^2 = 0.64$ and $n = 65$)
Y is number of hoppers per 5 sweeps
X is prevailing minimum temperature

(ii) $Y = (0.009275) X^{(2.75)}$

(where $r^2 = 0.73$ and $n = 65$)
Y is number of hoppers per 5 sweeps.
X is vapour pressure

The data on population build up of hopper at different vapour pressure and temperatures prevailed during night hours (Table 1) revealed consistent increase in hopper population from 8 to 135 with rise in temperature from 5° C to 20 ° C ,whereas reduction in hopper populations was found with rise in temperature from 21°C to 30° C. Similarly consistent influence of vapour pressure was also found on population build up of hoppers to the extent of 80 to 152 in a range of vapour pressure 5 to 20 mm of Hg.However, hopper population was reduced at higher vapour pressure.

As far as combined effects is concerned consistent increase in hopper population was observed at 5 to 20° C temperature coupled with 5 to 10 mm of Hg vapour pressure, whereas, hopper population was reduced with increase in temperature from 21° C vapour pressure more than 16 mm of Hg.

Thus from this study it may be concluded that minimum temperature and vapour pressure are two major abiotic factors affecting the population of mango hopper, *A.atkinsoni.*

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GAU Res. J. 1994. 20. (1) : 9-14

Intercropping in Cotton (*Gossypium hirsutum* L.)Under Rainfed Conditions

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ABSTRACT

Intercropping studies in cotton under rainfed conditions, on medium black soils, from 1977 to 85 at the Dry Farming Research Sub Station, Vallabhipur (Gujarat) revealed that cotton (variety GAU-Cot-10) sown in paired rows (60 to 120 cm) and intercropped with black gram or green gram was most remmunerative.This gave higher productivity per unit area over the sole crop of cotton. Other inter-crops studied were also found to be beneficial as compared to the sole cotton.

(Received on 29th Sept. 1993)

INTRODUCTION

Crop production under dry farming conditions is always risky and many times partial or complete failure of crop is not uncommon. Therefore, it is desirable to evolve suitable farming practices through which crop production could be obtained under unpredictable climatic conditions. Intercropping is such a desirable practice which provides insurance in the abberant weather conditions. Success of intercropping is mainly decided by crop compatability, suitability of planting pattern and careful selection of crops possessing minimum competion between base and companion crops. The intercropping system increases total production in addition to assures the stable production in the rainfed area Rao and Willey (1980) and Baker (1980). Also, the return from the intercropping is higher and more dependable than those from the relevant sole crop Rao *et al.*(1979).

Cotton is extensively grown in 3.17 lakh hectares in Gujarat State under rainfed conditions either as pure or a mixed crop. Cotton and green gram is one of the popular mixtures adopted by majority of farmers of Saurashtra in Gujarat having medium black soils. Net return from the existing system is poor due to inadequate maintenance of plant population of both the crops. Devotta and Chowdappan (1975) reported that cotton and green gram sown in alternate rows and in paired row system with 2 : 1 ratio gave higher net return. The present investigation was initiated to explore suitability of various short duration legumes as intercrops under cotton based intercropping system on medium black soil in the Saurastra region.

MATERIALS AND METHODS

A field trial on intercropping in cotton was conducted on medium black soil of Dry Farming Research Sub Station, Vallabhipur (Bhavnagar) from *kharif* 1977-78 to 1984-

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TABLE 1

Yield (kg/ha) of intercropping of cotton (GAU Cot - 10) with different legume intercrops.

Sr. No.	Treatment	Years											
		1977-78 *				1978-79 *				1981-82 *			
		Main produce		By produce		Main produce		By produce		Main produce		By produce	
		Seed Cotton	Inter crop	Cotton stalk	Inter crop fodder	Seed Cotton	Inter crop	Cotton stalk	Inter crop fodder	Seed Cotton	Inter crop	Cotton stalk	Inter crop fodder
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	Cotton alone (90 cm)	495	---	1000	---	488	---	1029	---	1285	---	1566	---
2.	Paired row cotton (60 : 120 cm)	494	---	1000	---	559	---	977	---	1058	---	1543	---
3.	Paired row cotton + Green gram (G - 1)	486	330	980	550	321	299	941	1286	947	604	1566	1479
4.	Paired row cotton + Black gram (T - 9)	509	363	1050	450	552	437	934	874	665	489	1388	1157
5.	Paired row cotton + cowpea (P.F.)	474	99	975	200	472	235	960	599	846	147	1311	898
6.	Paired row cotton + Soybean (J-86)	484	404	980	600	578	25	995	180	746	385	1543	1089
7.	Paired row cotton + Clusterbean (Local)	381	158	800	300	615	50	977	95	1022	44	1427	1028
8.	Paired row cotton + Groundnut (GG - 1)	458	91	930	150	536	77	951	280	975	437	1381	1504

TABLE 1 (contd.)

Years								Pooled Av.*			
1983-84 *				1984-85 *							
Main produce		By produce		Main produce		By produce		Main produce		By produce	
Seed Cotton	Inter crop fodder	Cotton stalk	Inter crop fodder	Seed Cotton	Inter crop fodder	Cotton stalk	Inter crop fodder	Seed Cotton	Inter crop	Cotton stalk	Inter crop fodder
15	16	17	18	19	20	21	22	23	24	25	26
1354	---	1466	---	822	---	1800	---	889	---	1372	---
1543	---	1445	---	1030	---	2186	---	937	---	1430	---
1674	887	1476	2461	998	84	1800	68	885	441	1313	1269
1609	355	1378	1066	1110	71	2058	51	889	343	1362	720
1485	328	1311	1640	953	318	1929	225	846	225	1297	712
1451	3805	1435	925	1030	28	2058	32	858	929	1402	565
1335	421	1427	1363	1010	165	1800	617	873	168	1286	680
1173	248	1324	1092	995	110	1880	133	827	193	1293	632

The year wise yield data (mean values) of base and inter crops without statistical analysis has been given, while statistical analysed data of converted, equivalent seed cotton yield is projected in Table 2.

TABLE 2

Equivalent seed cotton yield (kg/ha) alongwith economics and different legume intercrop.

Sr. No.	Treatments	Years (Equivalent yield) *						Expected money value (Rs./ha)	Additional expected income over control (Rs./ha)	Additional expenditure over control (Rs./ha)	Net additional expected money value (Rs./ha)
		1977-78	78-79	81-82	83-84	84-85	Pooled				
1.	Cotton uniform row (90 cm)	413	732	1287	1354	822	921	4605	---	---	---
2.	Paired row cotton (60:120 cm)	412	840	1059	1544	1031	977	4885	260	---	260
3.	Paired row cotton + green gram (G - 1)	602	859	1493	1960	1074	1197	5985	1380	150	1230
4.	Paired row cotton + Black gram (T - 9)	668	1375	1105	1915	1171	1247	6235	1630	150	1480
5.	Paired row cotton + Cowpea (P.F.)	444	907	935	1684	1144	1023	5115	510	150	360
6.	Paired row cotton + Soybean (J - 86)	567	885	945	1604	1041	1008	5040	534	150	285
7.	Paired row cotton + Cluster bean (Local)	377	953	1043	1528	1084	997	4985	380	125	255
8.	Paired row cotton + groundnut (GG - 1)	454	907	1342	1386	1100	1038	5190	585	180	405
	S. Em. ±	29	84	83	133	64	66				
	C.D. at 0.05 %	89	256	250	403	194	190				
	C.V. %	10.33	15.67	12.41	14.17	10.47	14.08				

Y x T Interaction S. Em. ± = 85 and C. D. at 5 % = 240

* Projected year wise data is mean values of equivalent seed cotton yield converted from the year wise yields of base and intercrops considering market seeding price of seed cotton, green gram, black gram, cowpea, cluster bean, soyabean and groundnut at the rate of Rs. 500/-, Rs. 450/-, Rs. 450/-, Rs. 300/-, Rs 225/-, Rs. 475/-, and Rs. 375/- per quintal, respectively for the year 1985.

85 having low to medium available nitrogen and available phosphorous but high potash availability. The soil was alkaline in reaction.

The treatments consisted of two planting pattern of cotton (1) uniformally spaced rows 90 cm apart and (2) paired rows (60/120 cm) and six inter crops viz., green gram (Gujarat-1), Black gram (T-9), cowpea (Pusa Falguni), soyabean (J-86), clusterbean (Local) and groundnut errect (GG-1). One row of inter crops was planted inbetween paired rows of cotton (var. GAU-Cot-10). The experiment was sown in a randomised block design with three replications the gross and net plot sizes were 7.2 m x 5.4 m and 7.2 m x 3.6 m, respectively.

The seeds were sown after the receipt of sufficient soaking rains with a seed rate of 2.5 to 3 kg/ha of cotton, 20 kg/ha of green gram, black gram, cowpea, soybean and cluster bean and 100 kg/ha of groundnut. Cotton was harvested in two to four picking during different years. Results were compiled and statistically analysed in term of equivalent seed cotton yield considering price of main product of cotton, green gram, black gram, cowpea, cluster bean, soyabean and groundnut at the rate of Rs.500/-, Rs. 450/-, Rs. 450/-, Rs. 300, Rs. 225/-, Rs. 475/- and Rs. 375/- per quintal, respectively at the time of completion of experiment as on (15-1-1985).

RESULTS AND DISCUSSION

The yied data of seed cotton and intercrops, as well as by produce obtained during different years are presented in Table 1.Whereas, an average equivalent yield and economics are furnished in Table 2. The data on equivalent seed cotton yield indicated (Table 2) that the treatments uniform row (90 cm) and paired row (60/120 cm) planting of cotton did not differ materially for their seed cotton yield in almost all the years of testing and in pooled except in the year 1984-85 where in paired row system gave significantly higher yield (1030 kg/ha) over uniform row (822 kg/ha). The treatment consisting of cotton + black gram gave significantly higher equivalent seed cotton yield (1247 kg/ha) over all the other intercropping treatments and sole crop of cotton sown in uniform rows (921 kg/ha) or paired rows (977 kg/ha). However, this treatment remains on par with the treatment consisting cotton + green gram (1197 kg/ha). These results are in accordance with the results of Pothiraj (1985).

The economics of various intercrops revealed (Table 2) that both these intercropping system i.e.cotton + black gram (Rs.1480/ha) and cotton + green gram (Rs.1230/ha) gave higher net additional return over rest of the intercropping system (Rs. 285 to 405/ha). Similar increase in monetary return in intercropping with legumes and cereals has been reported by Kalara and Gangwar (1980). Thus black gram and green gram are the profitable intercrops with the base crop of cotton grown on medium black soils of Saurashtra.

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Effect of Drip Irrigation on Incidence of Insect Pests of Sugarcane

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ABSTRACT

A study was carried out to detemine the effect of different levels of drip irrigation with traditional flood method on incidence of insect pests viz., shoot borer (*Chilo infuscatellus* Snellen), scale insect (*Melanaspis glomerata* Green) and mealybugs (*Saccharicoccus sacchari* Cockerell) attacking sugarcane at Main Sugarcane Research Station, Gujarat Agricultural University, Junagadh Campus, Junagadh during 1990-91 and 1991-92. Results of the study revealed that the maximum dead hearts due to shoot borer and the highest population of mealy bugs were recorded in the treatment of minimum level of irrigation (0.4 CPE) but as the levels of irrigation increased with drip system the damage due to shoot borer and population of mealy bugs were deceased, whereas the population of scale insect increased. However its highest population was recorded in traditional flood method of irrigation and it was minimum in treatment of 0.4 CPE. Among the various levels of irrigation water with drip system, the treatment of 0.8 CPE gave significantly higher yield than the other treatments.

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INTRODUCTION

Extensive and intensive cultivation of sugarcane with the introduction of new high yielding varieties and adoption of modern agro-techniques have increased the occurrence of several pests in sugercane crop. Due to continous cultivation of sugarcane crop with phase plantings and ratooning resulted in maintaining the crop perennially. This being a long duration crop it passes through different climatic conditions. The climatic factors such as temperature relative humidity , rainfall, light and soil type have been considered as the most important for the survival, distribution and abundance of insect pests. According to Hapse *et al.* (1979) the maximum temperature has significant positive correlation, whereas relative humidity showed a negative relationship in the buildup of shoot borer population. Kalra and David (1966) reported that the population of mealy bug was higher under drought and dry conditions, but severe outbreaks of the scale insect was observed under high humidity due to frequent irrigational schedules and water-logged conditions (Tripathi and Shukla, 1982).

Published literature has shown that the information of direct effect of irrigation levels on incidence of the sugarcane pests is verry scanty. Therefore, present investigation was carried out under field conditions to determine the effect of different levels of irrigation with drip system and traditional method of flood irrigation on the insect incidence in sugarcane crop.

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MATERIALS AND METHODS

An experiment was conducted at the Sugarcane Research Station, Gujarat Agricultural University, Junagadh Campus, Junagadh during 1990-91 and 1991-92 for determining the effect of different levels of irrigation with drip system and local flood irrigation method on incidence of pests of sugarcane. The field trial was carried out in randomized block design with four replications and six treatments viz., 0.4 CPE, 05 CPE, 06 CPE, 0.7 CPE, 0.8 CPE, and the flood irrigation. The crop was planted with pair row planting method (70 cm : 30 cm) using three eyes buded setts of CO-6304 sugarcane cultivar. The lateral pipe-lines per treatment were installed with drippers capable of dripping water @ 2 lit/hr. The drippers were fixed at 50 cm apart on the lateral lines laid between two narrow rows of 30 cm . Drip irrigation levels were controlled by fixing a separate valve near each treatment. Evaporation was recorded daily in morning at 8.0 a.m. through a Sanken Pan Evaporimeter which was fixed near the experiment area. The requirement of irrigation water for each treatment was worked out daily on the basis of climatological data. It was applied to the crop by a water meter.

Incidence of shoot borer was recorded by counting the number of healthy plants and dead hearts from net plot area.The data were converted to per cent damage and subjected to statistical analysis. In order to determine the incidence of mealy bug, its population was recorded from 9 sq. cm area around buds on 4th, 5th and 6th internodes of the top portion from randomly selected ten canes in each treatment. Average population of mealy bug nymphs per 9 sq. cm was worked out. Similarly, for recording the population of scale insect, ten plants were selected randomly at the time of harvest and population of this pest was recorded from 9 sq. cm area of three buds at top, middle and basal portions of the cane.

RESULTS AND DISCUSSION

Data on per cent damage (Table 1) due to shoot borer indicated that among the different levels of irrigation, the lowest incidence of this pest (20.61%) was recorded in the treatment of flood irrigation and it was at par with the irrigation level of 0.7 CPE and 0.8 CPE. However, it was increased with the decrease of amount of irrigation water. Thus, drip irrigation @ 0.7 and 0.8 CPE helped in minimizing the shoot borer incidence . The data further indicated that these levels of drip irrigation were also found effective in reducing the mealy bug population and was statistically at par with the flood irrigation. The flood irrigation and higher level of water applied with drip system might have caused the buildup of high humidity which helped in preventing the buildup of the pest population. Similar effect of humidity was also reported by Hapse *et al.* (1979) for shoot borer and Kalra and David (1966) for the mealy bugs.

A close perusal of the data (Table 1) on incidence of scale insect revealed that incidence of this pest was significantly increased with increase of level of irrigation water. The highest infestation of the scale insect was recorded when the crop was irrigated with flood method, but was gradually decreased with decrease in level of irrigation water with drip method. This might be due to the buildup of high humidity with flood irrigation which may have helped in the build up of scale insect population. Tripathi and Shukla (1982) concluded that high humidity due to frequent and scheduled irrigation resulted in out-break for scale insect. Shukla and Tripathi (1979) also reported the similar effect of humidity on pests of sugarcane.

TABLE 1

Effect of different levels of irrigation with drip system and traditional flood method on incidence of insect pests of sugarcane (Pooled mean of 1990-91 and 1991-92).

Sr. No	Method of irrigation	Levels of irrigation	Incidence or population of pests			Yield tonnes ha.
			Per cent dead hearts due to shoot borer	Population of mealybugs nymph/9. sq.cm.	Population of scale insect nymph/9 sq.cm.	
1.	Drip irrigation	0.4 C.P.E.	30.48 (33.51)*	49.98 (7.07)**	8.70 (2.95)**	55.967
2.	Drip irrigation	0.5 C.P.E.	27.36 (31.74)	41.60 (6.45)	11.97 (3.46)	69.761
3.	Drip irrigation	0.6 C.P.E.	25.15 (30.10)	36.72 (6.06)	21.16 (4.60)	78.704
4.	Drip irrigation	0.7 C.P.E.	23.78 (29.19)	31.25 (5.59)	25.50 (5.05)	93.690
5.	Drip irrigation	0.8 C.P.E.	22.05 (28.01)	28.09 (5.30)	34.10 (5.84)	103.972
6.	Traditional flood method	Flood irrigation	20.61 (27.00)	29.05 (5.39)	57.91 (7.61)	95.175
		S.Em. ±	(0.77)	(0.17)	(0.14)	2.77
		C.D.at 5 %	(2.22)	(0.49)	(0.40)	8.417
		C.V. %	(7.28)	(8.10)	(8.38)	6.740

* Figures in parantheses are transformed values.

** Figures in parantheses are square root transformed values.

The data on sugarcane yield revealed that the irrigation with the drip system @ 0.8 CPE found significantly superior in increasing the sugarcane yield (103.972 tonnes/ ha) which was higher than the traditional method of irrigation. Therefore, considering the yield and different levels of irrigation on incidence of different pests under study, drip irrigation @ 0.8 CPE was found effective in reducing the pest incidence and gave economic yield. However, the scale insect population was increased due to flood irrigation which can be minimized with applying light irrigation with drip system. Patel *et al.* (1984) showed that the infestation of shoot borer was decreased with frequent irrigation (1320 mm of water). Thus, the present findings are in close agreement of the earlier reports.

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Effect of N, P, K and Zn on the Grain Yield of Bajra under Rainfed Conditions on Farmers' Fields in Mehsana District of Gujarat

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ABSTRACT

Experimental results obtained on farmers', fields indicated that application of nitrogen, phosphorus and potash significantly increased the grain yield of bajra variety "B.J.-104" in Mehsana district of Gujarat State during 1982-83 to 1985-86 in kharif season. The grain yield increased with increasing levels of nitrogen from N_{30} to N_{90} and that phosphorus from P_{30} to P_{60} over corresponding N levels. While it was decreased with increasing levels of potash from K_{30} to K_{60} over corresponding NP levels. No significant response was observed with the application of zinc sulphate. The highest NICBR of Rs. 1.14 was obtained with $N_{60}P_{60}K_{30}$.

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INTRODUCTION

Among the cereal crops grown in N.Gujarat in the kharif season, bajra (*Pennisetum typhoides* S and H) occupies an important place. The total cultivated area in the State under this crop is 1243.1 thousand ha. Out of which North Gujarat grows bajra in 101.4 thousand ha. under rainfed condition (1979-80 to 1984-85). The average yield of bajra in Gujarat State is 9.1 q/ha, while the average yield in N. Gujarat is 8.2 q/ha. This shows that there is a possibility of increasing the yield of this crop by adopting the improved dryland technology coupled with balanced use of fertilizer. An addition of NPK in proper proportion will not give better and economical crop yields. Besides these, micronutrients which are equally important. The deficiency of Zn in Indian soils especially in light textured soils is wide spread (Kunwar and Randhawa; 1974) and hence it assumes great importance in crop production. With a view to supply reliable information to cultivators an endeavor was made to study the response of bajra (B. J. 104) to fertilizer application and to work out its economics under rainfed conditions.

MATERIALS AND METHODS

The field experiments were conducted on bajra variety B.J.104 in four zones on randomly selected blocks, villages and cultivators' fields in Mehsana district of Gujarat State for four years from 1982-83 to 1985-86 in kharif season under the All India Co-ordinated Agronomic Research Project (AICARP). Four zones were homogeneous in respect of climate, soils, cropping pattern, rainfall, irrigation facilities etc. There were thirty five locations selected for the trials. The seed rate, raw distance and

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sowing dates were respectively 5 kg/ha, 15 cm and onset of monsoon. The soil samples were collected prior to conducting the experiments from 0-15 cm soil depth as usual way from randomly selected fields and analysed for nutrient status. Texturally the soils were sandy loam. The initial soil analysis of the fields indicated that pH, organic carbon and electric conductivity ranged from 7.2 to 8.9, 0.20 to 0.85 per cent and 0.05 to 0.88 m.mhos/cm at 25 °C; respectively. The available status of N, P and K ranged from 160 to 405, 12 to 81 and 180 to 700 kg/ha; respectively. The DTPA extractable zinc is in the range of deficient to marginal in status in these soils. The rainfall (mm) distribution from June to September for four years is given in Table-2. The following twelve treatments were tested in a randomised block design.

T_1 - $N_0P_0K_0$	T_5 - $N_{30}P_{30}K_0$	T_9 - $N_{90}P_{60}K_0$
T_2 - $N_{30}P_0K_0$	T_6 - $N_{60}P_{30}K_0$	T_{10} - $N_{60}P_{60}K_{30}$
T_3 - $N_{60}P_0K_0$	T_7 - $N_{60}P_{60}K_0$	T_{11} - $N_{90}P_{60}K_{60}$
T_4 - $N_{90}P_0K_0$	T_8 - $N_{90}P_{30}K_0$	T_{12} - $N_{90}P_{60}K_{60}Zn_{25}$

Sources of N, P and K were urea, single superphosphate and muriate of potash ; respectively, while Zn was applied as zinc sulphate. All the phosphorous, potash, zinc and half the nitrogen were applied by drilling just before sowing and rest of the nitrogen was topdressed after about three weeks from sowing.

RESULTS AND DISCUSSION

The results of 35 trials presented in Table-1 revealed that the response to nitrogen application was significant at each level. It increased significantly with increasing levels of N from 30 to 90 kg/ha. The results are in agreement with those reported by Kumar and Sardana (1973) and Pal and Kaushik (1973). The increase in yield due to 30, 60 and 90 kg N/ha over control was 10.54, 20.40 and 25.87 per cent respectively. The response was positively correlated with the net profit of Rs. 138, 328 and 402 per hectare.

The response to P application in the form of S. S. P. was significant over corresponding N levels. The response was increased with increasing levels of P from 30 to 60 kg P_2O_5/ha. Significantly the highest response (429 kg/ha) was obtained with P_{60} in presence of N_{90} with net gain of Rs. 792 per hectare.

The response to potash application was decreased with increasing levels of K from 30 to 60 kg K_2O/ha over corresponding NP levels, the difference being significant at each level. The highest profit per rupee investment was obtained when 30 kg K_2O/ha was applied alongwith $N_{60}P_{60}$. The results are in close conformity with those reported by Sekhawat *et al.* (1972) and Ramkala *et al.* (1983).

Zinc application did not produce the significant yield difference. It might be due to marginal Zn status in the soil. The results are in agreement with those reported by Ramkala *et al.* (1983).

The grain yield of bajra varied from year to year with the fertilizer applications. Low magnitude of yield was observed during the years 1984-85 and 1985-86 which might be due to low rainfall (Table-2).

The data in Table-1 also depict the economics of fertilizer use in bajra crop. It is evident from this table that phosphorus application in combination with nitrogen increased the net profit and the profit per rupee invested. The application of higher level of potash in combination with NP decreased the net profit and the profit per rupee invested. The highest profit per rupee invested was obtained when 60 kg N/ha

TABLE 1

Effect of N, P, K and Zn on the grain yield of bajra.

Tretment No.	*Yield (kg/ha)*				*Ave. yield*	*Resp. over control*	*Per unit response kg/ha*	*Cost of ferti. (Rs.)*	*Value of add. yield (Rs.)*	*Net profit (Rs.)*	*Net profit /Re-investment*
	82-83	*83-84*	*84-85*	*85-86*							
N P K											
T_1 - 0 0 0	1892	1502	887	845	1264						
T_2 -30 0 0	2095	1625	1015	991	1413	149	4.97	159.9	298	138.1	0.86
T_3 -60 0 0	2189	1826	1215	1129	1599	324	5.40	319.8	648	328.2	1.03
T_4 -90 0 0	2358	1910	1350	1275	1705	441	4.90	479.7	882	402.3	0.84
T_5 -30 30 0	2163	1637	1224	1340	1575	311	5.18	394.2	622	227.8	0.58
T_6 -60 30 0	2432	2094	1375	1475	1827	563	6.26	554.1	1126	571.9	1.03
T_7 -60 60 0	2586	2080	1423	1593	1901	637	5.31	788.4	1274	485.6	0.62
T_8 -90 30 0	2633	2287	1573	1639	2016	752	6.27	714.0	1504	490.0	1.11
T_9 -90 60 0	2771	2361	1702	1774	2134	870	5.80	948.3	1740	791.7	0.83
T_{10} -60 60 30	2788	2408	1719	1878	2181	917	6.11	855.9	1834	978.1	1.14
T_{11} -90 60 60	2826	2464	1854	1987	2267	1003	4.78	1083.3	2006	922.7	0.85
T_{12} -90 60 60	2847	2511	1941	2074	2329	1065	4.54	1161.1	2130	969.0	0.83
+ Zn_{25}											
S. E.	69	97	61	66	37						
C. D. at 5 %	137	194	122	131	73						
No. of Expts.	8	9	9	9	35						

The price of N, P, K, Zn & bajra were 5.33, 7.81, 2.25, 3.11 & 2.0 Rs./kg respectively.

TABLE 2

Average rainfall (mm) in Mehsana district.

Month / *Year*	*June*	*July*	*August*	*September*	*October*
1982-83	25.9	216.6	163.7	8.5	---
1983-84	47.0	243.7	314.6	95.0	---
1984-85	29.0	161.2	468.2	37.2	---
1985-86	---	158.0	80.0	8.0	30.0

was applied along with 60 kg P_2O_5/ha. The results are in close conformity with those reported by Sekhawat *et al.* (1972) and Ramkala *et al.* (1983).

Zinc application also resulted in the increase in the net profit but did not effect unit profit. The highest net profit was obtained with $N_{60}P_{60}K_{30}$. The results are in agreement with Ramakala *et al.* (1983).

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Effect of Potassium and Hormones Under Normal and Higher Levels of N & P on Yield and Uptake of Nutrients by Summer Groundnut (*Arachis hypogaea* L.)

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ABSTRACT

The results of a field experiment conducted during summers of 1985 to 1987 on Typic Ustochrepts testing three hormone treatments *viz.*, control (H_0), two sprays of 50 ppm GA_3 (H_1) and 50 ppm IBA (H_2) individually and in combination with four levels of fertilizer treatments viz., 25 : 50 : 0 (F_1-i.e. recommended dose), 37.5 : 75 : 0 (F_2), 37.5:75:37.5 (F_3) and 37.5 (25 basal + 6.25 + 6.25 as foliar spray of urea) : 75:37.5 (F_4) revealed that spraying of 50 ppm IBA (H_2) significantly increased the pod yield (2169 kg ha^{-1}) , N, P and K uptake by pod and haulm as well as oil and protein content in kernels. The same trend was also noted with fertilizer treatments F_3 and F_4. But splitting of 37.5 kg N into 25 kg basal and 12.5 kg N in two equal sprays of urea (2%) solution with incorporation of K and IBA further boosts the groundnut production. The treatment combinations H_2F_4 and H_0F_3 outyielded the other treatment combinations in respect to pod (2306 kg ha^{-1}) and haulm (2721 kg ha^{-1}), respectively. The higher N, P and K uptake were recorded with H_2 and F_4 treatments individually and that of only N uptake by haulm was with their combination. The highest values of N concentration in haulm (1.67%), of P concentration in pod (0.30%), of harvest index (50.3), of oil content in kernel (49.2%) and of protein content (28.5%) were recorded in treatment combinations H_2F_2, H_1F_1, H_2F_3, H_1F_3 and H_1F_1, respectively.

INTRODUCTION

The Saurashtra region of Gujarat is a bowl of the groundnut production in India. The cultivating of summer groundnut has increased considerably in the area where irrigation facility is available. Spraying of hormones (IBA & GA_3) increased the growth and yields of summer groundnut (Patel *et al.*, 1988, Gundalia *et al.*, 1990) which naturally demand more nutrients. Dubey and Shinde (1986) reported that groundnut has low requirement of P but high of K which not only improve both the yield and quality of kernels but also increase the transfer of N from the haulm to the kernels. The present study was, therefore, conducted to investigate the combined effect of K and hormones (IBA & GA_3) in normal and higher levels of N and P during summers of 1985 to 1987 on calcareous medium black soils.

MATERIALS AND METHODS

The twelve treatment combinations consisting of three levels of different hormone treatments *viz.*, (i) control (H_0), (ii) two sprays each of GA_3 (H_1) and (iii) IBA(H_2) both @ 50 ppm at 40 and 60 days after sowing and four levels of fertilizer treatments *viz.*, (i) 25:50:0 (F_1), (ii) 37.5:75:0 (F_2), (iii) 37.5:75:37.5 (F_3) and (iv) 37.5 (25 basal + 6.25 + 6.25 as foliar) : 75:37.5 (F_4) of $N:P_2O_5:K_2O$ ha^{-1}, respectively were tested in randomised block design with four replications on highly calcareous (31.8 to 41.0%)

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mildly alkaline (pH 7.7 to 7.9) and well drained silty clay to clay textured soils (Typic Ustochrepts) of the Instructional Farm of the College of Agriculture, Junagadh. The soils were fairly well supplied with nitrogen (organic carbon 0.63 to 0.88 %), phosphorus (available P_2O_5 25.4 to 45.0 kg ha^{-1}) and potassium (available K_2O 224 to 265 kg ha^{-1}). The required quantities of N, P and K as per treatments were applied as urea, single super phosphate and muriate of potash, respectively in the previously opened furrows before sowing except in the split dose of N in treatment F_4, where 25% N was applied in two equal sprays on foliage through 2% urea solution at 40 and 60 days after sowing. The variety 'GG 2' was used as the test crop and it was sown 30 x 30 cm^2 apart using 125 kg seed rate per hectare. In all 13 to 15 irrigations and two to three sprays of dimecron to control aphids were applied as and when required during different years and three each of hand weedlings and interculturing were carriedout during the every year. The crop was harvested at maturity and yields were recorded after sundry. The oil content in kernel was estimated by NMR and the N content in kernel, pod and haulm was determined using Kjeldahl's method as suggested by AOAC(1960). The powdered pod and haulm samples were digested in a diacid (HNO_3 : $HClO_4$, 3:1) mixture as described by Johnson and Ulrich (1969), P and K from the acid extract were determined by following the standard procedures (Jackson, 1967).

RESULTS AND DISCUSSION

Effect of hormone

The pooled data of pod and haulm yields (Table 1) showed that spraying of IBA (@ 50 ppm) not only significantly increased the pod yield (2169 kg ha^{-1}) over that of control (1945 kg ha^{-1}) also improved the quality of the produce in terms of harvest index, shelling percentage, 100 kernels weight and oil and protein contents of the kernels (Table-1). These findings are in agreement with those observed by Patel *et al.* (1988) and Gundalia *et al.* (1990). The increase in yield and improvement in quality seem to be due to enhancement and regulation of physiological processes like relative growth rate, photosynthesis rate and dry matter accumulation by the application of plant regulators. The results (Table-1) further revealed that spraying of IBA @ 50 ppm significantly increased N, P and K uptake to the tune of 74.3,5.05 and 12.8 kg ha^{-1} respectively by pod. However, the uptake of these nutrients by the haulm and their contents in pod and haulm remained unaffected by the harmones.

Effect of Potassium

Incorporation of potassium alongth with N and P (F_3 and F_4 treatments) significantly increased the haulm yield (2557 and 2499 kg ha^{-1}), respectively in the pooled but the pod yield (2126 kg ha^{-1}) in the pool failed to show significant effect. Of course, during two out of three years, treatments F_4 had recorded significantly higher pod yield (2647 and 1632 kg ha^{-1}) over the normal recommended (F_1) as well as higher (F_2) dose of fertilizers. Similarly, treatment F_3 proved significantly superior to F_1 during these years (Table-1). Such favourable effect of N application on this crop was also reported elsewhere by Dubey *et al.* (1986), Dubey and Shinde (1986), Lombin and Singh (1986). The potassium is known to accelerate the synthesis and translocation of fatty acids and enhances the synthesis of the esters in the seed (Weber, 1985) and reduces water loss and thereby increases the dry matter production (Beringer, 1982). In the present case also, the application of K seemed to have increase the transfer of N from the haulm to the kernels and thus improved

TABLE 1

Effect of hormone and fertilizer treatments on yield and quality of summer groundnut (GG 2).

Treatment	*Yield (kg ha^{-1})*					*Harvest Index*	*Shelling (%)*	*100 kernels wt.(g)*	*Oil content (%)*	*Protein content (%)*
	Pod				*Haulm*					
	1985	*1986*	*1987*	*Pool*						
Hormone treatments										
H_0-control	2406	1387	2041	1945	2426	42.47	70.4	35.1	47.9	22.8
H_1-GA_3	2397	1307	1987	1897	2441	41.90	70.7	36.0	48.4	23.1
H_2-IBA	2691	1552	2266	2169	2490	47.00	71.1	37.0	48.6	23.7
C.D.@ 5%	112.0	105.9	139.0	67.5	NS	1.89	0.46	1.57	0.15	1.55
H × year			NS							
Fertilizer treatments										
F_1	2386	1243	1997	1876	2390	42.9	70.9	34.0	48.6	24.6
F_2	2406	1238	2123	1949	2366	44.0	70.2	36.4	48.7	25.6
F_3	2472	1547	2172	2064	2557	48.8	70.7	37.0	48.4	25.8
F_4	2647	1632	2099	2126	2499	44.3	71.1	36.8	47.5	25.5
C.D. @ 5%	129.4	122.3	NS	NS	145.3	2.18	0.54	1.75	0.17	1.9
F × year			135.1							

TABLE 2

Effect of hormone and fertilizer treatments on K content and nutrient uptake by pod and haulm.

Treatment	*K content (%)*		*Nutrient uptake (kg ha^{-1})*					
	Pod	*Haulm*	*Pod*			*Haulm*		
			N	*P*	*K*	*N*	*P*	*K*
Hormone treatments								
H_0	0.66	0.47	69.5	4.31	11.6	38.2	2.61	11.5
H_1	0.65	0.45	46.6	4.29	11.2	37.6	2.70	11.4
H_2	0.62	0.44	74.3	5.05	12.8	40.3	2.61	12.0
C.D @ 5%	NS	NS	3.54	0.27	0.52	NS	NS	NS
Fertilizer treatments								
F_1	0.57	0.47	63.1	4.22	10.7	36.8	2.60	11.5
F_2	0.59	0.43	66.4	4.41	11.5	37.6	2.66	10.1
F_3	0.60	0.48	69.8	4.72	12.3	41.1	2.81	12.3
F_4	0.61	0.50	71.8	4.88	13.0	39.8	2.77	12.5
C.D. @ 5%	0.02	0.04	4.09	0.31	0.82	3.22	NS	1.52

TABLE 3

Interaction effect of hormone and fertilizer treatments on yield, quality, content and uptake by summer groundnut (GG 2).

Treatment	Pod yield (kg ha^{-1})				Haulm yield (kg ha^{-1})	Harvest index	oil content (%)	Protein content (%)	N content in haulm (%)	P content in pod (%)	N uptake by haulm (kg ha^{-1})
	1985	1986	1987	Pool							
H_0F_1	2125	1113	2021	1753	2273	42.0	48.3	21.7	1.42	0.26	32.4
H_0F_2	2483	1258	2060	1967	2330	44.9	46.8	25.3	1.56	0.29	36.5
H_0F_3	2479	1554	2038	2024	2721	39.3	47.5	22.2	1.64	0.26	44.6
H_0F_4	2438	1621	2046	2035	2388	43.2	47.2	22.1	1.66	0.28	39.4
H_1F_1	2333	1113	1688	1711	2250	41.1	48.2	28.5	1.65	0.30	36.7
H_1F_2	2375	1150	1992	1839	2379	40.5	48.2	24.2	1.56	0.27	41.3
H_1F_3	2417	1433	2150	2000	2583	44.9	49.2	24.3	1.52	0.28	36.6
F_1F_4	2463	1532	2117	2037	2550	44.1	47.8	22.1	1.52	0.27	39.8
H_2F_1	2700	1504	2283	2162	2647	45.6	49.1	23.6	1.57	0.27	39.2
H_2F_2	2500	1304	2317	2040	2389	46.5	49.0	27.3	1.67	0.29	39.3
H_2F_3	2521	1654	2329	2168	2366	50.3	48.5	25.3	1.64	0.29	38.1
H_2F_4	3012	1744	2133	2306	2559	45.7	47.6	23.2	1.58	0.29	40.8
C.D.@ 5%	135.1	NS	NS	NS	247	3.78	0.29	3.10	0.12	0.02	5.57
H × F × year		233.9									

TABLE 4

Economy of hormone and fertilizer treatment combinations of summer groundnut (GG 2).

Treatment	Yield (kg ha^{-1})		Additional yield over control		Addition income over control (Rs / ha^{-1})	Addition expenditure over control (Rs. / ha^{-1})	Net income (Rs. / ha^{-1})	Net cost benefit ratio (NCBR)
	Pod	Haulm	Pod	Haulm				
H_0F_1	1753	2273	-	-	-	-	-	-
H_0F_2	1967	2330	214	57	2211	345	1866	1:5.41
H_0F_3	2024	2721	271	448	3171	516	2754	1:5.34
H_0F_4	2035	2388	282	115	2964	596	2368	1:3.97
H_1F_1	1711	2250	42	23	-	3682	-	-
H_1F_2	1839	2379	86	106	993	4025	-	-
H_1F_3	2000	2583	247	310	2474	4197	-	-
H_1F_4	2037	2550	284	277	2843	4197	-	-
H_2F_1	2162	2647	409	374	4095	980	3115	1:3.18
H_2F_2	2040	2389	287	116	3015	1325	1690	1:1.28
H_2F_3	2168	2366	415	93	4266	1496	2770	1:1.85
H_2F_4	2306	2559	553	286	5888	1496	4392	1:2.94

Price considered : Pod Rs. 1000g^{-1}, Haulm Rs. 125 g^{-1}, N Rs. 6.96 kg^{-1} as urea, P_2O_5 Rs. 7.92 kg^{-1}, K_2O Rs. 2.96 kg^{-1}, GA_3 120 Rs. g^{-1}, IBA 30 g^{-1}, cost of one spray Rs. 40 ha^{-1} cost of fertilizer application Rs. 60 ha^{-1}.

both the yield and quality of the kernels (Dubey and Shinde, 1986). The superiority of F_4 over F_3 is thus attributed to the favourable effect of folior spray of urea solution.

The results (Table-1) further showed that the harvest index and shelling percentage significantly increased with F_3 and F_4 treatments, respectively over the others. However, these two treatments significantly increased the 100 kernels wt. over F_1. The results are in close agreement to those reported by Dubey *et al.* (1986) and Umar *et al.* (1991). On the contrary, the significant reduction in protein content was recorded both in F_3 and F_4 treatments. The results are in accordance with the findings of Dubey *et al.* (1986), who noted reduction in the protein content from 24.62% with 20 kg K_2O ha $^{-1}$ to 21.62% with 40 kg K_2O ha $^{-1}$. Similarly, treatment F_4 significantly decreased the oil content in kernels. Of course, such reduction in the oil content was not observed with treatment F_3. The probable reason for such reduction in F_4 treatment could be due to the dilution effect as the seed yield increased with this treatment.

Significantly the highest K content in the pod (0.61%) and haulm (0.50 %) was recorded with the treatment F_4, followed by F_3 (Table-2). This observation is in conforming with that made by Lombin and Singh (1986) and Dubey and Shinde (1986), who noted that K application increased significantly only the K content of haulm and N content of kernel. However, Dubey and shinde (1986) recorded significant increase in the content of all the macronutrient in kernels with increase in K levels. The maximum N, P and K uptake by pod and of K by haulm under treatment F_4 and that of N and P by haulm under treatment F_3 suggest that the incorporation of K along with N and P seemed to have helped in the absorption of these nutrients by the crop, which manifested itself in significantly increasing the groundnut production. The results are in accordance with those reported by Dubey and Shinde (1986).

Interaction effect

The results in Table 3 showed that significantly the highest haulm yield (2721 kg ha $^{-1}$) was noted with treatment combination H_0F_3, followed by H_2F_1, H_1F_3, H_2F_4 and H_1F_4 in that order, which were at par with each other but were significantly superior to H_0F_1 (2273 kg ha $^{-1}$). While in case of pod yield, although the maximum pod yield in pool (2306 kg ha $^{-1}$) was recorded with treatment combination H_2F_4, it did not reach the level of significance as treatment X year (Y X H X F) interaction was found significant. However, it had recorded the maximum pod yield of 3042 kg ha $^{-1}$ in 1985 and maximum pod yield 1744 kg ha $^{-1}$ in 1986.

The data in Table 3 revealed that significantly higher harvest index (50.3) was noted with the treatment combination H_2F_3. Although the minimum harvest index (39.3) was noted with H_0F_3, but it was at par with the control (42.0). The treatment combination H_2F_2 proved significantly superior to control. In general, reduction in the oil content was noted with the treatment combinations H_0F_2 (46.8), H_0F_4 (47.2), H_0F_3 (47.5), H_2F_4 (47.6) and H_1F_2 (49.0) had significantly higher oil content over control (H_0F_1 - 48.3%). The remaining treatment combinations were at par with the control. In case of protein content, only treatment combinations H_1F_1 (28.5), H_2F_2 (27.3), H_0F_2 and H_2F_3 (25.3%) recorded significantly higher values than control (21.7%), while the remaining treatment combinations were at par in their effect with the control. In respect to phosphorus content in the pod, the treatment combinations followed the

order : $H_1F_1 > H_0F_2 = H_2F_2 = H_2F_3 = H_2F_4 > H_0F_4 = H_1F_3$ which were found superior to the control (H_0F_1) while remaining were at par. In case of N content and its uptake by haulm, all the treatment combinations were found significantly superior to the control, except H_1F_3, and H_1F_4 in case of N content and H_0F_2, H_1F_1 and H_1F_3 in case of N uptake by haulm. The treatment combination H_0F_3 outyielded the other treatments in respect of N uptake by haulm (44.6 kg ha^{-1}).

Economic consideration

The results presented in Table 4 showed that the treatment combination H_2F_4 gave the maximum additional pod yield of 553 kg ha^{-1} and haulm yield of 286 kg ha^{-1} accuring net additional return of Rs. 4392 ha^{-1}. However, H_0F_3 also gave additional pod yield of 271 kg ha^{-1} and haulm yield 448 kg ha^{-1} accuring net additional return of Rs.2754 ha^{-1}. Of course, H_2F_1 also gave additional pod yield of 409 kg ha^{-1} and haulm yield of 374 kg ha^{-1} with net additional return of Rs. 3115, over the normal recommendation practice i.e. H_0F_1.

The foregoing results suggest that incorporation either of IBA with the recommended dose of fertilizer (25:50:0) or of potassium (37.5 kg K_2O ha^{-1}) with higher levels of N and P (37.5 : 75) significantly increased pod yield, however, combined incorporation of IBA as well as of potassium did not much improve the yield. But spliting of 37.5 kg N into 25 kg basal and 12.5 kg N in two equal sprays of urea (2%) solution with incorporation of K and IBA as above further boosts the groundnut production.

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Batch Fermentation of Ipomea Carnea into VFA and Biogas by Two Phase System

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ABSTRACT

Dried and green ipomea leaves were anaerobically fermented at 6.7% total solids concentration at 37°C through batch fermentation two phase system. The maximum volatile fatty acid (as acetic acid) was produced from dried ipomea (7.38 g acetic acid/litre) and green ipomea leaves (8.46 g acetic acid/litre) after 3 days of digestion. After these first flush of VFA filtered and plant material was again incubated after water charging and additional recovery of VFA during this second flush was 31 and 13 per cent of the total VFA production (first flush + second flush) observed from dried and green ipomea leaves after the digestion of 4 and 2 days respectively. The pH changes during digestion were also observed. Biogas produced from methanogenic phase the VFA of first flush was 433 ml and 436 ml/g dry weight of dried and green ipomea leaves with methane content 63.6 and 64.6 per cent respectively.

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INTRODUCTION

Utilization of agricultural and animal wastes as an energy sources has received wide attention recently. Wolf and Keenan (1973) suggested a two stage digestion of dog food and similarly for plant residues (Neelakantan *et al.*, 1978) with reference to anaerobic fermentation for methane (biogas) production. Hence, in the present study, the possibility of anaerobically digesting dried and green ipomea leaves to yield volatile fatty acids in the first stage digester was attempted and the plant acids so produced were fed into a second stage methanogenic fermenter for the production of boigas.

MATERIALS AND METHODS

The dried and green ipomea leaves were obtained from the road side of Gujarat Agril. University, Anand. The culture inoculum was obtained from an active ipomea leaves fermentation system maintained for the last 16 weeks. The ipomea leaves were analysed before and after fermentation for volatile solid (Jones and Warner, 1969), organic carbon, Total- N (Jackson, 1967), cellulose (Updegraffs, 1969), hemicellulose (Deschat-elets and Yu, 1986) and lignin (Ranade and Gadre, 1988) while VFA was determined by distillation method (Kroman *et al.*, 1967) and pH by pH meter.

A slurry containing 6.7% TS was prepared by mixing finely ground dried and

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green ipomea leaves. The samples were charged in 250 ml conical flask to which 10 ml starter inoculum was added. The flasks were stoppered with one pored rubber tube which dipped into water in a beaker to prevent entry of air in to the flask. The flasks were incubated at 37°C and contents of the flasks were shaken for 2 minute daily for 5 days. The pH and the VFA produced in the flask were measured daily. In the second flush of VFA produced, the plant material was filtered on the day of maximum VFA production and flasks transfered and charged again with the same volume of water to obtain 6.7% solids and incubated again up to 4 additional days.

The second phase methanogenic digester was started in one litre flask with digested cattle dung slurry filtered through muslin cloth into which the maximum VFA produced of I flush from dried and green ipomea leaves were charged and the biogas yield was recorded for a period of ten days during digestion at 37° C. The gas was analysed for methane content by Orset gas analysis appratus (Vogel, 1968).

RESULTS AND DISCUSSION

The chemical composition of ipomea leaves showed that they contained 86.8 % VS, 37.2 % O.C., 3.84 % total N, 34.9 % cellulose, 12.1 % hemicellulose and 11.1 % lignin.

Figure- 1 present the concentration of VFA formed daily from digestion of the dried and green ipomea leaves. It was observed that the maximum VFA production during the I flush from dried and green ipomea leaves was 7.38 and 8.46 g/lit (Figure 1) respectively after the 3 days of digestion (first phase). No further increase in VFA production occured thereafter. This might be due to lowering of pH during digestion or might be due to end product inhibition

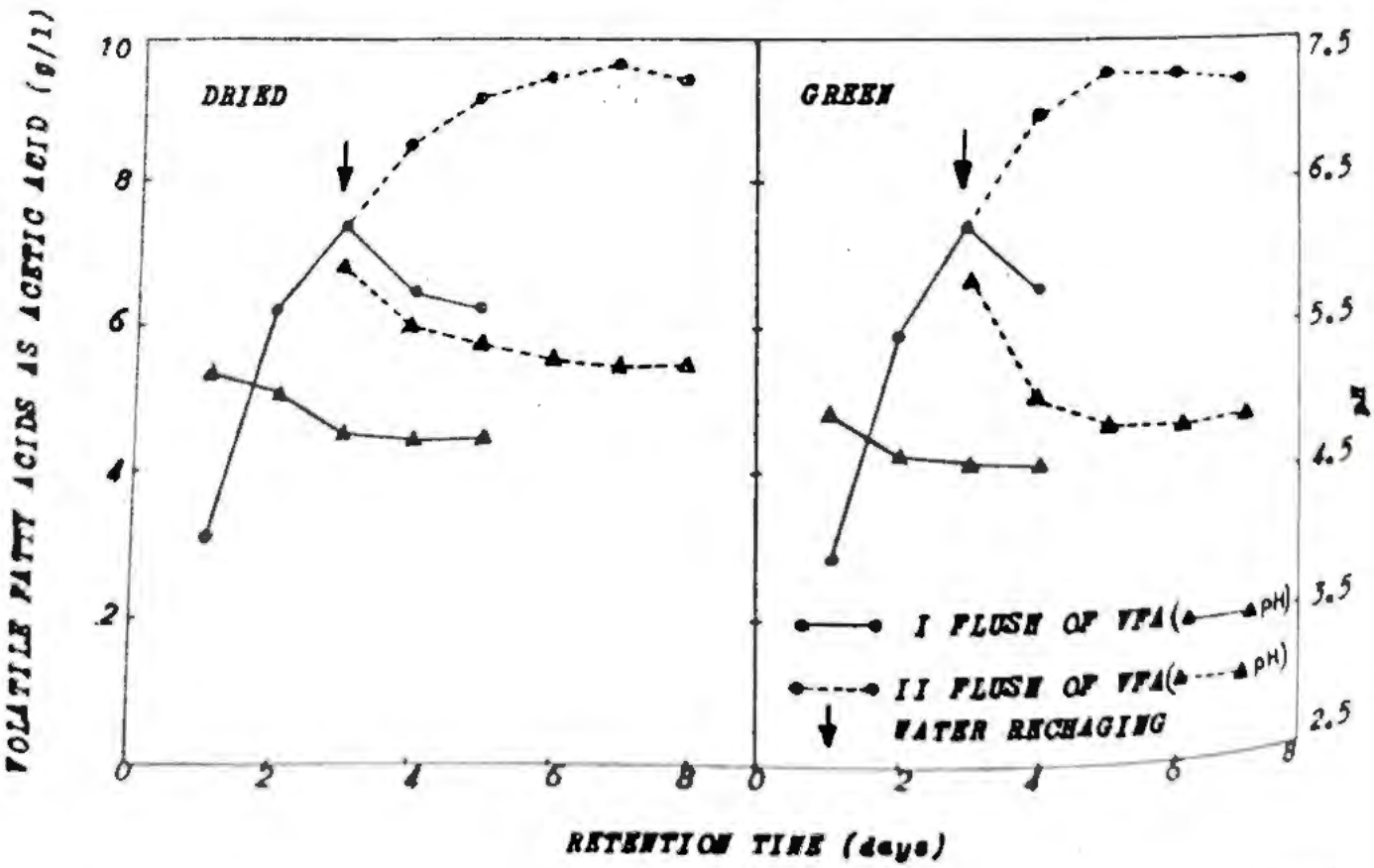

Fig. 1 : Effect of retention time on VFA production and pH at 37°C from dried and green ipomea leaves by two phase (batch) system (I phase)

(Neelakantan *et al.*, 1978). The initial pH of both dried and green ipomea leaves were 7.2 which decreased to 4.75 and 4.64 after 3 days of digestion (Figure 1) respectively. It was observed that the pH of digester liquor decreased at a faster rate due to higher rate of VFA production. The resultant pH changes are due to interaction of the buffering capacity of plant tissues and the types of the acids formed during different periods of digestion. Sarma (1976) reported that the alfalfa plant acids were found to be primarily made of C_2, C_3, i-C_4, C_4, i-C_5 and C_5 acids and an unidentified relatively long chain fatty acids.

Effects of dilution (water charging) at maximum VFA production from dried and green ipomea leaves has been represented in figure 1. It was observed that when the dried and green ipomea leaves were digested in two flushings, additional amount of VFA recovery was obtained which was 9.70 g and 9.58 g as acetic acid from dried and green ipomea leaves respectively during 3 + 4 days of digestion.

Figure 2 presents the biogas yield from VFA of dried and green ipomea leaves during 10 days methanogenic digestion at 37° C. The total biogas yield from I flush of VFA (7.38 g as acetic acid/lit.) of dried ipomea and (8.46 g as acetic acid/lit.) of green ipomea leaves was 433 ml and 436 ml/g dry matter respectively and contained 63.6 and 64.6 per cent methane after 10 days methanogenic digestion. Most of the biogas yield (86 % and 72 %) was produced from dried and green ipomea leaves during the first 4 days of digestion. The extent of degradation of primary constituents in 10 days of methanogenic digestion was cellulose 57.3 and 62.6 per cent, hemicellulose 53.5 and 58.4 per cent from dried and green ipomea leaves respectively. The degradation of VS was 60.8 and 64.1 per cent from the dried and green ipomea leaf samples respectively, while the lignin percentage was increased in the residues after fermentation in both the material due to the loss of dry matter which indicates that lignin was not degraded by the microorganisms.

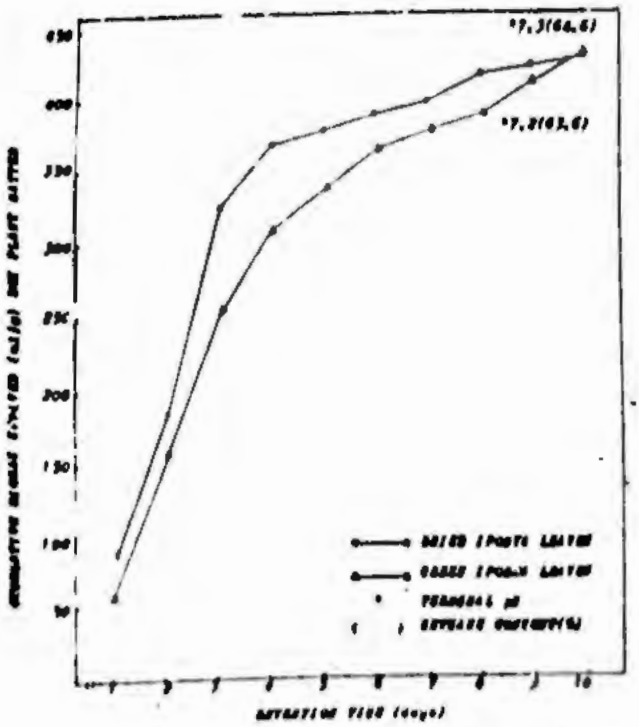

Fig. 2 : Biogas evolved from VFA of dried and green ipomea leaves by the 2nd phase of two phase batch system at 37° C.

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Standardization of Method for Determining Available Sulphur and its Critical Limit for Low-Land Paddy

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ABSTRACT

Three levels of S (0, 10 and 20 ppm) were tried on paddy variety Jaya grown in pots containing soils from ten series. Significant effect of S application was noted on yield and uptake of S by crop. Amongst ten methods of extracting S, the Heat Soluble - S and the organic S showed significant positive relationship with uptake by plants grown without addition of S. The critical concentration established for Heat soluble-S was 18.0 ppm.

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INTRODUCTION

On account of intensive cropping, use of high yielding varieties, S-free fertilizers and scarce use of organic manures, the sulphur deficiency has been noted in many parts of India including Gujarat (Tandon, 1991). Low-land paddy is extensively grown in South Gujarat in summer as well as in kharif seasons. Formerly, the N need was met through ammonium sulphate (containing about 24% S) and P through single superphosphate (containing about 12% S). However, the N and P are predominantly met through S-free sources like urea and DAP. Keeping in view, the importance of S in present day intensive agriculture, it was thought worth while to standardize the extractant for determination of available- S and to fix its critical limit.

MATERIALS AND METHODS

A pot experiment was conducted by growing paddy variety Jaya in 4 kg capacity alkathene lined earthen pots containing soils from ten paddy growing soil series viz., (i) Kabilpur (ii) Gadat (iii) Jalalpur (iv) Sisodra (v) Bedmal (vi) Mulad (vii) Eru (viii) Dandi (ix) Att and (x) Onjal. The chemical properties of these series are given in Table 1. Three levels of S replicated thrice were (i) 0 (ii) 10 and (iii) 20 ppm and the source was ammonium sulphate. The doses of N and P_2O_5 were 100 and 50 ppm, respectively and the sources were ammonium sulphate, DAP and urea. The entire amount of S and P_2O_5 were given at the time of planting while N was given in three splits i.e. 50 % at the time of planting and remaining 50 % in two equal instalments each after 30 days and 45 days of planting. After giving the needed amounts of nutrients, the soil from each series was transferred to alkathene lined pots and the pots were flooded in such a way that 3 cm of standing water was kept and was maintained throughout the experimental period. Eight seedlings of paddy

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raised without addition of S were dibbled in each pot which were thinned to four after eight days of establishment. The crop was allowed to grow upto 70 days after which the above ground portion from each pot was harvested and the green and dry matter yields were recorded. After grinding the plant material in a willey mill, the diacid extracts (HNO_3 : $HC10_4$) were prepared and the sulphur was estimated by turbidimetric method (Chesnin and Yien, 1950). Simultaneously, the available S was also determined from each soil series by (i) Heat-soluble method (Williams and Steinbergs, 1959) as well as reagents such as (ii) 1 % NaCl (Williams and Steinbergs, 1959) (iii) 0.5 N NH_4OAc + 0.25 N HOAc (Bardsley and Lancaster, 1960) (iv) N NH_4OAc pH 7.0 (MaClung *et al.* 1959) (v) N NH_4OAc pH 4.8 (Olson and Carlson, 1950) (vi) Morgan's reagent (Chesnin and Yien, 1950) (vii) 0.15% $CaCl_2$ (Williams and Steinbergs, 1959) and (viii) KH_2PO_4 - 500 ppm-P (Ensminger, 1954). The fractions organic-S (Bardsley and Lancaster, 1965) and total-s (Chaudhary and Cornfield, 1966) were also determined from each of the series. In all the cases, the sulphur was determined by turbidimetric method (Chesnin and Yien, 1950). The values of S determined by these methods and S uptake by control plants were correlated.

RESULTS AND DISCUSSION

Sulphur in soil series

The 1 % NaCl extractable-S showed (Table 2) relatively low values in majority of the series. Leaving Kabilpur and Bedmal series, the phosphate extractable-S showed highest values amongst the rest of the extractants. The ranges of the variation in values of S extracted by different methods were 7.52-27.90, 5.86-34.20, 4.56-47.40, 4.72-81.33, 4.97-81.75, 4.85-86.26 and 11.39-71.32 ppm, respectively in cases of Heat soluble, 1% NaCl, 0.5 N NH_4OAc + 0.25 N HOAc, N NH_4OAc pH-7.0, N NH_4OAc pH-4.8, Morgan's reagent and 0.15 % $CaCl_2$. On an average, the order for values of S obtained was : total S (159.03) > Organic S (66.59) > KH_2PO_4 - 500-ppm -P (33.43) > Morgan's reagent (27.53) > 0.15 % $CaCl_2$ (26.30) > N NH_4OAc pH-4.8 - (25.70) > N NH_4OAc pH-7.0 (23.03) > 0.5N NH_4OAc + 0.25 N HOAc - (16.43) > Heat-soluble (14.34) > 1 % NaCl (14.14). The different series indicated relatively highest amount of S in organic form. This might be due to high clay content in the soil series. Reddy *et al.* (1985) in A.P. and Pandey *et al.* (1989) in U.P. have also observed relatively high proportion of S in organic form in soils containing high clay.

Effect on dry matter yield and uptake

A significant increase in dry matter yield (Table 3) was noted with each rise in level of S application. A significant variation in dry matter yield was also noted with respect to different soil series. The interactions between dry matter yield and series were not significant. Application of S increased the S uptake significantly over control. However, the levels 10 and 20 ppm were at par. The series as well as the interactions between series and levels of S showed significant difference. In general, the S uptake varried between 42.3 mg/pot in case of Gadat series under control and 83.4 mg/pot in Sisodra under 20 ppm level of S application.

The prime purpose of the experiment was to establish the correlation of S extracted by different methods with yield and uptake by plants grown without application of S. For workingout the correlation, the per cent yield was workedout for each series by considering the 100% yield of the

TABLE 1

Chemical properties of experimental soil series.

Sr. No.	*Soil series*	*Great group*	*Clay (%)*	*Texture*	*pH 1:2.5*	*EC 1:2.5 dsm $^{-1}$*	*Organic C (%)*	*Available P_2O_5 (kg/ha)*	*Avilable K_2O (kg/ha)*
1.	Kabilpur	Ustochrepts	58.6	Clayey	8.0	0.30	0.39	29	389
2.	Gadat	Ustochrepts	42.9	Clayloam	7.9	0.13	0.70	48	540
3.	Jalapur	Ustochrepts	55.7	Clayey	8.0	0.39	0.40	23	370
4.	Sisodra	Ustochrepts	48.0	Clayey	8.1	0.20	0.45	27	381
5.	Bedmal	Ustochrepts	35.5	Siltyclay	6.5	0.09	0.80	43	289
6.	Mulad	Chromusterts	52.3	Clayey	7.9	0.21	0.50	41	440
7.	Eru	Chromusterts	64.8	Clayey	7.9	0.17	0.51	23	343
8.	Dandi	Halaquepts	60.6	Clayey	8.9	0.80	0.65	17	1089
9.	Att	Halaquepts	44.4	Clayloam	8.6	1.35	0.60	49	389
10.	Onjal	Halaquepts	45.4	Clayey	8.5	2.80	0.73	21	310

TABLE 2

Values of S (ppm) extracted by different methods from experimental soil series.

Sr. No.	*Soil series*	*Heat soluble-S*	*1% NaCl*	*0.5 N NH_4OAC +0.25N HOAc*	*N NH_4 OAC pH 7.0*	*N NH_4 OAC pH 4.8*	*Morgan's reagent*	*0.15% $CaCl_2$*	*Phosphate extractable (KH_2PO_4-500 ppm-p)*	*Organic S*	*Total S*
1.	Kabilpur	8.30	7.68	4.56	5.68	5.90	4.85	11.39	5.19	39.97	135.57
2.	Gadat	7.52	6.37	10.08	5.10	4.97	11.01	14.61	15.87	44.83	116.53
3.	Jalalpur	9.92	8.59	10.68	14.94	10.98	14.50	14.51	18.19	48.74	108.31
4.	Sisodra	8.89	5.86	9.05	12.99	17.76	16.00	15.54	17.96	48.30	122.91
5.	Bedmal	14.26	8.21	5.76	4.72	11.10	12.57	12.05	7.71	78.80	151.55
6.	Mulad	11.93	10.97	11.92	17.83	12.27	20.11	25.32	31.91	65.20	198.96
7.	Eru	13.20	9.30	9.35	13.64	17.27	20.14	18.00	33.02	54.65	143.59
8.	Dandi	16.38	32.38	38.86	48.39	64.25	63.81	59.81	76.85	98.40	213.12
9.	Att	25.67	18.30	16.61	25.64	25.70	26.05	20.41	32.96	82.55	162.22
10.	Onjal	27.90	34.20	47.40	81.33	81.75	86.26	71.32	94.54	100.51	237.59
	Average	14.34	14.14	16.43	23.03	25.70	27.53	26.30	33.43	66.59	159.03

TABLE-5

Effect of levels of S on dry matter yield and uptake of S by paddy.

Treatments	Soil series	Dry matter yield, g/pot (Sulphur levels, ppm)				Sulphur uptake, mg/pot (Sulphur levels, ppm)			
		0	10	20	Mean	0	10	20	Mean
1.	Kabilpur	27.30	37.00	38.00	34.10	42.70	63.30	59.30	55.10
2.	Gadat	31.70	31.30	36.70	33.23	42.30	64.70	65.70	57.56
3.	Jalalpur	30.30	32.00	36.30	32.90	47.70	48.70	51.00	49.13
4.	Sisodra	30.30	32.70	39.60	34.20	45.70	62.30	83.40	63.90
5.	Bedmal	33.00	35.00	39.00	35.66	54.30	69.30	80.00	57.90
6.	Mulad	31.60	35.30	36.00	34.30	52.70	62.00	61.00	55.6
7.	Eru	28.60	29.30	29.00	29.00	48.70	52.30	56.00	52.3
8.	Dandi	27.00	31.30	35.30	31.20	50.00	51.30	69.30	56.90
9.	Att	34.00	32.00	39.30	33.43	52.70	55.70	62.30	56.90
10.	Onjal	23.70	32.60	29.70	28.70	52.00	74.00	60.70	62.23
	Mean	29.75	32.85	35.40	-	48.88	60.36	64.87	-
			S.Em±	C.D.@ 5%	C.V.%	S.Em±	C.D.@5%	C.V.%	
	Soil series		1.18	3.42		2.12	7.41		
	Levels of S		0.65	1.88	10.9	1.40	4.06	13.3	
	Soil series × Levels of S		2.05	N.S.		4.45	12.80		

TABLE 4

Relationship of S extracted by different methods with per cent yield and uptake.

Sr. No	Methods	Values of 'r' with % Yield	Uptake
1.	Heat - soluble	0.22	0.67 *
2.	1 % NaCl	-0.17	0.42
3.	0.5 N NH_4 OAc + 0.25 N HOAc	-0.91	0.34
4.	N NH_4OAc pH 7.0	-0.17	0.40
5.	N NH_4 OAc pH 4.8	-0.18	0.41
6.	Morgan's reagent	-0.18	0.41
7.	0.15 % $CaCl_2$	-0.25	0.36
8.	KH_2PO_4 - 500 ppm - P	-0.08	0.39
9.	Organic - S	-0.11	0.75 *
10.	Total - S	-0.08	0.62

Figures having * sign were significant at 5 % level. Rest of the values were not significant.

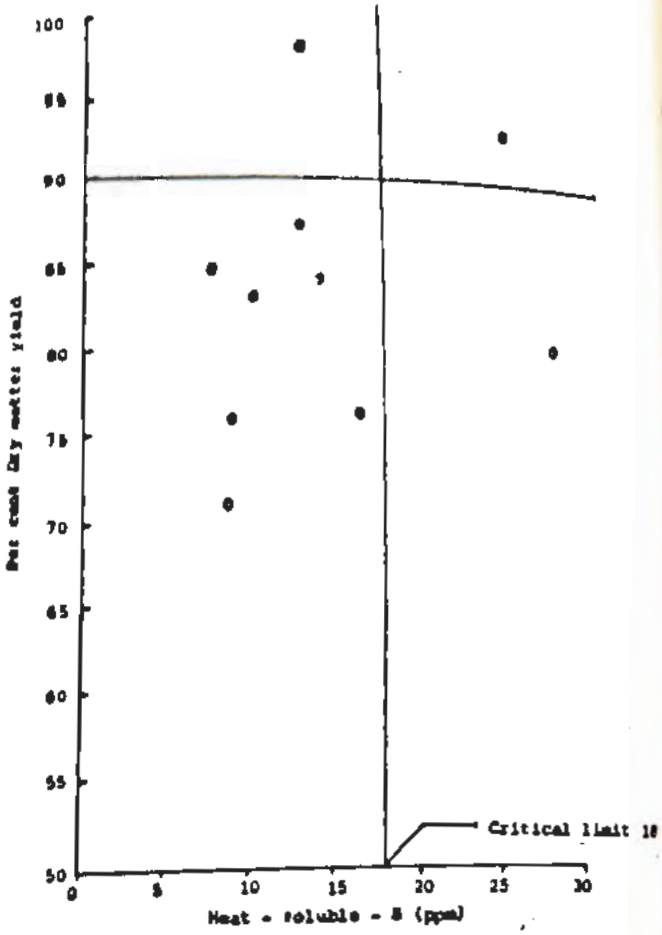

Fig. 1 : Critical limit of Heat - Soluble - S for low land paddy.

treatment showing the highest yield. None of the methods showed significant relationship with per cent yield (Table 4). However, the uptake showed significant possitive relationship with values of Heat soluble-S ($r = \leq 0.67$ $p \leq 0.05$) and organic -S ($r = + 0.75$ $p \leq 0.05$). Reddy and Mehta (1970) and Patel and Marsonia (1985) have also obtained significant relationship between Heat soluble-S extracted from different soils of Middle Gujarat and South Saurashtra regions and uptake by alfalfa and wheat crops, respectively.

Critical value of S for response

Because of the occurrence of significant relationship between values of Heat soluble-S and uptake, an effort was made to establish the critical value of Heat soluble-S for getting response to-S application in paddy growing soil series through employing the procedure of Cate and Nelson (1971). By ploting the values of Heat soluble-S and per cent yield obtained under control treatment (Fig.1), a value of 18 ppm was obtained. Tiwari *et al.* (1983) and Tandon (1991) have reported a critical value of 16 ppm for Heat soluble-S. The present value is slightly higher than the values reported by these workers. The study indicated a necessity of S addition in soils containing less than 18.0 ppm Heat soluble -S for low-land paddy.

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Effect of Source and Rate of Sulphur Fertilization on Castor

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ABSTRACT

An experiment conducted in sandy loam soil of Sardar Krushinagar during 1987-88 to 1989-90 to study the influence of 0, 20, 40 and 60 kg S/ha in the form of gypsum (GS) and elemental sulphur (ES) revealed that application of GS @ 20 kg S/ha gave maximum yield with a net ICBR of 1:47.2. Oil content of the seeds was not significantly influenced. With increase in sulphur rates sulphur content in seeds increased, GS being more efficient than ES. The residual available sulphur content in soil after harvest was not high.

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INTRODUCTION

Sulphur deficiency in sandy soils of North Gujarat has been reported (Patel and Kalyan- sundram, 1988).The response of different oilseed crops to sulphur application has been widely reported in India. (Aulakh and Pasricha, 1988) but work on castor is limited, if any, keeping this in view, effect of different sources and levels of sulphur on yield and oil and sulphur contents of castor were studied.

MATERIALS AND METHODS

A field experiment was undertaken at Sardar Krushinagar of Gujarat Agricultural University from 1987-88 to 1989-90. The soil of the experimental plots were sandy loam (Typic Ustifluvents) with low available nitrogen, medium to high in available phosphorus and high in available potash. Heat soluble sulphur was 2.9, 7.0 and 8.0 ppm in the year 1987-88 and 1989-90, respectively.

The experiment was laid out in R. B. D with eight different treatments comprising two sources of sulphur viz., gypsum (GS) and elemental sulphur (ES) each having four levels of sulphur viz., 0, 20, 40 and 60 kg S/ha (S_0, S_{20}, S_{40} and S_{60}) replicated three times.The crop was sown on 9th September, 29th July and 30th August in the year 1987-88, 88-89 and 89-90, respectively. The recommended full dose of phosphorus (50 kg P_2O_5) and half dose of nitrogen (37.5 kg N/ha) sulphur as per treatments were applied in furrow before sowing. The remaining half dose of nitrogen (37.5 kg/ha) was applied in two equal splits at 40 and 70 days after sowing. Urea and DAP were sources of N and P respectively. The crop had a spacing of 90 cm x 60 cm.During the years 1987-88, 1988-89 and 1989-90 the crop received 68.4, 390.0 and 568.1 mm rainfall in 4.25 and 54 rainy days and it was irrigated 8, 7 and 6 times respectively. Estimation of heat soluble sulphur (Williams and Stainbergs,1959) in soil before sowing and after harvest and

sulphur content (Chaudhary and Cornfield,1966) and oil content (A.O.A.C.,1960) in castor seed were done.

RESULTS AND DISCUSSION

Yield

Data presented in Table-1 showed that sources of sulphur had non-significant effect on yield of castor during the year 1987-88,1989-90 and in pooled analysis. The cost of S from gypsum and elemental S being 1.75 and 2.23 Rs/kg respectively (Dev and Sharma,1988) gypsum as a source of S is economical.Gypsum and single super phosphate (which contains 50 % gypsum) have been reported superior to other sources of S in increasing the yields of oilseeds grown in coarse textured soils (Dalal *et al.*,1963 and Dhillon and Dev. 1980).

Levels of sulphur had significant effect on seed yield of castor in all the three years.But the pooled data showed non-significant result.

The pooled analysis revealed a significant Y x L interaction.The influence of S levels on yield varied from year to year. though a significant response was registered in all the years.During the year 1987-88, S_{40} gave the maximum yield and it was significantly better than S_0 and S_{20}.During 1988-89, S_{40} gave the highest yield and it was significantly superior than S_0 and S_{20}.In the year 1989-90, S_{20} gave the maximum yield and it was significantly superior than the rest.Thus response to S application was observed during all the three years but the degree of response to each level varied with years resulting in an overall non-significant impact of levels of S in the pooled analysis. Irrigated castor crop is not gener-

TABLE 1

Castor yield, oil and sulphur content in seeds as influenced by source and rate of sulphur.

Sulphur treatment	*Yield (kg / ha)*				*Oil content (%)*			*Sulphur content in castor seed (%)*
	87-88	*88-89*	*89-90*	*Pooled*	*87-88*	*89-90*	*Pooled*	
Source								
GS	2269	3028	3688	2995	50.10	49.54	49.82	0.10
ES	2298	2007	3695	2967	49.89	49.46	49.68	0.09
C.D. at 5 % Rate	NS	93	NS	NS	NS	NS	NS	0.01
S_0	2166	2845	3315	2775	49.26	49.20	49.23	0.07
S_{20}	2323	2777	4076	3059	49.91	49.76	49.84	0.10
S_{40}	2437	3052	3689	3059	50.17	49.44	49.81	0.11
S_{60}	2207	3195	3685	3029	50.62	49.59	50.11	0.11
C.D. at 5 %	135	131	345	NS	54	NS	NS	0.01
Interaction								
C.D. at 5 %								
S X I	NS	186	NS	NS	NS	NS	NS	NS
Y X L	---	---	---	214	---	---	NS	---
C.V %	4.81	3.58	7.54	6.15	0.87	0.81	0.84	11.46

ally irrigated in kharif. During the years of experimentation, the crop was rainfed in kharif and because of fluctuating soil moisture regimes, varying response over the years could have occured.

Individual years and pooled data showed nonsignificant results of S X L interaction except in the year 1988-89. Interaction Y X S and Y X S X L were found non-significant.

Net ICBR for 20, 40 and 60 kg S/ha were 1:47.2, 1:22.9, 1:13.2 for GS and for ES 1:22.3, 1:10.1, 1:5.6 respectively for the pooled mean yield of castor @ 1.75 and 2.23 Rs/kg sulphur for GS and ES sources respectively (Dev and Sharma, 1988 - prices given for GS and ES) @ 5.50 Rs/kg castor seeds. Thus application of gypsum @ 20 kg S/ha gave maximum NICBR. It has been reported that each rupee spent on S from gypsum generated extra yield worth Rs.7.7-38.5 in groundnut, Rs. 4.6-59.0 in mustard and Rs. 2.5-31.0 in sunflower in different parts of the country (Takkar, 1987).

Oil content

Oil content of castor seeds as influenced by the treatments (Table-1) showed that the sources of sulphur had no signficant effect during both the years and in the pooled analysis. During the year 1987-88, S_{60} gave significantly higher oil content than S_0 and S_{20} but was at par with that of S_{40}. Though similar trend was observed in 1989-90 and in pooled data, the differences were not statistically significant.

Pooled analysis indicated that the effect of all the interaction were non-significant for oil content.

Sulphur content

Concentration of sulphur in castor seed was significantly higher due to gypsum as compared to elemental sulphur during 1989-90. The concentration (0.11%) was maximum for S_{40} which was at par with those of S_{20} and S_{60} was significantly higer than S_0 (0.07%). Oil seed crops other than rape and mustard are reported to contain from 0.10 to 0.33 % in seeds (Aulakh and Pasricha, 1988).

Residual effect

Available sulphur in soil collected after the harvest of the crop and averaged over the three years showed there was a linear increase in the content from S_0 to S_{40} (Table-2). Between the two sources, elemental sulphur left a higher residual available sulphur than gypsum in each of the levels. This could be due to incomplete oxidation of ES in the soil. However, the value of 5.17 ppm for S_{20} in the form of gypsum being less than the critical level of 10 ppm indicated that the residual effect was not so much as to make a soil deficient in available S to sufficient.

TABLE 2.

Residual available sulphur content (kg/ha) in soil as influenced by source and rate of sulphur application (Mean of 3 year's data).

Rate of	*Source of S*		
S	*GS*	*ES*	*Mean*
S_0	4.18	4.44	4.31
S_{20}	5.17	7.89	6.53
S_{40}	8.42	10.69	9.56
S_{60}	7.62	10.53	9.08
Mean	6.34	8.39	

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Genetic Analysis of Heterogeneous Population in Pigeonpea (*Cajanus cajan* (L.) Millsp*.)

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ABSTRACT

Combining ability for grain yield and its component characters was studied in F_2 set of a diallel crosses involving ten cultivars of pigeonpea (*Cajanus cajan* (L.) Millsp.). The magnitude of additive genetic variance was higher than that of non-additive variance for all the characters except seed yield per plant. In general the *per se* performance of the parents was closely associated with their gca effects. Among the parents ICPL 87 and H 76 - 208 for seed yield / plant, earliness, pods / plant and protein content ; Pusa Sweta 2, IPCL 312 and IPCL 151 for earliness, dwarfness, pod length, seeds / pod and seed weight and GAUT 82 - 89, BDN 31 and BWR 245 for protein content were the best general combiners. Most of the crosses with significant sca effects involved at least one good general combiner parent except for the character seed yield per plant. The crosses involving both average combiners could possibly be utilised for further selection of high yielding progenies in this crop.

(Recieved on 18th May, 1993)

INTRODUCTION

Choice of parents is considered to be an important step in any plant breeding programme aimed at improving yield and related attributes. Combining ability analysis helps in selecting desirable parents which on crossing would give rise to desirable segregants. Besides, it also provides the information on nature and magnitude of genetic variation.In the present study, an effort has been made to estimate combining ability of some pigeonpea cultivars for grain yield and its component characters using heterogenous F_2 populations of a ten parent diallel crosses

MATERIALS AND MATHODS

A set of 55 genotypes comprised of 10 early maturing parents and their 45 half diallel F_2's (10 × 10) were grown in a randomised block design with 4 replications at Instructional Farm, Sardar Krushinagar during *kharif* 1989. Each entry was represented in four row plot of 4 metre length. The inter and intra - row distance was 60 and 20 cm, respectively. The observations were recorded on ten randomly selected plants from a plot on ten characters (Table 1). The combining ability analysis was done according to Method 2, Model 1 of Griffing (1956).

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TABLE 1

Analysis of variance for combining ability in pigeonpea.

Source	*d.f.*	*Days to flowering*	*Days to maturity*	*Plant height (cm)*	*Branches/ plant*	*pods/ plant*	*Pod lenght (cm)*	*Seeds/ pod*	*Seeds yield/ plant (g)*	*100 seed weight (g)*	*Protein content (%)*
gca	9	295.24**	381.80**	1412.72**	1.90**	3907.11**	0.33**	0.25**	48.66**	3.85**	2.61**
sca	44	24.75**	63.23**	184.43**	1.50**	1792.23**	0.13**	0.07**	76.19**	0.51**	1.04**
Error	162	0.40	1.97	28.99	0.39	43.59	0.02	0.02	14.63	0.09	0.01
σ^2 gbs σ^2 sca		11.93	6.04	7.66	1.27	2.18	2.54	3.57	0.64	7.55	2.52

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

TABLE 2

General combining ability effects and mean values (in parenthesis) of parents for different characters in pigeonpea.

Parents	*Days to flowering*	*Days to maturity*	*Plant height (cm)*	*Branches/ plant*	*pod/ plant*	*pod length (cm)*	*Seeds/ pod*	*Seed yield/ plant (g)*	*100-seed weight (g)*	*Protein control %*
ICPL-269	0.21	-1.95**	6.43**	-0.17	-0.74	0.23**	0.20**	0.65	-0.07	-0.95**
	(101.00)	(152.75)	(141.18)	(7.13)	(20.3.23)	(4.35)	(3.98)	(50.87)	(9.08)	(16.12)
Pusa sweta2	-0.60**	-1.63**	2.40	-0.35**	-17.30**	0.17**	0.18**	-0.82	0.46**	-0.13**
	(85.25)	(139.25)	(89.0.8)	(3.93)	(86.85)	(4.63)	(4.25)	(25.77)	(10.44)	(17.28)
ICPL 87	-2.00**	-3.80**	5.81**	-0.14	12.75**	0.04	-0.01	2.94**	-0.34**	0.21**
	(93.00)	(142.00)	(89.35)	(6.15)	(185.35)	(4.13)	(3.35)	(50.34)	(8.02)	(17.15)
GAUT 82.99	2.67**	1.97**	2.10	0.02	3.50**	-0.08*	-0.11**	1.15	0.61**	0.22**
	(94.75)	(146.50)	(101.30)	(6.80)	(125.00)	(3.70)	(3.40)	(27.78)	(10.55)	(18.09)
H 76 - 208	-0.88**	-3.40**	5.86**	0.15	42.83**	-0.22**	-0.14**	2.78**	-0.83**	0.20**
	(85.75)	(133.50)	(100.53)	(7.23)	(171.23)	(3.30)	(3.15)	(53.96)	(6.99)	(18.44)
ICPL 312	-2.04**	-2.65**	-5.49**	-0.45**	-7.00**	0.18**	0.18**	-1.53	0.47**	-0.05**
	(84.50)	(143.25)	(79.98)	(3.63)	(69.33)	(4.88)	(4.70)	(21.02)	(10.75)	(15.05)
ICPL 151	-2.79**	-0.13	-9.10**	-0.26	-20.95**	0.10**	0.06	-2.28*	0.63	-0.52**
	(85.50)	(158.00)	(88.45)	(5.53)	(100.68)	(3.90)	(3.85)	(27.59)	(9.37)	(15.14)
ICPL 8306	-5.85**	-2.32**	-9.34**	0.12	-4.26*	-0.15**	-0.05	-2.25*	-0.83**	-0.10**
	(74.50)	(156.75)	(81.28)	(6.43)	(97.80)	(3.65)	(3.55)	(20.16)	(7.10)	(16.30)
BDN 31	-1.40**	-1.43**	-8.26**	0.13	-10.59**	-0.14**	-0.14**	-1.88	-0.36	0.51**
	(86.50)	(142.50)	(83.75)	(5.53)	(137.50)	(3.45)	(3.10)	(32.43)	(8.61)	(18.16)
BWR 245	12.69**	15.35**	25.91**	0.97**	1.75	-0.14**	-0.17**	1.25	0,26**	0.60**
	(127.00)	(193.75)	(138.93)	(6.48)	(65.05)	(3.58)	(3.18)	(19.58)	(9.14)	(18.25)
S E gi ±	0.17	0.38	1.47	0.17	1.76	0.04	0.04	1.05	0.08	0.03
Mean	91.02	172.76	105.11	6.64	150.89	4.10	3.81	37.87	8.90	17.09
S Em ±	0.63	1.40	5.39	0.63	6.41	0.15	0.15	3.82	0.31	0.11

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

TABLE 5

Best specific combinations for yield alongwith desirable sca effects a for other traits and gca effects of parents.

Cross	*Mean*	*Sca effect for Seed yield per plant*	*Significant sca effect for other traits*	*gca effect of parents* $P_1 \times P_2$	$\sigma^2 P$	*PCV %*
GAUT 82-99 x ICPL 312	62.38	**	BP, PP, PH, PC	A x A	700.74	42.45
DCPL 8306 x BWR 245	54.08	**	BP, PP, PL	L x A	825.55	53.13
Pusa Sweta 2x BWR 245	49.44	**	PP, DF, DM, PC	A x A	608.02	49.88
ICPL 151 x BWR 245	46.27	**	BP, PP, CF, PH	L x A	582.65	52.17
ICPL 269 x BDN 31	45.40	*	PP, SP, PL, PH	A x A	716.11	58.75
Pusa Sweta 2 x BDN 31	42.97	*	BP, PP, PL, PC	A x A	352 .36	43.69

*, ** Significant at 5 and 1 per cent probability level, respectively.

DF = Days to 5 % flowering

DM = Days to maturity

PH = plant height

BP = Number of branches per plant

PC = protein content

PP = Number of pods per plant

PL = Pod length

SP = Number of seeds per pod

A = Average combining ability

L = Low combining ability

PCV % = Phenotype coefficient of variation.

RESULTS AND DISCUSSION

Analysis of variance for combining ability (Table 1) revealed that variance due to gca and sca were highly significant for all the characters indicating importance of both additive and non-additive gene effects in their inheritance. However, role of additive gene effects was more predominant for all the traits except of seed yield/plant. The present findings are in agreement with Sidhu and Sandhu (1981), Venkataswarlu and Singh (1981) and Zaveri, *et al.* (1989). While the predominant role of additive genetic variance for days to flowering and maturity (Cheralu *et al.*, 1989), number of branches and pods per plant (Singh *et al.* 1983) and (Cheralu *et al.* 1989); and for plant height (Patel *et al.*, 1987) was also reported.

The estimate of gca effects (Table 2) revealed that varieties ICPL 87 and H 76 - 208 were good general combiners for seed yield/plant, earliness, pods/plant and protein content. The parents, Pusa Sweta 2, ICPL 312 and ICPL 151 appears to have genes for inducing earliness and dwarfness associated with longer pods and higher number of bolder seeds per pod. Desirable combining ability could be seen in GAUT 82-99 and BWR 245 for 100 seed weight and protein content and ICPL 8306 and BDN-31 for earliness and dwarfness. The use of parental lines namely, ICPL 87, H 76 - 208, ICPL 312, ICPL 151 and ICPL 8306 in crossing programme would be rewarding to evolve high yielding, dwarf and early maturing types.

Specific combining ability in F_2 revealed that none of the F_2 was consistently good for all the characters. Six F_2's showing desirable and significant sca effects for seed yield alongwith useful sca effects for other traits and combining ability of parents involved, are listed in Table 3. The F_2 populations with significant sca effects for seed yield also exhibited significant sca effects for component characters, the most important being pods/plant and branches per plant. Of these six F_2's, 4 combinations involved both the parents with average combining ability. There is possibility of isolating transgressive segregants in later generation from these crosses. These F_2 populations were found to show high phenotypic veriability (Table 3) suggesting better scope of selection.

In the present investigation most of the yield components are influenced by additive gene effects and therefore, pedigree method would be rewarding to improve the traits. In case of seed yield which is highly influenced by non-additive gene effects, biparental mating in segregating generation will break the tight linkages and the subseqent generations yield can be increased.

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Phenophasewise Study of Evapotranspiration in Maize (*Zea mays* L. Cv. Ganga Safed-2)

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ABSTRACT

Lysimetric studies had been conducted in *kharif* season of the years 1989-91 to determine the actual evapotranspiration in different phenophases of maize crop (cv. Ganga Safed-2). The peak value of ET/EP were 2.04, 2.19 and 1.71 in the years 1989, 1990 and 1991 respectively during flowering stage (i.e. 49 Days After Sowing) of the crop and were established earlier than the crop attained the maximum leaf area index (LAI). The highest value of LAI observed during the years 1989, 1990 and 1991 were 4.48, 4.85 and 2.49 respectively, during flowering stage (from 42 to 56 DAS) of the crop. The ratio of ET/EP was found progressively higher in 1990 than 1989 and 1991 which had higher LAI and ultimately higher grain yield. The water use efficiencies were 10.1 kg/ha/mm, 13.3 kg/ha/mm and 10.0 kg/ha/mm in 1989, 1990 and 1991 respectively.

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INTRODUCTION

Maize is an efficient user of water in terms of total dry matter production and it is the highest grian yielding crop among all other cereals. The maize crop requires between 500 and 800 mm of water depending on climatic condition for maximum grain yield production in medium duration maturity varieties (Doorenbos and Kassam 1979). Maize is one of the important crops in India and it is sown during both the kharif and rabi seasons. Actual evapotranspiration and the crop coefficient (The ratio of evapotranspiration to evaporation) are the important tools for conforming the actual water requirement of the crop during its different phenological stages . Lysimeter and the class-A Pan evaporimeters are most useful instruments for such a study. Present study analysis the actual amount of evapotranspiration (ET) and the ratio of evapotranspiration to evaporation (ET/EP) during different phenological stages of the crop and the relationship between ET/EP and Leaf Area Index (LAI).

MATERIALS AND METHODS

An experiment was conducted during the year 1989-91 at Gujarat Agricultural University, Anand Campus on Maize crop (cv. Ganga Safed-2). The daily evapotranspiration values were recorded from two gravimetric lysimeters installed by India Meteorological Department in the field adjacent to the agrometeorological observatory at Anand. Data on daily pan evaporation were also recorded from USWB class-A open pan evaporimeter installed in the meteoro-

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logical observatory. The crop was sown on 11th, 7th and 22nd July during the years 1989, 1990 and 1991 respectively. Daily meteorological and periodic agronomical observations were recorded regularly during the crop growing seasons. The crop was harvested on 11th October, 8th October and 3rd November during the years 1989, 1990 and 1991 respectively. After harvesting the crop, the grain and fodder yields were recorded and yearwise water use efficiencies were worked out.

RESULTS AND DISCUSSION

The seasonal cumulative evapotranspiration, evaporation, total rainfall, total irrigation water applied to the crop, grain and fodder yields of the crop for all three years are presented in Table 1. Weekly mean weather parameters that prevailed during the crop growing seasons are presented in Table 2.

Figure 1 shows the variations in ET/EP with the growth of the crop and the corresponding march of LAI during the years 1989-1991. The ratios ET/EP and LAI followed more or less similar curvilinear path during the growing period for all the three years. The ratio ET/EP remained low during the establishment stage and increased gradually during the vegetative stage of the crop (up to 42 DAS). The crop developed uniformly all the three years. The value of ET/EP was less than one from emergence to vegetative stage and also during the ripening stage of the crop. The values of ET/EP exceeded one and reached peak values of 2.04, 2.19 and 1.71 during the period between flowering phase (Tassel and Silking) and initial grain formation stage of the crop in the years 1989, 1990 and 1991 respectively. These were established earlier than when the crop attained maximum LAI in all the three years. Ramana Rao *et al.* (1982) reported higher water requirement of pearlmillet during flowering stage. Reduction in the values of ET/EP ratios towards the later part of the crop growth may be attributed to leaf and root sensescence and also to increased resistance in water transport inside the leaf because of ageing (Rathore 1986). The progressing trend of LAI during the year 1989 and 1990 was more or less uniform. The value of LAI was higher during the year 1990. The increasing trend of LAI during the year 1990 was higher than that during the years 1989 and 1991 throughout the crop

TABLE 1

Seasonal cumulative evapotranspiration, evaporation, total rainfall, irrigation water ; grain yield and crop water use efficiency.

Parameters	*1989*	*1990*	*1991*	*Mean*
Cumulative Evapotranspiration (mm)	470.0	493.0	456.0	473.0
Cumulative Evaporation (mm)	378.0	356.0	389.0	374.0
Total Rainfall (mm)	509.0	998.0	481.0	663.0
Total Irrigation (mm)	0.0	0.0	185.0	----
Grain Yield (kg/ha)	4749.0	6553.0	4585.0	5296.0
Fodder Yield (kg/ha)	6213.0	10829.0	7988.0	8343.0
Crop duration (days)	93.0	93.0	103.0	96.0
Crop Water use efficiency (kg/ha/mm)	10.1	13.3	10.0	11.1

TABLE 2

Meteorological parameters during crop growing seasons.

Days after sowing	*1989*			*1990*			*1991*		
	Total Rainfall (mm)	*Mean Temp. °C*	*Mean Relative humidity (%)*	*Total Rainfall (mm)*	*Mean Temp. °C*	*Mean Relative humidity (%)*	*Total Rainfall (mm)*	*Mean Temp. °C*	*Mean Relative humidity (%)*
7	96.2	28.6	80	79.0	30.1	69	280.5	26.3	92
14	64.6	29.1	81	47.0	28.5	80	105.6	27.6	87
21	110.9	28.1	82	31.2	28.4	78	13.8	28.4	78
28	0.5	28.1	75	19.4	27.6	83	2.2	29.1	73
35	17.3	27.6	79	50.4	28.7	80	21.9	27.8	82
42	54.6	27.9	83	215.6	28.1	83	27.0	27.6	81
49	131.0	26.7	90	342.5	27.0	89	30.2	27.7	77
56	12.0	28.2	79	45.3	27.5	84	0.0	28.0	70
63	0.0	28.8	71	138.8	27.8	83	0.0	29.3	66
70	0.0	29.3	71	15.4	28.0	78	0.0	29.3	65
77	21.4	29.8	74	1.8	28.8	72	0.0	26.8	50
84	0.0	29.7	74	79.7	28.0	83	0.0	28.2	58
91	---	---	---	---	---	---	0.0	27.1	49

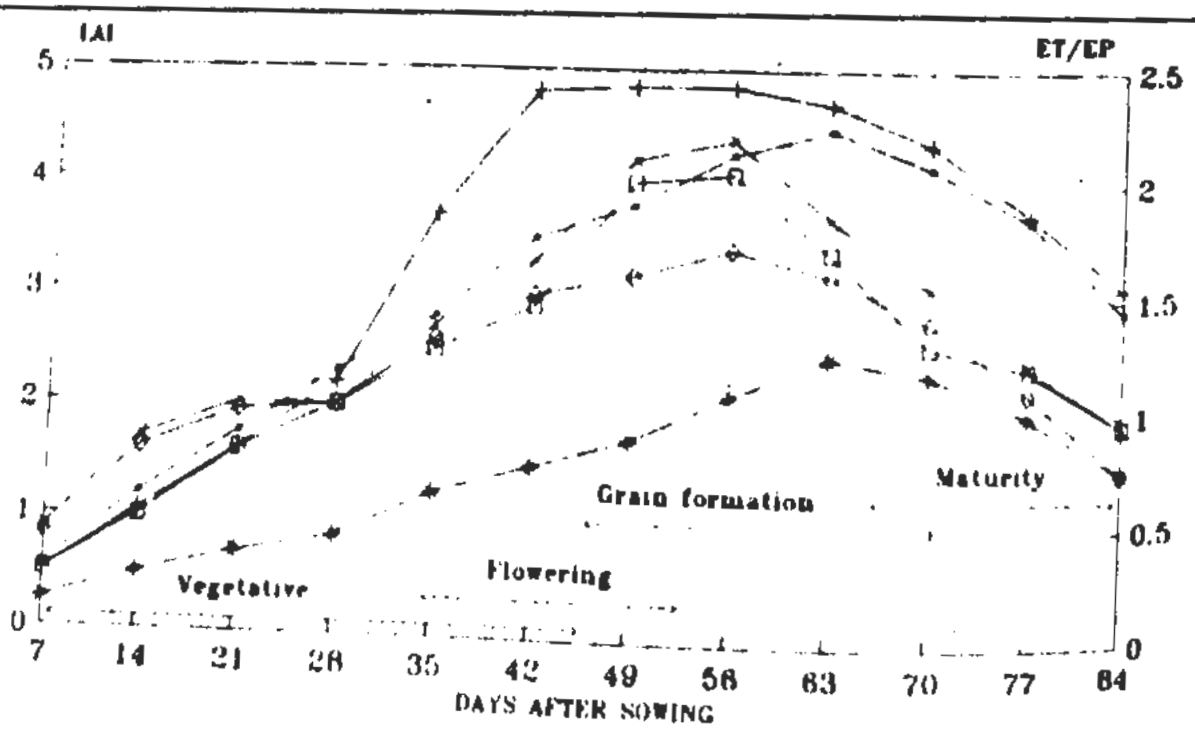

Fig. 1 : Behaviour of ET/EP and LAI during the years 1989-91.

growing season because of continuous availability of higher soil moisture and prevalence of moderate temperature and humidity. The peak values of LAI observed during the years, 1989, 1990 and 1991 were 4.48, 4.85 and 2.49 respectively. Direct linear dependent relation between ET/EP and LAI (R^2 = 0.88) had also been observed. The LAI and ET/EP both were found higher in the year 1990 during the flowering (Tassel and Milking) to grain formation stage of the crop which are the critical period of water requirement (Popov 1984). During the year 1991, the grain yield was obtained less due to reduction in grain number per cob because of scanty rainfall and prevalence of high temperature and low relative humidity. The related trend was also observed by Doorenbos (1979). The average actual evapotranspiration observed by Hundal and Sandhu (1989) at Ludhiana was 342 mm and that observed by Magar *et al.* (1989) at Rahuri was 424 mm, which were less, on an average, than that reported in this study. The yield also had the same trend. The seasonal cumulative values of ET and mean values of ET/EP during the year 1989-91 were 470, 493 and 456 mm and 1.24, 1.38 and 1.17 respectively. The water use efficiencies obtained were 10.1, 13.3 and 10.0 kg/ha/mm in the years 1989, 1990 and 1991 respectively.

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Genetic Architecture of Yield and It's Components in Bread Wheat in Optimal and Sub-Optimal Environments

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ABSTRACT

Gene actions involved in the inheritance of grain yield and four other traits were studied under high fertility and low fertility conditions in six generations of bread wheat (*T aestivum* L.) crosses viz. GW 89 X J 24 and VW 237 X J 498 during rabi 1991-92. Additive and non-additive gene effects were found to control the inheritance of all the characters. The estimates of additive (d) were less sensitive to environmentsl variation as compared to dominance (h) . Low fertility conditions were found to favour the expression of dominance / partially dominance genes governing the higher mean expression - plant height and grain / plant but reverse was true for grain/yield/spike. The results suggested the need for estimation of gene actions in multi-environments.

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INTRODUCTION

Sprague (1963) listed three major factors that must be considered and which may limit progress in the analysis of quantitative genetic variation ; the number of genes involved, the type of gene action and the genotype-environmental interaction. Champman and Mc.Neal (1971) and Sawant and Jain (1985) have reported the influence of environmental variation on the expression of additive and dominance genes governing the inheritance of the character. The present study reports the results on these aspects from two crosses of common wheat grown in two different environments represented by high fertility and low fertility irrigated conditions.

MATERIALS AND METHODS

The parents, F_1 , F_2 and back cross generations of two crosses, viz., VW 237 X J 498 and GW 89 X J 24 formed the material for present study. One row each of F_1, P_2 and F_1, two rows each of BC_1 and BC_2 and 4 rows each of F_2 were sown per each replication in completely randomized block design with three replications. Row length was 2.5 m. Row to row and plant to plant distance was 30 cms and 10 cms respectively. The experiment was grown in two environments, viz., (E_1) timely sown, high fertility (20th Nov. and 120 N + 60 P kg p/ha), and (E_2) timely sown, low fertility (20 Nov. and 60 N + 60 P kg. p/ha). Observations were recorded on five competetive plants in each row for plant height, grains/spike, grain yield/plant, 1000-grain weight and grain yield/spike. Individual scales (Mather 1949, Hayman and Mather 1955) were adopted to test adequacy of additive dominance model. Cavalli's (1952) Joint scaling test was

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employed to detect the presence of epistasis as well as to obtain weighted least square estimates of additive (d) and dominance (h) gene effects. Whenever this simple additive dominance model failed to be adequate to explain the variation in generation means, the six parameters perfect fit solution advocated by Hayman (1958) was used to estimate interaction effects.

RESULTS AND DISCUSSION

The estimates of genetic parameters for different characters recorded in two crosses under two environments are presented in Table 1. Since the variation among six generation means was not significant for grains/spike in cross one and environment one(E_1); 1000 grain weight in both crosses in environment two (E_2) and grain yield/plant in cross two and environment two (E_2); their data were not subjected to generation mean analysis. Additive dominance model was adequate in cross VW 237 x J 498 for plant height under both the environments and for the remaining characters under timely sown high fertility conditions only. No significant epistatic effect was observed for grains/spike in both crosses and grain yield/spike in cross VW 237 x J 498 under low fertility conditions and for grain yield/plant in GW 89 x J 24 under high fertility conditions, though the X^2 value of joint scaling test was significant. The failure to detect epistatic effects based on analysis of generation means does not necessarily indicates that epistatic interactions play no role in determination of phenotypic values as comparable balancing could exist for interaction (Sun *et al.*, 1970).

The estimates of (d) and (h) given in Table 1 show that (d) was significant for all the characters irrespctive of the crosses and environments except in cross GW 89 x J 24 for grain/yield spike and 1000 grain weight under high fertility and grain yield/plant under both the conditions. Its magnitude under both the environments was similar for grains/spike and grain yield/plant. Whereas for yield/spike there was an increase in the magnitude of (d) under low fertility conditions while for plant its magnitude increased in cross-2 but reverse was true for cross-1. The estimate of (h) was also significant in all the cases under high fertility except plant height in both the crosses where as it was significant in cross GW 89 x J 24 and non significant in VW 237 x J 498 in all the traits except 1000-grain weight under low fertility condition. For a majority of the characters the magnitude of (h) was also greatly influenced by the cross and the environment. Under timely sown high fertility conditions in all the cases in which additive and dominance genes were controlling the inheritance of the character, magnitude of (d) was greater than that of (h) but reverse was true under low fertility. Though the magnitude of (h) was higher than (d) under low fertility for plant height, grain yield/spike and grain yield/plant it was found decreasing as compared to high fertility conditions in all the above cases. Additive x dominance, dominance x dominance and additive x additive gene interaction also found to contribute in the inheritance of plant height, grain yield / spike and grain yield/plant respectively with greater proportion of later two epistasis under high fertility condition. Whereas dominance x dominance for plant height and grain yield/ plant alongwith additive x dominance and aditive x aditive respectively in former and later characters were also important under late sowing.

It is appearent that environment has played an important role in influencing the magnitude of additive and dominance effects but the character and population showed variable sensitivity to such environmental variation. Overall, the additive gene

TABLE 1
Estimates of genetic parameters for five plant characters in two crosses of wheat under timely sown high fertility (E_1) and low fertility (E_2) conditions.

Cross	Envet.	Genetics parameters						Types of epistasis
		m	(d)	(h)	(i)	(j)	(l)	
Plant hight								
C-I	E_1	79.4	-11.07**	0.13	-0.07	-6.27*	5.40	Duplicate
	E_2	75.1	-6.57**	26.47**	24.13**	0.97	-32.07**	
C-II	E_1	75.3	6.65*	1.82	---	---	---	
	E_2	72.1	8.87**	1.72	---	---	---	
Grains / spike								
C-I	E_2	36.8	-2.20**	6.60*	3.40	0.53	1.40	Complimentary
C-II	E_1	41.7	7.11**	2.06*	---	---	---	
	E_2	38.8	2.77*	4.10	1.20	-2.20	7.93	
Grain yield / spike								
C-I	E_1	1.5	-0.01	0.20	0.22	0.20**	0.56	Complimentay
	E_2	1.3	-0.05*	0.09**	---	---	---	
C-II	E_1	1.7	0.34**	0.13*	---	---	---	
	E_2	1.5	0.30**	0.16	0.08	0.06	0.34	
1000 Grain wight								
C-I	E_1	39.7	-1.60	0.88**	7.98**	1.16	-3.59	Duplicate
C-II	E_1	40.1	2.36**	1.84**	---	---	---	
Grain yield / plant								
C-I	E_1	13.0	0.08	6.06*	4.10	0.69	1.50	Complimentry
	E_2	9.8	0.07	6.07	4.69	-0.85	-9.86**	
C-II	E_1	11.6	1.83**	2.72	---	---	---	Duplicate

C-I GW 89 x J 24, C-II VW 237 x J 498

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

Envet. : Environments, E_1 / E_2

effect was less sensitive to such environmental variations but that was not so for dominance effect. Further, there was a general trend that less favourable growing conditions depressed the expression of dominant / partially dominance genes which were responsible for higher mean expression of grain yield/spike. However, reverse was true for plant height and grain yield/ plant. But in both the above cases (for plant height and grain yield/plant) in which low fertility conditions influenced the expression of dominance / partially dominance genes presence of duplicate epistasis multiplied its effect by negative values of dominance x dominance gene interactions

Thus there would be bias in the interpretation of the importance of dominance unless the growing conditions are taken into consideration. Chapman and Mc.Neal (1971) reported that less favourable growing conditions enhance the expression of dominance genes for plant height and grain yield/plant. Similar findings were reported by Sandhu and Anand, 1972; Singh *et al.* 1974: and Gill *et al.* 1977. However, Sawant and Jain (1985) indicated that less favourable growing conditions depress the expression of grain yield, ear number, 1000-grain weight, grains/spike and plant height. It is therefore concluded that for any logical interpretation regarding gene action for 4 particular character, it is therefore necessary to conduct the experiment over a range of environments.

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Cytological Effects of Pesticides on Onion (*Allium cepa* L.) Root Tip

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ABSTRACT

Cytological effects of fungicides Carbendazim, Mancozeb, Tridemorph, insecticides - Monocrotophos, Oxydemeton methyl and Quinalphos and weedicides - Oxyfluorten, Fluchloralin and Alachlor on onion root tips was studied using recommended and higher doses of pesticides for four different durations. Reduction in mitotic index and reduction in germination was observed in all pesticides exception in Carbendazim. There was a concentration and time dependent mitodepression. Different types of chromosomal aberrations were observed. Induction of chromosomal breaks suggested clastogenic action of pesticides. Increased abnormalities with increase in concentration indicated genotoxic level of respective pesticide.

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INTRODUCTION

Pesticides are usually taken up in human system through inhalation, residue present in grain, fruits and vegetables. They may be detoxified in the human blood. However, part of it may remain as such in the system and cause physiological disturbances or can alter the genetic material. If the changed genes are harmful in function and stabilize in the population, may cause genetic hazarde in the future generation. Thus, it poses a " genetic risk " to the offspring and hence estimation of effects of pesticides on chromosome of onion is important. The effect of pesticides on onion seeds during mitosis was studied by finding out the effect on seed germination, mitotic index, and type and frequency of chromosomal aberrations in different pesticides.

MATERIALS AND METHODS

The seeds of the onion variety Junagadh local were treated with recommended dose of pesticides and several other concentrations as given in Table.

The duration was 4, 8, 12 and 24 hours. After the termination of the treatment, the seeds were thoroughly washed by distilled water. One thousand seeds were germinated on the moist filter paper in a petridish. The germination count was recorded on 6th and 12th day after seed treatment. Seed treated only with distilled water were taken as control. When redicles were 0.3 to 0.6 cm in length, they were fixed Cornoy's fluid II (glacial acetic acid ; chloroform and ethanol in the ratio of 1:3:6) for 24 hours. After fixation ; the root tips were stored in 70% ethanol for further cytological studies. Root tips treated separately with test solutions were taken and hydrolysed in 1 N Hcl for 10 to 12 minutes at 60° C in oven. Aceto-carmine Smears were prepared after hydrolysis and about ten root tips, each with

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Pesticide	*Recommended dose* (%)	*Other concentrations used* (%)
Carbendazim	0.2	0.4, 0.6, 0.8, 2.0 and 4.0
Mancozeb	0.2	0.4, 0.6, 0.8, 2.0 and 4.0
Tridemorph	0.2	0.4, 0.6, 0.8, 2.0 and 4.0
Monocrotophos	0.040	0:080, 0.120, 0.160, 0.400 and 0.800.
Oxydemeton methyl	0.025	0.050, 0.075, 0.100, 0.250 and 0.500.
Quinalphos	0.030	0.060, 0.090, 0.120, 0.300 and 0.600.
Oxyfluorten	0.25	0.50, 0.75, 1.00, 2.50 and 5.00.
Fluchloralin	0.16	0.32, 0.48, 0.64, 1.60 and 3.20.
Alachlor	0.40	0.80, 1.20, 1.60, 4.00 and 8.00.

an average of more than 600 metaphase or anaphase were analysed. Mitotic index and frequency of cells showing different type of chromosomal abnormalities were counted.

RESULTS AND DISCUSSION

Gradual to drastic reduction in germination with increase in concentration and treatment duration was observed for all pesticides (Table 1, 2 and 3). This reduction can be attributed to the mitodepressive. Carbendazim and Mancozeb caused slight increase in mitotic index (Table 1) whereas, Tridemorph resulted in slight decrease. The insecticides- Monocrotophos, Oxydemeton methyl and Quinalphos, Fluchloralin and Alachlor caused considerable reduction in mitotic index (Table 2 and 3 respectively). Mitotic inhibition by weedicides has been attributed to blocking of mitotic cycle during interphase which may result from a prolonged G_2 period synthesis (Mohandas and Grant,1972). The mitotic index for control was found to be 8.585.

The chromosomal aberrations were found in all the pesticide treatments, at all concentrations, with varying intensity. The normal mitotic cycle without any aberrations was observed in control. The chromosomal aberrations observed were chromosomal stickiness, scattering and clumping of chromosomes, formation of micronuclei, chromosome fragments, chromosome laggards, chromatid bridges, disturbed metaphases and breakage of spindle fibres. All the fungicides showed increase in percentage of chromosomal aberrations with increase in treatment concentration and duration (Table 1) whereas, the insecticides and weedicides (Table-2 and 3, respectively) showed decrease in per cent chromosomal abnormalities. This is because the mitotic index is increased by fungicides.

Chromosome stickiness has been attributed to the improper folding of chromosome fibres which makes the chromatids connected by means of sub-chromatid bridges (Mc Gill *et al.*, 1974; Klasterskha *et al.*, 1976). Chromosomal bridges, abnormal prophase, condenced prophase and laggards may be due to chromosomal stickiness, chromosomal bridges may be due to chromosomal stickiness and subsequent

TABLE 1

Effects of fungicides on germination, mitotic index and frequency of chromosomal aberrations in root tips of *Allium cepa* L.

Fungicide	*Concentration (%)*	*Germination (%)*	*Mitotic Index*		*Chromosomal aberration (%)*			
			4 hrs	*24 hrs*	*4 hrs*	*8 hrs*	*12 hrs*	*24 hrs*
Carbendazim	0.2	74	8.994	8.888	3.049	12.564	14.548	18.125
	0.4	52	8.133	8.726	6.170	17.908	19.968	31.962
	0.6	76	8.121	7.407	9.950	19.701	22.852	33.937
	0.8	46	7.567	9.243	14.147	23.023	39.080	44.677
	2.0	40	6.829	11.682	20.162	38.142	72.195	79.674
	4.0	38	6.665	11.162	23.140	41.914	79.537	87.953
Mancozeb	0.2	64	6.598	7.486	1.003	3.541	5.794	8.306
	0.4	62	6.060	6.220	1.824	4.643	6.270	9.807
	0.6	47	5.714	6.467	2.764	6.129	8.319	14.303
	0.8	60	5.472	6.349	3.980	7.178	17.218	20.033
	2.0	48	5.140	5.429	6.862	12.254	24.796	33.713
	4.0	44	4.761	5.633	9.830	13.050	26.384	34.516
Tridemorph	0.2	67	7.291	8.627	2.970	12.091	12.978	14.556
	0.4	57	7.543	8.982	4.084	12.376	13.201	15.702
	0.6	42	7.123	7.836	6.000	14.023	18.137	21.112
	0.8	46	6.991	9.333	8.485	15.210	20.859	25.870
	2.0	43	6.565	8.676	8.609	17.915	26.101	35.016
	4.0	43	6.321	8.928	10.981	22.094	35.702	48.142

TABLE 2

Effects of insecticides on germination, mitotic index and ferquency of chromosomal aberrations in root tips of *Allium cepa* L.

Insecticide	*Concen-tration (%)*	*Germi-nation (%)*	*Mitotic Index*		*Chromosomal aberration (%)*			
			4 hrs	*24 hrs*	*4 hrs*	*8 hrs*	*12 hrs*	*24 hrs*
Monocrotophos	0.040	72	7.778	7.236	5.980	5.280	4.084	3.273
	0.080	70	7.923	7.126	3.993	3.150	2.995	2.815
	0.120	62	7.237	6.829	3.010	2.254	1.960	1.650
	0.160	62	7.128	6.728	2.495	1.661	1.495	1.495
	0.400	61	7.012	6.731	2.127	1.147	0.985	0.821
	0.800	59	6.950	6.423	1.633	0.653	0.498	0.166
Oxydemeton methy	0.025	70	8.269	7.823	5.481	4.152	5.289	6.456
	0.050	60	8.123	7.651	2.454	4.032	4.854	4.761
	0.075	63	8.012	7.321	1.948	1.774	1.636	1.158
	0.100	66	7.928	6.980	1.824	1.782	1.639	0.966
	0.250	60	7.362	6.818	0.975	0.826	0.653	0.492
	0.500	57	7.457	7.012	0.657	0.484	0.327	0.161
Quinalphos	0.030	70	8.210	7.821	4.125	3.927	4.081	3.770
	0.060	68	8.136	7.543	3.770	3.606	3.927	3.764
	0.090	59	8.016	7.219	3.119	2.960	2.750	2.635
	0.120	59	7.782	6.926	2.120	1.957	1.800	1.143
	0.300	60	7.218	6.831	1.815	1.650	0.974	0.819
	0.600	54	7.012	6.526	0.825	0.660	0.490	0.164

TABLE 3

Effects of weedicides on germination: mitotic index and ferquency of chromosomal aberrations in root tips of *Allium cepa* L.

Weedicide	*Concentration (%)*	*Germination (%)*	*Mitotic Index*		*Chromosomal aberration (%)*			
			4 hrs	*24 hrs*	*4 hrs*	*8 hrs*	*12 hrs*	*24 hrs*
Oxyfluorten	0.25	70	7.521	7.012	5.445	5.115	4.620	3.630
	0.50	68	7.498	7.210	4.078	3.758	3.231	3.074
	0.75	62	7.037	6.717	3.241	2.926	2.764	2.597
	1.00	60	7.109	6.515	2.597	2.759	2.283	1.960
	2.50	58	7.010	6.333	2.261	1.935	1.779	1.618
	5.00	57	6.881	6.111	1.663	1.492	1.305	1.127
Fluchloralin	0.16	67	7.555	7.112	5.280	5.263	4.934	4.942
	0.32	58	7.565	7.125	5.107	4.862	4.901	4.567
	0.48	60	7.248	6.931	4.893	4.575	4.411	4.084
	0.64	63	7.218	6.867	4.530	4.207	4.045	3.889
	1.60	57	7.180	6.723	3.833	3.654	3.488	3.150
	3.20	54	6.992	6.254	3.431	3.267	3.109	2.782
Alachlor	0.40	67	8.013	7.728	4.715	4.567	4.248	4.091
	0.80	68	7.782	7.622	4.255	4.065	3.733	3.548
	1.20	58	7.792	7.431	3.721	3.559	3.241	3.084
	1.60	59	7.542	7.329	3.482	3.316	2.936	2.777
	4.00	57	7.497	7.282	2.995	2.786	2.618	2.295
	8.00	57	7.323	6.881	2.622	2.446	2.113	1.954

failure of the anaphase or may be atrributed to unequal translocation or inversion of chromosome segments (Najjar and Soliman, 1980). The chromosome breakages is now generally considered to invole DNA molecule responsible for the linear continuity of the chromosome or may be due to misrepair of DNA (Evans, 1977). Suggesting clastogenic action of pesticides. It is logical to assume that the pesticides might have interfered with the normal function of repair enzymes and series of reactions involved in the process of rejoining or altering the DNA sequence.

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Correlations and Causations in Chickpea(*Cicer arietinum* L.)*

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ABSTRACT

Correlations and path analysis was computed for yield and its components using 76 genotypes of chickpea. It revealed significant association between yield and 100 seed weight, plant height, number of primary branches/plant, number of pods/plant, days to maturity and days to flowering at genotypic and phenotypic levels. There was high direct effects of 100 seed weight and number of pods/plant on seed yield.

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INTRODUCTION

For a rational improvement in yield of any crop the knowledge of correlations between yield and its components and among themselves is considered verry useful. However, as the estimates of correlations alone do not provide a comprehensive picture of cause and effects, path analysis developed by Wright(1921) is performed for ascertaining the relative importance of each of the traits. The present study was conducted to know the extent of association (genotypic and phenotypic) between yield and other quantitative characters and their direct and indirect effects on seed yield in chickpea.

MATERIALS AND METHODS

Seventy six geographically diversed strains of chickpea were planted in randomised block design with three replications at the College Farm of Gujarat Agricultural University, Navsari during winter 1991-92. Each strain consisted single row of 5 m length grown at a spacing of 30 x 10 cm. Correlations and path analysis were computed as per A1-Jibouri *et al.* (1959) and Wright (1921) respectively.

RESULTS AND DISCUSSION

The genotypic and phenotypic correlations for all possible combinations among ten characters are presented in Table 1. In general the values of genotypic coefficients were higher than their corresponding phenotypic coefficients, revealing the influence of environment on their phenotypic expressions. Jivani and Yadvendra (1988) and Kumar and Arora (1991) have also observed such environmental effects on these traits in chickpea.

Seed yield was found to be significantly and positively correlated with 100 seed weight, plant height, number of primary

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Genotypic (G) and phenotypic (P) correlations among ten characters of chickpea.

Characters		*Days to flowering*	*Days to maturity*	*Number of primary branches/ plant*	*Plant height (cm)*	*No.of pods/ plant*	*No.of seeds/ pod*	*No.of pods/ primary branch*	*100-seed weight (g)*	*Harvest index (%)*
Seed yield/palnt (g)	G	0.324**	0.375**	0.509**	0.685**	0.490**	-0.222	0.146	0.867**	-0.031
	P	0.288*	0.339**	0.434**	0.591**	0.441**	-0.197	-0.119	0.760**	0.290
Days to flowering	G		0.618**	0.492**	0.568**	-0.144	0.301**	-0.386**	0.270	-0.242*
	P		0.608**	0.444**	0.505**	-0.139	0.300**	-0.361**	0.260*	-0.150
Days to maturity	G			0.254*	0.609**	0.036	0.266*	-0.082	0.330**	-0.156
	P			0.228*	0.551**	0.036	0.262*	-0.077	0.321**	-0.086
No of primary	G				0.558**	0.043	-0.157	-0.545**	0.425**	-0.369**
branches/plant	P				0.460**	0.035	-0.149	-0.577**	0.366**	-0.191
Plant height (cm)	G					0.159	-0.055	-0.157	0.633**	-0.537**
	P					0.141	-0.043	-0.131	0.570**	-0.260*
No. of pods/plant	G						0.068	0.808**	0.126	0.163
	P						0.065	0.788**	0.117	0.138
No. of seeds/pod	G							0.148	-0.439**	0.105
	P							0.143	-0.427**	0.067
No. of pods/primary	G								-0.100	0.346**
branch	P								-0.087	0.212
100-seed weight	G									0.022
(g)	P									0.026

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

TABLE 2

Direct and indirect effects of nine causal variables on grain yield in chickpea.

Characters	*Days to flowering*	*Days to maturity*	*No. of primary branches/plant*	*Plant height (cm)*	*No. of pods/ plant*	*No. of seeds/ pod*	*No. of pods/ primary branch*	*100-seed weight*	*Harvest index (%)*	*Correlation coefficient with seed yield*
Days to flowering	0.078	0.005	-0.029	-0.058	-0.093	0.042	0.109	0.239	0.031	0.324**
Days to maturity	0.048	0.007	-0.015	-0.062	0.023	0.037	0.023	0.293	0.020	0.375**
Number of primary branches/plant	0.038	0.002	-0.060	-0.057	0.028	-0.022	0.154	0.377	0.048	0.509**
Plant height	0.044	0.005	-0.034	-0.102	0.103	-0.008	0.044	0.562	0.070	0.685**
Number of pods/plant	-0.011	0.000	-0.003	-0.016	0.648	0.009	-0.228	0.112	-0.021	0.490**
Number of seeds/pod	0.023	0.002	0.009	0.006	0.044	0.139	-0.042	-0.390	-0.014	-0.222
No. of pods/primary branch	-0.030	-0.001	0.033	0.016	0.524	0.021	-0.282	-0.089	-0.045	0.146
100-seed weight	0.021	0.002	-0.025	-0.064	0.082	-0.061	0.028	0.888	0.003	0.867**
Harvest index	-0.019	-0.001	0.022	0.055	0.106	0.015	-0.098	0.019	-0.130	-0.031

Residual :- 0.0533

Direct effect on main diagonal

**, Significant at 1 per cent level

branches/plant, number of pods/plant, days to maturity and days to flowering at both the levels. These characters except number of pods per plant were also found to have positive associations among themselves, which confirms the earlier findings of Jadhav and Mane (1991) and Dasgupta *et al.* (1992). Because of their positive association with yield these attributes can serve as an indicator characters for seed yield.

Number of seeds per pod was noted to have significant positive association with days to flowering and days to maturity and negative with 100 seed weight. Mandal and Bahl(1980) and Salimath and Bahl (1985) have preferred for seed size over seed number/pod as an important yield component in chickpea.

The partitioning of correlations into direct and indirect effects (Table 2) indicated high positive direct effects of 100 seed weight, number of pods per plant, and seeds per pod on seed yield. Sontakey *et al.* (1991) and Dasgupta *et al.* (1992) have also observed high direct effect of these traits. The importance of 100 seed weight was further increased as most of the yield attributes like plant height, number of primary branches, days to maturity and days to flowering were exerting their indirect effects through this character, which is an accordance of Sandhu *et al.*(1991).

Days to flowering and maturity, which were significantly and positively correlated with seed yield had very low positive direct effect on it. In fact their high correlation with yield was only because of 100 seed weight.

Thus the correlation and causation analysis revealed the pods per plant and 100 seed weight as the most important characters followed by number of seeds per pod. Therfore they can be considered for improving seed yield in chickpea.

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Combining Ability in Cowpea (*Vigna unguiculata* (L.) Walp.)

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ABSTRACT

Combing ability and gene action for 10 characters, including seed yield, in cowpea were studied in diallel crosses of nine diverse genotypes, excluding reciprocals. Analysis of variance revealed significant mean squares due to gca as well as sca for all the characters. The higher magnitude of gca variance compared to sca variance signified the predominant role of additive type of gene action in the expression of all the characters.

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INTRODUCTION

In a crop improvement programme, the success rests upon isolation of valuable gene combinations as determined in the form of lines with high combining ability. The lines which produce good progenies on crossing, are most desired by a plant breeder. The knowledge of gene action and combining ability not only helps in identifying the best combiners which may be hybridized either to exploit heterosis or to accumulate fixable genes through selection but also helps in understanding the inheritance of quantitative characters, so as to choose the proper selection method to be followed in future breeding progrmmes. There are only few reports available on these aspects for cowpea. The present investigation was, therefore, undertaken to study the combining ability effects and variance using 9 X 9 diallel (excluding reciprocals) in cowpea.

MATERIALS AND METHODS

Nine varieties viz., GC-1, GC-2, GC-82-3, GC-82-8, Pusa Phalguni, RC-8, V-240, V-269 and CO-4 were selected on the basis of their diverse geographical origin and conspicuously different morphological characteristics including the yielding ability. These were crossed in all possible combinations (excluding reciprocals). A set of 45 entries comprising of nine parents and their 36 hybrids were sown in a randomized block design with three replications at Instructional Farm, College of Agriculture, Gujarat Agricultural University, Sardar Krushinager during Kharif-1990. Each entry comprised of single row of 3.0 m length. The distance between two rows was 60 cm, while the plant to plant distance was 30 cm. Observations were recorded on five randomly selected plants from each entry in each replication for days to flowering, days to maturity, plant height, effective

branches per plant, clusters per plant, pods per plant, pod length, seeds per pod, test weight and seed yield per plant. The gca and sca variance and effects were worked out following Model-I Method-II of Griffing (1956).

RESULTS AND DISCUSSION

The analysis of variance for combining ability for different characters (Table 1) revealed highly significant gca for all the characters, while sca variances were highly significant for all the characters except pod length, which was significant at 5 per cent level of significance. These suggested the role of both additive and non additive genetic components in the expression of all the characters. However, higher magnitude of gca variances over sca variances for all the traits indicated that the additive component of genetic variance was predominantly involved in the expression of yield and its attributing characters. Similar results were reported by Lal *et al.* (1975), Patil and Bhapkar (1986) and Patil and Shete (1986). It is evident from these observations that breeding for high yielding varieties in cowpea may become more effective if additive gene effects are more appropriately exploited along with non additive gene effects. In cowpea it could be achieved by the use of good general combining parents in hybridization and selecting desirable segregants from the segregating generations by adopting progeny selection technique meant for exploiting additive genetic variance. Adoption of progeny selection technique for exploiting additive genetic variance in cowpea was also suggested by Lal *et al.* (1975) and Jatasra (1980). Since the present experiment was conducted for one season and at one location only, the estimates of the genetic variances are expected to be biased due to genotype x environment interaction which may mislead the breeder in drawing conclusions regarding gene action.Hence, it is suggested to

TABLE 1

Analysis of variance for combining ability in cowpea.

Characters	*Mean Squares*		
	gca	*sca*	*error*
Days to flowering	217.938**	39.598**	3.946
Days to maturity	841.375**	183.268**	2.580
Plant height	7085.091**	2076.960**	118.821
Effective branches per plant	0.645**	0.410**	0.145
Clusters per plant	49.252**	17.213**	1.386
Pods per plant	143.275**	33.100**	3.525
Pod length	6.834**	0.226*	0.129
Seeds per pod	2.563**	1.018**	0.284
Test weight	16.384**	0.835**	0.111
Seed yield per plant	68.366**	25.032**	2.403

*, **

TABLE 2.

Estimates of general combining ability (gca) effects of cowpea parents for various characters.

Parents	*Days to flowering*	*Days to maturity*	*Plant height*	*Effective branches per plant*	*Clusters per plant*	*Pods per plant*	*Pod length*	*Seeds per pod*	*Test weight*	*Yield per plant*
GC-1	-6.33**	-11.63**	-31.72**	0.23*	0.05	-0.01	0.10	-0.34*	-0.82**	-1.54**
GC-2	0.98	3.37**	18.63**	0.48**	5.27**	8.99**	-1.28**	-0.02	-0.89**	5.98**
GC-82-3	0.24	-0.51	11.17**	-0.11	-2.06**	-3.21**	0.32**	0.05	0.59**	-1.83**
GC-82-8	-0.62	-3.36**	4.14	0.06	-0.64	-1.13*	0.62**	0.16	-0.06	-0.32
Pusa Phalguni	-5.74**	-10.54**	-43.80**	0.10	-0.61	0.11	-0.58**	-0.86**	-1.30**	-2.53**
RC-8	-1.31*	-5.42**	-7.89*	-0.21	-1.19**	0.88	-0.77**	0.83**	-1.39*	-0.59
V-240	3.32**	7.25**	-5.56	-0.23*	-0.76*	-1.90**	0.17	0.12	0.86**	-0.25
V-269	1.09	5.73**	19.38**	-0.25*	-0.77*	-1.39*	0.05	-0.35*	0.73**	-0.04
CO-4	8.38**	15.10**	35.65**	-0.06	0.70*	-2.33**	1.37**	0.40**	2.28**	1.13*
S.E. $(gi) \pm$	0.56	0.46	3.10	0.11	0.33	0.53	0.10	0.15	0.10	0.44
S.E $(gi - gj)_1 \pm$	0.85	0.68	4.65	0.16	0.50	0.80	0.15	0.23	0.14	0.66

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

TABLE 3

Comparative study of first five high yielding hybrids with their sca effects for different characters.

Hybrids	*Days to flowering*	*Days to maturity*	*Plant hight*	*Effective branches per plant*	*Cluster per plant*	*Pods per plant*	*Pod length*	*Seeds per pod*	*Test weight*	*Seed yield per plant*
GC-2 x CO-4	18.91**	12.81**	-23.18*	1.27**	5.23**	7.66**	-0.02	-0.31	-0.11	9.59**
GC-2 x V-269	1.87	23.50**	74.49**	0.16	7.13**	9.12**	-0.20	-1.27	-1.03**	7.10**
GC-82-8 x CO-4	10.78**	17.53**	61.47**	1.22**	12.06**	14.02**	0.10	-1.53**	1.84**	11.97**
GC-2 x V-240	11.91**	17.66**	27.76**	-0.06	5.79**	6.84**	0.06	-0.45	0.98**	5.59**
GC-1 x GC-2	-3.65*	-8.13**	-48.08**	0.35	0.91	7.21**	0.51	0.99*	0.31	6.20**

*, ** = Significant at 5 and 1 per cent level of significance, respectively,

test the material over environments and/or locations so that clear cut inferences could be drawn. Estimates of gca effects for parents (Table 2) indicated that GC-2 was the good combiner for major yield attributing characters like effective branches per plant, clusters per plant, pods per plant and also for seed yield per plant it- self. Parent CD-4 was found to be good general combiner for clusters per plant, pod length, seeds per pod, test weight and seed yield per plant. The parents GC-1, Pusa Phalguni and RC-8 were good general combiners for days to flowering, days to maturity and dwarfness. It was also generally observed for most of the charecters that parents exhibiting high mean performance had high gca effects. A close relationship between the mean performance and gca effects was also reported by Patil and Bhapkar (1986) and Patil and Shete (1986).

No cross combination was consistently good for all characters (Table 3).The cross combination GC-2 x CO-4 manifested significant positive sca effects in desired direction for seed yield per plant, effective branches per plant, clusters per plant and pods per plant, whereas, for plant height, it expressed significant negative sca effect. The cross GC-2 X V-269 showed significant sca effects in desired direction for clusters per plant, pods per plant, test weight and seed yield per plant. The hybrid GC-82-8 x CO-4 recorded highest significant positive sca effect of 11.97 for seed yield per plant. This hybrid also recorded significant sca effects in desired direction for effective branches per plant, clusters per plant, pods per plant and test weight. The cross combination GC-2 x V-240 exhibited significant sca effects in desired direction for clusters per plant, pods per plant, test weight and seed yield per plant. The hybrid GC-1 x GC-2 had significant sca effects in desired direction for days to flowering, days to maturity, plant height, pods per plant, seeds per pod and seed yield per plant. The *per se* performance of crosses was found to be related with sca effects of hybrids for effective branches per plant, clusters per plant, test weight and seed yield per plant.

The crosses exhibiting high sca effects for different characters points to the possibility of improving these characters by selection and hybridization.

Estimates of gca effects suggested that parent GC-2 was good general combiner for effective branches per plant, clusters per plant, pods per plant and seed yield per plant.Parent CO-4 was good combiner for clusters per plant, pod length, number of seeds per pod, test weight and seed yield per plant. Parents Pusa Phalguni, GC-1 and RC-8 were good general combiners for early flowering, early maturity and dwarfness. The crosses GC-2 x CO-4, GC-2 x V-269, GC- 82-8 x CO-4, GC-2 x V-240 and GC-1 x GC-2 were good specific combinations which may be exploited for seed yield.

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Heterosis in Relation to General and Specific Combining Ability in Safflower*

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ABSTRACT

Hetrosis was studied in relation to gca and sca effects in line x tester involving diverce genotypes of safflower. Highest heterosis of 94.62, 65.16, 55.05 and 51.48 per cent was observed over standard check for No. of seeds / capitulum, No. of capitula / plant, No. of secondary branches / plant and seed yield /plant, respectively. Mean performance of the crosses showed close association with sca effects indicating that selection of the crosses based on heterotic response is equaly effective. Additive x dominance and dominance x dominance epistasis was involved in the best cross combinations.

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INTRODUCTION

In safflower number of secondary branches / plant, number of capitula/plant and number of seeds/capitulum contribute maximum to seed yield (Lakha *et al.*, 1992 and Makne *et al.* 1985). An effective breeding programme depends on these important yield components. The relative amount of gca and sca effects play a vital role in planning the most appropriate breeding programme. In the present paper heterosis in relation to gca and sca effects has been reported.

MATERIALS AND METHODS

Five male sterile lines (MS 101, MS 102, MS 103, MS 104 and MS 105) developed at M.A.U., Parbhani were crossed with ten diverse male lines (Annegeri, Bly 652, B-3-16-57, BSF-9-97, JLSF 49, JLSF 88, NDS 1, NS 1016, Bhima and PS 1). The resultant fifty hybrids along with their fifteen parents were planted in two different sowing dates under rainfed as well as irrigated conditions during rabi 1987-88. The hybrids and parents were grown under four different environments in a randomized block design with three replications. The distance between rows and within row was 45 and 15 cm, respectively. Observations were recorded on ten randomly selected plants for secondary branches/plant, capitula/plant, seeds/capitulum and seed yield. Heterosis (%) was calculated over standard check variety Bhima. Combining ability analysis was based on the procedure given by Kempthorne (1957).

RESULTS AND DISCUSSION

Analysis of variance for the characters studied showed significant genetic differences among parents and hybrids for the

* Part of the Ph.D. Thesis, submitted by the senior author to Marathwada Agricultural University, Parbhani.

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TABLE 1

Best six crosses each in respect of heterosis and sca effects for different characters in safflower.

Character	*Crosses*	*Heterosis in per cent*	*gca*	*Mean perfor-mance*	*Crosses*
No. of secondary branches / plant	MS 104 x NDS 1	55.05**	(L x H)	20.56	MS 105 x BSF-9-97
	MS 101 x NS 1016	53.09**	(H x L)	20.30	MS 102 x Annegeri
	MS 102 x Annegeri	49.39**	(L x L)	19.81	MS 105 x JLSF49
	MS 101 x NDS 1	46.90*	(H x H)	19.48	MS 104 x PS 1
	MS 103 x Bhima	46.90*	(L x L)	19.23	MS 103 x Bhima
	MS 101 x B-3-16-57	45.02*	(H x L)	19.23	MS 101 x NS 1016
No. of capitula / plant	MS 105 x BSF-9-97	65.16**	(L x H)	34.90	MS 105 x BSF-9-97
	MS 104 x NDS 1	59.01**	(L x H)	33.60	MS 104 x NDS 1
	MS 101 x NDS 1	49.50**	(L x H)	31.59	MS 104 x PS 1
	MS 103 x NDS 1	49.36**	(L x H)	31.56	MS 103 x Bhima
	MS 102 x NDS 1	48.36**	(L x H)	31.35	MS 102 x Annegeri
	MS 101 x B-3-16-17	46.56**	(L x L)	30.97	MS 103 x Annegeri
No. of seeds / Capitulum	MS 103 x NS 1016	94.62**	(L x L)	32.23	MS 105 x Annegeri
	MS 104 x NS 1016	93.84**	(H x L)	32.10	MS 104 x Bly 652
	MS 102 x Bhima	72.76**	(L x H)	29.12	MS 102 x PS 1
	MS 104 x Bly 652	69.80**	(H x L)	28.12	MS 103 x NS 1016
	MS 102 x NS 1016	67.81**	(L x L)	27.79	MS 101 x JLSF 88
	MS 105 x Annegeri	58.63**	(L x L)	26.27	MS 102 x Bhima
Seed yield/plant	MS 105 x Annegeri	51.48**	(L x H)	20.92	MS 104 x BSF-9-97
	MS 101 x Bhima	48.00*	(L x H)	20.44	MS 102 x NDS 1
	MS 101 x Annegeri	46.70*	(L x H)	20.26	MS 102 x JLSF 49
	MS 104 x BSF-9-97	36.78	(L x L)	18.89	MS 105 x Annegeri
	MS 102 x JLSF 88	36.49	(H x H)	18.75	MS 102 x PS 1
	MS 101 x NS 1016	35.62	(L x H)	18.73	MS 101 x Bhima

TABLE 7 (Contd.)

sca effects	gca	Common crosses	gca	'r' Value
5.56**	(L x H)	MS 101 x NS 1016	(H x L)	
2.67**	(L x L)	MS 102 x Annegeri	(L x L)	-0.3024
2.45**	(L x L)	MS 103 x Bhima	(L x L)	
1.76	(L x L)			
1.62	(L x L)			
1.62	(H x L)			
9.22**	(L x H)	MS 105 x BSF-9-97	(L x H)	
4.12**	(L x H)	MS 104 x NDS 1	(L x H)	0.770**
2.94**	(L x L)			
2.57**	(L x L)			
2.45**	(L x L)			
2.32**	(L x L)			
5.66**	(L x L)	MS 103 x 1016	(L x L)	
3.59**	(H x L)	MS 102 x Bhima	(L x H)	0.5233**
3.16**	(L x L)	MS 105 x Annegeri	(L x L)	
3.12**	(L x L)	MS 104 x Bly 652	(H x L)	
3.08**	(L x L)			
2.37**	(L x H)			
4.61**	(L x L)	MS 105 x Annegeri	(L x H)	
4.29**	(H x L)	MS 101 x Bhima	(L x H)	0.4193**
3.49**	(H x L)	MS 104 x BSF-9-97	(L x L)	
3.45**	(L x H)			
3.25**	(H x L)			
2.85**	(L x H)			

Lessters in parentheses indicate magnitude of general combining ability of parents.

* and ** indicate significant at 5% and 1% levels, respectively.

'r' value = Association of mean performance of hybrids with sca effects.

characters studied indicating significant heterotic response. The gca and sca mean square were also significant for all the characters . The best six crosses each in respect of heterosis and sca effects for different characters are presented in Table 1. The highest heterosis for number of secondary branches/plant was observed in MS 104 x NDS 1 (55.05 %) followed by MS 101 x MS 1016 (53.09 %) and MS 102 x Annegeri (49.39 %). For number of capitula / plant, the highest heterosis was found for cross MS 105 x BSF-9-97 (65.16%) followed by MS 104 x NDS-1 (59.01%) and MS 101 x NDS 1 (49.50 %). Similarly, highest heterosis for number of seeds/ capitulum was observed in MS 103 x NS 1016 (94.62 %) followed by MS 104 x NS 1016 (93.84 %) and MS 102 x Bhima (72.76 %). For seed yield / plant MS 105 x Annegeri exhibited maximum heterosis (51.4 %) followed by MS 101 x Bhima (48.00 %) and MS 101 x Annegeri (46.70 %).

In the varietal development programme on the basis of these results it is suggested that the parents having high gea effect for yield (Annegeri and Bhima), for secondary branches and No.of capitula / plant (NDS-1 and BSF-9-97), and for no. of seeds / capitulum (Bhima) can be used in the breeding procedure like recurrent selection. The approach suggested by Redden and Jensen (1974) may also be useful to increase the desirable gene and genotypic frequency. From Table 1 it is seen that three crosses were common for two characters namely no. of secondary branches and seed yield / plant while two and four crosses were common for no. of capitula / plant and no. of seeds / capitulum, respectively. The mean performance of crosses showed significant association with specific combining ability effects indicating that selection of the cross combinations on the basis of heterotic respose would be reliable. In the present study, low x high, high x low combiners were involved in the high expression of sca effects in superior crosses. This indicated that the genic interactions for best crosses for these characters were accountable to additive x dominance or dominance x dominance type of gene effects.

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Diallel Cross Analysis for Tillering Ability and Kernel Weight in Bread Wheat (*Triticum aestivum* L. em. Thell) Under Normal, Sodic and Saline Sodic Soils

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ABSTRACT

Combining ability variances and effects of 8 x 8 diallel crosses were estimated in F_1 and F_2 generations under normal, sodic and saline sodic soils for tillers/plant and 100-kernel weight. Both gca and sca variances were important for controlling the traits studied. However, predominant role of additive gene effects was noted for both traits. The gca and sca were influenced by environments. This suggested that to have an unbiased estimates of gca and sca, the material may be evaluated over a wide range of environments. In general, Lok 1 and Kharchia 65 were good general combiners for both traits under normal as well as salt stress environments. For tillers per plant, HD 2009 under normal soil and Raj 3077 under saline sodic soil were good combiners. HW 452 was uniformly observed to be good general combiner for 100-kernal weight over environments. Most of the crosses showing significant sca effects involved at least one high general combiner. Kharchia 65 x HW 452 over environments, K 8565 x Lok 1 and Lok 1 x HW 452 under normal soil and Raj 1972 x Raj 3077 in saline sodic soils were the promising crosses for 100-kernal weight.

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INTRODUCTION

In wheat, tillering ability and kernel weight are considered to be most yield components under normal and salinity conditions (Kumar *et al.*, 1986 ; Vijay Prakash, 1988). The genetic architecture of these characters is essential to stabilize the yield not only under favourable soil condition but also under salt affected soils. In view of it, a set of 8 x 8 half diallel crosses (F_1 and F_2 generations) and their parents were evaluated under normal, sodic and saline sodic soils for tillers per plant and 100-kernel weight.

MATERIALS AND METHODS

Eight divege genotypes viz., K 8565, HD 2009, CPAN 1992, Kharchia 65, Raj 1972, Raj 3077, Lok 1 and HW 452 of bread wheat were crossed in a half diallel fashion. The experiment consisting of 8 parents, 28 F_1s and 28 F_2s were conducted in randomized block design with three replications under normal (pH 8.4, ECe 305 dS/m), sodic (pH 9.3, ECe 3.6 dS/m) and saline sodic (pH 9.1, ECe 8.6 dS/m) soils at College Farm, S.K.N. College of Agriculture, Jobner. The experiment under sodic soil was grown during *rabi* 1989-90, whereas other two were grown during *rabi* 1990-91. Each plot of nonsegregating (Parents and F_1s) and segregating (F_2s) materials consisted of 1.5 m long single and four rows, respectively. The rows and plants within rows were spaced at 15 and 5 cm distance, respectively. At maturity, five compititive plants selected

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from each plots in parents and F_1s and 15 plants in F_2s were evaluated for effective tillers/plant and 100- kernel weight. Combining ability analysis was carried out according to Method 2, Model 1 of Griffing(1956), which further extended by Singh (1973, 1979) for pooled analysis.

RESULTS AND DISCUSSION

The mean squares due to general (gca) and specific combining ability (sca) in F_1 and F_2 generations under each of three environments were significant for both the traits (Table 1), except sca for tillers/plant in F_1 under normal and in F_2 under sodic soils. The gca and sca variances in pooled analysis were also highly significant for both the traits (Table 2), except for tillers / plant in F_2. The gca : sca ratio was much larger for both the traits (Table 1, 2). The above results revealed that both additive and nonadditive types of gene effects were involved in the inheritance of these traits with the preponderence role of additive gene effects as also reported by Singh (1988) under normal and sodic soils. This warrants some kind of population improvement approach as earlier suggested by Jensen (1970). Further, the dominance genetic variances (sca mean squares) were decreased largely in F_2 than F_1. It may be ascribed due to breakage of linkage and decrease in hybrid vigour in F_2 generation.

The variances due to gca x environment and sca x environment interactions were also significant (Table 2) in F_1 and F_2 generations for both the traits studied. This

TABLE 1

ANOVA for combining ability in F_1 and F_2 under three environments for tillers per plant and 100-kernel weight in bread wheat.

Character	*Environment*	*Generation*	*Source of variation and degree of freedom (in parentheses)*			
			GCA (7)	*SCA (28)*	*Error (70)*	*GCA : SCA ratio*
Tillers per plant	E_1	F_1	1.275**	0.173	0.128	7.37
		F_2	1.489**	0.092**	0.053	16.18
	E_2	F_1	1.430**	0.202**	0.112	12.76
		F_2	1.267**	0.123	0.102	10.30
	E_3	F_1	2.166**	0.131**	0.074	16.53
		F_2	1.112**	0.066**	0.034	16.85
100-kernel weight	E_1	F_1	1.478**	0.122**	0.018	12.12
		F_2	0.724**	0.068**	0.020	10.65
	E_2	F_1	1.086**	0.123**	0.023	8.83
		F_2	1.405**	0.029**	0.015	48.45
	E_3	F_1	1.503**	0.060**	0.024	25.05
		F_2	0.963**	0.042**	0.025	22.93

** Significant at 1 % level

E_1 = Normal soil, E_2 = Sodic soil, E_3 = Saline sodic soil

TABLE 2

ANOVA for combining ability in F_1 and F_2 pooled over three environments for tillers per plant and 100-kernel weight in bread wheat.

Source of variation	d.f.	Tillers per plant		100-kernel weight	
		F_1	F_2	F_1	F_2
GCA	7	4.272**	3.481**	3.969**	2.927**
SCA	28	0.158**	0.055	0.204**	0.054**
Environments (E)	2	25.946**	43.864**	22.257**	17.105**
GCA x E	14	0.299**	0.194**	0.049*	0.083**
SCA x E	56	0.172**	0.113**	0.050**	0.042**
Error	210	0.144	0.086	0.024	0.021
GCA : SCA ratio		27.04	63.29	19.46	54.20

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

indicated that both additive and nonadditive gene effects were less stable. Obviously, it suggests that the information based on experiment in a single environment may not give reliable conclusions.

The gca effects for tillers / plant and 100-kernel weight (Table 3) showed that Lok 1 (except F_1 in normal soil for tillers/plant) and Kharchia 65 (except F_2 in normal and sodic soil for 100 kernel weight) were good general combiners in F_1 and F_2 generations over environments. For tillers / plant, HD 2009 under normal soil and Raj 3077 under saline sodic soil were good general combiners over generations and environments. HW 452 was consistently good general combiner for 100-kernel weight over environments, but it was observed to be poor combiner for tillers / plant Raj 1972 was good general combiner for 100-kernel weight in F_1 and F_2 generations under sodic soil and in F_1 under normal soil. While for tillers/ plant, it was observed good general combiner in F_2 under normal and sodic soils.

The estimates of sca effects for tillers / plant revealed that two crosses in normal, five crosses in sodic and one cross in saline sodic soils exhibited significant and positive sca effects either in F_1 or F_2 generation. For 100-kernel weight, Kharchia 65 x HW 452 exhibited positive and significant sca effects over generations and environments, except F_2 in both stress soils. Whereas, crosses K 8565 x Lok 1 and Lok 1 x HW 452 in normal soil, and Raj 1972 x Raj 3077 in saline sodic soil expressed positive and significant sca effects over generations. The crosses which showed significant possitive sca effects for both the characters involved all three possible combinations between parents of high and low gca effects, i.e. high x high, high x low and low x low. However, in majority of the crosses at least one high general combiner was involved for the manifestation of high sca effects. These crosses in early segregating generations are likely to throw transgressive segregants.

TABLE 3

Generl combining ability effects of the parents in F_1 and F_2 under three environments for tillers per plant and 100-kernel weight in bread wheat.

Parents	*Tillers per plant*						*100-kernel weight*					
	E_1		E_2		E_3		E_1		E_2		E_3	
	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
K 8565	-0.436**	-0.478**	-0.500**	-0.392**	-0.491**	-0.275**	-0.041	-0.091	-0.027	-0.031	-0.065	-0.063
HD 2009	0.210**	0.232**	0.080	0.027	-0.463**	-0.323**	-0.604**	-0.339**	-0.432**	-0.537**	-0.596**	-0.570**
CPAN 1992	-0.397**	-0.387**	-0.220*	-0.292**	-0.338**	-0.292**	-0.442**	-0.380**	-0.401**	-0.372**	-0.435**	-0.334**
Kharchia 65	0.610**	0.548**	0.580**	0.557**	0.836**	0.526**	0.253**	0.055	0.135**	-0.022	0.257**	0.212**
Raj 1972	0.069	0.192**	0.160	0.188*	0.023	0.003	0.088**	0.069	0.113*	0.159**	-0.019	-0.012
Raj 3077	0.183	0.140*	0.170	0.097	-0.365**	0.313**	0.084**	-0.057	-0.194**	-0.172**	-0.067	-0.088
Lok 1	0.055	0.209**	0.260**	0.277**	0.269**	0.287**	0.576**	0.322**	0.497**	0.598**	0.499**	0.371**
HW 452	-0.396**	-0.458**	-0.510**	-0.462**	-0.203*	-0.237**	0.254**	0.363**	0.309**	0.377**	0.427**	0.384**
SE(gi) ±	0.106	0.068	0.099	0.094	0.081	0.054	0.040	0.042	0.044	0.037	0.046	0.047

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

E_1 = Normal soil, E_2 = Sodic soil, E_3 = Saline sodic soil.

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Botanical Materials as Protectant of Green Gram, *Vigna radiata* (L.) Wilczek Against Pulse Beetle, *Callosobruchus analis* Fabricus - I

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ABSTRACT

Laboratory experiment was carried out to know the relative bio-efficacy of various botanical materials against pulse beetle, *Callosobruchus analis* Fabricus infesting stored green gram. Among the various plant materials studied the powders of custard apple, *Annona squamosa* L. seeds, black pepper, *piper nigrum* L. seeds, mint, *Mentha piperita* L.leaves and orange, *Citrus reticulata* Blanco peels all @ 5 parts per 100 parts of green gram (W/W) gave cent per cent adult mortality after 3 days of treatment and completely prevented the female beetles from laying eggs till 60 days of treatment. Further, no population build up and grain damage was observed till four months of storage, whereas neem *Azadirachta indica* A. Juss seed kernels powder gave protection for only three months.

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INTRODUCTION

Among bruchids, *Callosobruchus analis* F. (Coleoptera : Bruchidae) is one of the most serious pests of pulses including green gram and it attacks invariably on all the pulses under storage conditions. It is therefore, imperative to save green gram from this serious pest. Keeping in view the beneficial effects of grain protectants of plant origin, a laboratory experiment was set up to know the relative bio-efficacy of different botanical materials against *C. analis* infesting stored green gram.

MATERIALS AND METHODS

With a view to determine the relative bio-efficacy of various botanicalma terials against pulse beetle, *C.analis* infesting stored green gram, statistically designed laboratory experiment was conducted in the laboratory during 1990-91. The culture of *C. analis* was raised from a single pair of adults collected from the local market of Anand town in stored green gram and maintained for the experimental purpose on green gram in glass jars measuring 20 x 14 cm. The jars were covered by using muslin cloths and rubber bands. The culture jars were replenished with fresh quantities of green gram time to time.The seeds and leaves of various plants tested were dried under the shade except orange peels which were dried in open sunlight and then dried materials were powdered in an electric grinder.In order to find out the effect of grain protectant on adult mortality, ovipositional deterrent, population build up and grain damage,100 g green gram were mixed with 5 g of respective botanical material powder

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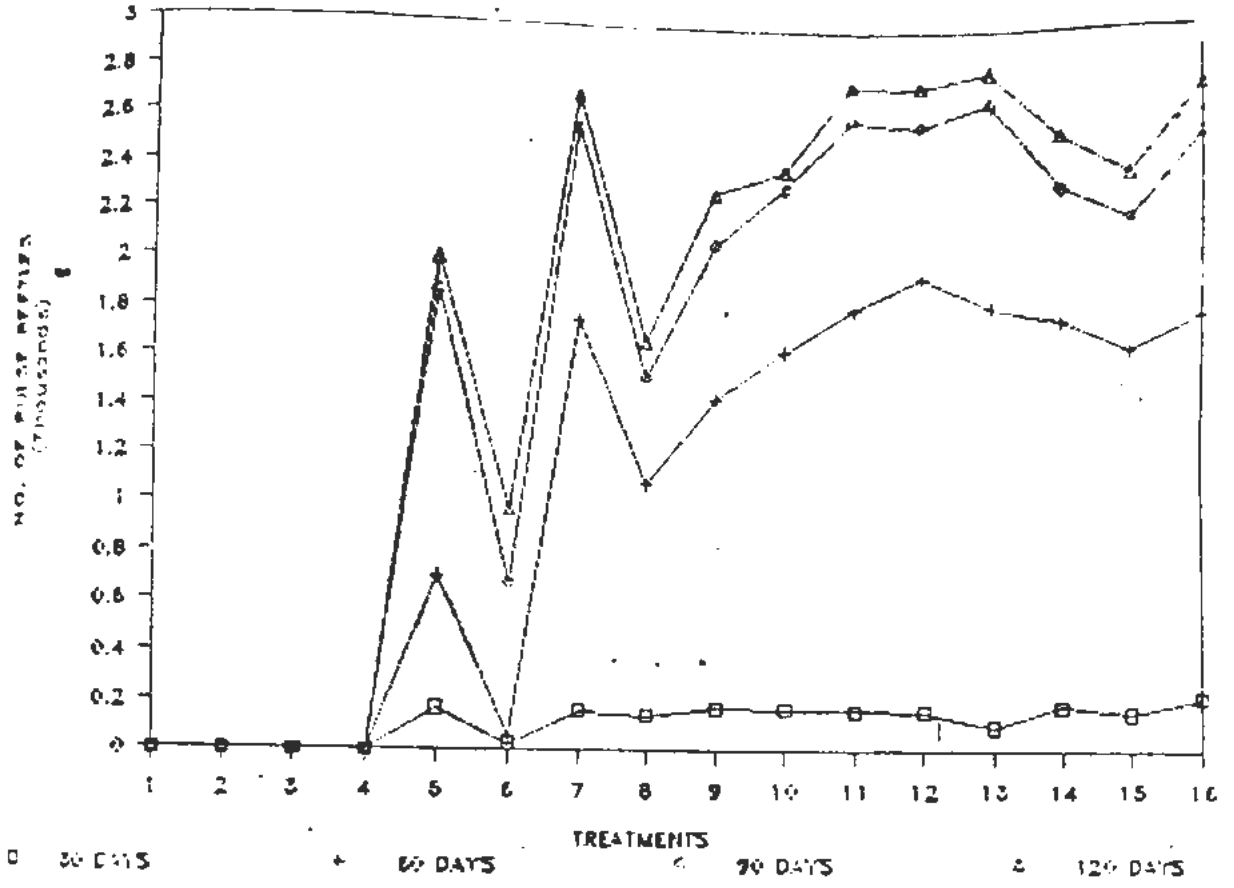

Fig. 1 : Population build up of *C. analis* in stored green gram mixed with various botanical materials.

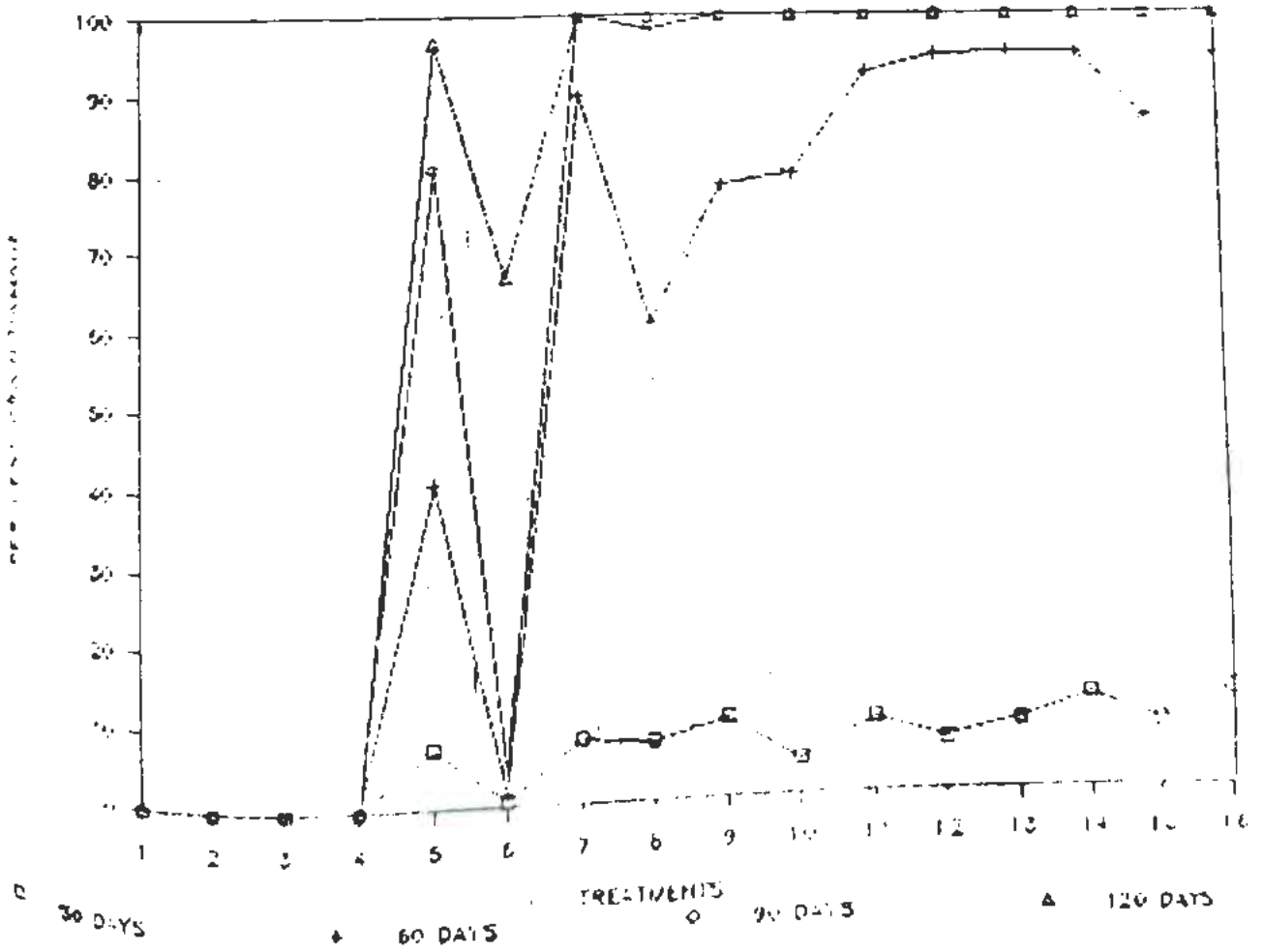

Fig. 2 : Damage to stored green gram by *C. analis* mixed with various botanical materials.

TABLE 1

Effect of various botanical materials against *C. analis* for adult mortality and ovipositional deterrent property in stored green gram.

	Treatment	Adult mortality after 3 days of release (%)		Av. no. of eggs laid per 100 grains after 5 days *		60 days	
1.	Custard apple seeds	200.03*	(100.00)	0.71*	(00.00)	0.71*	(00.00)
2.	Black pepper seeds	10.03	(100.00)	0.71	(00.00)	0.71	(00.00)
3.	Mint leaves	10.03	(100.00)	0.71	(00.00)	0.71	(00.00)
4.	Orange peels	10.00	(100.00)	0.71	(00.00)	0.71	(00.00)
5.	Soapnut shells	5.48	(30.00)	3.42	(11.25)	15.28	(233.00)
6.	Neem seed kernels	1.97	(5.00)	2.06	(3.75)	5.74	(32.00)
7.	Neem seeds coats	1.34	(2.50)	3.70	(13.25)	32.46	(1053.25)
8.	Neem seeds whole	2.93	(10.00)	3.19	(9.75)	21.03	(442.00)
9.	Neem leaves	2.30	(7.50)	3.77	(13.75)	28.89	(834.25)
10.	Dharek drupes	2.30	(7.50)	2.82	(7.50)	27.21	(739.75)
11.	Jamun seeds	1.34	(2.50)	3.57	(12.25)	30.51	(936.50)
12.	Tulsi seeds	1.97	(5.00)	3.70	(13.25)	31.41	(986.00)
13.	Tulsi leaves	2.30	(7.50)	3.56	(12.25)	31.21	(937.50)
14.	Garlic leaves	2.93	(10.00)	3.77	(13.75)	29.81	(855.00)
15.	Chrysanthemum leaves	4.70	(22.50)	4.12	(16.50)	31.60	(998.00)
16.	Control	0.71	(0.00)	5.54	(30.25)	33.25	(1080.0)
S. Em ±		0.63		0.10		0.18	
C. D. (P = 0.05)		1.79		0.29		0.52	
C. V. (%)		28.57		7.09		1.83	

* $\sqrt{x + 0.5}$ transformed values

Figures in parentheses are original values.

and the treated grains were kept in plastic jars (11 x 9 cms) and four replications were maintained including control. In each replicate 5 pairs of 0-24 h old *C.analis* were released in each jar and its mouth was covered with muslin cloth. The data recorded on these aspects are presented in Table 1 and Figure 1 and 2. The data were subjected to the analysis of variance test.

RESULTS AND DISCUSSION

The results on the effect of various botanical materials on adult mortality of pulse beetle *C. analis* after 3 days of treatment (Table 1) revealed that the powders of custard apple seeds, black pepper seeds, mint leaves and orange peels all at 5 parts per 100 parts of green gram (W/W) gave cent per cent adult mortality and completely prevented the females from laying eggs on treated grains till 60 days after treatment. Soapnut, *sapindus laurifollus* Vahl. Shells powder was found next best by giving 30 per cent adult mortality and remained at par with chrysanthemum *C. cinerariaefollam* Triv. leaves powder (22.5 per cent) in effectiveness. Whereas, minimum (3.75) eggs were observed on green gram treated with neem seed kernels powder after 5 days of treatment. Even after 2 months of treatment to green gram with neem seed kernels powder (32.00 eggs) its effectiveness was significant.

The botanical materials viz., custard apple seeds, black pepper seeds, mint leaves and orange peels completely prevented the population build up (Fig. 1) and grain damage (Fig. 2) till 4 months of storage period. Don-pedro (1985) and Pandey and Varma (1977) have also reported good grain protectant property of orange peels powder and custard apple seeds powder against *C. maculatus*, respectively. Whereas, Mathur *et al.* (1985) and George (1990) have found black pepper and mint as an effective pulse protectant against *C. chinensis* and *C. analis* respectively. Neem seed kernels powder though gave low adult mortality (5 %) however, the treated grains had minimum oviposition after 5 days (3.75 eggs per 100 grains) and even after 60 days (32 eggs per 100 grains) also. Further the population build up was low (678.75 beetles) and the grain damage was minimum (5.15 %) after 3 months of storage period among all the treatments Jotwani and Sircar (1967) also reported neem seed powder as an effective green gram protectant against *C. maculatus*.

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Estimation of Economic Injury Level and Economic Threshold Level for *Helicoverpa armigera* (Hubner) on Gram Crop*

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ABSTRACT

The loss in grain weight ranged from 6.09 to 34.71% when the caged gram plants were infested with 1 to 10 larvae of *H. armigera*. The presence of one larva/m row length crop cauged 3.36 g. loss in yield. Larval population increase in field ranged from 0.01 to 0.14 with an average of 0.05 larva/m/day. The gain threshold computed was 144.23, 139.76, 164.47 and 132.67 kg/ha for fenvalerate, endosulfan, quinalphos and monocrotophos respectively. The corresponding values of economic injury level (EIL) were workedout to be 1.29, 1.25, 1.47 and 1.18 larvae/m row length. The economic threshold level (ETL) estimated were 1.15, 1.11, 1.33 and 1.04 larvae/m row length for fenvalerate, endosulfan, quinalphos and monocrotophos respectively.

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INTRODUCTION

The damage potential of *H. armigera* certainly proved that it is undoubtedly the most serious pest of gram all over India.

Pre-scheduled chemical control technology failed to provide satisfactory protection against the pest. Frequent application of insecticides was not only uneconomical but also led to a number of serious and well documented problems. To overcome this, integrated pest management tactics was developed. Later on the concept of pest control through "economic threshold" was introduced (Stern *et al.*, 1959), which emphasized tha control measures to prevent an increasing pest population from reaching the level where it may cause economic damage. The present investigation was, therefore, undertaken to estimate the economic injury and threshold levels for *H. armigera* on gram.

MATERIALS AND METHODS

(I) Yield loss at different larval densities

In order to determine the relationship of different larval densities of *H. armigera* with yield, an experiment was conducted in specialized cages. Each cage was 1.1 x 0.6 x 0.6 m having 100 mash brass net on each side except the bottom. The lower extremities of these cages were provided with hard alluminium sheet for fixing the cages in the field. A window of 25 x 25 cm with shutter was provided on the front face to facilitate the larval release and subsequent checking.

Laboratory culture was maintained by collecting adults of *H. armigera* from light traps and releasing them in oviposition chambers (15 x 10 cm). A cotton wool plug dipped in 10 per cent sugar solution was kept in each chamber to provide food. The eggs obtained were

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transferred to clean petridishes (10 cm diameter) containing fresh gram leaves. The newly hatched larvae were again transferred to clean petridishes containing fresh leaves. The food were replaced daily.

The crop was raised in a seperate plot with inter row spacing of 1.5 m. The plants were sprayed with 0.07 per cent endosulfan to make it free from all pests. After 15 days to spreying the cages were fixed on the plants.

Different densities of laboratory reared late second instar larvae viz., 0, 1, 3, 4, 6, 8 and 10 were released on caged plants at post flowering stage, when the crop was about 100 days old. Before releasing of larvae, all plants were thoroughly examined to make it free from any pest. The dead larva, if any, during experimentation was replaced by fresh ones of the same age group from the laboratory culture.

On completion of the larval period the cages were removed. Endosulfan @ 0.07 per cent was then sprayed on these plants and repeated at weekly intervals to check the infestation by other pests. At harvest, healthy and damaged pods were recorded. The data thus obtained were subjected to statistical analysis (Table 1).

In order to determine the loss caused by one larva the regression equation for larval density and reduction in grain yield was obtained (Table 2).

(II) Determination of economic injury level

The economic injury level was determined as per procedure suggested by Hammond and Pedigo (1972). The calculation of gain threshold and EIL are as follows :

$$\text{Gain threshold (GT)} = \frac{\text{Management cost (Rs / ha)}}{\text{Market value of grain (Rs / Kg)}} = \text{kg/ha}$$

$$\text{Economic injury level} = \frac{\text{Gain threshold (kg / ha)}}{\text{Loss per insect (kg / Insect)}} = \text{Insects/ha}$$

The management cost was calculated based on prevailing market price of the insecticides and application cost. Market value of gram was calculated from the wholesale value of gram at local market around the harvesting time.

(III) Estimation of economic threshold

To estimate the economic threshold the method reported by Johnston and Bishop (1987) was adopted in the present investigation. They established that economic threshold would be the population at economic injury level minus the population increase per day. Thus in present study the increasing rate of larval population in field was determined by recording weekly population of *H. armigera* during larval activity (twice a week from 72m row length). The rate of increase in population was calculated arithmatically. Economic threshold was estimated for four insecticides viz., fenvalerate, endosulfan, quinalphos and monocrotophos. The economic threshold level for each insecticides was estimated by deducting larval population increase rate per day from the respective economic injury level.

RESULTS AND DISCUSSION

(I) Yield loss at varying larval densities

The data dipicted in Table 1 revealed that reduction in grain weight increased with the increase in larval density showing a positive correlation ($r=0.896$), since simple correlation often does not disclose the fact of economic significance, a regression equation $Y = 2.131 + 3.229\ X$ was obtained, which permitted the amount of resultant yield loss for each unit of larval density. The

TABLE 1

Effect of different larval densities of *H. armigera* on the yield of gram during 1987-88.

S.No.	Larval density /m row length	Number of pods/m row length		Damaged pods (%)	Weight of grains /m row length (g)	Reduction in grain weight		Weight of hundred grains (g)
		total	damaged			g/m	%	
1	0	333.00 (18.27)**	0.00 (0.00)**	0.00 (0.00)***	44.43	0.00	0.00 (0.00)***	12.20
2	1	315.00 (17.78)	10.33 (3.36)	3.27 (10.41)	41.73	2.70	6.09 (14.25)	11.97
3	2	321.00 (17.94)	16.33 (4.16)	5.10 (13.03)	40.47	3.97	8.72 (17.37)	12.63
4	3	316.67 (17.82)	23.67 (4.96)	7.47 (15.84)	38.63	5.80	13.04 (21.16)	11.97
5	4	314.00 (17.74)	32.00 (5.74)	10.22 (18.55)	36.93	7.50	16.88 (24.25)	12.60
6	6	317.33 (17.84)	40.67 (6.45)	12.82 (20.94)	34.40	10.03	22.51 (28.25)	12.20
7	8	317.00 (17.83)	55.67 (7.52)	17.55 (24.74)	31.03	13.40	30.14 (33.28)	12.90
8	10	309.00 (17.60)	62.33 (7.93)	20.20 (26.70)	29.00	15.43	34.71 (36.08)	12.17
S. Em. ±		(0.18)	(0.17)	(0.64)	0.61	0.61	(0.90)	0.34
C. D. at 5%		(N.S.)	(0.51)	(1.73)	1.85	1.85	(2.73)	N.S.

* Means of three replications.

** Figures in parentheses are means of n+1 transformed values.

*** Figures in parentheses are means of angular transformed values.

TABLE 2

Correlation between larval density and yield loss (1987-88).

S. No.	Aspects	r 'value'	Regression equation
1.	Larval density (X) and reduction in grain weight (Y)	0.896	Y = 2.131 + 1.229 X
2.	Larval density (X) and weight of grain (Y)	-0.896	Y = 42.280 - 1.227 X
3.	Larval density (X) and percentage of pods damaged (Y)	0.809	Y = 2.715 + 1.615 X
4.	Percentage of pods damaged (X) and weight of grains (Y)	-0.999	Y = 44.335 - 0.759 X

TABLE 3

Increasing rate of larval population of *H. armigera* on gram crop during 1987-88.

S. No.	Standard weather week number	Cumulative number of larvae in 72 m row length/week	Increasing rate of larvae/m/week	Increasing rate of larvae/m/day
1.	2	11	0.15	0.02
2.	3	39	0.39	0.06
3.	4	108	0.96	0.14
4.	5	116	0.11	0.02
5.	6	158	0.58	0.08
6.	7	184	0.36	0.05
7.	8	186	0.03	0.01
8.	9	204	0.25	0.04
	Total	–	2.83	0.42
	Average	–	0.354	0.05

TABLE 4

Computation of gain threshold, economic injury levels and economic threshold levels of *H. armigera* on gram crop during 1987-88.

S. No.	Treatments	Dosage a. i. kg/ha*	No. of sprays	Cost of control (Rs/ha)	Gram price (Rs/kg)	Gain thres-hold (kg/ha)	Economic injury level		IRL (larvae/ m row)	ETL (larvae/ m row)
							Larvae/ha	Larvae/m		
1.	Fenvalerate 0.02 %	0.14	2	613.00	4.25	144.23	42927	-1.29	0.14	1.15
2.	Endosulfan 0.07 %	0.49	3	594.00	4.25	139.76	41597	1.25	0.14	1.11
3.	Quinalphos 0.05%	0.35	3	699.00	4.25	164.47	48950	1.47	0.14	1.33
4.	Monocrotophos 0.04 %	0.28	3	563.85	4.25	132.67	39485	1.18	0.14	1.04

IRL : Increasing rate of larval population in field.

ETL : Economic thershold level.

* : Spray volume used 700 lit/ha.

equation indicated thet the presence of 1 larva/ m row length caused 3.36 g loss in grain weight.

(II) Determination of economic injury level

The gain threshold computed on the basis of gram price (Rs. 425.00 per quintal) were 144.23, 139.76, 164.47 and 132.67 kg/ha for fenvalerate, endosulfan, quinalphos and monocrotophos respectively. The corresponding value of economic injury levels were worked out to be 1.29, 1.25, 1.47 and 1.18 larvae/m row length or 42,927, 41,597, 48,950 and 39,485 larvae respectively per hectare (Table 4). Singh (1980) reported economic injury level of *H. armigera* on gram crop to be one larva/m length.

(III) Estimation of economic threshold level

In field the weekly larval population of *H. armigera* was found to be increased from 11 to 204 in 72 m row length during flowering to pod formation stage (Table 3). However the rate of increase in larval population was not uniform and ranged from less than 0.01 to 0.14 larva per metre row length with an average of 0.05, but for the safer side the maximum rate of increase was taken in the present investigation for estimating the economic threshold levels of *H. armigera*.

Based on economic injury level and increasing rate of larvae, the economic threshold levels of *H. armigera* in gram were 1.15, 1.11, 1.33 and 1.04 larvae/m row length for fenvalerate, endosulfan, quinalphos and monocrotophos, respectively (Table 4). Singh and Reddy (1976) recommended control measures for *H. armigera* on gram crop soon after the appearance of one larva in a metre row length of the crop.

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Development and Recovery of *Elasmus nephantidis*, Rohwer and *Trichospilus pupivora* Ferriere, Parasitoids of *Opisina arenosella* Walker

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ABSTRACT

Studies on the development and establishment of *Elasmus nephantidis* Rohwer and *Trichospilus pupivora* Ferriere, parasitoids of *Opisina arenosella* Walker were done during 1981-86 at Plantation Crops Research Station,Mahuva (Gujarat). Egg to larval period, pupal period, fecundity, female longevity and host killing capacity of *E. nephantidis* averaged 3.50, 7.50, 30.80, 10.50 days and 3.50 larvae, respectively. Egg to adult emergence and longevity of *T. pupivora* were 20.42 and 5.12 days, respectively when reared on *O. arenosella*. This parasitoid could be multiplied on *Spodoptera litura* Fab. and *Corcyra cephalonica* (Stain.) in the laboratory. *S. litura* produced higher number of the parasitoid adults. Both parasitoids were mass released in coconut orchards for different four years (1981-85) to seek their establishment. No establishment of both could be obtained.

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INTRODUCTION

The leaf eating caterpillar, *Opisina arenosella* Walker (Lepidoptera: Oecophoridae) is a serious pest in the coconut growing areas of Saurashtra region of Gujarat State. It was found associated with different twenty three natural enemies at Coconut Plantation, Mahuva. Among them, two larval parasitoids, *Bracon brevicornis* Wesm., *Goniozus (= Parasierola) nephantidis* Mues. and three pupal parasitoids, *Brachymeria nephantidis* Gahan, *B.lasus* Walker and *Xanthopimpla punctata* Fab were observed regulating the pest population.With view to determine the possibility of suppressing this pest below economic threshold level by introducing the Elasmid, *Elasmus nephanidis* Rohwer (prepupal) and Eulophid, *Trichospilus pupivora* Ferriere (pupal) which were reported the important ones in South India (Rao *et al.* 1948), studies on development and field recovery of both the parasitoids were, therefore, undertaken for the period of four years (1981-85).

MATERIALS AND METHODS

The stock culture of *E.nephantidis* and *T.pupivora* received each year of 1982-85 from CRCRI,Kayangulam (Kerala) were attempted to multiply under the laboratory conditions. *E. nephantidis*, a host specific parasitoid, was reared on the prepupal stage of *Opisina* larvae which had formed silken layer.These *Opisina* larvae along with leaf bits were exposed to four days old pair of the parasitoid in the glass tubes (9 x 2.5 cm) for the parasitization. Honey droplets

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on a small plastic strip was provided as food for them. The parasitized host larvae were removed on the next day and replaced by another healthy ones. Number of larvae parasitized by an individual female parasitoid were kept seperately and reared until the adult emergence. The fecundity of a single female was counted on the basis of total puparia produced. The similar procedure was adopted to multiply this parasitoid.

For studying *T.pupivora*, 100 adults were exposed to fresh pupae of *O.arenosella* in the glass tube (9 x 2.5 cm). The host pupae were removed on next day and replaced by another fresh pupae. The exposed pupae were kept seperately and reared until the adult emergence. The development of the parasitoid on *Spodoptera litura* Fab. and *Corcyra cephalonica* (Stain.) was also studied. Number of parasitoid adults from a single host pupa was recorded. Adopting this rearing technique the parasitoid was mass reared utilizing *S.litura* pupae.

The field releases of both the parasitoids were made whenever the sufficient amount was available during the periods of their mass multiplication. Periodical collections of the pest stage i.e. prepupal and pupal from the released orchards were made after the field release. These materials were reared in the laboratory to see their establishment. The results obtained are presented in Table 1 and 2.

RESULTS AND DISCUSSION

1. Development

Egg to larval period of *E.nephantidis* averaged 3.50 days with a range of 3 to 5 days. The pupal period lasted for 7 to 9 days. The fecundity was 32.80 on an average with range of 23 to 55. The females survived for 7 to 15 days, whereas males died within 4 to 5 days after the mating. Unmated females produced only male progeny. A female had killed 3.50 host larvae during its life-span, however, 2.33 larvae were deposited with its eggs. Only 2.04 per cent puparia failed to help the adult emergence. The sex ratio was 2.07 females : 1 male (Table 1). Pillai and Nair (1982b) reported that the development from egg to adult was 10-16 days and fecundity was 14-57.

TABLE I

Development stages of *Elasmus nephantidis* when reared on *O. arenosella*.

Sr. No.	*Stage/particular*	*Nos. Studies*	*Duration in days*	
			Average	*Range*
1.	Egg to larva	50	3.50	3 - 5
2.	Pupa	50	7.50	7 - 9
3.	Fecundity	10	32.80	23-55
4.	Longevity (Female)	10	10.50	7 - 15
5.	No. of larvae killed by the parasitoid female	10	3.50	1 - 7
6	No. of larvae killed along with eggs deposition	10	2.33	1 - 5
7.	0/0 adult emergence from puparia	2306/2354	97.96 %	
8.	Sex ratio (Female : male)	750 : 1556	1 : 2.07	

TABLE 2

Development and yield of *Trichospilus pupivora* on different insect hosts.

Insect - Host	Development of Trichospilus		Parasitism (%)	No. of Trichospilus adults yielded/host pupa
	Egg to adult emergence period (days)	Longevity (days)		
Opisina arenosella	20.42[a] (18-23)	5.12[a] (1-10)	14.29[a] (18/28)*	146.00[b] (125-215)
Spodoptera litura	20.82[a] (20-26)	5.01[a] (5-6)	75.76[c] (50/66)	334.07[c] (200-395)
Corcyra cephalonica	23.00[b] (21-25)	4.20[b] (4-5)	60.00[b] (15/25)	50.57[a] (30-90)

Figures in parentheses indicate the range.

* Number of pupae parasitized out of total pupae exposed.

Means in the same column followed by the same letter are not significantly different by Duncan's Multiple Test.

The period for egg to adult of *T.pupivora* was shorter (20.42 days) when reared on *O.arenosella* as compared to *S.litura* (20.82 days) and *C.cephalonica* (23.00 days). On the contrary, the parasitoid adults survived longer (5.12 days) when reared on *O.arenosella* than *S.litura* (5.01 days) and *C.cephalonica* (4.20 days).It indicated that hosts influenced the development of the parasitoid, and *O.arenosella* proved as a good host for the development. However, *S.litura* had yielded higher number of the parasitoid puparia (334.07) as compared to *Opisina* (146.00) and *Corcyra* (50.57). *S.litura* was also preferred for higher parasitization (75.76 %) than *Opisina* (64.29 %) and *Corcyra* (60.00 %).Thus, *S.litura* was found the most suitable alternate host for mass rearing of *T.pupivora*.Pillai and Nair (1982 a) reported that the life cycle-was 16-19 days and 133 parasitoid adults were obtained from *O.arenosella* pupa.Patil and Lingappa (1986) reported *S.litura* to be less susceptible to this parasitoid than the natural host.

2. Field releases and establishment

Total 26,402 *E.nephantidis* adults were produced during five years (1981-86).Out of these,13,846 adults could be released in the coconut orchards in different months of four years (1982-86).The maximum liberation could be made in the months of November,December and March.Two hundred *Opisina* pre-pupae were collected at random from the released orchard, after 15 days of release in each month, for determining its establishment. No. establishment of the parasitoid was noticed from any of the released orchards.This parasitoid had been released against *O.arenosella* in ceylon and no recoveries were made (Dharmaraju,1963 and Kanagaratnan, 1975).

Total 1,04,443 *T.pupivora* adults were produced during four years (1981-85).Out of these, 61,169 adults were released in different coconut orchards.Maximum

releases were made during the months of January, February and March. One hundred *Opisina* pupae were collected at random from the released orchard, after 15 d ys of release in each month, to ascertain its establishment. Its establishment was not obtained from any of the released orchards. About 50 per cent parasitism was, however, recorded when it was liberated on a small infested palm vhich was caged with muslin cloth. This parasitoid has been reported extremely polyphagous and hyperparasitic habit in the nature (Sudha Nagarkatti, 1973). Pillai and Nair (1982a) concluded that poor serching and dispersive ability and low temperature tolerance render it as ineffective species for the control of *O. arenosella*.

The studies concluded that the parasitoids, *E.nephantidis* and *T.pupivora* of *O.arenosella* being important in Kerala, could be multiplied in the laboratory under Mahuva conditions (Gujarat), but their recoveries were not made.

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Evaluation of Insecticides Against Safflower Aphid, *Uroleucon compositae* (Theobald)

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ABSTRACT

The bio-efficacy and economics of eleven insecticides was evaluated against safflower aphid, *Uroleucon compositae* (Theobald).Considering cost benefit ratio the highest benefit ratio was found in phosphamidon 0.03% (17.56), followed by endosulfan 0.035 % (11.63), malathion 0.05% (10.28), phosalone 0.035% (9.15) and nicotine sulphate 0.05% (9.06).

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INTRODUCTION

Safflower, *Carthamus tinctorius* (Linn.) is one of the major rabi oilseed crops cultivated in India on an area of 8.51 lakh hectares with an annual production of 3.33 lakhs tonnes (Anonymous,1989).Among the various factors affecting the yield, insects are the major bottle neck. The crop is attacked by twenty two insect-pests, of which the safflower aphid, *Uroleucon compositae* (Theobal) is the most serious one (Rai, 1976) causing an yield loss from 36.05 to 67.72 per cent (Bhumnnavar and Thontadarya, 1979; Basavanagoud *et al.*, 1981).

MATERIALS AND METHODS

A field experiment was conducted at Anand in rabi 1988-89 and 1989-90 to evaluate the bio-efficacy and economics of eleven insecticides against sufflower aphid (Table-1) with four replications. The gross and net plot size was 5.0 x 3.6 m and 4.0 x 2.7 m respectively. A distance of 45 cm between the rows and 10 cm between the plants was maintained.

The aphid population was recorded regularly at weekly interval from the appearance of aphid on randomly selected 10 apical twings of 10 cm length in each plot. The first and second spray of each of the insecticides were given @ 600 and 800 i/ha respectively when the population reached 15 or more aphids per 10 cm twig (Rathore and Pathak, 1982). The aphid population was recorded 24h prior to spray and 24h, 48h, 72h and 1 week after spray. The data obtained on aphid population and yield were analysed statistically after square root transformation.

RESULTS AND DISCUSSION

The significant effectiveness of all the insecticides was observed against safflower

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TABLE 1

Effect of various insecticides on safflower aphid, *Uroleucon compositae* Theob. at different time interval (Pooled 1988-89 and 1989-90).

Insecticide	*Average no. of aphid per 10 cm twig after*				
	Before spray	*24 h*	*48 h*	*72 h*	*One week*
1	*2*	*3*	*4*	*5*	*6*
Monocrotophos	6.24 +	0.96	0.92	0.83	1.28
0.036 %	(40.38)	(0.53)	(0.38)	(0.20)	(1.49)
Dimethoate	5.97	1.02	0.91	0.84	1.20
0.03 %	(35.66)	(0.60)	(0.38)	(0.25)	(1.16)
Formothion	6.09	1.56	1.17	0.85	1.58
0.025 %	(37.48)	(2.24)	(1.08)	(0.25)	(2.56)
Formothin	6.14	1.47	1.05	0.77	1.42
0.05 %	(38.55)	(2.00)	(0.76)	(0.10)	(2.11)
Methyl-o-demeton	6.14	1.50	1.11	1.07	1.84
0.025 %	(37.68)	(2.44)	(0.88)	(0.79)	(4.23)
Phosphamidon	6.11	1.06	1.04	0.93	1.36
0.03 %	(37.30)	(0.78)	(0.83)	(0.53)	(1.81)
Phosalone	5.99	1.78	1.18	1.23	2.06
0.035 %	(35.74)	(2.84)	(1.04)	(1.21)	(4.48)
Endosulfan	6.38	1.98	1.72	1.19	3.11
0.035 %	(40.68)	(4.36)	(3.08)	(1.21)	(9.13)
Quinalphos	6.18	1.36	1.10	0.95	1.35
0.05 %	(38.16)	(1.56)	(0.83)	(0.44)	(1.53)
Malathion	6.26	1.69	1.68	1.56	3.63
0.05 %	(39.16)	(3.13)	(2.88)	(2.43)	(13.01)
Triazophos	6.61	1.41	1.29	1.02	2.08
0.1 %	(44.25)	(1.83)	(1.48)	(0.66)	(4.49)
Nicotine sulphate	6.16	3.65	3.59	4.30	5.47
0.05 %	(38.15)	(16.21)	(14.80)	(20.09)	(31.03)
Control	6.32	7.08	7.04	7.16	6.64
	(40.05)	(49.99)	(49.60)	(51.58)	(44.41)
S. Em ±	0.24	0.54	0.49	0.49	0.40
C. D. at 5 %	NS	1.71	1.50	1.49	1.23
C. V %	11.08	20.90	19.77	24.73	27.44

Insecticide	Average no. of aphid per 10 cm twig after second spray				Per cent reduction after one week of spray			ICBR ratio
	Before spray	24 h	48 h	One week	First	Second	Meen	
Monocrotophos 0.036 %	7.96 (67.13)	1.08 (0.85)	0.96 (0.49)	0.96 (0.45)	96.6	99.4	98.0	1 : 6.44
Dimethoate 0.03 %	7.52 (58.93)	1.25 (1.19)	1.10 (0.76)	0.87 (0.28)	97.4	99.6	98.5	1: 8.41
Formothion 0.025 %	7.67 (61.36)	1.10 (0.78)	1.14 (0.93)	1.00 (0.56)	94.2	99.3	96.8	1: 6.19
Formothin 0.05 %	7.86 (65.49)	1.11 (0.89)	1.11 (0.86)	1.00 (0.56)	95.2	99.3	97.3	1: 3.66
Methyl-o-demeton 0.025 %	7.41 (55.55)	1.23 (1.19)	1.17 (1.01)	1.07 (0.96)	90.5	98.8	94.7	1: 7.30
Phosphamidon 0.03 %	7.44 (57.74)	1.45 (1.95)	1.80 (1.05)	0.92 (0.38)	95.2	99.5	97.7	1: 17.56
Phosalone 0.035 %	8.17 (69.23)	1.72 (2.89)	1.49 (2.31)	1.61 (2.96)	89.9	96.2	93.1	1: 9.15
Endosulfan 0.035 %	7.57 (57.93)	2.19 (4.98)	1.63 (2.53)	2.60 (9.40)	88.4	88.0	88.2	1: 11.63
Quinalphos 0.05 %	8.47 (75.31)	1.26 (1.51)	1.13 (0.89)	1.21 (1.25)	96.5	98.4	97.5	1:3.44
Malathion 0.05 %	8.45 (78.74)	2.15 (4.53)	1.13 (0.89)	1.51 (2.20)	66.2	97.2	81.7	1: 10.28
Triazophos 0.1 %	7.66 (63.00)	1.27 (1.18)	0.92 (0.40)	0.91 (0.41)	89.9	99.5	94.7	1: 1.89
Nicotine Sulphate 0.05 %	9.71 (108.19)	5.36 (29.50)	3.24 (10.90)	6.14 (58.63)	30.1	25.3	27.7	1:9.06
Control	9.58 (104.59)	9.18 (98.71)	8.59 (83.01)	7.91 (78,51)				
S. Em. ±	0.83	1.10	0.88	1.71				
C. D. at 5 %	NS	3.37	2.70	NS				
C. V.%	11.19	25.45	28.97	26.23				

+ $\sqrt{x + 0.5}$ transformed values

Figures in parentheses are original values.

aphid till one week after first spray. However, nicotine sulphate was significantly less effective than synthetic insecticides except endosulfan after 24h of spray. However, after 48h of spray endosulfan superior to nicotine sulphate till one week. All the synthetic systemic and non-systemic insecticides except malathion were found equally effective till one week after first spray. However, safflower sprayed with dimethoate had maximum reduction in aphid population followed by monocrotophos, phosphamidon, quinalphos, formothion, methyl-0-demeoton, triazophos, phosalone, endosulfan, malathion and nicotine sulphate. Chaudhary *et al* . (1983) and Chandrakar and Gupta (1989) have also reported the effectiveness of monocrotophos, phosphamidon, dimethoate and methyl-O-demeton agains safflower aphid.

The aphid population on plants sprayed with insecticides was significantly low as compared to unsprayed plants till 72 h after second spray. However, nicotine sulphate recorded significantly higher aphid population than synthetic insecticides except malathion and endosulfan after 24 h of spray. After 48 of spray no significant differnce in aphid population was found among the various insecticides treatments. The aphid population was lowest on safflower sprayed twice with dimethoate followed by monocrotophos, phosphamidon, quinalphos, formothion, methy-O-demeton, triazophos, phosalone, endosulfan, malathion and nicotine sulphate.

Phosphamidon sprayed safflower crop had significantly higher yield as compared to nicotine sulphate and formothion whereas, yield obtained from crop sprayed with other insecticides was at par to each other including phosphamidon. Considering the cost of protection and benefit obtained phosphamidon treatment showed highest ICBR. (1:17.56) followed by endosulfan, (1:11.63), malathion (1:10.28) and phosalone (1:9.15).

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Field Screening of Pigeonpea Genotypes Against Pod Borers and Podfly

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ABSTRACT

The susceptibility to pod borers and podfly as well as yield potential of various pigeonpea genotypes in comparison to adopted varieties were studied in a field experiment during 1988-89 and 1989-90 at Anand. Genotype GAUT 82-90 was found less susceptible to *Helicoverpa armigera* Hb., plume moth, *Marasmarcha lophanes* Meyrick and podfly, *Melanagromyza obtusa* Malloch with higher yield potential.

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INTRODUCTION

Pigeonpea is an importent pulse crop which is heavily attacked by pod borers and podfly. To minimize the use of insecticides for the control of pests on pigeonpea availability of resistant pigeonpea varieties is very essential. In the present investigation screening of the available 24 varieties genotypes of pigeonpea for their resistance/ tolerance to pod borers and podfly was carried out under natural infestation in pesticide free open field condition at Gujarat Agricultural University, Anand campus, Anand during 1988-89 and 1989-90.

MATERIALS AND METHODS

Field experiments were conducted in randomised block design with 24 varieties / genotypes of pigeonpea as treatments (Table 1). Each treatment was replicated twice. The gross plot size was 4.5 X 2.7 m with row to row distance 90 cm. and plant to plant 30 cm. All the 24 varieties/ genotypes were sown in the 3rd week of June and crop was fertilized @20 kg N_2 and 40 kg P_2O_5 per hectare.

To assess the degree of infestation of *Helicoverpa armigera* Hubner; plume moth, *Marasmarcha liophanes* Meyrick and podfly, *Melanagromyza obtusa* Malloch, 250 mature pods were randomly picked up form all the plants in 8.1 sq.m of each plot at the time of harvesting. The pods damaged by *H. armigera* and *M. liophanes* were detected by the presence of characteristic larger and comparatively smaller bore holes respectively. The infested and healthy pods were counted separately. To assess the grain damage by the podfly, all the pods in a sample were split open to count the damaged and healthy grains in the sample. The data on pod damage by each of the insects and grain damage by podfly were converted into per cent values and then analysed statistically. Yield of healthy grain in each entry was also recorded.

RESULTS AND DISCUSSION

Screening of 24 varieties/genotypes of pigeonpea for their resistance/tole rance to pod borers and podfly during two

TABLE 1

Comparative damage in different varieties/ genotypes of pigeonpea by pod borers and yield.

Variety / Genotype	*Pod damage (%) by*						*Grain damage (%) by*					
	H. armigera			*M.liophanes*			*M. dotusa*			*Grain yield (g/ha)*		
	1988-89	*1989-90*	*Pooled*	*1988-89*	*1989-90*	*Pooled*	*1988-89*	*1989-90*	*Pooled*	*1988-89*	*1989-90*	*Pooled*
Early maturing and determinate type plant												
GAUT - 82 -56	27.77* (22.13)	24.91 (17.92)	26.34 (20.02)	15.03 (6.96)	11.34 (4.51)	13.19 (5.74)	21.52 (13.50)	34.21 (31.65)	27.87 (14.25)	3.12	3.71	3.41
GAUT - 82 -91	33.63 (31.13)	23.67 (17.40)	28.65 (24.26)	10.38 (3.40)	9.69 (3.30)	10.03 (3.39)	28.54 (22.88)	37.09 (36.90)	32.81 (29.89)	2.15	6.36	4.25
GAUT - 82 -92	28.50 (22.97)	21.77 (14.06)	25.13 (18.51)	16.31 (8.18)	11.54 (4.04)	13.92 (6.11)	25.22 (18.21)	29.26 (24.21)	27.24 (20.66)	2.87	6.36	5.11
GAUT - 82 -99	28.16 (22.44)	23.38 (15.82)	25.77 (19.13)	14.88 (6.91)	8.61 (2.66)	11.75 (4.78)	20.93 (12.70)	31.32 (27.15)	26.12 (19.97)	4.86	5.60	5.22
GAUT - 82 -100	34.80 (33.44)	31.27 (27.10)	33.03 (30.27)	20.82 (13.14)	10.71 (4.01)	15.76 (8.57)	25.85 (19.00)	45.67 (51.20)	35.76 (35.12)	3.67	1.20	2.42
GAUT - 82 -104	32.08 (28.55)	25.16 (18.60)	28.62 (23.57)	14.29 (6.15)	15.99 (8.31)	15.24 (7.23)	22.81 (15.07)	36.21 (35.00)	29.15 (25.03)	3.65	5.67	4.65
GAUT - 82 -105	35.18 (33.71)	22.88 (15.80)	29.03 (24.75)	16.12 (7.84)	12.01 (4.75)	14.06 (6.29)	18.79 (10.39)	29.53 (24.52)	24.16 (12.21)	5.19	3.22	4.20
GAUT - 82 -106	20.13 (13.10)	25.97 (20.08)	23.05 (16.59)	11.42 (3.97)	10.21 (4.02)	10.81 (3.99)	32.61 (27.07)	33.76 (30.90)	33.18 (29.99)	4.55	5.33	4.93
GAUT - 82 -137	37.70 (38.59)	26.17 (20.04)	31.94 (29.32)	21.79 (13.92)	13.20 (5.40)	17.50 (9.66)	30.07 (25.14)	33.76 (30.90)	31.91 (28.02)	4.01	3.67	3.84
GAUT - 83 -17	31.35 (27.53)	26.09 (19.40)	28.72 (23.47)	16.30 (8.14)	7.61 (1.85)	11.96 (5.00)	24.53 (17.26)	38.19 (38.40)	31.36 (27.83)	2.58	2.00	2.44
GAUT - 83 -23	31.29 (27.24)	18.40 (10.27)	24.85 (18.71)	10.30 (11.34)	14.93 (12.91)	17.11 (12.13)	20.12 (19.46)	25.81 (19.30)	25.97 (29.38)	3.70	2.64	3.16
ICPL-87	30.81 (26.60)	20.85 (25.34)	30.33 (25.97)	13.51 (5.56)	12.54 (5.34)	13.02 (5.45)	21.97 (14.02)	33.66 (30.90)	27.81 (22.46)	3.12	4.57	3.85
ICPL-312	31.03 (27.58)	29.06 (23.95)	30.05 (25.76)	14.64 (7.52)	14.49 (6.71)	14.56 (7.12)	19.94 (11.67)	37.09 (36.90)	28.51 (24.29)	3.89	2.17	3.04
Pusa agati	24.97 (23.16)	22.68 (15.42)	28.82 (24.29)	14.85 (6.88)	9.95 (3.23)	12.40 (5.05)	18.56 (10.15)	35.65 (34.05)	27.10 (22.10)	2.62	6.69	4.66

TABLE 7 (Contd.)

1	2	3	4	5	6	7	8	9	10	11	12	13
Mid - late maturing and indetremimate type plant												
GAUT - 82 - 43	29.94 (25.75)	20.22 (12.11)	25.08 (18.93)	16.14 (7.95)	08.81 (2.90)	12.48 (5.42)	22.68 (15.00)	32.15 (28.40)	27.41 (21.70)	5.48	1.43	3.45
GAUT - 84 - 44	29.69 (24.64)	22.43 (15.11)	26.06 (19.87)	16.03 (7.93)	12.42 (5.50)	14.22 (6.71)	24.54 (17.40)	31.95 (28.04)	28.27 (22.72)	3.41	2.33	2.87
GAUT - 82 - 58	28.54 (22.88)	25.22 (18.38)	26.88 (20.63)	16.71 (9.03)	10.88 (3.62)	13.79 (6.32)	24.17 (16.79)	34.09 (31.82)	29.13 (24.30)	4.15	3.65	3.90
GAUT - 82 - 90	23.23 (15.92)	18.70 (12.37)	20.96 (14.14)	19.21 (10.28)	8.05 (3.20)	13.63 (7.04)	23.96 (16.58)	27.92 (22.02)	25.94 (19.30)	3.57	7.73	5.65
GAUT - 82 -128	38.44 (38.91)	28.10 (23.37)	33.27 (31.14)	18.69 (10.67)	14.52 (7.08)	16.60 (8.87)	31.49 (27.35)	38.17 (38.70)	33.83 (33.03)	1.93	4.23	3.08
GAUT - 82 - 135	33.50 (30.97)	18.55 (10.37)	26.03 (20.67)	16.10 (7.74)	9.20 (3.08)	12.65 (5.41)	20.83 (12.68)	29.69 (24.40)	25.21 (18.54)	2.25	7.98	5.12
GAUT - 84 - 54	26.79 (20.86)	24.00 (16.97)	25.39 (18.92)	13.21 (5.35)	7.68 (1.82)	10.45 (3.59)	23.82 (16.48)	38.34 (38.70)	31.08 (27.59)	4.04	3.10	3.57
I C P L - 332	19.49 (13.18)	21.96 (15.28)	20.72 (14.23)	15.04 (7.19)	7.87 (2.77)	11.45 (4.98)	25.19 (18.17)	27.50 (21.35)	26.35 (19.76)	2.57	5.44	4.01
T - 15 - 15	28.85 (23.46)	23.84 (17.22)	26.34 (20.34)	14.64 (6.78)	7.71 (2.01)	11.17 (4.39)	20.32 (5.21)	31.78 (27.80)	26.05 (20.00)	2.65	4.10	3.38
B D N - 2	36.76 (35.96)	30.62 (26.35)	33.69 (31.16)	14.82 (6.83)	9.51 (3.23)	12.17 (5.03)	21.15 (13.00)	30.69 (26.50)	25.92 (19.77)	4.02	4.97	4.49
S. Em. ±	3.55	3.12	2.39	1.97	2.67	1.65	1.35	4.13	2.33	1.01	1.23	1.13
C. D. (P=0.05)	9.96	NS	6.61	5.53	NS	NS	3.96	NS	6.52	NS	3.60	3.22
C. V. %	27.03	27.48	27.37	24.16	50.51	35.38	7.99	17.46	15.14	40.29	40.13	40.39

* Arcsin $\sqrt{\text{percentage}}$ transformed values.
Figures in parentheses are original values.

consequtive years under central Gujarat conditions revealed that none of the varieties/genotypes was completely free from the *H. armigera*, *M. liophanes* and *M. obtusa* (Table 1).

H. armigera

The pods of pigeonpea genotypes ICPL 332(14.23 %) and GAUT 82-90 (14.14 %) were found significantly less damaged by *H.armigera* as compared to those of GAUT 82-104, GAUT 82-91,GAUT 83-17, Pusa Agati, GAUT 82-105, ICPL-312, ICPL 87, GAUT 82-137, GAU-82-100, GAUT 82-128 and BDN-2 in which the pod damage varied from 23.57 to 31.16 per cent and was statistically at par, whereas no significant difference in pod damage was observed between genotypes ICPL 332, GAUT 82-90, T-15-15, GAUT 82-106,GAUT 83-23, GAUT 82-43, GAUT 82-92, GAUT 84-54, GAUT 82-99, GAUT 82-135, GAUT 84-44, GAUT 82-56 and GAUT 82-58. T-15-15 showed low (20.34 %) susceptibility to *H. armigera* as compared to BDN-2 (31.16 %), GAUT 82-100 (30.27 %) and GAUT 82-128 (31.14 %) but was at par with Pusa Agati (24.29 %). Patel (1988) and Anonymous (1990) have also reported higher susceptibility of BDN-2 to *H. armigera* than rest of the pigeonpea genotypes tested in central Gujarat and southern Gujarat respectively.

M. liophanes

All the varieties/genotypes of pigeonpea were found equally susceptible to plume moth, *M. liophanes* without any significant difference in pod damage. However, genotypes GAUT 82-91 (3.48 %) and GAUT 82-106 (3.97 %) had significantly low pod damage by the pest during 1988-89.

M. obtusa

The grain damage by pod fly, *M. obtusa* was significantly low (12.21 %) in GAUT 82-105 as compared to that in genotypes GAUT 84-54, GAUT 83-17, GAUT 82-137, GAUT 82-91, GAUT 82-106, GAUT 82-128 and GAUT 82-100, in which grain damage varied from 27.59 to 35.12 per cent, whereas rest of the varieties/genotypes including BDN-2 (19.77 %), T-15-15 (20.00 %) and Pusa Agati (22.10 %) were found equaly susceptible to pod fly in comparison to GAUT 82-105.

Grain yield

Data on the grain yielding potential of various varieties/genotypes of pigeonpea indicated that genotype GAUT 82-90 (5.65 q/ha) was significantly higher grain yielder than GAUT 82-100 (2.42 q/ha), whereas rest of the varieties/genotypes were at par with respect to yield potential. Patel (1988) has also reported the highest yield potential in mid-late maturing and indeterminate type genotype GAUT 82-90.

In view of the higher yield potential and low susceptibility to *H. armigera*, *M. liophanes* and *M. obtusa*, GAUT 82-90 may be recommended for cultivation in those areas where pod borer is a limiting factor for pigeonpea cultivation.

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Infection Process in Rhizopus and Botryodiplodia Rots of Guava Fruits*

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ABSTRACT

Germination of spores of *Rhizopus arrhizus* (Fischer) and *Botryodiplodia theobromae* (Pat.) was more on injured ripe fruits than on semi-ripe and unripe fruits. The disease severity of the rots increased with increasing levels of spores concentration. Germination of spores of rot pathogens were maximum at 30 o C at which the severity of the two rots was also maximum.

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INTRODUCTION

Fungal rots do not develop in fruits that are inoculated at unripe stage (Majumdar, 1987). To ascertain whether unripe fruits contain some compound(s) which adversely affect the activities of the pathogens, the present experiment was laid out and finding were reported in this paper.

MATERIALS AND METHODS

Fruit ripeness and injury in relation to spore germination

Unripe, semi-ripe and ripe fruits were surface sterilized and inoculated by placing a drop of spore suspension (10^6 spores/ml) of both the pathogen (*Rhizopus carrhizus* and *Botryodiplodia theobromae*) on the fruit surface. Fifty per cent fruits of each stage were inoculated after pricking, while the remaining were inoculated without injury. The inoculated fruits were incubated at 28 ±2° C in desicators containing a thin layer of water at their bottom. Drops of spore suspension were removed from the fruit surface after 6, 12, 18 and 24 hours and examined for spore germination under microscope.

Fruit ripeness and spore concentration in relation to and disease development

Four spore concentrations viz., 10^6 spores/ml to 10 spores/ml were used for both the pathogens. In case of *Rhizopus arrhizus*, spore were obtained from 7- day - old culture, while 45 day - old pycnidia were crushed in sterile water to prepare spore suspension of *Botryodiplodia theobromae*. Spore concentrations were adjusted using haemocytometer. Harvested semi-ripe and ripe fruits were separately inoculated with each spore concentration by pick injury method. The pricked fruits were dipped in spore suspension for 2 minutes. Inoculated fruits were incubated at 28 ± 2 °C and severity of rots was recorded on 4th and 8th day of inoculation. The severity was recorded on the basis of per cent fruit area infected, Each treatment was replicated 20 times.

* Part of the Ph.D. research work submitted to Rajasthan Agricultural University, Bikaner in 1991.

RESULTS AND DISCUSSION

Fruit ripeness and injury in relation to spore germination

(a) Rhizopus arrhizus

The spores did not germinate on injured and uninjured fruits of the three stages upto 6 hours of incubation (Table 1).Between 6 and 12 hours,the spores germinated on ripe and semi-ripe fruits while they did not germinate upto 12 hours on unripe fruits.At 18 and 24 hours, spore germination on ripe fruits,whether injured or uninjured,was more than on injured and uninjured fruits of semi-ripe and unripe stages.Germination was significantly more on injured ripe fruits than on uninjured ripe fruits.On the basis of means,it becomes evident that germination increased with increased in duration.

(b) Botryodiplodia theobromae

Unlike spores of *Rhizopous arrhizus,* spores of *Botryodiplodia theobromae* started germination within 6 hours even on unripe fruits (Table 1).The spore germination of this pathogen was less influenced by ripeness and injury,as at 24 hours, germination or injured ripe fruits differed non-significantly from the germination in all other treatments except germination on uninjured unripe fruits.It is noteworthy that germination on injured unripe fruits was significantly higher than the germination on uninjured unripe fruits.

Fruits ripeness and spore concentration in relation to infection and disease development

On 4th day of inoculation,highest severity level were recorded on ripe and semi-ripe fruits at the maximum spore concentration (Table 2 & 3).In general,there was increase in severity with increase in spore concentrations.On the basis of means, severit level was significantly higher in ripe fruits than in semi-ripe fruits. Further on the bases of means, it can be concluded that highest severity resulted after inoculation with highest spore concentration (10^6).

On 8th day of inoculation, the trend was same as on 4th day of inoculation.

The findings revealed that spore germination on injured or uninjured epicarp of semi-ripe fruits was more than on injured or uninjured epicarp of unripe fruits and likewise germination on ripe fruits was more than on semi-ripe fruits.This suggests that unripe fruits perhaps contain some spore germination inhibitor (s) which progressively decrease in concentration or activity in semi-ripe and ripe fruits.Ripe and unripe fruits of guava are greater differ in availability of sugars. The susceptibility of ripe fruits may be due to utilised nutrients rather than absence of inhibitors.Interestingly, on ripe fruits, spores germination of *Rhizopous arrhizus* was significantly more on injured apicarp than on uninjured epicarp.This suggest that the activity of the inhibitor(s) perhaps gets reduced due to certain compounds which appear at the site of injury. Unlike *Rhizopus arrhizus*, spores of *Botryodiplodia theobromae* managed to germinate considerably on unripe fruits.The system of spore germination in *Botryodiplodia theobromae* thus appeared less sensitive to defence mechanism of the fruit.

Inoculum density is known to influence disease severity in several plant diseases (Patil, 1992). The severity levels in semi-ripe and ripe fruits increased with the increasing levels of spore concentration and it was higher in ripe than in semi-ripe fruits.These findings suggest that all measures aimed at reducing the inoculum density as well as providing adequate protection to semi-ripe and ripe fruits can help manage the two rots satisfactorily.

TABLE 1

Effect of fruit ripeness* and injury on spore germination of *Rhizopus arrhizus* and *Botryodiplodia theobromae*.

Drop of spore suspension placed on	Average per cent germination of *Rhizopus arrhizus* after (hour)					Average per cent germination of *Botryodiplodia theobromae* after (hour)				
	6	12	18	24	Mean	6	12	18	24	Mean
Injured ripe fruit	0.57 (0.00)	14.13 (5.96)	48.87 (56.73)	58.17 (72.18)	30.43 (25.65)	31.75 (27.69)	48.24 (55.64)	70.32 (88.66)	72.44 (90.90)	55.69 (68.23)
Uninjured ripe-fruit	0.57 (0.00)	8.66 (2.27)	39.31 (40.13)	47.42 (54.22)	23.99 (16.53)	33.97 (31.22)	42.55 (45.73)	46.39 (52.43)	79.53 (96.70)	50.61 (59.73)
Injured semi-ripe	0.57 (0.00)	16.17 (7.76)	28.33 (22.52)	33.03 (29.71)	19.53 (11.18)	28.89 (23.34)	35.61 (33.90)	42.55 (45.73)	66.26 (83.79)	40.33 (47.09)
Uninjured semi-ripe fruit	0.57 (0.00)	9.96 (2.99)	31.66 (27.55)	39.97 (41.27)	20.54 (12.31)	37.77 (37.51)	44.00 (48.26)	59.61 (74.41)	63.72 (80.40)	51.27 (60.86)
Injured unripe fruit	0.57 (0.00)	0.57 (0.00)	14.68 (6.42)	18.22 (9.78)	8.51 (2.19)	28.77 (23.16)	42.55 (45.73)	44.93 (49.88)	79.22 (96.50)	48.87 (56.73)
Uninjuerd unripe fruit	0.57 (0.00)	0.57 (0.00)	12.51 (4.69)	18.22 (9.78)	7.70 (1.92)	45.23 (50.40)	46.39 (52.43)	51.29 (60.89)	50.87 (60.17)	48.44 (55.99)
Mean	0.57 (0.00)	8.34 (2.10)	29.23 (23.85)	35.84 (34.28)		34.40 (31.92)	43.22 (46.90)	52.51 (62.96)	68.67 (84.75)	

Source	SEm	CD at 5 %	SEm	CD at 5 %
Treatment (T)	0.69	2.07	2.54	NS
Period (P)	0.54	1.53	2.31	6.54
TP	1.32	3.75	5.65	16.92

* Fruits were incubated at 28 ±2°C

Figures in parentheses are retransformed values.

NS = Non significant

TABLE 2

Effect of spores concentration on severity of Rhizopus rot in ripe and semi-ripe fruits*.

Spore concentration (spore/ml)		Observation on 4th day of incoulation in			Observation on 8th day of inoculation in		
		S_1 Ripe fruits	S_2 Semi-ripe fruits	Mean	S_1 Ripe fruits	S_2 Semi-ripe fruits	Mean
T_1	(10^6)	12.46 (4.66)	8.49 (2.18)	10.48 (3.31)	54.67 (66.56)	39.76 (40.91)	47.21 (53.85)
T_2	(10^5)	11.55 (4.01)	7.21 (1.58)	9.38 (2.66)	47.95 (55.14)	40.19 (42.16)	44.22 (48.64)
T_3	(10^4)	9.72 (2.85)	6.43 (1.25)	8.08 (1.98)	36.54 (35.45)	29.62 (24.43)	33.08 (29.79)
T_4	(10^3)	8.44 (2.15)	5.88 (1.05)	7.16 (1.55)	30.48 (25.73)	21.63 (13.59)	26.05 (19.29)
T_5	(10^2)	6.38 (1.23)	4.88 (0.72)	5.63 (0.96)	23.09 (15.38)	14.43 (16.21)	18.76 (10.34)
T_6	(10)	6.66 (1.35)	3.37 (0.35)	5.01 (0.76)	17.82 (9.37)	10.15 (3.11)	13.98 (5.84)
Mean		9.20 (2.56)	6.04 (1.11)		35.09 (33.05)	26.01 (19.23)	

Surce	SEm	CD at 5 %	SEm	CD at 5 %
Stage (S)	0.51	1.41	1.19	3.31
Concentration (T)	0.88	2.44	2.07	5.73
ST	1.24	NS	2.92	NS

* Fruits were incubated at 28 ±2°C

Figures in parentheses are retransformed values.

TABLE 3

Effect of spore concentrations on severity of botryodiplodia rot in ripe and semi ripe fruits.

Spore concentration	*Observation on 4th day of inoculation in*			*Observation on 8th day of inoculation in*		
(spore/ml)	S_1 *Ripe fruits*	S_2 *Semi-ripe fruits*	*Mean*	S_1 *Ripe fruits*	S_2 *Semi-ripe fruits*	*Mean*
T_1 (10^6)	18.51 (10.08)	8.94 (2.41)	13.73 (5.63)	49.60 (57.99)	35.35 (33.47)	42.47 (45.59)
T_2 (10^5)	13.29 (5.28)	8.21 (2.04)	10.75 (3.48)	44.99 (49.98)	29.08 (23.62)	37.04 (36.29)
T_3 (10^4)	13.17 (5.19)	6.89 (1.44)	10.03 (3.03)	41.32 (43.59)	23.06 (15.34)	32.19 (28.38)
T_4 (10^3)	8.21 (2.04)	5.38 (0.88)	6.80 (1.40)	29.79 (24.68)	14.95 (6.66)	22.37 (14.48)
T_5 (10^2)	8.17 (2.02)	4.37 (0.58)	6.27 (1.19)	25.46 (18.48)	14.14 (5.97)	19.80 (11.47)
T_6 (10)	2.86 (0.00)	2.86 (0.00)	2.86 (0.00)	9.53 (2.74)	7.76 (1.82)	8.65 (2.26)
Mean	10.70 (3.45)	6.11 (1.13)		33.45 (30.38)	20.72 (12.52)	

Source	SEm	CD at 5 %	SEm	CD at 5 %
Stage (S)	0.50	1.38	0.94	2.59
Concentration (T)	0.86	2.39	1.62	4.49
ST	1.22	3.38	2.29	6.35

* Fruits were incubated at 28 ± 2°C

Figures in parentheses are retransformed values.

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Influence of Harmones and Chemicals on the Germination of Coriander Seed (*Coriandrum sativum* L.)

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ABSTRACT

Coriander is an important crop of M.P. Its flavored leaves and seeds are used as flavouring agents and condiments in various reciples. Its seed take longer time for germination when sown dry after spliting into two mericarps. To enhance germination and field emergence of coriander an experiment having 20 treatments like seed soaking in water, treating seed with solutions of 50, 100 and 150 ppm of GA_3, NAA and MH as well as with 5, 10 and 15% solutions of H_2SO_4, HNO_3 and HCL, was conducted at JNKVV, Deptt. of Horticulture in the year 1985. After 28 DAS, maximum field emergence was noted in water soaking for 24 hrs (71.33 %) followed by GA_3 (59.70 %) and NAA treatments (68-69%) as compared to untreated dry seed sowing (55 %). MH slightly increased the initial germination upto 14 days but was at par with control on 28 DAS. The treatments with inorganic acids upto 10% initially enhanced germination, but were not beneficial on later dates. Higher concentration seems to be injurious to coriander embryos as they brought down the field emegence to 1.10 to 4.88 % against control which was 45.33 on 14 DAS.

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INTRODUCTION

Coriander is an annual herb belonging to the family umbelliferae. It is cultivated for its leaves and seeds which have fragrant odour and pleasand essential oils of oxigenated hydrocarbon origin. The coriander seed takes longer time for germination and the delay in germination consume lot of time during which good amount of leafy vegetable could be harvested. By shortening the period of field emergence the productivity of green leaves as well as net return per hectare can be increased.

MATERIALS AND METHODS

The present investigation was conducted at JNKVV Vegetable Research Farm, Dept. of Hort., Jabalpur during 1985. The experiment was laid out in randomised block design with twenty treatments and three replications. The coriander seed was splited into two pericarps. The treatments were dry sowing, sowing seed after 24 hrs soaking in water, 2 hours treatment in seed with 50, 100 and 150 ppm of GA_3, NAA and MH as well as 5 minutes treatment of seed with 5, 10 and 15 per cent solutions of H_2SO_4, HNO_3 and HCL to give abrasive effect on the seedcoat so that sufficient water for germination could be absorbed. The soil of the field was clay loam with normal pH and medium in nitrogen and phosphorus while very high in available potash. After treatments the seeds were sown in line at the depth of 2-3 cm on 2nd March 1985. To maintain proper moisture for germination, irrigation was provided in the plots by hazara just after sowing. Treatment combinations was as follows.

RESULTS AND DISCUSSION

The data on germination and field emergence given in Table 2 revealed that significant increase in the germination percentage was observed in different treatments. The treatments induced early and uniform germination as compared to unsoaked (control) treatment.

After 7 DAS maximum germination was observed in 100 ppm GA (4.14 %) followed by 10 % H_2SO_4 solution (3.69 %) and GA 150 ppm (3.23 %). Though initiation of germination was noted in other treatments also, but dry sowing, H_2SO_4 15 %, HCL 15 % and HNO_3 15 % and MH ppm failed to induse germination. Similarly, after 14 DAS, maximum germination percentage was noted in GA 100 ppm (49.26%) followed by NAA 50 and 100 ppm (48.66 % and 47.99 % respectively),GA 150 ppm (47.23%),NAA 150 ppm (46.23%),MH 150 ppm (45.66%) and 24 hr soaked in water (45.33%) whereas minimum germination ranging from 1.10% to 10.11% was observed in all the treatments of HNO_3,HCL 15 %, H_2SO_4 15 % ,and dry sowing.While remaining treatments recorded germination in the range of 18.66% to 44.33%. However on 21 DAS, significant and higher germination (60.23%-48.23%) was noted in all the treatments of GA and NAA followed by 24 hrs soaking in water; 5 and 10% H_2SO_4 ; 5 and 10% HCL ; and MH 100 ppm and 150 ppm over control (40.39%).Putievsky (1980) reported beneficial effect of seed soaking in water for enhancing germination of coriander over dry sowing.Similarly,increase in the germination percentage with 50 ppm GA and 10 ppm NAA treatments in Methi and Palak seed has been reported by Bharud (1981).Badgujar & Wavhal (1990) also reported higher germination after soaking coriander seed in cold water for 12 hrs while soaking for 12 hrs in 50 ppm GA solution also gave higher germination over dry sowing of seed. They also reported that when seed was soaked in water, 50 ppm GA solutions and wrapped in polythene or gunny bags gave still higher germination of seed on 20th DAS.

At 28 DAS, the higher and significant germination percentage was recorded in 24 hrs soaking in cold water treatment (71.33%) followed by 100 ppm GA solution (70.29%), 50 ppm GA solution (69.99) and 50 ppm NAA (69.70%) while minimum seed germination was noted in 15% H_2SO_4 (4.88%) followed by !5% HNO_3 solution i.e. 9.91% indicating the higher concentration of

TABLE 1
Treatments.

Treatments	*ppm*			*percentage*		
	50	*100*	*150*	*5*	*10*	*15*
GA				--	--	--
NAA				--	--	--
MH				--	--	--
H_2SO_4	--	--	--			
HCL	--	--	--			
HNO_3	--	--	--			
Soaking in water	--	--	--	--	--	--
Dry sowing of seed	--	--	--	--	--	--

TABLE 2

Germination percentage at 7th, 14th, 21st and 28th days after sowing as influenced treatments.

Treatments		*Stages*			
		7th day	*14th day*	*21st day*	*28th day*
(1)	Control	0	10.11	40.39	55.13
(2)	24 hrs soaked in water	2.13	45.33	60.16	71.33
(3)	5% H_2SO_4 solu.	1.11	20.13	49.18	60.66
(4)	10% H_2SO_4 "	3.69	21.68	53.33	55.69
(5)	15% H_2SO_4 "	0	2.69	3.98	4.88
(6)	5% HCL '	0	18.66	48.32	55.63
(7)	10% HCL '	2.11	29.33	56.66	60.63
(8)	15% HCL '	0.99	4.88	21.39	41.09
(9)	5% HNO_3 '	1.01	3.89	41.32	58.13
(10)	10% HNO_3 "	0.90	3.90	36.66	40.32
(11)	15% HNO_3 '	0	1.10	2.38	9.91
(12)	50 ppm NAA	2.20	48.66	59.19	69.70
(13)	100 ppm NAA	2.11	47.99	60.11	68.76
(14)	150 ppm NAA	2.13	46.23	58.37	69.66
(15)	50 ppm NAA	2.33	43.17	56.13	69.99
(16)	100 ppm GA	4.14	49.26	60.23	70.29
(17)	150 ppm GA	3.23	47.23	56.13	59.39
(18)	50 ppm MH	0	39.13	46.14	52.31
(19)	100 ppm MH	1.39	43.33	52.63	58.19
(20)	150 ppm MH	1.10	45.66	53.33	59.13
	C.D. 5%	0.88	1.01	2.03	3.13

inorganic acids are detrimental to coriander embryo. Pre soaking of seeds in water and in the solution of plant growth regulators and other chemicals have been found useful in increasing the germination rate and percentage of germination. Maier (1964) and Tallarico (1983) reported higher germination by pre soaking in GA solution in vegetable seeds.

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Scale to Measure Attitude of SMSs Participants Towards Monthly Workshop in T & V System

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ABSTRACT

The main purpose of the monthly workshop is to build up the technical skills of SMSs regularly in the field of their specialization, so they can meet effectively and actual technological needs of farmers. Attitude is preconditional factor for any action. Thus, the attitude of the SMS towards monthly workshop play important role in making the workshop effective. However the assessment of the attitude would he vague without standard devices, hence an effort was made to construct an instrument. The scale could be used to measure the attitude of SMSs working in Gujarat as well at other places with partial modification.

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INTRODUCTION

A professional extension service is not possible without technically competent, skilled and highly motivated extension functionaries at all levels of net-works. Therefore, training of extension personnel and the practicing farmers in improved technology of agriculture constitute an important extension education activity under T & V System. Thus, in fact the entire strategy of transfer of technology under T & V system is based on the quality/effectiveness of monthly workshops.

Attitude of an individual play an important role in determining his behaviour with respect to a particular psychological object. As corollary of this fact, the Subject Matter Specialists, (SMSs) attitude towards the monthly workshops of T & V system will largely determine the nature and extent of their involvement, participation in the monthly workshops and motivation to learn, which in turn, reflect on the effectiveness of the workshops.If, SMS's have nagative attitude towards monthly workshop, then they may not have strong motivation to learn in workshop and which results in failure to train them or failure to transfer the latest agricultural technologies to them and ultimately to farmers.It is therefore crucial to identify the attitude of the SMSs towards monthly workshops.Keeping this in view,it was felt that the standardized and objective scale be developed to measure the attitude of SMSs towards monthly workshops.

MATERIALS AND METHODS

Among the techniques available for construction of scales, the Thurstone's Equal Appearing Interval Scale (1929) and the Likert's Summated Rating Scale (1932) are quite well known.But both the methods

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suffer from limitations, the first one in getting discriminating response and the second one in selection of items (statements).

Guilford (1950) has described the "Scale Product Method" in which the scale value of the statement of Thurstone Scale and the response on Likert scale are combined to get the total attitude score of the respondents. Therefore, 'Scale Product Method' was used in the study.

Item collection

As a first step in developing the scale, 29 attitudinal statements about monthly workshop were collected from relevant literature and experts. The statements, thus collected were edited on the basis of the criteria suggested by Thurstone and Chave (1929).

The criteria under consideration were : each statement should contain only one complete thought, language of statement should be simple, clear and direct, avoid statement that may be interpreted in more than one way, avoid the use of double nagatives, etc.

Judge's rating of attitudinal state

In order to to judge the degree of 'Unfavoura-bleness favourableness' of each statement on the seven point equal appearing interval continium a panel of 50 judges was selected. The judges selected for this study comprised of professors of the department of extension education of Agricultural College, Anand, Navsari, Junagadh and Sardar Krushinagar: extension personnel of Department of Agriculture, and other persons with considerable practical expreience of monthly workshop. All the judges were personally contacted to get the response, so as to avoid mistakes. However, the letter of instructions was also kept along with statements to guide the judges for rating the statements in desired manner.

Determination of scale and "Q" values

The seven points of the rating scale were assigned scores ranging from 1 (for strongly unfavourable) to 7 (for strongly favourable). Based on the judgement, the medium value of the distribution, the "0" value for the statement concerned was calculated with the help of following formula (Edward, 1957).

$$S = L + \left(\frac{0.50 - \Sigma pb}{pw} \right) x \quad 1$$

Where,

S = the median or scale value of the statement

l = the lower limit of the interval in which the median falls.

Σpb = the sum of the proportions below the interval in which the median falls.

pw = the proportion within the interval in which the median falls.

i = the width of the interval and is assumed to be equal to 1.0

The interquertile range $Q = Q_3 - Q_2$ for each statement was also worked out for determination of ambiguity involved in the statement.

Reliability of the Scale

To know the reliability of the scale developed, split-half menthod was used. The scale was administrated to 18 SMSs (participants) who were neither previously used as judge nor had chance to come in the final sample. The coefficient of correlation between the two sets of scores was found 0.66 (r - value) which was significant, hence the scale was dependable.

RESULTS AND DISCUSSION

The interquatile range (Q) for each statement was worked out determinations of ambiguity involved in the statement. When there was a good agreement among the judges in judging the degrees of favourableness or unfavourableness of a statement, Q was small compared to the value obtained when there was a relatively little agreement among the judges. Only those items were selected whose median (scale) values were greater than Q values. Based on the median and Q values 17 statements out of 29 of the original list were selected. Thus, the final attitude scale constituted of 17 statements was constructed as per Table-1.

TABLE 1

Final format of the scale to measure attitude of SMSs (participants) towards monthly workshop in T & V system.

Sr.No	*Statement*	*Strongly agree*	*Agree*	*Undecided*	*Disagree*	*Strongly disagree*
1	*2*	*3*	*4*	*5*	*6*	*7*
1.	MTs (Master Trainers) provides important technologies in the monthly workshop (MW)					
2.	If the additional information asked by the participants and not known to MT, then he provides in the next MW					
3.	To refresh the knowledge MW is required					
4.	The information given in the MW is timely.					
5.	Physical facilities and other infrastructural facilities are insufficient to organise MW effectively.					
6.	Required field visits are not organised during MW.					
7.	There is a fruitful discussion between MTs and participants during MW.					
8.	The duration of MW is not optimum to cover all the topics.					
9.	The MW helps in developing confidence in my work.					
10.	The literature provided in MW is of generalised nature and does not answer location specific problems.					
11.	More weightage is given on the theoretical aspects rather than practical					
12.	The farmers' problems brought from the field are solved by the MTs during MW.					
13.	It is not necessary to conduct MW in every month, as there is a lot of repetation in the subject matter.					
14.	Subjects/topics chosen for MW are proper and need based.					
15.	Top level scientists are not coming as MT in MW.					
16.	MTs are using insufficient teaching aids.					
17.	MTs conducting MW effectively and with maintaining interest of learners.					

Conclusion

The real attitude of SMSs (participants) can be known with the help of this standardize attitude scale and on the basis of it, the necessary changes can be made in the organisation of monthly workshop. Such changes in the organisation of monthly workshop might develop more favourable attitude of SMSs towards monthly workshop. Ultimately the effectiveness of the monthly workshop can be increased.

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Factors Associated With Adoption of Niger Production Technology

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ABSTRACT

The present study highlights the various production technologies adopted by the tribal farmers and identifies the production factors affecting niger crop. The study reveals that only 23.50 pre cent of the respondents fell under high adopter's categories, whereas nearly one-third (28.00 per cent) were medium adopters. The study also indicates that education, social participation, size of land holding and area under niger cultivation are the important variables having direct bearing on extent of adoption of niger production technology.

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INTRODUCTION

Oilseed crops being the second major group of agricultural crops in the country next to foodgrains in terms of tonnage and value, cultivated over 21 million hectares producing about 17 million tonnes.

Niger is one of the oilseed crops cultivated predominantly in hilly areas of Dangs district of Gujarat. The area and productivity of this crop is static since last decade. The productivity of this crop could be raised if the farmers adopt recommended package of practices. The adoption of a technology by the farmers is influenced by some personal, social, economical and situational characteristics. In context to above, the study has been taken up to identify the factors affecting the production of niger crop.

Objective

1. To study the extent of adoption of niger production technology by the tribal farmers.
2. To explore the association between some selected characteristics of the farmers and their extent of adoption of niger production technology.

MATERIALS AND METHODS

The study was conducted in Dangs district of Gujarat State. Ten villages, where niger was grown extensively, were selected randomly. The list of the niger cultivators was collected from the village level worker of the area concerned and twenty farmers from each selected villages were selected randomly. Thus, in all, 200 tribal niger cultivators were selected. The data were collected by personally, interviwing the respodents with the help of a schedule prepared for the purpose. The extent of adoption of an individual farmer was calculated with the help of formula suggested by Sengupta (1967).

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RESULTS AND DISCUSSION

It was observed that nearly half of the respondents (48.50 per cent) were low adopters, whereas 28.00 and 23.50 per cent of them fell under medium and high adopter's categories, respectively.

As evident from Table 1, respondents' age, size of family and type of family were not found to have association of significant level with the extent of adoption. Accordingly, these three variables and extent of niger production technology were independent of each other. The finding is in line with that of Parmar and Soni (1991), who reported that any increase in these variables were found to promote adoption of summer groundnut production technology.

The possible reasons that could be attributed for the significant relationship of education size of land holding, social participation and area under niger cultivation may be as follows.

Formal schooling enables an individual understanding of the benefits of adopting new technologies under larger area. Also, eduction level and size of land hoding stimulates an individual to participate in different extension activities to vizualize the advantage of new technology. Participation in social organisation enable them to obtain necessary information regarding various improved practices.

Extension worker has to play an important role in pursuing farmers by organising suitable educational activities by way of arranging group discussion, home visit, demonstration and training programme.

TABLE 1

Association of socio-economic characteristics and extent of adoption of niger production technology.

Sr.No.	*Characteristics*	*Chi-square values*
1.	Age	5.16 NS
2.	Education	23.25**
3.	Size of family	0.61 NS
4.	Type of family	0.18 NS
5.	Social participation	41.67**
6.	Size of land holding	14.73**
7.	Area under niger cultivation	13.76**

NS : Non-Significant
** : Significant at 1 per cent level of probability.

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A Day in the Life of Rural Women

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ABSTRACT

The present study was carried out in Daskroi taluka of Ahmedabad district of Gujarat State in 1989, to find out the extent of contribution of rural women in different activities viz., household, agriculture and animal husbandry from their day of life. The results indicated that average daily hours spent by the rural women in agricultural activities were 5.38 hours and 3.28 hours and 2.91 hours in household and animal husbandry activities respectively. Whereas during the peak period of agricultural activities, average daily hours spent by the rural women in agricultural activities were 6.97 hours and 2.51 hours in each of both household and animal husbandry activities.

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INTRODUCTION

Rural women constitute 77 per cent of women's population in our country and majority of them are labourers in the agricultural sector and allied fields. Rural women in the present stage facing the most challenging situation of performing their roles in and outside the home for social and economic development of nation. The daily work schedule of rural women is very demanding and ardous one. The day of her starts in the early hours of the rnorning evenbefore the sunrise and she is the last to retire to bed at night. They have not only to attend various field operations like transplanting in rice, weeding crops and scaring birds but have also been practically in complete charge of many harvest and post-harvest operations like harvesting, weeding, threshing, winnowing and storage. In many places the entire managernent of livestock starting from cutting, collection, carrying and chatting of fodder, feeding and milking, preparation of milk products, cleaning cattle shed, collection of urine and cowdung for manure pits, preparation of cowdung cakes and their storage etc. are done by rural women. All cleaning operations like removal of stones, dust and dirt, drying of crops, dehusking and other labourious household duties are performed by rural women. Often during peak periods of agricultural operations, home tasks are shifted to the back ground and the rural women experience an almost unsurmountable difficulty in accomplishing both types of tasks satisfacatorily.

The daily work schedule of a rural women is very busy. Even after fourty two years of independence, our rural women continue to be in a state of neglect. In most part of our country, her clothing is as scanty, as her food is devoid of nutrition.

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Keeping in view the above said facts and informations about the rural women's situations and their multiple roles, an attempt was made to find out extent of contribution of rural women in different activeties viz., household, agricultural and animal husbandry from their day of life.

MATERIALS AND METHODS

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

Contribution of each rural women was recorded in hours spend daily, weekly or seasonally in various houshold, agricultural and animal husbandry activities. The weekly and seasonally hours of contribution were converted in the daily hours contribution.

With a view to categories the overall extent of contribution of the rural women in to low, medium and high extent of contribution, mean and standard deviation were calculated. To form the extent of contribution group, the maximum and minimum hours limits were formulated with help of following formula.

$$X_i = \text{Mean} \pm \text{Standard deviation}$$

RESULTS AND DISCUSSION

The data regarding the overall extent of contribution of the rural women in different activities viz., household, agricultural and animal husbandry are presented in table 1 and fig.1.

The data presented in table 1 reveal that majority of the respondents (73.00 per cent) in household activities (67.00 per cent) in agricultural activities and (80.00 per cent) in animal husbandry practices were in medium contribution group. Table 1 also shows the daily mean hours spent by rural women

TABLE 1

Distribution of the respondents according to their overall extent of contribution in different activities.

Activities	*Extent of contribution*			*Mean of daily hours spent*
	High	*Medium*	*Low*	
Household	21 (>3.0 hrs.)	73 (1.5 to 3 hrs.)	6 (<1.5 hrs)	3.28 (13.67)
Agricultural	17 (>7.36 hrs.)	67 (3.38 to 7.36 hrs.)	16 (<3.38 hrs)	5.38 (22.42)
Animal Husbandry	14 (>3.83 hrs)	80 (1.99 to 3.83 hrs)	6 (<1.99 hrs)	2.91 (12.12)
Rest and daily routine activitie	—	—	—	12.43 (51.79)

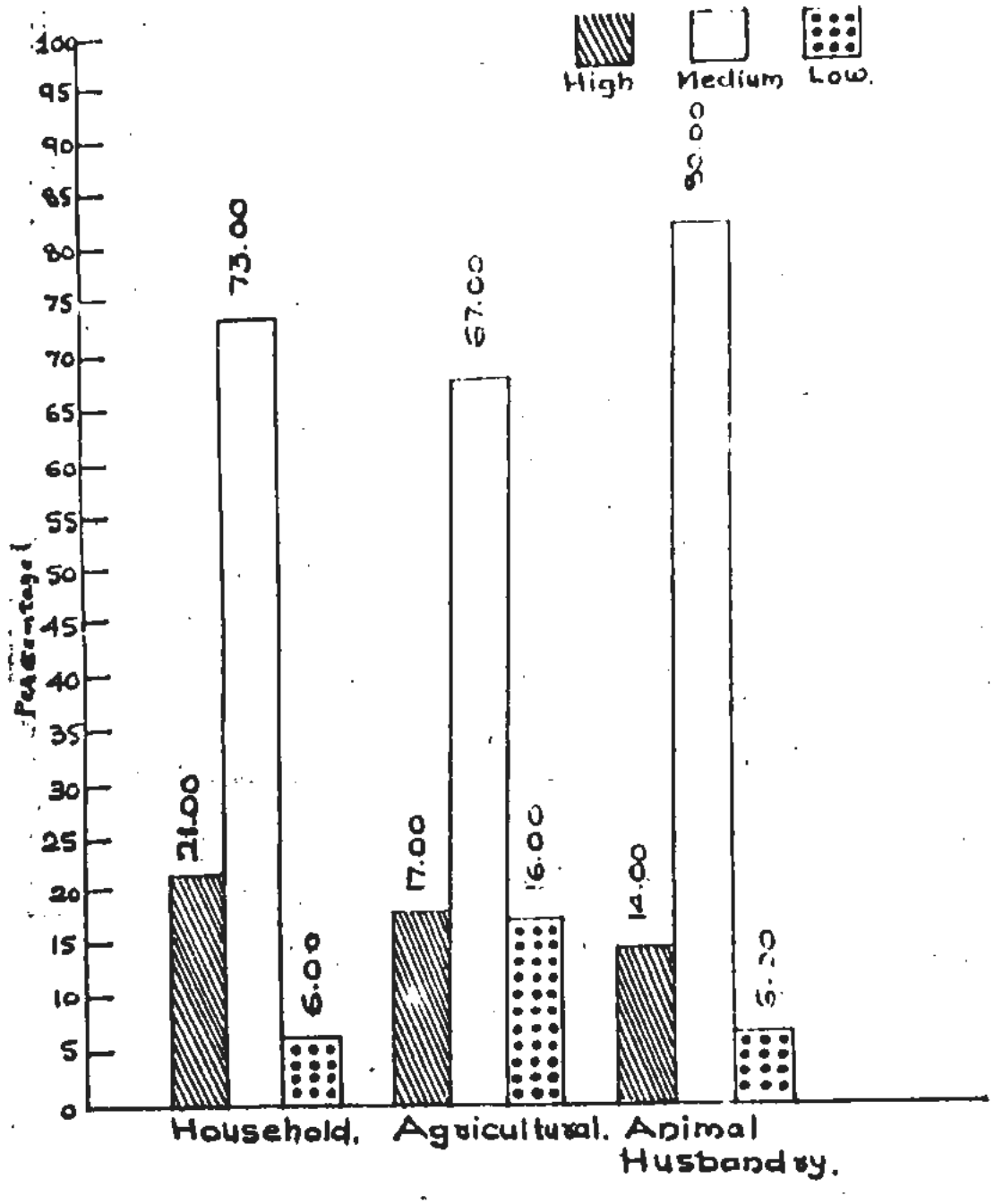

Fig. 1 : Distribution of the respondents according to their overall extent of contribution in different activides.

in different activities. Average daily hours spent by rural women was 5.38 hours on agricultural activities, compared to household 3.28 hours and animal husbandry activities 2.91 hours, revealing to working hours of rural women ranging around 12 hours a day.

The data regarding the overall extent of contribution in different activities during the peak period of agricultural activities are presented in table 2 and fig.2.

Table 2 shows that majority of the respondent (63.00 per cent) in agricultural activities and (88.00 per cent) in animal husbandry activities were in medium contribution group.

It is clearly seen from table 1 and table 2 that percentage of the respondents in high contributing group in household and animal husbandry activities decreases during peak period of the agricultural activities.

TABLE 2

Distribution of the respondents according to their overall extent of contribution in different activities during the peak period of agricultural activities.

n = 100

Activities	*Extent of contribution*			*Mean of daily hours spent*
	High	*Medium*	*Low*	
Household	8 (>3.22 hrs.)	84 (1.78 to 3.22 hrs.)	8 (< 1.78 hrs.)	2.51 (10.46)
Agricultural	18 (> 9.39 hrs.)	63 (4.55 to 9.39 hrs.)	19 (<4.55 hrs.)	6.97 (29.04)
Animal Husbandry	5 (> 3.48 hrs.)	88 (1.54 to 3.48 hrs.)	7 (< 1.54 hrs.)	2.51 (10.46)
Rest and daily routine activities	---	---	---	12.01 (50.04)

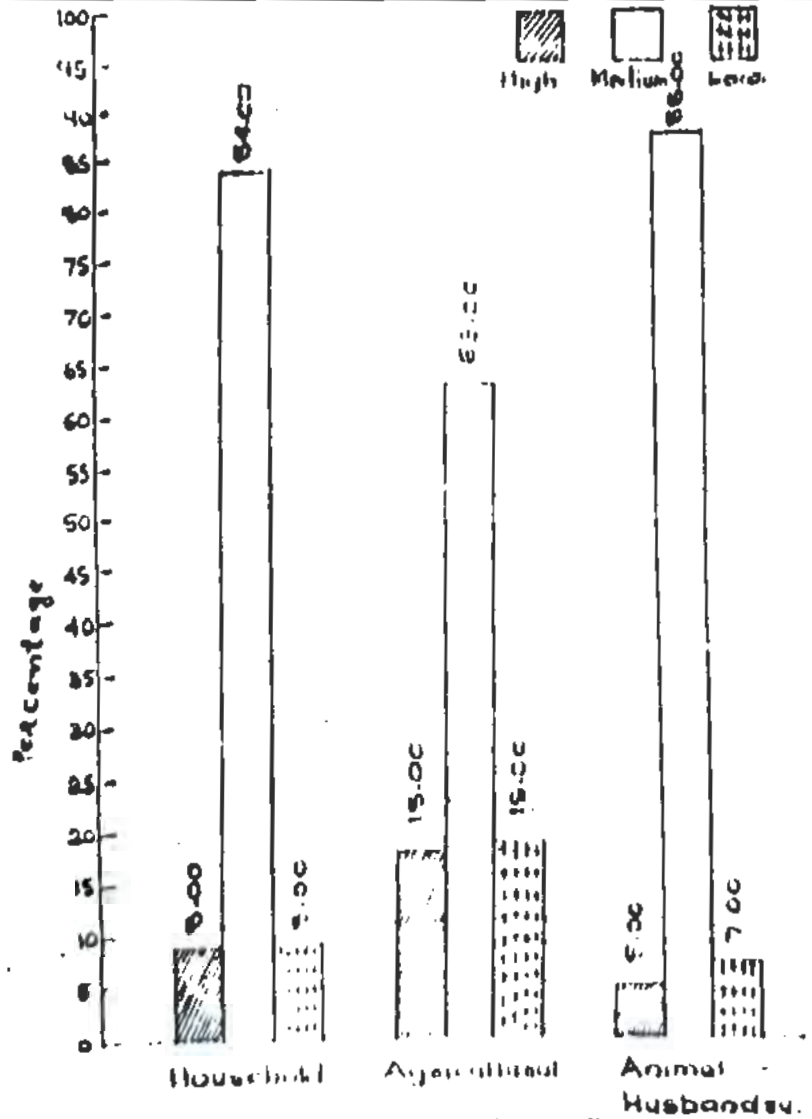

Fig. 2 : Distribution of the respondents according to their overall extent of contribution in different activities during the peak period of agricultural activities.

Table 2, also shows that rural women spent average 6.97 daily hours on agricultural activities compared to 2.51 hours on household as well as on animal husbandry activities, revealing the working hours of rural women ranging around 12 hours a day. Remaining time was spent in taking rest and daily routine activities. The main works during peak period of agricultural activities were showing, manuring, harrowing, interculturing, transplanting, harvesting, winnowing, storage of seeds, transporting of farm produces and keeping water on the fields. The findings are in concurrence with the findings reputed by Devadas *et al.*(1972) Chakravarty (1975), Bhatnagar (1982), Munjal *et al.*(1985) and Saxena and Bhatnagar(1985).

It is concluded that rural women work had spending their more than 12 hours except time spent for daily routine work. Rural women spent more daily hours on agricultural operations as compared to household and animal husbandry activities. It is also concluded that rural women spent more daily hours on agricultural operations during peak period of agricultural activities then normal days.

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Selection Index Study in Chickpea (*Cicer arietinum* L.)

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ABSTRACT

The interrelationship between grain yield and its attributes in chickpea (*Cicer arietinum* L.) was studied using experimental data of twenty treatment combinations comprising of four levels of N and five levels of P. The field experiment was conducted at the Agriculture College Farm, Gujarat Agricultural University, Sardar Krushinagar during *rabi* season of 1988. The straw yield, number of pods per plant, 1000 - grain weight and number of branches per plant accounted for 98 per cent of the total variation in the grain yield.

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INTRODUCTION

Improvement of yield potential is the foremost consideration in crop breeding programme. The success depends on many yield attributing characters. Therefore, it is always of interest to know the contribution of such characters on yield and interrelationship among them. Chickpea (*Cicer arietinum* L.) is one of the most important pulse crops of India because of high protein content for which such information is rarely available. Hence the present investigation was taken up.

MATERIALS AND METHODS

An experiment was conducted at the Agriculture College Farm, Gujarat Agricultural University , Sardar Krushinagar, during rabi season of 1988 to ascertain the interrelationship among yield and its components in chickpea. Twenty treatments comprising of four levels of N and five levels of P were tried using randomised block design with four replications. The popular variety ICCC-4 was sown 30 cm. apart for the purpose. The observations were recorded on five randomly selected plants from each plot. Besides grain yield (Y), straw yield (X_1), number of pods per plant (X_2), number of branches per plant (X_3) plant spread (X_4), number of grains per pod (X_5), 1000 - grain weight (X_6), grain protein content per cent (X_7), plant height (X_8) and harvest index (X_9) were studied. The correlations as well as selection indices were worked out (Montgomery and Peck, 1982).

RESULTS AND DISCUSSION

The correlation matrix of grain yield and its contributing characters (Table-1) showed positive correlation coefficients. These characters were also positively correlated among themselves, suggesting that selection for

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TABLE 1

Correlation coefficients* among yield and its attributes in chickpea.

Characters	*Grain yield kg/plot* Y	*Straw yield, kg/plot* X_1	*No. of Pods per plant* X_2	*No. of branches per plant* X_3	*Plant spread* X_4	*No. of grains per pod* X_5	*1000 grain weight,* X_6	*Grain protein content, (%)* X_7	*Plant height cm.* X_8
X_1 : Straw yield	0.95								
X_2 : No. of pods per plant	0.96	0.72							
X_3 : No. of branches/plant	0.91	0.88	0.85						
X_4 : Plant sperad	0.90	0.85	0.82	0.82					
X_5 : No.of grains/pod	0.88	0.84	0.88	.087	0.85				
X_6 : 1000-grain weight	0.96	0.80	0.81	0.81	0.80	0.82			
X_7 : Grain protein content	0.72	0.69	0.69	0.68	0.79	0.75	0.70		
X_8 : Plant height	0.63	0.61	0.65	0.70	0.68	0.63	0.70	0.72	
X_9: Harvest index	0.58	0.53	0.60	0.52	0.60	0.62	0.61	.055	0.59

* All estimates are significant at 5 per cent level of significance.

TABLE 2

Regression coefficients and their std. errors.

Character	*Regression coefficient*	*Std.error*	*'t'*	R^2 *per cent*
X_1	0.3481	0.0996	3.49**	
X_2	0.4020	0.0968	4.15**	
X_3	0.4231	0.1619	2.61*	
X_4	0.3632	0.1165	3.12**	
X_5	0.4683	0.2569	1.82	99.40
X_6	0.5130	0.1662	3.09**	
X_7	0.4081	0.2588	1.58	
X_8	0.5026	0.4307	1.17	
X_9	0.2076	0.1703	1.22	

** Significant at 1 per cent level of significance.

* Significant at 5 per cent level of significance.

TABLE 3

Selection indices and R^2 values.

Sr. No.	*Multiple regression equation*	*Multiple correlation coefficient (r)*	*Variation explained (R^2 per cent)*
(1)	$-36.6518 + 0.1865\,X_1 + 0.7216\,X_2 + 0.3850\,X_6$	0.9819	96.41
(2)	$-50.2230 + 0.1630\,X_1 + 0.1915\,X_2 + 0.2358\,X_3 + 0.4608\,X_6$	0.9902	98.04
(3)	$-43.1275 + 0.0721\,X_1 + 0.0904\,X_2 + 0.2093\,X_3 + 0.6503\,X_6 + 0.3710\,X_4$	0.9922	98.46

these traits may bring a substantial improvement in all these traits including grain yield. The grain yield had very high positive correlations with straw yield (0.95), number of pods per plant (0.96), number of branches per plant (0.91), plant spread (0.90) and 1000-grain weight (0.96). These results are akin to those reported by Singh and Khangarot (1987), who observed a substantial influence of number of pods per plant and 1000-grain weight on grain yield of chickpea. Rathi and Singh (1976) also found significant correlation between grain yield and its components in chickpea.

When all the characters were regressed with grain yield, the total variation accounted by them was 99.4 per cent. The regression coefficients, their standard errors and 't' values are shown in Table 2. The results (Table 2) showed that the contribution of all the characters were not of the same magnitude. In order to check this aspect, selection indices were generated through multiple regression technique (Table 3). The results (Table 3) indicated that straw yield (X_1), number of pods per plant (X_2) and 1000-grain weight (X_6) contributed 96.41 per cent variation. When number of branches per plant (X_3) was added to the model, the coverage has gone upto 98.04 per cent. Further the marginal increase of 0.42 per cent was also observed when plant spread (X_4) was included in the model. Dasgupta and Das (1984) studied selection indices in blank gram and observed the similar results.

The results thus lead to the conclusion that the straw yield, number of pods per plant, 1000-grain weight and number of branches per plant are the most influential characters for increasing the grain yield in chickpea.

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Physical Properties of Peanut Kernels

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ABSTRACT

The effect of moisture content on physical characteristics and properties viz., dimensions, bulk density, specific gravity, porosity and coefficient of friction of peanut kernels were determined for five varieties within the moisture range of 5 to 22 per cent (wb).The tri-axial dimension, size, coefficient of friction and angle of internal friction of groundnut kernels were found to be increased with increase of moisture content while bulk density and specific gravity decreased.

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INTRODUCTION

Whenever an equipment or a system is to be designed to perform certain specific task of post harvest processing, handling and storage,information on characteristics of material being handled in the operation is needed.The characteristic most often required are the engineering characteristics and properties.The physical characteristics and properties are the parameter of the grat importance for analysis during handling, drying and processing etc. The review revealed that very few attempts have been made in the past to determine the physical characteristics of peanut kernels. Adhaoo *et al.* (1976) and Gupta *et al.* (1988) reported that the moisture content had marked effect on overall size of peanut kernels.

MATERIALS AND METHODS

The peanut of GAUG-1, GG-2, GAUG-10, GG-11 and M-13 varieties were used in this study.The available raw peanuts were naturally air dried and of two years old and their moisture content was found to be between 4 to 5 per cent (wb). The peanut were shelled and used for studies of physical characteristics and properties of peanut kernels.To achieve the desired level of moisture content 5, 12, 17 and 22 per cent (wb) a known amount of water was thoroughly mixed and kept for 48 hrs for conditioning in plastic jars(2). The moisture content of peanut kernels were determined by hot air oven method (5).

Size

The maximum tri-axial dimensions which were obtained as length,breadth and thickness of peanut kernels were determined from 15 randomly selected kernels using vernier calliper having a least count of 0.001 mm. The average of readings were taken as length, breadth and thickness.

Size and sphericity were calculated by using the following formula (Mohsenin 1980).

$$\text{Size} = (\text{length} \times \text{breadth} \times \text{thickness})^{1/3}$$

$$\text{Sphericity} = \frac{\text{size}}{\text{largest dimension}}$$

The longitudinal and lateral cross sections of the kernels were compared with shapes as described by Mohsenin (1980).

Bulk density

The bulk density was measured with the help of a cylinder of 1000 cm^3. The material was filled in the cylinder upto the brim, mildly tapped and weights were recorded. The measurement of bulk density were replicated five times and the average of the reading were expressed in kg/m^3.

Specific gravity

The specific gravity of peanut kernels was determined by using a liquid displacement method. (Mohsenin, 1980). The liquid used was hexane. The specific gravity was calculated with the help of following formula :

$$S = \frac{(W_2 - W_1)}{(W_4 - W_1)(W_3 - W_2)} \times S_k$$

where,

S = specific gravity of peanut kernels
W_1 = weight of empty bottle
W_2 = weight of empty bottle and peanut kernels, g.
W_3 = weight of empty bottle, peanut kernels and hexane, g.
W_4 = weight of empty bottle and hexane, g.
S_k = specific gravity of hexane (0.66)

Property

An experimental set up similar to one reported by Day (1984) was fabricated for the porosity measurement of peanut kernel. Two glass bottle were used for determination of porosity. The fractional porosity was calculated by using the following expression

$$P_f = \frac{P_1 - P_2}{P_2}$$

Where :

P_f = fractional porosity
P_1 = initial pressure (cm of Hg)
P_2 = final pressure (cm of Hg)

Coefficient of friction

The coefficient of friction of peanut kernels was determined with the help of the inclined plane methods. The test surfaces used were plywood, galvanized sheet and glass sheet. The peanut kernels were placed on the test surface at the top edge. The table was tilted until the peanut kernels begun to move leaving a inclined surface. The angle of inclination with the horizontal was measured by a scale provided and taken as angle of internal friction and tangent of the angle was taken as coefficient of static friction between surfaces and peanut kernels.

RESULTS AND DISCUSSION

Effect of moisture content on size, sphericity and shape

The size was determined from measurement of length, breadth and thickness of peanut kernels. The length, breadth, thickness and size (Table 1) increase with an increase in peanut kernels moisture content for all the five varieties. The shape of peanut kernel could be expressed in form of their sphericity. The sphericity (Table 1) of GAUG-1 and GG-2 varieties decreases with an increase in moisture content, whereas for the varieties, viz.; GAUG-1, GG-2 and M-13 sphericity increases between 5 to 17 per cent moisture content and after that it decreases. It may due to the fact that, rate of increase in the size of peanut kernel decreases with increase in moisture content. In other words rate of swelling of kernel has a decreasing trend after certain level of moisture content i.e. beyond 12 %. The shape of the peanut kernel is ovate for

TABLE 1

Axial dimensions, size, sphericity and shape of peanut kernels at different moisture content.

Variety	*Moisture content* %	*Length* mm (a)	*Breadth* mm (b)	*Thickness* mm (c)	*Size* mm $(abc)^{1/3}$	*Sphericity*	*Shape*
GAUG-1	5	9.32	7.40	7.10	7.88	0.845	Ovate
	12	9.59	7.69	7.18	8.09	0.834	Ovate
	17	10.47	8.39	7.42	8.67	0.825	Ovate
	22	11.32	8.80	7.51	9.04	0.799	Ovate
GG-2	5	10.38	7.48	7.42	8.32	0.802	Ovate
	12	10.79	7.68	7.54	8.55	0.792	Ovate
	17	11.65	8.50	7.80	9.17	0.788	Ovate
	22	12.51	9.03	7.93	9.63	0.770	Ovate
GAUG-10	5	14.52	6.47	6.45	8.46	0.582	Oblong
	12	14.88	6.67	6.75	8.75	0.588	Oblong
	17	15.75	7.87	7.14	9.60	0.609	Oblong
	22	16.71	8.51	7.39	10.17	0.607	Oblong
GG-11	5	14.46	6.76	6.82	8.74	0.604	Oblong
	12	14.77	7.12	7.02	9.04	0.612	Oblong
	17	15.72	7.79	7.48	9.71	0.618	Oblong
	22	17.00	8.50	7.57	10.30	0.606	Oblong
M-13	5	15.77	6.63	6.98	9.00	0.571	Oblong
	12	16.02	6.86	7.09	9.20	0.574	Oblong
	17	17.08	7.87	7.49	10.02	0.587	Oblong
	22	18.48	8.71	7.67	10.72	0.581	Oblong

GAUG-1 and GG-2, whereas it is oblong for GAUG-10,GG-11 and M-13 varieties of peanut kernel as per classification given by Mohsenin (1980).

Effect of moisture content on bulk density, specific gravity and porosity

Table 2 shows the effect of moisture content on bulk density and specific gravity of peanut kernels.The bulk density and specific gravity of peanut kernels decrease with the increase in moisture content. The increase in moisture content promotes the decrease in bulk density and specific gravity for all varieties of peanut kernels.Tha change in volume was found more as compared to the change in weight,which resulted in decreasing of bulk density and specific gravity.The maximum variation in bulk density was observed to be 29 kg/m^3 for GAUG-10 whereas variation in specific gravity was 0.027 in case of GG-11 variety of peanut kernels.

The effect of moisture content on porosity of peanut kernels is also presented in Table 2.The porosity of the peanut kernels increase with an increase in moisture content.The maximum variation was observed as 2.59 and 2.5 per cent for M-13 and GAUG-10 varieties respectively.It is evident from the Table 2 that there is no definate relationship between moisture content and the change in tri-axial dimension of the peanut kernels.This un-even swelling in different direction due to high moisture content results in change in porosity.

TABLE 2

Bulk density, specific gravity and porosity of peanut kernels at different moisture content.

Variety	*Moisture content %*	*Bulk density kg/m3*	*Specific gravity*	*Porosity %*
GAUG-1	5	715.00	1.255	33.12
	12	710.00	1.256	33.80
	17	700.00	1.243	34.87
	22	698.00	1.237	35.15
GG-2	5	705.00	1.261	33.79
	12	702.00	1.242	34.32
	17	691.00	1.230	35.60
	22	685.00	1.226	35.83
GAUG-10	5	698.00	1.238	35.59
	12	690.00	1.234	35.97
	17	677.00	1.223	37.27
	22	669.00	1.219	38.09
GG-11	5	689.00	1.233	36.34
	12	682.00	1.227	38.29
	17	669.00	1.212	38.29
	22	664.00	1.206	38.55
M-13	5	673.00	1.220	36.97
	12	673.00	1.215	37.39
	17	669.00	1.201	38.94
	22	654.00	1.194	39.56

Effect of moisture content on coefficient of friction and angle of internal friction

The effect of moisture content on coefficient of friction and angle of internal friction is presented in Table 3 for all surfaces i.e plywood, galvanised sheet and glass sheet.The coefficient of friction and angle of internal friction of all varieties of peanut kernels increase with increase in moisture content for all surfaces.The coefficient of friction and angle of internal friction were found maximum for plywood and it was minimum for steel surface for M-13 variety respectively.

Conclusion

1. All the physical characteristics and properties were influenced by moisture content.

2. The tri-axial dimensions, size, porosity, coefficient of friction and angle of friction of peanut kernels increases with increase in moisture content.

3. Bulk density, specific gravity and porosity decreases with increase in moisture content.

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TABLE 3
Angle of internal friction and coefficient of friction of peanut kernels at different moisture content.

Variety	*Moisture*	*Angle of internal friction, deg.*			*Coefficient of friction*		
	Content %	*Plywood*	*Glass*	*Steel*	*Plywood*	*Glass*	*Steel*
GAUG-1	5	20.13	20.75	17.61	0.366	0.370	0.317
	12	20.95	21.87	21.36	0.383	0.401	0.391
	17	22.72	22.11	22.49	0.419	0.406	0.414
	22	24.82	23.23	23.23	0.452	0.429	0.429
GG-2	5	21.36	21.87	10.06	0.391	0.401	0.345
	12	23.49	22.29	21.68	0.434	0.410	0.357
	17	25.42	23.65	22.89	0.475	0.458	0.422
	22	27.26	25.34	25.40	0.515	0.473	0.474
GAUG-10	5	23.08	22.47	20.75	0.426	0.413	0.378
	12	24.60	23.76	22.55	0.457	0.440	0.415
	17	26.08	24.40	23.84	0.489	0.453	0.442
	22	27.74	25.83	25.99	0.526	0.484	0.487
GG-11	5	25.09	24.42	24.09	0.468	0.454	0.447
	12	26.16	25.32	24.40	0.491	0.473	0.453
	17	27.35	26.22	25.56	0.517	0.492	0.478
	22	28.69	27.02	26.94	0.547	0.510	0.508
M-13	5	27.58	25.25	24.51	0.522	0.471	0.455
	12	28.13	26.05	24.98	0.534	0.489	0.466
	17	28.38	27.72	26.77	0.540	0.526	0.504
	22	28.98	28.44	27.80	0.554	0.541	0.527

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Short Communications

Effect of Sowing Dates on Different Varieties of Rabi Maize

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A field experiment was conducted with a view to study the effect of three sowing dates (1st, 3rd week of November and 1st week of December) and six varieties of maize during *rabi* season of the years 1988-89, 1989-90 and 1990-91 at the main Maize Research Station, Gujarat Agricultural University, Godhra. The highest grain yield was obtained to the tune of 5296 kg/ha from 1st week of November sowing. The yields declined with delayed sowing, i.e. in 3rd week of November and 1st week of December was 4314 kg/ha and 2823 kg/ha respectively. The overall differences in yield among varieties were not significant.

Maize (*Zea mays* L.) is traditionally a *kharif* season (July -September) crop of Gujarat. Its cultivation in *rabi* (November - February) season has been started for quite a some time in certain parts of agro-climatic zone of middle Gujarat. Its has also been shown that the yield levels in the *rabi* season are 30-40 per cent higher than those of obtained in the *kharif* season due to better weed control and less incidence of pest and diseases. Very often the sowing of maize in *rabi* season gets delayed due to late harvest of preceding *kharif* crops like paddy and kharif maize. The delayed sowing of maize resulted in low germination due to low temperature resulting reduction in grain yield. The present study was therefore, planned to know the optimum sowing time for *rabi* maize varieties in middle Gujarat, conditions.

An experiment was conducted during *rabi* seasons of the years 1988-89, 1989-90 and 1990-91 at the main Maize Research Station, Gujarat Agricultural University, Godhra. The soil is sandy loam to clay loam in texture with PH 7.6, low in organic carbon (0.30%), available P_2O_5 (70 kg/ha) and rich in available K_2O (214 kg/ha). Treatment involving three sowing dates (1st, 3rd week of November and 1st week of December) as in main plots and six varieties Daccan-103 (V1) NLD-DEPU-106 (V2), EH 401075 (V3), R2 (V4), D765 X D787 (V5) and PK Hunis- V18 (V6) in 1988-89, Deccan-1 (V1), Ageti-76 (V2), Surya (V3), Ganga-11 (V4), Deccan-103 (V5) and Arun (V0) in 1989-90 and Deccan-1 (V1) DHM-103 (V2), Ageti-76 (V3), Navjyot (V4), Ganga-11 (V5) and Hi-Starch (V6) in 1990-91, respectively, as in sub plots were replicated four times in split-plot design. The crop received uniform fertilizer doses of 120 kg -N and 50 kg. P_2O_5/ ha.

Effect of sowing dates (Table 1) significantly influenced the grain yield. The highest grain yield to the tune of 5296 kg/ha was obtained from 1st week of November sowing. The yield reduced with delayed sowing in 3rd week of November and 1st week of December to the tune of 18.5 % and 47%,

respectively. The highest grain yield in early date might be attributed to the complete grain filling at relatively milder temperature during the reproductive phase. These results are in confirmity with the findings of Khetira *et al.*(1981) and Nayak *et al.*(1981). The lower grain yield in third week of November and 1st week of December sowing was due to higher day temperature (38°C) at the time of fertilization which resulted in during of pollen grains (Apraru *et.al* . 1983).

Performance of Varieties

Hybrid and composite maize varities were tried (Table-1) indicated that in the first and third year of the experiment the varietal differences were significant. The highest grain yield to the tune of 4413 Kg/ha and 4912 kg/ha was recorded with varieties R-2 and DHM-103 in 1st and 3rd year, respectively. However, in the second year the differences were not significant. The overall differences among varieties were not significant.

Economics

Results (Table 2) indicated that the highest net realization to the tune of Rs. 12214/- and CBR (2.44) was recorded with respect to 1st week of November sowing.

The results also confirmed the fact that the early sowing (1st week of November) gave the maximum grain yield for rabi maize (Sawlney, *et al* . 1989 and Nandal and Agrawal 1991).

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TABLE 1

Relative performance of promising varieties of maize under different dates of sowing on grain yield.

Treatment/Year	*Grain yield (kg/ha)*			
	1988-89	*1989-90*	*1990-91*	*Pooled*
Dates				
1st week of November	5338	6113	4438	5296
3rd week of November	4441	4752	3748	4314
1st week of December	2493	3507	2470	2823
S.Em. ±	95	55	31	163
C.D.at 5%	329	191	104	642
C.V. %	11.4	5.65	4.32	7.81
Varieties				
V1	3856	5130	3718	4235
V2	3935	4620	4921	4492
V3	4225	4500	4024	4266
V4	4412	4569	4495	5492
V5	3935	4940	1787	3554
V6	4181	4989	2315	3827
S.Em. ±	113	179	59	452
C.D. at 5%	321	N.S.	165	N.S.
C.V. %	9.55	12.93	5.75	10.59

N.S.= Non Significant.

TABLE 2

Mean realization as influenced by different treatments.

Sr. No.	Treatments	Mean grain yield (kg/ha)	Gross realization (Rs/ha)	Cost of cultivation (Rs/ha)	Net realization (Rs/ha)	*Mean net realization over varieties for each date (Rs/ha)	CBR	Mean net CBR over varieties for each date
1.	$D_1 V_1$	5523	17950	5000	12950	12214	2.89	2.44
2.	$D_1 V_2$	5773	18769	5000	13769		2.75	
3.	$D_1 V_3$	5380	17485	5000	12485		2.50	
4.	$D_1 V_4$	5343	17365	5000	12365		2.47	
5.	$D_1 V_5$	4634	15060	5000	10060		2.01	
6.	$D_1 V_6$	5125	16656	5000	11656		2.33	
7.	$D_2 V_1$	4421	14368	5000	9368	9185	1.87	1.83
8.	$D_2 V_2$	4620	15015	5000	11015		2.20	
9.	$D_2 V_3$	4544	14768	5000	9768		1.95	
10.	$D_2 V_4$	4852	15769	5000	10769		2.15	
11.	$D_2 V_5$	3620	11765	5000	6765		1.35	
12.	$D_2 V_6$	3824	12428	5000	7428		1.49	
13.	$D_3 V_1$	2759	8967	5000	3967	4175	0.79	0.83
14.	$D_3 V_2$	3083	10020	5000	5020		1.00	
15.	$D_3 V_3$	2875	9344	5000	4344		0.87	
16.	$D_3 V_4$	3282	10667	5000	5667		1.33	
17.	$D_3 V_5$	2407	7822	5000	2822		0.56	
18.	$D_3 V_6$	2532	8229	5000	3229		0.65	

* For computing mean net relization over varieties for each date the price of maize grain was taken as Rs. 3.25 per kg.

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Studies on Growth and N Accumulation of Various Green Manure Crops Under Different Fertility Levels

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A field experiment was conducted at the Instructional Farm, Gujarat Agricultural University, Navsari during June 1991 to compare the performance of newly introduced green manure species *Sesbania rostrata* with *Sesbania aculeata* and *Crotalaria juncea* green manure crops commonly grown in South Gujarat with and without NP fertilizer. The soil was clayey in texture with pH 7.6, 0.46 % organic carbon, 0.05 % total N, 24 kg/ha available P_2O_5 and 434 kg/ha available K_2O. The trial was conducted in randomised block design with six replications. Three irrigations were given for sowing and initial establishment due to delayed onset of monsoon. Rainfall received during crop growth period was 928 mm. *S. rostrata* seeds were inoculated with *Azorhizobium caulinodans* and liquid calture was sprayed (about 10^8 cells/ml) on 40 day old plants (Bhagwat *et al.*, 1988). At this stage plant were 50 cm tall bearing only root nodules. Drymatter production, N accumulation and yield attributing parameters were estimated by using standard procedures at 70 DAS.

TABLE 1

Effect of fertility levels on the performance of green manure crops.

Treatment	*Plant Height (cm)*	*Total dry matter/ plant (g)*	*Nodules number/ plant*	*Nodules weight (mg/plant)*	*Fresh weight (t/ha)*	*Dry weight (t/ha)*	*N accumulation (kg/ha)*
Green manure crop							
S.rostrata	224	17.68	261 (190)	387 (235)*	32.16	8.04	212
S.aculeata	243	19.20	127	431	35.72	9.28	183
C. Juncea	156	4.55	17	68	11.45	3.20	64
C.D. at 5%	13.7	3.08	48	61	4.15	1.06	27
Fertility level (N-P_2O_5 kg/ha)							
0-0	190	11.25	107	239	23.37	6.04	137
25-50	225	16.36	164	352	29.52	7.64	169
C.D. at 5%	11.2	2.52	39	50	3.38	0.87	22
Interaction	NS	NS	NS	NS	NS	NS	NS

* Value in parentheses indicates stem nodules.

S. aculeata recorded significantly highest drymatter (9.28 t/ha) compared to other two species due to better performance of individual plants (Table 1). *S. rostrata* though, recorded the next highest drymatter (8.04 t/ha), accumulated highest N yield (212 kg/ha). The significant improvement in N accumulation was attributed to profuse and repeatable nodules noticed on stem and also relatively higher N content (2.65%). Onset of monsoon, long day period, high humidity and temperature and waterlogged condition prevailed after 35 DAS, were also responsible for increased stem nodulation and N accumulation in *S. rostrata* (Becker *et al.*, 1990). On the contrary, the performance of *C. juncea* was poor due to waterlogged condition prevailed during its later period of crop growth.

Application of fertilizer (25 kg N + 50 kg P_2O_5 / ha) improved the drymatter yield and N accumulation. Becker *et al.* (1991) also reported that application of mineral fertilizer stimulate the growth, nodulation and N_2-fixation.

The present study has shown that *S. rostrata* could be grown with fertilizer application to get higher N accumulation than local species tried under South Gujarat condition.

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Effect of Different Mulches on the Yield of Groundnut Under Rainfed Conditions

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One of the important factors contributing to low yields of crops under rainfed conditions, is development of water stress during critical stages of crop growth, a situation arising very often as a result of uncontrolled evapotranspiration losses of water. Intense solar rediation coupled with droughts experienced during *kharif* season, under dry farming excessive results in excessive reduction of soil moisture. This give setback to growth and development. Mulching is known to be an effective measure to encounter act and it facilities uniform and early germination, keeps the soil temperature regims within favourable limits, controls weed growth which improves soil fertility status and increase in soil moisture conservation and finally gives higher crop yields (Choudhary and Chatterjee, 1967, Black 1970). The present study was conducted to evaluate the efficacy of different mulches increasing groundnut production under rainfed conditions.

A field experiment was conducted on medium black soil at Main Dry Farming Research Station, Targhadia (Rajkot) for three consecutive years (*kharif* 1982 to 1984) to evaluate the efficiency of different mulches in rainfed groundnut (Junagadh-11). Five treatments comprising of fou r mulches viz., soil mulch (dust mulch c eated by interculture), pearl millet stubble, pearl millet straw and groundnut husk and control i.e. without mulch were tried in a randomised block design with four replications. The soil of experimental plot was neutral in reaction (pH 7.8), low to medium in available nitrogen and phosphorus and high in available potash. The crop was supplied with 12.5 kg N + 25 kg P_2O_5 /ha. Whole dose of nitrogen and phosphorus was applied at the time of sowing. The experimental crop during all the three years was sown after receiving sufficient soaking rains during *kharif* season with a seed rate of 100 kg/ha. Observations on soil moisture content form 0-25 and 25-50 cm soil depth were recorded at sowing and fourteen days interval up to harvest. Mulches were applied @ 4 t/ha immediately after sowing. Soil mulch or dust mulch was created through interculturing.

Pooled data (Table 1) indicated significant effect of different mulches on pod yield of groundnut. Pearlmillet straw mulch proved it's superiority over rest of mulches except pearlmillet stubble mulch and gave significantly higher pod yield (12.71 q/ha). Further pearl millet stubble mulch was found significantly better than groundnut husk and soil mulches. However, soil and groundnut husk mulches had no significant effect on pod

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TABLE 1
Effect of different treatments on yield of groundnut, yield attributing characters and soil moisture content.

Treatments	*Yield (q/ha)*		*Yield attributing characters*			*Average moisture content (%)*	
	Pooled		*Number of pods/ plant*	*Number of pegs/ plant*	*Weight of pod/ plant (gm)*	*Soil depth*	
	Pod	*Veins*				*0-25*	*25-50*
Control (No mulch)	10.95	32.09	7.60	18.60	4.56	27.79	29.09
Soil mulch	11.74	33.75	9.00	19.77	4.83	28.28	28.80
Pearlmillet stubble	12.45	36.39	10.30	19.76	5.93	29.17	29.04
Pearlmillet straw	12.71	36.39	9.30	20.00	6.16	29.82	28.57
Groundnut pods husk	11.51	34.03	8.40	20.53	5.47	29.36	28.99
S.Em ±	0.29	2.29	--	--	--	--	--
C.D. 0.05 %	0.83	NS		--	--	--	--
C.V. %	8.44	12.27	--	--	--	--	--

yield as compared to control. The increase in pod yield with pearl millet stubble and straw mulch was due to favourable effect on growth parameters viz., number or pods and pegs/plant and weight of pods/plant. Similar higher yield due to mulch was also obtained by Patel and Singh (1980) in case of sunflower. The data of moisture content revealed that different mulches were found equally effective in soil moisture conservation and resulted in to higher soil moisture content as compared to control in surface soils. The moisture content in respective surface soils with soil, pearl millet stubble, pearl millet straw and groundnut husk mulches were 0.49, 1.38, 2.03 and 1.57 per cent respectively higher over control (No mulch). Thus, use of pearl millet stubble and straw mulch on medium black soil hold promise for augmenting pod yield of groundnut under rainfed conditions in Saurashtra region.

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Performance of *Rabi* Crops Under Moisture Stress Conditions of Bhal Tract

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Wheat is largely grown under moisture stress conditions of Bhal area during October in *rabi* season. Due to low yields per ha the cultivators do not get adequate germination per unit area as compared to other commonly grown *rabi* crops like gram, safflower and mustard. Gram and safflower are known to be the best moisture users and companion crops also.

With a view to study the performance of above crops in respect of their efficiency in utilizing conserved soil moisture, a field experiment with various varieties of wheat, gram, safflower and mustard was conducted on medium black soil during *rabi* (October) season of 1984-85 to 1989-90 at Dry Farming Sub Station, Dhandhuka (Ahmedabad District), G A U , Gujarat. The average rainfall of the area is 400 to 600 mm. Experiment was planned in randomised block design with four replications using varieties Sujata, A-28 and GW-1 of wheat, ICC-4, B.G.212 and Chaffa of gram, MR-71-3-2, Varuna and TM-4 of Mustard and Gilla, 143-20 and 116-4-20 of safflower. The gross and net plot size were 6.00 x 4.50 m and 4.80 x 2.70 m , respectively.

A perusal of data in Table-1 showed that the wheat crops equivalents of gram var. Chaffa and safflower var. Gilla were significantly higher than rest of the crops which might be due to better efficiency of these crops for utilization of conserved soil moisture. These results are in accordance with the results of Singh *et al.* (1985). On an average the safflower variety Gilla has recorded the highest monetary return which was about 210 to 250 per cent higher over that of wheat. Similarly sowing of gram var. Chaffa and safflower var. 143-20 and 116.4-20 registered double equivalent yield of wheat, i.e. almost double return as compared to sowing wheat. These findings are in accordance to Henderson and Doneen (1957), Ganga. Saran and Mahendra Pal (1981). On the basis of four years field experimentation, it is concluded that from the varieties, *rabi* crops gram var., Chaffa and Safflower varieies, Gilla and 116-4-20 appeared to be more remunerative under moisture stress conditions of Bhal tract than wheat crop.

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TABLE 1

Yield of crop varieties and their wheat equivalent yields under stored soil moisture (Dhandhuka) (yield q/ha).

Sr. No.	Treatments	1984-85		1985-86		1988-89		1989-90		Pooled av.	
		Crop yield	Equivalent yield in wheat crop	Crop yield	Equivalent yield in wheat crop	Crop yield	Equivalent yield in wheat crop	Crop yield	Equivalent yield in wheat crop	Crop yield	Equivalent yield in wheat crop
A. Wheat											
1.	Sujata	6.40	6.40	10.26	10.26	7.81	7.31	11.04	11.04	8.88	8.88
2.	A-28	7.89	7.89	9.32	9.32	6.08	6.08	8.00	8.00	7.69	7.69
3.	GW-1	6.29	6.29	9.45	9.45	7.31	7.31	8.51	8.51	7.89	7.89
B. Gram											
1.	ICC-4	3.53	8.24	4.84	11.30	5.98	13.95	6.59	15.26	5.24	12.19
2.	B.G.-212	3.82	8.91	5.48	12.78	4.90	11.43	6.91	16.11	5.28	12.31
3.	Chaffa	7.47	17.42	6.69	15.62	8.01	18.68	7.75	17.97	7.48	17.42
C. Mustard											
1.	MR-71-3-2	2.20	7.51	2.17	6.38	7.16	19.08	1.04	3.83	3.32	9.25
2.	Varuna	3.55	9.47	2.58	6.89	5.84	15.59	2.34	6.25	3.58	9.54
3.	TM-4	2.12	5.66	0.00	0.00	7.89	21.04	2.08	5.30	3.02	8.00
D. Safflower											
1.	Gilla	9.47	15.79	9.37	15.63	16.01	26.30	10.95	18.26	11.45	19.00
2.	143-20	11.43	19.05	7.04	11.74	11.00	18.32	8.53	14.21	9.50	15.83
3.	116-4-20	8.50	14.15	9.97	16.62	14.37	23.95	11.61	19.35	11.11	18.52
S.Em. ±		--	1.42	--	1.33	--	3.50	--	2.08	--	1.90
C.D. at 5 %		--	4.10	--	3.85	--	10.11	--	6.00	--	5.47
C.V. %		--	26.99	--	25.35	--	34.65	--	34.65	--	30.07

The price of wheat 300 Rs./q gram Rs. 700/q Mustard Rs.800/q and Safflower Rs.500/q.

Survey of Sugarcane Pests in Saurashtra Region

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Sugarcane is one of the major industrial crops in India. It is cultivated in both tropical and subtropical region with different varieties under diverse agroclimatic conditions. In Saurashtra region, the total area under sugarcane was about 30,000 hectares. The cane production of this region is quite camparable with the states of Maharashtra, Tamil-Nadu, Karnataka and Andhra Pradesh.

The large number of insect pests are found to occur on sugarcane in Saurashtra (Gujarat). The major pests are shoot borer, internode borer, root borer, scale insect, mealy bugs, pyrilla and whitefly. The maximum temperature showed significant positive correlation with shoot borer infestation and inadquate irrigation also increased the infestation (Hapase *et al.* 1979). Shukla *et al.* (1980) indicated that the sugar recovery is reduced 1.7 to 9.1 units under varying levels of scale insect infestation in Uttar Pradesh, *Pyrilla perpusilla* occurred as a serious pest (136 adults/leaf) during the post monsoon in Manda district at Madhya Pradesh (Kalra, 1979). A loss of 23.4 per cent in yield and 2.9 units of sucrose due to whitefly has been recorded in South Bihar, when there was 80 per cent leaf infestation, which counts 770 pupalia/leaf (17.5 pupalia/sq. inch) (Khanna, 1948).

For studying the incidence of various pests of sugarcane in Saurashtra region, a factory-wise survey was conducted during the period 1990-91.

Sugarcane fields under Adoptive Research Scheme were selected for recording necessary observation. The incidence of various pests of sugarcane was recorded during the month of May-June, August-September and October-November. The methodology for recording incidence and population of various pests was as follows.

Shoot borer (*Chilo infuscatellus* Snellen) : Each field (about one hectare) has been divided in four blocks. In each block, 5 metre row length was selected randomly. Total number of plants and dead hearts due to shoot borer was recorded for calculation of damage percentage.

Pyrilla, (*Pyrilla perpusilla* Walk) : Three leaves (4th, 5th, and 6th from the top) of one cane selected at randomly in each clump (total 5 clumpin each bloick). They were examined and population of pyrilla nymph and adults was counted and average population per leaf was worked out.

Whitefly, (*Aleurolobus barodensis* Mask) : Three leaves (4th, 5th and 6th from the top) of individual cane selected at randomly from 10 canes in each field were examined. The population of whitefly nymph and puparia was recorded in 9 cm^2 area of top, middle and basal portion of the leaf.

Scale insect, (*Melanaspis glomerata* Green) observed at cane basis. The number of infested cane was recorded from the total cane/5 m/row length and per cent infestation was worked out accordingly.

The data of shoot borer presented in Table-1, indicated that the maximum per cent of dead hearts of shoot borer due to shoot borer was observed to be 39.92 per cent in month of January-February planted canes at Kodinar area, whereas, it was recorded to be 20.10 per cent, 22.23 per cent and 13.46 per cent in January-February planting at Dhoraji, Una and Talala sugar factories area of Saurashtra region, respectively. In case of planting in November-December, it varied, having 5.14 to 8.62 per cent dead hearts. It was clearly observed that the infestation of shoot borer was very low in timely planting of crop, while higherin later planting.

Higher population of pyrilla nymphs and adults 38.80 per leaf was recorded in area of Kodinar sugar factory, whereas, it was very poor in remaining areas. National enemies of pyrilla (*Epiricania melanoleuca* Fletcher and *Metarrhizium anisopliae* Pathogen) were also observed in Kodinar Sugar factory area.

In sugarcane pests, the whitefly was recorded as a minor pest in earlier time. But, now it has become a major pest of sugarcane in Saurashtra region. The higher population of whitefly 3711 nymph and puparia/leaf was obsereved in Dhoraji and Upleta area of Rajkot district. Whereas, 2875, nymph and puparia/leaf in Kodinar area and it was lower in Talala (750 nymph and puparia/leaf) and Una (433 nymph and puparia/leaf) sugar factory area.

During survey, data revealed that the higher per cent (86.20%) of infested cane due to scale insect was recorded in Kodinar area followed by 69.80, 61.20 and 47.20 per cent in Talala, Dhoraji and Una sugarcane growing area of Saurashtra region, respectively.

TABLE 1

Incidence of sugarcane pests in factory area of Saurashtra region during 1990-91.

Sr. No.	*Name of the area*	*Demage per cent*		*Population of*		*Per cent infested cane by scale insect*
		Month of planting	*Shoot borer*	*Pyrilla nymph adults / leaf*	*Whitefly nymph/ puparia / leaf*	
1	Farmers Co-operative Sugar Factory, Kodinar, Dist. Amreli	Nov.Dec. Jan.-Feb.	5.14 31.92	38.80	2875	86.20
2.	Farmers Co-operative Sugar Udyog, Una, Dist. Junagadh.	Nov.-Dec. Jan.-Feb.	6.26 22.23	0.50	433	47.20
3.	Talala Farmers Co-operative Sugar Factory, Dist. Junagadh.	Nov.Dec. Jan.-Feb.	8.62 13.46	1.26	750	69.20
4.	Dhoraji and Upleta area, Dist. Rajkot.	Nov.Dec. Jan.-Feb.	7.23 26.10	0.00	3711	61.20

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Germination and Growth of Summer Groundnut as Influenced by Seed Size and Planting Depth

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Importance of seed size in relation to germination, bigour and yield has been established in several crops. In groundnut, bold seed have been reported to be superior in germination (Dhillon *et al.* 1978). However, the selection of bold seeds remains an open question for groundnut, since availability of planting material itself is always scarce and costly. Therefore, present experiment was undertaken to study the effect of seed size and planting depths on germination and establishment of groundnut.

The experiment was carried out during summer 1989 in pots filled with 10 kg air dried vertisol mixed with FYM (3 : 1). A completely randomized design with four replications was used. Seeds of groundnut (*Arachis hypogea*) cv GG-2 were physically assorted into bold, medium, small size from composite seed sample. The test weight of bold, medium, small and composite seed was 60, 45, 28 and 36 g, respectively.

Ten seeds were planted in each pot at a depth of 2.5, 5.0 and 7.5 cm. The data on germination and plant height were recorded and statistically analysed wherever applicable.

TABLE 1

Effect of seed size and planting depth on the germination and establishment of summer groundnut Cv GG-2.

Treatments	*Germination percentage*	*Germination quotient*	*Plant height (cm)*	
			20 DAS	*40 DAS*
Seed size				
Bold	88.9	59.2	2.84	4.39
Medium	100.0	60.9	2.61	4.05
Small	94.4	48.9	2.35	3.71
Composit	100.0	56.4	2.44	3.70
S.Em. ±	3.0	--	0.09	0.08
C.D. at 5%	8.6	--	0.25	0.23
Planting depth				
2.5 cm	97.9	72.8	2.82	4.06
5.0 cm	97.9	55.4	2.49	3.96
7.5 cm	91.7	40.9	2.40	3.86
S.Em ±	2.6	--	0.08	0.07
C.D. at 5 %	NS	--	0.22	NS
Size x depth				
S. Em ±	5.2	--	0.15	0.14
C.D. at 5 %	NS	--	0.43	NS

The data presented in Table 1 indicate that germination percentage was statistically at par in medium, composite and small seeds. In farmer two, it was significantly better than that of bold seeds. Contray to earlier reports (Dhannalingam and Ram Krishna, 1981 and Naidu and Narayanan, 1981), the present results are not unexpected. In fact bold seeds are more prone to injury during post-harvest handling and any damage inflicted to seedcoat or endosperm may adversely affect the germination. Tank and Bhatt (1993) have also reported similar observations.

The pace of germination integrated over number of days and expressed as germination quotient indicated that values were almost same for bold and medium seed, followed by composite seed. The small seeds exhibited lowest quotient which could be probably accounted for comparatively less reserve food in the endosperm and subsequently slower inhibition and emergence.

The seedling growth in terms of height was maximum in bold seed and at par with medium seed (20 DAS). Small of composite seed produced smaller seedlings.This is again a product of total reserve and pace of subsequent metabolic activities that precede germination.

The effect of planting depth was not significant on germination. However, a distinct effect was noticed on germination quotient which reduced with increase in depth. This is quite obvious because a seed planted at lower depth has to exert more energy and time for emergence, therefore both quotient of germination and height will be less. The latter was evident from the data (20 DAS). Thus, the shallowest planted seed displayed maximum height. No difference was observed between 5.00 and 7.5 cm depth. Further, these differences between 2.5 versus other were almost nullified at 40 DAS. Therefore, sowing of summer groundnut at 2.5 to 5.0 cm could be ideal and practical.

In so far the seed size is concerned, although bold seed resulted in greater plant height, it may or may not reflect on economic produce. Further this advantage was not as attractive as heaving 33% or 67% higher population with same amount of medium of composite seed (based on present test weights) compared to the bold seed. Therefore, sizing did not offer any specific benefit to groundnut crop.

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Effect of Varying Levels of Seeds, Nitrogen and Phosphatic Fertilizer on the Growth and Yield of Summer Groundnut (*Arachis hypogaea* Linn.)

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Groundnut is an important oilseed crop of our country and plays a vital role in national economy. A crucial role played by seed rate and fertilizer in increasing crop production is well recognised. A field experiment was carried out on groundnut during summer 1983 at the Gujarat Agricultural University, Navsari Campus with twenty seven treatment combinations consisting of three seed rates (80, 100 and 120 kg seeds/ha), three levels of nitrogen (0, 25 and 50 kg N/ha) and three levels of phosphorus (0, 50 and 100 kg P_2O_5 / ha) accomodated in a 3^3 factorial partial confounding in Randomized Complete Block Design with three replications. A bunch groundnut GAUG-1 was sown on February, 19 and harvested on June, 8. The soil of the experimental plot was clayey in texture having higher water holding capacity, deficient in nitrogen (0.050 %), medium in available phosphorus (30.67 kg/ha) and sufficient in available potash (372 kg/ha) with pH 7.6.

TABLE 1

Growth and yield of summer groundnut as influenced by seed rate (kg/ha) and fertilizer application.

Treatments	*Plant height at harvest (cm)*	*Primary branches/ plant at harvest*	*Dry matter production/ plant at harvest (g)*	*Developed pods/ plant*	*Undeveloped pods/ plant*	*Total pods/ plant*	*Pod yield (kg/ ha)*	*haulm yield (kg/ha)*
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
Seed rate (kg/ha)								
S_{80}	38.6	5.1	37.0	14.3	8.8	23.1	2511	6616
S_{100}	39.7	5.2	32.2	14.3	7.5	21.8	2820	7401
S_{120}	40.0	5.1	28.2	10.5	7.0	17.5	2625	7710
S.Em ±	0.35	0.02	0.31	0.37	0.20	0.47	55.3	23.6
C.D. at 5%	0.98	0.06	0.85	1.02	0.55	1.29	153.1	65.4
Nitrogen levels (kg/ha)								
N_0	37.5	5.1	31.4	11.7	8.1	19.8	2501	6966
N_{25}	40.4	5.2	32.8	13.1	7.4	20.5	2721	7234
N_{50}	40.4	5.1	33.2	14.2	7.7	22.0	2733	7528
S.Em ±	0.35	0.02	0.31	0.37	0.20	0.47	55.3	23.6
C. D. at 5%	0.98	0.06	0.85	1.02	0.55	1.29	153.1	65.4

1	2	3	4	5	6	7	8	9
Phosphorus levels (kg/ha)								
P_0	40.0	5.1	30.6	11.4	8.0	19.4	2407	7174
P_{50}	39.3	5.2	32.7	14.2	7.9	22.2	2748	7251
P_{100}	39.3	5.1	34.2	13.5	7.3	20.7	2801	7302
S. Em ±	0.35	0.02	0.31	0.37	0.20	0.47	55.3	23.6
C.D. at 5%	NS	NS	0.85	1.02	0.55	1.29	153.1	65.4
C. V. %	4.66	2.28	4.88	14.67	13.34	11.68	10.83	1.69

The growth of crop measured in terms of plant height, number of primary branches per plant and dry matter production was significantly affected by various seed rates (Table 1). All these growth attributes ultimately reflected in increased yield of haulm by the higher seed rate of 120 kg/ha, followed by 100 kg/ha. The number of pods per plant was also significantly affected by the seed rate. Comparatively higher number of pods per plant was recorded with the lower seed rate as compared to higher seed rate. The maximum pod yield of 2820 kg/ha was recorded with 100 kg seeds/ha as compared to either lower or higher seed rates. These findings are in confirmation with those recorded by Singh (1979).

Most of the growth characters like palnt height (cm), number of primary branches per plant and dry matter production were significantly increased by application of 25 kg N/ha but significantly the highest (7528 kg/ha) haulm yield was recorded with the highest dose of 50 kg N/ha. Almost similar trend was reported by Choudary (1977). Various yield attributes like number of developed pods per plant, number of undeveloped pods per plant and number of total pods per plant were significantly affected by graded dose of nitrogen. Consequently maximum pod yield (2733 kg/ha) was obtaind with the application of highest dose of 50 kg N/ha but remained statistically at par with 25 kg N/ha. Goudreddy *et al.* (1977) also reported positive response of nitrogen application.

The dry matter production was increased significantly with phosphorus application. As a result, the highest haulm yield (7302 kg/ha) was obtained with 100 kg P_2O_5/ha, followed by 50 kg P_2O_5/ha. However, the difference in haulm yield between the two treatments was not remarkable. Similar trend was observed by Modhwadia *et al.* (1981). Various yield attributes such as developed pods, undeveloped pods and total number of pods per plant were significantly influenced due to application of phosphorus. Probably due to improvement in yield attributes, these results are in confirmation with those recorded by Aulakh *et al.* (1980), Choudary (1977) and Devarajan and Kothandaraman (1982).

Thus the higher yield of summer groundnut was obtained with 100 kg/ha seed rate and application of 25 kg N and 50 kg P_2O_5 per hectare under agro-climatic conditions of South Gujarat.

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A Modified, Rapid Digestion Method for Estimation of Multielements in Plants III Zinc, Copper, Iron and Manganese

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Adler and Wilcox (1985) proposed $HClO_4$ + H_2O_2 (30%) mixture (2:1) for digestion of plant tissues to estimate N, P, K, Ca & Mg from a single extract. This method was suitably modified to obviate explosiveness of the mixed reagent, bumping of the contents etc. The modified peroxidaion method was found to be safe, rapid and accurate. It recovered 0.2 -2.5, 1.0 - 6.4 and 0.5 -4.9% higher N, P and K respectively than conventional digestion method (Zade *et al.* I (1992) & II 1993). A critical evaluation of this method for estimation of micronutrients (Zn, Mn, Cu and Fe) from plant extract is presented.

One gram ground sample, soaked in little distilled water, was reacted with 8-10 ml concentrated $HClO_4$. After about an hour water (15-20 ml) was added and the contents were heated at low temperature to evaporate most of the water. After cooling, 5-6 ml H_2O_2 (30%) was added slowly. The contents were shaken till vigorous bubbling was subsided. Then, sufficient water (15-20 ml) was added and the contents were heated strongly. If yellow colour persisted, about 1 ml H_2O_2 was added and heating was continued till extract was clear. Addition of H_2O_2 and heating was repeated, if needed.

In 1991, different crops were selected (Table 1,I). The samples were finely ground except oilseeds, which were gently crushed without squeezing the oil. A separate set of 24 sorghum leaf samples (Table 1, II) were also taken. The samples were digested as per conventional diacid ($HClO_4$: HNO_3, 2:5) digestion method and modified peroxidation method (Zade *et al.* 1992). The micronutrients (Zn, Mn, Cu and Fe) were estimated with Atomic Absorption Spectrophotometer (AAS).

The data (Table 1) revealed significant and close correlation between conventional and modified peroxidation method Zn, Mn, Cu and Fe content in grain, plant and sorghum leaf. However, correlation was not significant for Cu content in sorghum leaf set.

It was revealed that out of total 48 samples (Table 1, A & B) identical values were obtained in 24, 12, 14 and 16 samples for Zn, Mn, Cu and Fe respectively. Whereras higher Zn, Mn, Cu and Fe content (1-5 ppm) was recorded in 15, 27, 17 and 24 samples respectively with modified peroxidation method.

Hence, it may be concluded that modified peroxidation method may be adopted for estimation of micronutrients (Zn, Mn, Cu an Fe) in plant as it is safe economical, precise and accurate against the conventional diacid extraction method.

TABLE 1

Micronutrient content (ppm) estimated by modified peroxidation method vis - a - vis diacid digestion.

		Zn		Mn		Cu		Fe	
		A	B	A	B	A	B	A	B
I	Sorghum grain	5, 7	5, 6	31, 40	32, 40	13, 19	13, 18	9, 11	9, 11
	(2)	(6)	(5.5)	(35.5)	(36)	(16)	(15.5)	(10)	(10)
	Straw	4, 6	4, 6	27, 30	27, 31	21, 30	20, 31	9, 12	9, 13
	(2)	(5)	(5)	(28.5)	(29)	(25.5)	(25.5)	(10.5)	(11)
	Gram seed	5, 8	5, 9	37, 39	38, 41	20, 22	21, 22	13, 16	12, 15
	(2)	(6.5)	(7)	(38)	(39.5)	(21)	(21.5)	(14.5)	(13.5)
	Straw	4, 5	4, 5	27, 30	28, 29	28, 30	28, 30	10, 12	9, 12
	(2)	(4.5)	(4.5)	(28.5)	(28.5)	(29)	(29)	(11)	(10.5)
	Rajma seed	2, 5	3, 5	38, 40	38, 39	13, 19	14, 18	8, 9	9, 10
	(2)	(3.5)	(4)	(39)	(38.5)	(16)	(16)	(8.5)	(9.5)
	Plant	5, 8	5, 8	29, 30	30, 31	29, 35	29, 34	18, 19	19, 21
	(2)	(6.5)	(6.5)	(29.5)	(30.5)	(32)	(31.5)	(18.5)	(20)
	Mustard Seed	4, 6	4, 7	40, 43	39, 44	14, 17	14, 16	8, 11	8, 11
	(2)	(5)	(5.5)	(41.5)	(41.5)	(15.5)	(15)	(9.5)	(9.5)
	Plant (2)	3, 7	3, 6	29, 33	29, 34	25, 30	14, 28	13, 17	14, 18
		(5)	(4.5)	(31)	(31.5)	(27.5)	(21)	(15)	(16)
	Groundnut (2)	3, 5	3, 5	21, 24	22, 27	12, 15	11, 14	36, 42	37, 43
	kernel	(4)	(4)	(22.5)	(24.5)	(13.5)	(12.5)	(39)	(40)
	Straw (2)	7, 11	8, 10	26, 29	28, 31	23, 25	23, 26	42, 47	42, 46
		(9)	(9)	(27.5)	(29.5)	(24)	(24.5)	(44.5)	(44)
	Wheat grain	4, 5	4, 5	39, 42	40, 43	12, 15	13, 14	9, 11	10, 10
	(2)	(4.5)	(4.5)	(40.5)	(41.5)	(13.5)	(13.5)	(10)	(10)
	Straw (2)	7, 9	7, 9	29, 30	30, 31	27, 29	28, 29	13, 16	13, 17
		(8)	(8)	(29.5)	(30.5)	(28)	(28.5)	(14.5)	(15)
	't' test	Sig.		Sig.		Sig.		Sig.	
	'r' value	0.969**		0.987**		0.992**		0.997**	
II	Sorghum leaf (24)	4,9	4, 9	27, 33	27, 35	10, 14	9, 15	36, 49	39, 49
		(6.5)	(6.5)	(30)	(31)	(12)	(12)	(42.5)	(44)
	'r' value	(0.98)		(0.491)		(0.21)		(0.841)	

A = Diacid method B = Modified peroxidation method

* Figures in the parenthesis show mean value

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Path Analysis in Safflower (*Carthamus tinctorius* L.) Under Conserved Moisture Conditions

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Knowledge of the model plant characteristics is very imperative to have an effective breeding programme. The present study was undertaken to formulate the basic morphological frame of a model plant type of safflower through character association under the Bhal conditions of Gujarat.

Twenty six genotypes of safflower representing a wide spectrum of variability were evaluated in a randomized block design with 3 replications at the Gujarat Agricultural University, Arnej. Each variety was accomodated in 6 m long 6 rows plots spaced 45 cm apart, the distance between plants being 20 cm. Observations on 5 randomly taken plants from each plot were recorded for plant height, number of branches, capitula per plant, seeds per capitulum, 100 seed weight, grain filling period, oil percentage and seed yield per plant. Path coefficient analysis was done as per method proposed by Dewey and Lu (1959).

In general correlation at genotypic level were higher than those at the phenotypic ones. Seed yield per plant was positively correlated with seed weight, capitula per plant and seed filling period. Among the yield components grain filling period was positively correlated with grain weight and oil percentage. Oil percentage evinced positive correlation with capitula per plant too-but its association with seed weight was negative. Paliwal and Solanki (1984) and Malleshappa *et al.* (1990) have also reported similar observations. Present findings are also in consonance with the findings of Patil (1985) for the association of seed yield with oil percentage. Path co-efficients (Table 1) revealed that seed weight has maximum direct positive effect on seed yield followed by capitula per plant, branches per plant, seeds per capitulum, oil percentage and plant height. Seed filling period which otherwise was positively correlated with seed yield exhibited negative direct effect on seed yield. Thus in model plant bold seeded varieties with more number of branches per plant, more number of capitula per plant, seeds per capitulum and oil percentage would be more desirable. Considering the negative correlation of seed weight with oil percentage, improvement has to be perpeterated by increasing capitula per plant with more number of upright branches. Similar results showing capitula per plant to be an important yield contributing character in safflower have also been reported by Subalakshmi and Sivasubramanium (1986). It would be worth while to examine the level of these characters in the high and low yielding genotypes. Table 2 revealed that the differences in yield potential of these lines was due to the vast differences in the seed weight and capitula per plant, though to

TABLE 1

Direct (diagonal) and indirect effects of component characters on seed yield.

Character	*100-seed weight*	*Seeds/ capi-tulum*	*Capitula/ plant*	*Plant height*	*Branches/ plant*	*Seed fill-ing period*	*Oil per-centage*	*Correla-tion with seed yield*
100 seed weight	1.186	-0.024	-0.399	0.009	0.028	-0.237	-0.112	0.451*
Seeds/capitulum	-0.146	0.192	0.164	0.004	-0.011	-0.039	-0.027	0.138
Capitula/plant	-0.435	0.027	1.087	0.002	0.002	-0.025	0.046	0.704*
Plant height	0.008	0.029	0.008	0.029	0.047	-0.031	0.023	0.113
Branches / plant	0.085	-0.028	0.001	0.016	0.247	-0.025	0.014	0.310
Seed filling period	0.952	0.023	0.020	0.003	0.004	-0.294	0.107	0.815*
Oil percentage	-0.730	-0.023	0.515	0.004	0.020	-0.173	0.182	-0.205
Residual effect	--	--	--	--	--	--	--	0.709

* Significant at P = 0.05

TABLE 2

Comparison of highest and lowest yielding lines (an average of 5 lines in each case) for seed yield & yield components.

Characters	*Highest*	*Lowest*	*Differences*
Seed yield/plant (g)	21.44	12.76	8.71*
100 seed weight (g)	4.56	3.57	0.99*
Seeds/capitulum	21.64	24.67	-3.03
Capitula/plant	19.92	16.24	3.68*
Plant height (cm)	98.20	105.08	-6.88
Branches/plant	5.84	4.94	0.90
Seed filling period	32.86	28.67	4.19
Oil percentage	31.96	32.17	-0.21

* Significant at P = 0.05.

TABLE 3

Comparison of seed yield (g/plant) in lines having highest and lowest level of expression of component characters (average of 5 lines in each case).

Characters	*High level*	*Low level*	*Differences*
100 seed wight (g)	20.45	14.19	6.16*
Seeds/capitulum	16.86	17.59	-0.73
Capitula/plant	18.81	13.44	5.37*
Plant height (cm)	13.79	17.73	-3.94
Branches/plant	17.67	13.50	4.17
Seed filling period	18.86	15.40	3.46
Oil percentage	16.65	18.39	-1.74

*Significant at P = 0.05

certain extent seed filling period and branches per plant too were responsible for these differences. At this juncture, a comparison of pattern of seed yield in lines with high and low levels of the seed yield components would be worth while to design model plant architecture. Here too seed weight and capitula per plant turned out to be the most important seed yield component (Table 3). Khidir (1974) has reported perdominant additive gene action and high heritability for capitula per plant and thus it would be easy to handle this trait in any selection programme.

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Yield and Yield Contributing Characters of Sunflower (*Helianthus annuus* L.) As Influenced by Cycocel (CCC)

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Sunflower (*Helianthus annuus* L.) is gaining importance as oilseed crop because of its potential to produce more oil per unit area in shorter time. The country is facing acute shortage of edible oil and therefore, there is an urgent need to increase the production and productivity of the oilseed crops to overcome this situation. Sunflower, in this context, occupies the special position because of the aforesaid reasons. The beneficial effect of CCC (2 Chloroethyl-Trimethyl Ammonium Chloride) have been reported by various workers such as Singh (1970), Desan and Kalandaiswamy (1974), Kulandaivelu *et al.* (1974), Chowdappan and Morachan (1976), Marisiddaiah and Gowda (1977), Singh and Kaur (1981), Pando and Srivastava (1987), Saini *et al.* (1987), Chandra *et al.* (1989) and Wasnik and Bagga (1992). The present study was, therefore, undertaken to see the effect of cycocel on yield and yield components of 5 sunflower varieties under arid and semi-arid conditions of Rajasthan.

The trial consisted of twenty five treatments consisting of various combinations of 5 sunflower varieties viz., 'EC 68413', 'EC 68415', 'EC 69874', 'Sunrise Sel' and 'Ramson Record', and 5 doses of cycocel, C_0 (0 ppm), C_1 (250 ppm), C_2 (500 ppm), C_3 (750 ppm) and C_4 (1000 ppm). The experiment was laid-out in a randomized block design with four replications at Regional Station of Agricultural Research, Sumerpur (Rajasthan) during kharif, 1974-75. The plot size consisted of 3 rows of 6 m length and the spacing followed was 60 cm between rows and 30 cm between plants within row. The spraying of cycocel was done before flower initiation. Five competitive plants were chosen in each treatment and in each replication and observations on seed yield per plant (g), plant height (cm), stem girth (cm), leaves per plant, days to 50% flowering, days to maturity, head diameter (cm) and 100-seed weight (g) were recorded.The data for various characters were analyzed following Panse and Sukhatme (1967).

The results obtained under the persent investigation are presented in Table 1 and Table 2. The analysis of variance revealed significant differences for seed yield, plant height, stem girth, days to flowering and days to maturity due to varieties (Table 1). Ramson Record registered the highest seed yield of 21.92 g per plant which was significantly superior to the rest of the varieties. This genotype also recorded the maximum plant height of 149.2 cm whereas Sunrise sel attained the lowest plant height of 129.8 cm.

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TABLE 1

Yield and yield contributing characters of sunflower varieties, as influenced by CCC.

Sr. No.	*Treatments*	*Yield/ plant (g)*	*Plant height (cm)*	*Stem girth (cm)*	*Leaves/ plant*	*Days to 50% flowering*	*Days to maturity*	*Head diameter*	*100-seed wt. (g)*
1.	EC - 68413	18.40	144.8	6.22	27.4	100.7	135.8	13.59	5.49
2.	EC - 68415	18.34	145.1	5.96	29.2	102.5	135.0	13.13	5.17
3.	EC - 69874	17.52	132.1	5.98	28.2	92.5	131.3	11.95	5.67
4.	Sunrise sel	17.12	129.8	5.52	27.7	93.7	131.8	12.64	5.95
5.	Ramson Record	21.92	149.2	6.05	30.4	107.0	136.7	13.62	4.91
	S.Em.	0.82	2.86	0.145	1.26	0.8	1.2	0.47	0.23
	C.D (5%)	2.52	8.82	0..42	NS	2.6	3.8	NS	NS
	C.V. %	19.61	9.13	10.11	19.74	3.77	4.08	16.30	19.11
Concentration of CCC									
1.	C_0 (0 ppm)	16.88	141.0	6.09	29.7	98.0	134.4	12.57	5.33
2.	C_1 (250 ppm)	18.60	138.7	5.78	27.1	98.0	133.5	13.11	5.61
3.	C_2 (500 ppm)	19.16	138.2	6.02	29.3	99.5	134.0	12.93	5.37
4.	C_3 (750 ppm)	19.62	140.8	6.00	29.0	100.2	134.4	13.34	5.34
5.	C_4 (1000 ppm)	19.02	142.2	5.85	27.8	100.4	134.2	12.98	5.54
	S.Em.	0.81	2.44	0.18	0.75	0.8	0.5	0.38	0.15
	C.D. (5%)	2.291	NS	NS	NS	NS	NS	NS	
	Interaction	Sig.	NS	NS	NS	NS	NS	NS	
	C.V. %	19.47	7.78	13.82	11.69	3.63	1.68	13.05	12.06

TABLE 2

The effect of various concentrations of cycocel on seed yield per plant of 5 varieties of sunflower.

Variety/ Concentrations	C_0	C_1	C_2	C_3	C_4
EC 68413	20.72	22.12	16.60	18.50	14.02
EC 68415	19.98	17.50	21.15	17.58	15.52
EC 69874	10.22	18.35	16.10	22.48	20.45
Sunrise sel	22.78	17.02	14.90	15.08	15.80
Ramson Record	19.28	20.82	29.38	21.48	16.62

C = Concentration of cycocel.

EC 68413 showed the maximum stem girth of 6.22 cm which was at par with Ramson Record, EC 69874, EC 68415 but was significantly superior to Sunrise sel. It was further noticed that EC 69874 was the earliest to flower and mature. Ramson Record which gave the highest seed yield was the latest to flower and mature.

The varieties did not differ with respect to leaves per plant, head diameter and 100-seed weight. However, Ramson Record possessed the maximum leaves per plant (30.4) and head diameter (13.62 cm) whereas Sunrise sel recorded the maximum 100-seed weight (5.950 g).

The analysis of variance for the effect of the graded doses of cycocel on different characters of sunflower revealed that the seed yield per plant was the only character which was significantly affected by cycocel. The perusal of the data revealed that C_3 (750 ppm) concentration of cycocel gave the highest seed yield of 19.62 g per plant which was at par with C_1, C_2 and C_4. It is, however, evident that all concentrations of Cycocel recorded the higher seed yield over control. The interaction component, variery x concentration, for seed yield was also significant which indicated the differential response of varieties to varying concentrations of cycocel. The interaction table (Table 2) revealed that the variety viz., Ramson Record registered the highest seed yield of 29.38 g per plant with 500 ppm concentration of cycocel. It is further clear from the data that EC 68413 with 250 ppm, EC 68415 with 500 ppm, EC 69874 with 750 ppm and Sunrise sel with 0 ppm concentration of cycocel recorded the highest seed yields per plant (Table 2). Cycocel has also been reported to increase the cotton yield by Sucha Singh (1970), Kulandaivelu *et al.* (1974) and Chowdappan snd Morachan (1976). The beneficial effect of cycocel has also been observed by Desan and Kalandaiswamy (1974) in ragi; Marsiddaiah *et al.* (1977) in hybrid tomato, Singh and Kaur (1981) in mungban, Pando and Srivastava (1987) in sunflower, Saini *et al.* (1987) in Indian mustard and Wasnik and Bagga (1992) in mungbean. Our findings on differential response of cycocel on different genotypes of sunflower are in conformity to those of Chandra *et al.* (1989) in pea.

The data revealed that other characters viz., plant height, stem girth, leaves per plant, days to flowering and maturity were not affected by varying concentrations of cycocel. The head diameter was, however, higher in all concentrations of C_1, C_2, C_3 than control.

Overall studies indicated that Ramson Record appears to be superior genotype which registered the highest seed yield per plant. With respect to the effect of cycocel, C3 i. e. 750 ppm concentration appears to be better as it gave the highest seed yield. However, in view of the significant interaction component, it is advisable to conduct the elaborate studies including spraying of the cycocel at different stages of the crop growth to evolve specific recommendations. The present study revealed that Ramson Record gave the highest seed yield per plant when treated with 500 ppm concentration of cycocel.

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Heterosis for Yield and Yield-Contributing Characters in Upland Rice*

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study of hybrid vigour could enable to dentify the crosses which are high-yielding, responsive to fertilizers and maturing early. Estimates of heterotic effects were higher for days to 50 per cent flowering, grains per panicle and yield per plant, whereas days to maturity, panicle length and harvest index showed least heterotic effects. Crosses Kalhari × S-34-36, Kalhari × GR-3, IRTP-9298 × IRTP-10800 and N-53 × GR-3 were found most heterotic hybrids for yield per plant.

Rice is the second-most widely-grown cereal in world but ranks third in net kernal production. India has the largest rice growing area of 41.16 million hectares but productivity of rice is comparatively low (Anonymous, 1986). Importance of hybrid vigour for further improvement in yield in rice has been studied by many workers (Chang *et al.* 1971; Huang, 1970; Saini and Kumar, 1973). Expression of heterosis in the form of increased number of grains per panicle, productive tillers, panicle weight in addition to good grain filling (Singh and Singh, 1978) would be of immense value in increasing the production of rainfed/semi-dry rice varieties. In order to realize substantial production improvement in autogamous crop plants, studies on heterosis merits special consideration.

In the present investigation on 'Line X Tester analysis in paddy' thirteen genotypes were crossed in L × T (10 X 3) fashion during 1987 at the N.A.R.P. Farm, Navsari. The cross-seeds were sown in nursery for raising the seedlings. Those seedlings were transplanted in randomized-block design with three replications. Observations were recorded on five competitive randomly-selected plants in each entry for ten quantitative characters. Heterosis was calculated as per cent increase (+) or decrease (-) of F1 , over superior parental performance for all the characters.

The magnitude of heterotic effects observed in different characters varied from cross to cross. As regard to days to 50 per cent flowering only three hybrids viz., 116 × S-34-36, Lalmati × IRTP-10800 and N-21 × IRTP-10800 showed significant negative heterosis over their respective better parents which flowered significantly earlier. It will be of considerable interest to know the cause of heterosis for grain yield, as yield is an end product of the mutiplicative interaction between the yield components (Williams and Gilbert, 1960). Maximum heterobeltiosis was recorded by Lalmati × IRTP-10800 (98.16%) followed by Kalhari × GR-3 (44.91%) and N-21 × IRTP-10800 (44.58%) for grain yield per plant. The crosses

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Kalhari x S-34-36 and N-53 x S-34-36 showing heterotic effects for grains per panicle and 100-grain weight were the main contributors to grain yield. Significant positive effects for productive tillers per plant in N-53 x S-34-36 and 116 x GR-3 and for panicle length in N-21 x IRTP-10800, 116 x GR-3 Lalmati x IRTP-10800 and N-53 x GR-3 indicated that in differant crosses path ways for releasing higher productivity varied from cross to cross. Positive heterosis reported for yield components by Mallick *et al.* (1978), Singh and Singh (1978), Singh *et al.* (1980), Shrivastava and Seshu (1982) and Amirthadevarathinam (1984) are in agreement with the persent results. In rainfed rice purpose of gapfilling with extra seedlings separated from the main clumps having high potential for further tillering in a short period must be served for increased number of tillers and increased yield.

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Estimation of Losses Due to Rice Stem Borer (*Scirpophaga incertulas* Wlk.)

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There are appreciable losses caused by insect pests to rice crop. The need for their assessment has become more important with the introduction of high yielding as well as fertilizer responding varieties of the crop and as such as a per-requisite for planning effective and economical need-based control measures against insect pests. Stem borer, *Scirpophaga incertulas* Wlk. is the major pest attacking rice in South Gujarat. The persent investigation was undertaken to generate information regarding losses caused by this pest under South Gujarat condition.

The study was conducted for summer and kharif seasons during the year 1986 on commercially grown rice cultivar, GR 11 which was allowed for natural infestation by the pest and without any insecticidal application. Randomly selected 1000 hills were observed for the incidence of pest. The observations on white earhead were recorded before harvest while on dead-hearts at 15 days interval commencing from transplanting and continued upto 75 days after transplanting (DAT). Finally, the produce of each selected hill was taken separately. The data on incidence of the pest was correlated with the yield of rice (gm/hill) and based on regression equation, per cent loss in yield of rice per unit per cent increase in infestation was also worked out.

The correlation studies (Table 1) showed that there existed highly significant negative correlation between yield and per cent dead-hearts at 15, 30, 45, 60 and 75 DAT and per cent white earheads before harvest during both the seasons. Further, the regression studies revealed that every unit per cent increase in dead hearts at 15, 30, 45, 60 and 75 DAT led to 2.30, 2.39, 2.46, 2.50 and 1.74 per cent loss in yield during summer, while 2.22, 2.18, 1.79, 2.39 and 2.47 per cent yield loss during kh*arif* season, respectively. The uint per cent increase in white earheads led to 1.98 and 2.10 per cent loss in yield during summer and kharif, respectively (Table 2). Thus, the losses due to this pest were higher during summer than the kharif which may be due to large borer populations during summer. Further, because of compensatory mechanism 60 DAT, the losses were found decreasing. Similar observations has also been reported by Pathak (1974).

It can be concluded from the present findings that as the direct influence of white earheads is much higher than that of dead-hearts on yield and the crop losses ranged from 1.98 to 2.10 and 1.74 to 2.47 per cent per unit damage respectively, suggesting to adopt control measures for avoiding the losses.

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TABLE 1

'r' values and regression equations for individual effects of rice insect pests.

Character	*Summer 1986*		*Kharif 1986*	
	'r' value	*regression equation*	*'r' value*	*regression equation*
Per cent of dead-hearts at ;				
15 DAT v/s yield	-0.3634**	Y=6.4295-0.1481X	-0.3008**	Y=2.1160-0.047X
30 DAT v/s yield	-0.4930**	Y=6.8663-0.1638X	-0.4087**	Y=2.6698-0.0582X
45 DAT v/s yield	-0.7618**	Y=22.4546-0.5527X	-0.6618**	Y=14.8542-0.2653X
60 DAT v/s yield	-0.7710**	Y=17.4490-0.4356X	-0.6783**	Y=11.2746-0.2695X
75 DAT v/s yield	-0.7760**	Y=40.2694-0.6992X	-0.7002**	Y=18.1806-0.4486X
Per cent white earhead before harvest v/s yield	-0.9220**	Y=61.4514-1.2149X	-0.8529**	Y=26.2145-0.5507X

DAT = Days after transplanting.
** Significant (P = 0.01)

TABLE 2

Per cent loss in yield per unit increase of rice stem borer infestation.

Character	*Per cent loss in yield per unit increase of rice stem borer infestation*	
	Summer 1986	*Kharif 1986*
Per cent of dead-hearts at ;		
15 DAT	2.30	2.22
30 DAT	2.39	2.18
45 DAT	2.46	1.79
60 DAT	2.50	2.39
75 DAT	1.74	2.47
Per cent white earheads before harvest.	1.98	2.10

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Biology of Mealy Bug, *Coccidohystrix insolita* Green (Pseudococcidae : Homoptera) on Pigeon pea

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Pigeon pea, C*ajanus cajan* (L.) Millsp. is one of the important pulse crops. Among some limiting factors, insect pests take a very heavy toll of the crop in low yielding reason. Right from the seedling stage upto maturity, the plants fall victim to various pests. Mealy bug, C*occidohystrix insolita* (Green) a pest of brinjal (S*olanum melongena* L.) has been observed to attack and survive on pigeon pea at Navsari campus of Gujarat Agricultural University in Valsad District (Patel et *al.*, 1985). It is a notorious pest of the pigeon pea crop in Gujarat, particularly in south Gujarat. It causes severe damage from September onwards till the crop ramains in the field. The incidence of this pest is not so wide spread, but, heavy infestation often leads to the death of the plants, resulting thereby in the total failure of crop. No work has been done on biology of this pest on pigeon pea in India. Hence, the present studies have been undertaken to fill up the lacuna in research information.

Well developed pigeon leaves with petioles were brought to the laboratory and washed thoroughly with water. The petiole of each leaf was wrapped with wet cotton wool, so as to keep leaf turgid for longer period. The leaf was then placed on a wet pad of absorbent cotton placed in petridish. The freshly emerged adult male and female were allowed to pair for 2 to 3 days on such leaves in the petridishes. Lateron, the mated famales were released on laboratory reared pigeon pea plant for egg laying. The plants for egg laying were prepared by raising seedlings of pigeon pea in polythene bags containing black cotton soil. Leaves of 15-20 days old plants were plucked retaining 2-4 leaves per plant. These plants were used for egg laying. The freshly laid eggs were transferred with fine camel hair brush to the glass slide (75 x 25 mm) and measured under microscope with the help of ocular microscope after caliberating with stage micrometer. Counted number of freshly laid eggs were observed daily till hatching for studying incubation period and hatching percentage. The crawlers emerging from eggs were transferred individually to leaf of pigeon pea plant with the help of camel hair brush and marked individually by drawing a circle around them. The nymphs were observed daily till the emergence of adult for studying the biology. For female, the moulting was confirmed by the presence of exuvium on leaf whereas for male from exuvium on the posterior end of cocoon. The shape, size and colour of each nymphal instar of male and female were also studied. The measurement of length and breadth of third and fourth instars of male were taken by removing silken covering.

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TABLE 1

Information regarding life history of mealy bugs, *Coccidohystrix insolita* (Green) on pigeon pea.

Sr. No.	*Stage*	*Minimum*	*Maximum*	*Average*
1.	Egg period (days)			
	I. In presence of male	06	08	06.97±00.25
	11. In absence of male	06	08	07.03±00.27
2.	Nymphal period (days)			
	I. instar : Male	05	07	05.58±00.73
	Female	05	07	05.98±00.85
	II. instar : Male	05	07	06.12±00.77
	Female	04	06	04.52±0.65
	III. instar : Male	02	04	02.38±00.56
	Female	04	06	05.04±00.73
	IV. instar : Male	02	05	02.96±00.88
	Total : Male	15	19	17.02±01.08
	Female	13	18	15.50±01.83
3.	Adult period (days)			
	I. Pre-oviposition	07	11	08.68±01.22
	II. Oviposition	02	04	03.12±00.73
	III. Post-oviposition	02	05	03.32±01.03
	IV. Longevity : Male	01	03	01.44±00.65
	Female	12	19	15.12±01.86
4.	Total life cycle (days)			
	I. Male	22	30	25.32±01.55
	II.Female	32	43	37.44±02.74
5.	Fecundity (No. of eggs)			
	I. Mated female	82	230	158.00±41.52
	II.Parthenogenatically	52	206	142.38±46.85
6.	Hatching percentage			
	I. In presence of male	87.5	96.29	93.13±03.53
	II.In absence of male	82.5	93.55	89.37±04.23
7.	Sex ratio (Male : Female)	1:2.54	1:1.35	1:1.97

The emerging male and female adults were kept separately for studying longevity and fecundity. With a view to determining parthenogenetic behaviour, third instar female nymphs were collected from the field and released on pigeon pea plants, such plants were kept separately in cage to avoid mating.

Information regarding life history of mealybug, C. *insolita* is given in Table 1.

The female of C. *insolita* laid eggs in groups, within the protective sac, mostly on lower surface of leaves. On an average, 89.43±3 .37 per cent female laid eggs on lower surface of leaf, while only 10.58±3.37 female laid it on upper surface, indicating lower side of the leaf as most preferred site for egg laying. these observations tally with those reported by patel et *al.* (1985) for pigeon pea and Banerjee and Basu (1956) for brinjal.

Eggs were smooth, translucent,shining buff to light yellow in colour and oval to cylindrical in shape with round ends. The length of the egg varied from 0.30 mm to 0.36 mm with an average of 0.33±0.16 mm and the breath varied from 0.15 mm to 0.18 mm with an average of 0.17± 0. 013 mm.

The average incubation period of the eggs laid after sexual mating was 6.67 ± 0.25 days while it was 7.03 ± 0.27 days for parthenogenetically laid eggs. The average hatching percentage of eggs laid by the mated female was higher (93.13±3.53) than that laid by unmated female (89.37±4.23).

Nymph passed through three nymphal instar to develop into female adult while it passed through four nymphal instar to develop into male adult.

Freshly emerged first instar nymphs remained crawling on leaf for five to ten minutes and settled at a suitable spot on ventral surface of the leaf lateron. They were oval in shape light yellow in colour, slinghtly convex dorsally with three pairs of well developed legs, a pair of antennae and two bright red eyes. the body colour of newly hatched nymphs changed to dull white wihtin 2 days after hatching due to secretion of white mealy powder. Short waxy dorsal threads also appeared and increased gradually two days after hatching from egg. The newly hatched first instar nymph measured from 0.38 mm to 0.42 mm with an average of 0.39±0.018 mm in length and o.18 mm to 0.21 mm with an average of 0.19±0.013 mm in breadth.

The freshly moulted second instar nymphs were light yellow in colour and oval in shape. They were similar to the first instar nymph in their general appearance and morphological features except bigger in size. After 24 hours of the first moult, white waxy powder and dorsal waxy fibres were secreted which gradually became dense. The length ranged from 0.60 mm to 0.72 mm with an average of 0.66 ± 0.035 mm, while the breadth ranged from 0.30 mm to o.36 mm with an average of 0.3±0.21 mm.

One or two days before the second moulting, the nymph, likely to develop into male, formed a white covering on its body, within which it passed through three moulting and emerged out as male adult. Third instar nymphal stage was pale yellow in colour and elongated in shape, which started assuming the form of adult. Three pairs of well developed legs were present on thorasic region. The length ranged from 1.08 mm to 1.20 mm with an average of 1.13±0.042 mm and breadth from 0.39 mm to 0.48 mm with an average of 0.43±0.034 mm. Third instar nymph, like to develop into female, was

bigger in size than second instar and oval in shape, light yellow in colour with dark brown spot on dorsal side and red eyes on head. It measured from 0.84 mm to 0.93 mm with and average of 0.87±0.03 mm in length and 0.39 mm to 0.45 mm with an average of 0.43 ± 0.02 mm in breadth.

Fourth instar was observed in the nymph to develop into male adults. The fourth instar emerged out after third moulting under white covering which was pale yellow in colour. It began to assume the form of adult by possessing wing buds. It measured from 1.11 mm to 1.23 mm with an average of 1.17±0.04 mm in length and 0.39 mm to 0.48 mm with an average of 0.44±0.033 mm in breadth.

The adult males were slender, delicate and elongate in shape with somky brown thorax and pale yellow abdomen. They possessed single pair of well developed matathoracic wings and two long waxy anal filaments having an average length of 1.13±0.123mm. On an average male was 1.15±0.045 mm in length from head to the tip if abdemen and 2.34±0.077 mm in breadth with expanded wings. They were observed flying distance of 2 to 4 feets.

The female was apterous, soft bedied elongate oval in shape and light yellow in colour with greenish strip and spots on dorsal side and a number of hairs over the body which was covered with white waxy powder. The newly formed adult females measured on an average 1.42±0.051 mm in length and 0.66±049 mm in breadth. The female attained larger size at egg laying and measured one an average 2.63±0.276 mm in length and 1.47±0.124 mm in breadth.

The average longevity of male and female was 1.44±0.65 and 15.12±1.86 days, respectively. The sex ratio of male: female was found to be 1:1.57. The total life cycle of C. *insolita* occupied an average of 25.32±1.55 days ranging from 22 to 30 days in male, while 37.44±2.74 days ranging from 32 to 43 days in female. Most of the observations on biology of C. *insolita* reported here could not be compared as very little work has been done and reported on this aspect. However, Lall et *al.* (1973) reported the total life cycle of this pest to be 15.01 days when reared on S. *nigrum* and S. *xanthocarpium*.

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Estimation of Losses Due to Rice Leaf Folder, *Cnaphalocrocis medinalis* Guenea

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There are appreciable crop losses caused by insect pests of rice but the need for their assessment has became more important with the introduction of high yielding, fertilizer responding varieties of the crop, since small amount of loss of production per unit area will account much more in total production of the crop. Such assessments are a pre-requisite for planning effective and economical need based control measures against insect pests which can cause considerable losses. Rice leaf folder, *Cnaphalocrocis medinalis* Guene is the major insect pest of rice in Gujarat. However, no information is available on the extent of losses caused due to this pest. Therefore, the persent investigation was carried out, wherein losses caused by rice leaf folder was assessed for South Gujarat condition.

To assess the extent of losses caused by rice leaf folder, *Cnaphalocrocis medinalis* Guenee, randomly selected 1000 hills of commercially grown rice cultivar, GR 11 were observed at tillering, early earing and milky seed stage for incidence of the pest during summer and wet season of 1986. The data on incidence of the pest were correlated with the yield of rice (gm/hill) by using the standard method (Chandel, 1974) and based on regression equation, per cent loss in yield of rice per unit per cent increase in infestation was also worked out.

Correlation coefficient and regression equation were worked out (Table 1) using the per cent incidence of the pest and yield of rice (gm/hill). There existed highly

TABLE 1

"r" values and regression equations for individual effects of rice leaf folder.

Character	*Summer 1986*		*Wet Season 1986*	
	"r" value	*Regression equation*	*"r" value*	*Regression equation*
Per cent incidence at ;				
Tillering v/s yield	-0.4879**	Y=61.4512-1.2146X	-0.6518**	Y=02.6696-0.0581X
Early earing v/s yield	-0.6569**	Y=02.1158-0.0467X	-0.7259**	Y=17.4487-0.4354X
Milky seed v/s yield	-0.3478**	Y=45.8800-0.5142X	-0.3863**	Y=90.3068-1.1496X

** Significant at 0.01 probability level.

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significant negative correlation between yield of rice and the incidence of pest during both summer and wet season. The regression studies revealed that every unit per cent increase in the pest incidence at tillering, early earing and milky seed stage led to 1.98, 2.22 and 1.12 per cent loss in yield during summer, while 2.18, 2.50 and 1.27 per cent yield loss during wet season, respectively. The present findings are in confirmation with the results of field studies on yield loss caused by *Cnaphalocrocis medinalis* (Gn.) in China which also revealed that the heaviest yield losses occurred at the early earing stage, medium at the tillering stage and the lightest at the milky seed stage (Shon and Lu, 1984). Similarly, Miyashita (1985) observed no yield loss at the grain filling stage, although 67 per cent of the leaves were injured by rice leaf folder. However, when damage occurred at the heading stage, yield was reduced due to reduction in the percentage of ripened grains and 1000-kernal weight. The findings of the present study are in corroboration with that of Bautista *et al.* (1984), who reported 3.2 per cent yield loss per 4.2 per cent damaged leaves per plant.

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Record of Three New Pests of Coconut in Gujarat

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Coconut palm is attacked by a number of insect pests at all stages of its growth. Two sucking pests viz., thrip, *Halpothrip tenuipennis* Bagnall (Phlaeothripidae : Thysanoptera) and mite, *Neocypholaelaps stridulans* Evans (Meroseiidae : Acarina) and a slug caterpillar, *Phalacra vidhisara* Walker (Drepanidae : Lepidoptera) were found for the first time infesting coconut palm at the Coconut Plantation, Mahuva (Gujarat). The available literature have shown that they supplement the list of coconut pests.

Both the *H. tenuipennis* and *N. stridulans* were observed damaging the inflorescence particularly male flowers of the coconut palm. They fed upon the pollens. The population of both the pests was observed high in August and September. The mite dispersed on the coconut foliage after rainy season and sucked the leaflet tissues. Johnson (1965) reported *H. ceylonicus* Schmutz as a inflorescence pest of coconut in Malaysia.

The caterpillars of *P. vidhisara* attacked the young coconut palms and fed on the lower epidermal tissues of the leaflet. The biology of this pest was studied in laboratory. The egg period lasted for 5 to 6 days. The larva was a slug like creature covered all over with spines. The larval stage averaged 38.13 days with a range of 32 to 46 days. The larva spin dense cocoon on the underside of the leaflet. The pupal period was 5 to 7 days. The pre - oviposition, oviposition and post - oviposition periods averaged 1.60, 2.80 and 1.40 days, respectively. A female moth laid 183.60 eggs on an average with a range of 80 to 255 eggs. The female and male moths lived for 4 - 7 and 4 - 5 days, respectively. The sex ratio was observed to be 3.25 females : 1 male in the field collected samples.

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Life Tables and Intrinsic Rate of Increase in Number of *Caryedon serratus* (Olivier) (Coleoptera : Bruchidae) on Groundnut

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Caryedon serratus (Olivier) is a bruchid of African origin and well known as a primary storage pest of unshelled groundnut (*Arachis hypogaea* L.) and tamarind *(Tamarindus inidca* L.) (Davey, 1958). According to Mittal and Khan (1967-68), it is an important pest of stored fruit of tamarind in Rajasthan, Maharashtra, Madhya Pradesh and Uttar Pradesh. Arora and Singal (1978) reported its infestation on rice in Kerala. Larva of this pest is characterised by its habit of boring through shell of the dried unshelled nut and causes heavy loss in quality and quantity of the stored groundnut (Howe, 1952). According to Dick 1987), the pest caused 20 per cent seed loss of groundnut over the period of 5 months storage in Andhra Pradesh which resulted in loss of kernels, increased level of free fatty acid in oil and heavily damaged seed showed poor germination.

Life table is a useful tool to determine bio-potential and provides a format for recording and accounting all population changes in the life cycle of a species. This being a new pest of stored groundnut in Gujarat, information on its bio-potential and innate capacity of increase in numbers is very scanty. Therefore, an attempt is made to construct the life-tables under laboratory condition on groundnut.

The laboratory culture of *C. serratus* was used for this study. Known number of adult pairs were released for egg laying in glass jars (21 x 15 cm) contining groundnut kernels of variety GG-2. The kernels containing the eggs were collected next day morning. In order to facilitate the observations, one egg was kept on the kernel, while others were removed with the help of a needle. Such 200 kernels were kept individually in plastic vials (6.5 x 2.5 cm) in BOD incubator adjusted to 28° ± 1° C. Observations on hatching of eggs, pupation and emergence of adults were recorded daily. The adults emerged on a particular day were released in glass jar for egg laying. Fecundity of females on subsequent days was noted daily till all the females died. The number of eggs laid per female were divided by two (sex ratio 1:1) to get the number of female births (mx). Observations on mortality during different stages from hatching of eggs till the emergence of adults were recorded daily which provided the values for the life table (lx). Life- tables were constructed according to the method of Birch (1948), Howe (1953) and Atwal and Bains (1974). The innate capacity of increase(rm), net reproductive rate(Ro) and mean generation time(T), were the basic parameters used to assess the population growth.

TABLE 1

Life-table (for female) and age specific fecundity for Caryedon serratus on groundnut variety GG 2.

Pivotal age in days (X)	*Survival of female at different age interval (1x)*	*Age schedule for female birth (mx)*	*1xmx*	*x1xmx*
0-39	—	—	—	Immature
40	0.70	3.33	2.33	93.24
41	0.70	2.25	1.58	64.58
42	0.70	4.73	3.31	139.06
43	0.70	4.98	3.49	149.90
44	0.70	3.92	2.74	120.74
45	0.70	3.72	2.60	117.18
46	0.70	2.74	1.92	88.23
47	0.70	2.70	1.89	88.83
48	0.70	2.78	1.95	93.41
49	0.70	2.50	1.75	85.75
50	0.70	2.05	1.44	71.75
51	0.70	1.77	1.24	63.19
52	0.70	1.33	0.93	48.41
53	0.70	1.24	0.87	46.00
54	0.695	0.90	0.63	33.78
55	0.685	0.94	0.64	35.41
56	0.675	0.89	0.60	33.64
57	0.665	0.89	0.59	33.74
58	0.645	0.75	0.48	28.06
59	0.625	0.53	0.33	19.54
60	0.605	0.34	0.21	12.34
61	0.58	0.31	0.18	10.97
62	0.58	0.19	0.11	6.83
63	0.58	0.30	0.17	10.58
64	0.545	0.07	0.04	2.44
65	0.525	0.19	0.10	6.48
66	0.485	0.31	0.15	9.92
67	0.45	0.30	0.14	9.05
68	0.43	0.34	0.15	9.94
69	0.42	0.27	0.11	7.82
70	0.40	0.28	0.11	7.84
71	0.38	0.75	0.29	20.24
72	0.36	0.75	0.27	19.44
73	0.36	1.00	0.36	26.28
74	0.36	0.75	0.27	19.98
75	0.36	0.75	0.27	20.52
76	0.36	0.75	0.27	20.52
77	0.355	1.00	0.355	28.05
78	0.355	1.00	0.355	27.69
79	0.355	0.00	0.00	0.00

Net reproductive rate (Ro) $\Sigma 1xmx = 35.22$ $\Sigma x1xmx = 1731.10$

TABLE 2.

Mean length of generation, Innate capacity for increase in number and finite rate of increase in number in *C. serratus* (Olivier).

Particulars	
Mean length of a generation :	
$TC = \frac{\Sigma xlxmx}{Ro}$	= 49.15 Days.
Innate capacity for increase in numbers :	
$rm = \frac{\log_e Ro}{TC}$	= 0.0725 females / female / day
Arbitary rm 0.07 and 0.08	
Σ_e^{7} - rmxlxmx = 1097 0.0764	females / female / day
Finite rate of increase (λ) = 1.0794	females / female / day
Weekly multiplication $(\lambda)^7$ = 1.707 times	
Hypotheticated F_2 females = 1240.45	

The life-table showing the survival (lx) and age specific fecundity of *C. serratus* is presented in Table 1. The preoviposition period ranged from 39th to 40th day of pivotal age. The first female mortality occurred on the 15th day and increase slowly thereafter. The maximum mean progeny production per day (mx) was 4.98 per female on 43rd day of pivotal age. The net reproductive ratio of total female birth in two successive generations was 35.22. The survival of immature stages (lx) from egg to adult was 0.70.

The innate capacity for icrease in number (rm) was 0.0764 female per female per day a daily finite rate of increase(l) 1.0794 females per female per day. The length of development and reproductive stage was found to be 49.15 days for this cohort. The hypothetical F2 females were worked out to the tune of 1240.45 and weekly multiplication of the pest was found 1.7070 times (Table 2). The information on life tables for this pest is meagre and thus results obtained through present investigation could not be discussed in light of previous findings.

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Bio-efficacy of Insecticides Against Armyworm, *Mythimna separata* Walker Infesting Maize

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The armyworm *Mythimna separata* Walker is an important polyphagous pest on cereal crops and causes 80 per cent loss in yield of sorghum in Ahmedabad district (Desai *et al.*, 1983). With a view to determine the relative efficacy of seven insecticides against M. *separata*, present investigation was undertaken and the results are elucidated.

Laboratory trials in a completely randomised design were carried out at Gujarat Agricultural University, Anand during 1989-90 and 1990-91 to evaluate the bio-efficacy of seven insecticides (Table). Leaves of maize were separately treated directly under Potter's tower at a constant air pressure of 2.5 kg/cm with 2 ml of spray solution. Then seven days old larvae of M. *separata* were released on treated food in

TABLE 1

Bio - efficacy of insecticides against armyworm, *M. separata* Wlk.

Treatment	*Larval mortality (%) after 24 h*		
	1989-90	*1990-91*	*Pooled*
Triazophos 0.1%	88.82*	88.82	88.82
	(99.96)	(99.96)	(99.96)
Acephate 0.075%	88.82	63.41	76.11
	(99.96)	(79.97)	(94.24)
Etrofolan 0.1%	88.82	88.82	88.82
	(99.96)	(99.96)	(99.96)
Butacarboxim 0.1%	88.82	50.75	69.78
	(99.96)	(59.97)	(88.05)
Quinalphos 0.05%	88.82	88.82	88.82
	(99.96)	(99.96)	(99.96)
Endosulfan 0.07%	88.82	80.35	84.58
	(99.96)	(97.19)	(99.11)
Monocrotophos 0.036%	88.82	80.35	84.58
	(99.96)	(97.19)	(99.11)
Control	1.15	1.15	1.15
	(00.04)	(00.04)	(00.04)
C D at 5%	--	9.61	23.12

Arc sin transformed values.

Figures in parentheses are retransformed values.

* Cent per cent mortality was obtained in all treatments.

plastic bowl of 10 cm in diameter and maintained at room temperature (28.5 ± 1.5 °C). In untreated control, water was sprayed. The observation of larval mortality were recorded after 24 h from each treatment. Data on per cent larval mortality were pooled and statistically analysed.

The results on bio-efficacy of various insecticides (Table) against larvae of M. *separata* indicated that all the insecticides remained significantly superior to untreated control 24 h after application. Among them quinalphos 0.05% gave higher mortality of *M. separata* in both the experiments. The higher efficacy of quinalphos also been reported by Mathur and Upadhyay (1981), Singh and Deol (1988) and Upadhyay *et al.* (1990) against the larva of *M. separata*.

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Bio-Efficacy of Plant Materials Against *Rhizopertha dominica* Fab. Infesting Stroed Wheat *Triticum aestivum* L.*

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Rhizopertha dominica Fab. is a serious pest of cereals causing heavy losses under storage by making circular holes in them and also affect the nutritional and bakeing quality as well as germination capacity. It makes grain susceptible to infestation by secondary pest like, *Tribolium castanum* and *Oryzaephilus surinamencis*. Certain organic pesticides are being used as seed dressing or fumigants against stored grain pests which are costly and also involve the risk of hazards. To avoaid these problems, some workers namely, Grirish and Jain (1974), Pandey and Varma (1977), Mishra *et al.* (1984) and Kashyap *et al.* (1974), have tried to find out suitable plant derivatives as the mean of effective control of storage pest. The plant materials, were tested for their efficacy against *R. dominica* infesting stored wheat.

All the test plants and their parts intended for screening were collected around Anand Campus. Materials collected were dried in shade for 30 to 45 days. Fully dried parts were grounded to fine particles by electric grinder separately. The dust, so prepared was passed through a sieve of 100 mesh for final use. The seeds of all the jars were then mixed respective powders and shaked vigourosly. Ten adults of *R. dominica* of one day age were released in each jar and month of the jar was coverved by muslin cloth and tied by rubber bands. These jars were kept under laboratory condition at 25.5°C and 65 RH without disturbance. Observation of mortality of beetles and extent of damage on grain were recorded after 7, 32, 64 and 96 days respectively and data were analysed statistically by using C.E.D. after aresion transformation.

Perusal of the data on effect of various plant materials (Table 1) revealed that the mint leaves and custard apple seeds powdered gave equal effectiveness at 2 per cent (W/W) causing maximum mortality of the *R. dominica* within 7 days, followed by soapnut shells, turmeric rhizomes and neem seed kernels powder were significantly superior to control, and rest of the treatments in reducing the pest infestation. In mint leaves and custard apple seeds only 0.29% damage was recorded and proved to be best plant materials for the control of lesser of grain borer till 96 days. The maximum 37.13% damage was observed in control. These findings tally with research work done by Pandey and Varma (1977), Mishra *et al.* (1984) and Kashyap *et al.*, (1974).

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TABLE 1

Protection of wheat against lesser grain borer *R. dominica* with plant materials.

Treatment (2 % powder)	*Percentage mortality after 7th day*	*(%) Grain damage after days*		
		32	*64*	*96*
Mint leaves (*Mentha spicata* L.)	88.97* (99.96)	0.29 (0.0)	0.29 (0.0)	0.29 (0.0)
Castard apple seeds (*Annona equamose* L.)	88.97 (99.96)	0.29 (0.0)	0.29 (0.0)	0.29 (0.0)
Soapnut shells (*Sapindus laurifoling* Vahl)	56.97 (70.28)	0.29 (0.0)	8.73 (2.34)	18.74 (10.3)
Turmaric rhizomes (*Curcuma longa* L.)	26.06 (19.29)	6.53 (1.29)	10.54 (3.34)	20.11 (11.82)
Neem seed kernels (*Azadirachta indica* A. Juss)	12.60 (4.75)	7.33 (1.62)	14.14 (5.96)	21.39 (13.30)
Tulsi leaves (*Ocimum sanctum*)	26.06 (15.29)	6.53 (19.29)	17.63 (9.17)	25.31 (18.27)
Neem leaves (*Azadirachta indica* A. .Juss)	0.91 (0.025)	13.62 (5.54)	19.90 (11.58)	24.80 (17.59)
Garlic scales (*Allium sativum* L.)	15.30 (6.96)	17.07 (8.61)	22.19 (14.26)	28.90 (23.35)
Jaman seeds (*Syzygium cuminii* S.)	18.58 (10.15)	16.97 (8.51)	20.63 (12.41)	31.54 (27.36)
AK leaves (*Calotropis gigantea* R. Br.)	6.35 (1.30)	18.72 (10.30)	22.60 (14.76)	32.33 (28.60)
AK flowers (*Calotropis gigantea* R. Br.)	18.42 (9.98)	18.72 (10.30)	21.96 (13.98)	31.72 (27.64)
Garlic leaves (*Allim sativum* L.)	6.75 (1.30)	18.77 (10.5)	19.90 (11.58)	35.03 (32.94)
Control	0.91 (0.025)	21.98 (14.00)	25.63 (18.71)	37.13 (36.43)
S.Em.	4.14	1.21	1.25	1.65
C.D. at 5 %	12.03	3.5	3.6	4.8
C.V. %	23.25	18.77	14.25	8.87

* Arcsin $\sqrt{\text{percentage}}$ transformed values.
Figures in parantheses are original values.

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Effect of Five Leguminous Host Plants on the Growth Index of Gram Pod Borer, *Helicoverpa armigera* (Hubner)*

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Among the various insect pests attacking legume crops, the gram pod borer, *Helicoverpa armigera* (Hubner) is a serious pest causing severe damage to such crops (Bindra, 1968). The study of insect host plant relationship helps to know the possible host range and the effect of host plants on insect development. It was evident that the growth index values increased with the increase in suitability of the diet. Different workers (Sangani, 1971, Verma *et al.*, 1972, Chaudhary and Sharma, 1981 and Dubey *et al.* 1981) had done some investigations on the biology of *Helicoverpa* on different hosts, but the informations with regard to legume hosts which are mainly cultivated in Gujarat State are not available. Thus, the present investigation was undertaken at Junagadh to study the effect of five leguminous host plants viz., chickpea (*Cicer arietinum* L.), pigeonpea (*Cajnus cajan* (L.) Millsp), greengram (*Vigna radiata* (L.) Wilczek), blackgram (*Vigna mungo* (L.) Hopper) and indianbean (*Dollchos lablab* L.) on the growth index of *H. armigera*.The experiment was conducted in a B.O.D. incubator maintained at 28 ± 2° C temperature and 75 ± 5 per cent relative humidity. In order to maintain stock culture, adult males and females of *H. armigera* were kept

TABLE 1

Effect of leguminous hosts on growth index value and pupal weight of *H. armigera*.

Food Plant	*Number of larvae observed*	*Per cent pupation 'n'*	*Average larval duration(Days) 'Av'*	*Growth index value (n/Av)*	*Dry weight of pupa (mg)*
Chickpea	40	85.00	18.74	4.54	60.09
Pigeonpea	40	75.00	19.57	3.83	44.28
Indianbean	40	65.00	21.46	3.03	35.12
Greengram	40	72.50	19.34	3.75	47.33
Blackgram	40	67.50	20.56	3.28	39.52
S. Em. ±	--	--	0.12	--	1.10
C.D. at 5 %	--	--	0.33	--	3.09
C.V.%	--	--	3.22	--	12.88

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in insect rearing cage (30 × 30 × 30 cm). Pieces of fine musline cloth and 5 per cent honey solution were kept in cage for oviposition and food, respectively. Freshly laid eggs were collected with the help of wet camel hair brush and placed in petri dishes (9 × 2.5 cm) for hatching. The newly hatched caterpillars were teansferred to different leguminous host plants with the help of hair brush. Observations were recorded on the duration of larval period (feeding - period), per cent population and dry weight of pupa. The growth index (GI) for development of larvae was also calculated as : GI = % population/average larval duration. The data obtained are presented in Table 1.

The results revealed that the different leguminous hosts influenced significantly on larval development of *H. armigera*. The average feeding period was significantly faster in chickpea (18.74 days), while it was significantly prolonged on indianbean (21.46 days). The data also indicated a highest per cent pupation of larvae on chickpea (85%) with 4.54 growth index value followed by pigeonpea (3.83), greengram (3.75) and blackgram (3.28). The lowest per cent pupation, however, was observed on indianbean (65%) with 3.03 growth index value. On the basis of growth index values computed for different leguminous hosts, chickpea was found to be the most favourable and indianbean the least for the larval growth of gram pod borer. The present results are in agreement with the findings of Sangani (1971) and Dubey *et al.* (1981). The data presented in Table-1 also indicated that significantly heavier pupa (60.09 mg on dry wt. basis) was obtained from larvae of H. *armigera fed* on chickpea. The pupae obtained on greengram and pigeonpeawere not significantly different, weighing 47.33 and 44.28 mg, on dry wt. basis, respectively. Significantly lighter pupa was obtained from the larva reared on indianbean (35.12 mg).

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Evaluation of Cheap and Easily Available Substrate for Mass Multiplication of *Trichoderma harzianum* Rifai

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In recent years, there is a renewed interest on the biological control agents in the management of soil borne diseases due to high cost of fungicides and their risk to human beings and the environment. Among the various bioagents reported, *Trichoderma harzianum* Rifai has been identified as an effective bio-control agent of *Rhizoctonia solani* Kaulm., *Sclerotium rolfsii* Sacc. and *Fusarium oxysporum* Schlecht (Elad *et. al.*, 1981 : Upadhyay and Mukhopadhyay, 1986 and Sivan et *al.*, 1987). Certain cereal grain and agricultural wastes were identified as ideal substrates for mass multiplication of *T. harzianum*. Hence, an attempt was made to evaluate some commonly available cereal grains and agricultural wastes for their suitability as substrates for mass multiplication of *T. harzianum*.

The media evaluated for the mass multiplication of *T. harzianum* were :

(i) Wheat-bran medium (Henis *et al.*, 1978)
- 10 g Wheat-bran
- 20 ml Tap water

(ii) Wheat-bran : Saw dust : tap water medium (Mukhopadhyay et *al.*, 1986)
- 75 g Wheat-bran
- 25 g Saw dust
- 100 ml Tap water

(iii) Sand : maize medium (Padmanaban and Alexander, 1987)
- 40 g powdered maize
- 160 g Sand
- 50 ml Tap water

(iv) Wheat straw medium (Kousalya Gangadharan and Jeyrajan, 1988)
- 200 g Wheat straw
- 100 ml Tap water

(v) Sorghum grain substrate (Upadhyay and Mukhopadhyay, 1986)
- 50 g Sorghum grain
- 2 % Sucrose solution

Ingradients of wheat bran, wheat bran : Saw dust : tap water and sand : Maize were taken in 500 ml Erlenmeyer flask, whereas wheat straw medium was taken in polypropylene bag. The media were then sterilized at 121° C for one hour on two successive days. Mycelial disk (5 mm) of three days old culture of T. *harzianum* was inoculated and incubated at 28° C for 15 days.

For preparation of sorghum grain substrate, sorghum grains were per-soaked overnight in 2 per cent sucrose solution before sterilization.

After 15 days of incubation, spore count was estimated by vigorously shaking 1 g of fungal growth in 100 ml of sterile distilled water using a haemocytometer.

Significant differences in number of spores was observed in each carrier (Table 1). Mximum number of spores were record-

TABLE I

Sporulation of *T. harzianum* on various solid food base carriers.

Carrier	*No.of spores/g* (x10⁶)*
Wheat-bran	298
Wheat straw	256
Sorghum grain	302
Wheat-bran : Saw dust : tap water	442
Sand : maize	288
S.Em.	25.71
C.D. (0.05)	77.49
C.V. %	16.22

* Data are average of four replications.

ed in case of wheat bran : saw dust : tap water carrier, while next in discending order were sorghum grain, wheat bran, sand : maize and wheat straw carrier. These results are in conformity with those of Mukhopadhyay *et al.* (1986) who reported that wheat bran : saw dust : tap water carrier gave excellent growth of *T. harzianum.* It can also be efficiently grown on wheat bran medium (Henis et *al.*, 1978 ; Hadar et *al.*, 1979 and Elad et *al.*, 1980). Thus present investigation suggested that *T. harzianum* can be mass cultured on commonly available substrates.

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Abstracts of Ph. D. Thesis

Crop Weather Relationship in Rabi Maize (*Zea mays* L.) and Testing of CERES Maize Model for Middle Gujarat Agroclimatic Zone

Submitted to Gujarat Agricultural University

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Field experiments were conducted in maize (C. V. Ganga Safed-2) during rabi seasons of the year, 1989-90 and 1990-91). Treatment comprising of 3 sowing dates (October 5, 20 and November 4) and for irrigation levels (IW/CPE = 0.8 z 1.0 Tc-Ta -0.5 and farmers method i.e. 12 interval) were laid out in a split-plot design with sowing dates as main plot treatments. The result obtained reveal that the grain yield was significantly higher in first date of sowing in the year 1990-91 only in which plant experienced low temperature during the period from the silk emergency to physiological maturity phase which lengthen the grain filling period. On the other hand, the irrigation treatment did not show any significant effect on grain yield in both the years. However, irrigation scheduling by infraredtherometry technique could save 20-25 % of irrigation water over farmers method.

Correlation studies reveal that the temperature from tasseling to maturity had negative association with grain yield whereas vapour pressures morning and afternoon during emergence to maturity and solar radiation and photo-active radiation during silk emergence to physiological maturity have showed significant positive correlation with grain yield. Similarly agrometeorological indices like accumulated growing degree days, helio- thermal units and thermal inception rates during emergence to physiological maturity have a positive association with grain yield. CERES maize model was tested and found to be good for pridiction for this region by modifying the genetic to co-efficients and could predict the silking and maturity datas with minimum error. However the grain yields perdicted by CERES maize model showed larger error as compared to that of yield predicted by regression models developed with help of stepwise regression technique in the study.

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