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CONTENTS

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Combining ability in Indian mustard

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ABSTRACT

Combining ability and gene action for 11 economic characters including yield in Indian mustard was studied in *diallel* (excluding reciprocals) crosses of 7 diverse cultivars. Combining ability variances indicated the predominance of additive and additive x additive gene actions for flowering maturity, primary branches/plant,length of main shoot whereas predominance of non-additive gene action was observed only for 1000 -seed weight. However, Secondary branches/plant, seeds/siliqua and *yield/plant,were solely governed by additive genes.*

Key words: Combining ability; Indian mustard; Gene action.

INTRODUCTION

Indian mustard *[Brassica juncea (L) Czern & Coss]* is an important*rabi* oilseed crop grown extensively in northern and eastern India. Very little work, has, however, been done to understand the nature of gene action and the inheritance of yield and its components. Consequently, the progress in the development of new high yielding varieties has been quite slow as compared to other crops. The present study was, therefore, undertaken to study the gene action involved and the inheritance of yield and its component traits.

MATERIALS AND METHODS

Experimental material for the present study consisted of 7 varities/strains namely Varuna, RS-3, Prakash, PYSR-3 Pusabold PR-1D and B-85, and their all possible 21 F_1 's (excluding reciprocals) The experimental material was evalated in a RBD with 3 replications at the Crop Research Centre of G.B.Pant University of Agriculture & Techonology, Pantnagar during *rabi* 1981-82. The crop was grown at a fertility level of 80:40:40 kg NPK/ha with spacing of 30cm between rows and 10cm between plants. Observations were recorded on 10 randomly selected plants in each plot for days to flowering and maturity, plant height, number of primary and secondary branches / plant, length of main shoot, number of siliquae on main shoot, number of siliquae/plant, 1000-seed weight and yield/plant. Data were analysed following Griffing (1956) using model-1,method 2.

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Table 1: Analysis of variancefor combining ability for various quantitative characters.

Source	d.f.	days to flower initia-tion.	Days to Maturity	Plant height	Primary branches/ plants	Secondary branches/ plants	Length of MainShoot	No. of siliqua on main Shoot	No.of siliqua/ plant	Seeds/ siliqua	1000- seeds weight (g)	Yield/ plant (g)
gca	6	66.22**	170.98**	1112.52**	0.50**	7.72**	13.29**	145.41**	3945.77**	1.99**	0.03*	1.29**
sca	21	2.92**	8.17**	137.82**	0. 20*	2.37	8.41**	29.54**	605.71	0.33	0.15**	0.57
Error	54	0.44	1.87	19.86	0.11	1.64	2.45	1.56	584.99	0.33	0.01	0.39

* Significant at 5% probabilty level,

** Significant at 1% probability level

RESULTS

The variances due to general combining ability (gca) and specific combining ability (sca) were highly significant for days to flowering initiation and maturity, plant height, length of main shoot and siliquae on main shot (Table 1). Significant variances due to gca and sca were obtained for 1000-seed weight and primary branches/plant. Highly significant variances due to gca were obtained for primary and secondary branches/plant, siliquae/plant, seeds/siliqua and yield/plant. The relative magnitude of gca variance was larger for all the characters except 1000-seed weight.

Positive and significant gca effects for flowering were noted for RS-3, PYSR-3 and Prakash, while Varuna, Pusabold, PR-1D and B-85 exhibited significant and negative effects (Table 2). Pusabold, PR-1D and B-85were found to be good general combiners for early maturity. RS-3,PYSR-3 and Prakash showed significant and positive gca effect for plant height whereas Varuna, Pusabold, PR-1D and B-85 exhibited significant and negative gca effects for this trait. For the number of primary and secondary branches /plant, RS-3 was good general combiner. Amongst parents, Prakash and PR-1D showed positive and significant gca effects for length of main shoot. Former had the highest gca effect. Positive and significant gca effects for siliquae on main shoot were noted for Varuna, Pusabold, PR-1D and B-85, while the remaining parents exhibited significant and negative effects. RS-3 and B-85 were observed to be the good general combiners for siliquae/plant and seeds/siliqua, respectively. For 1000-seed weight,PYSR-3 showed desirable gca effect RS-3 was found as good general combiner for seed yield /plant.

For early flowering Varuna x RS -3, RS -3 x PYSR -3, RS -3 x PR - 1D, RS -3 x B -85, Prakash x Pusa bold, Prakash x PR -ID and Prakash x B-85 were best combinations. The best crosses for early maturity were Prakash x B-85 followed by Prakash x Pusabold, RS -3 x B -85, PYSR -3 x B -85 and Varuna x RS -3 . For desirable plant height RS -3 x B-85 was the best combination. None of the crosses showed significant sca effect for primary branches/plant. For secondary branches/plant, PYSR -3 x Prakash recorded maximum sca effects followed by PR-1D x B -85. Varuna x Prakash was best cross for length of main shoot followed by Varuna x PR-1D, PYSR -3 x Prakash, RS -3 x PYSR -3, Pusabold x B -85 and PYSR -3 x B-85. The Pusabold x B -85 exhibited maximum effect for siliquae on main shoot followed by Pusabold x PR -1D, PR-1D x B-85, Varuna x PR - 1D, RS -3 x PYSR -3, Varuna x RS -3, RS-3 x Prakash and Prakash x PR-1D. PYSR-3 x Prakash was best combination for siliquae/plant followed

by PR-1D x B -85, PR-1D x B-85 which showed highest sca effect in desireable direction for number of seeds/siliqua. Highly significant

Tables 2 : General combining ability effects of parents for various quantitative characters.

Parent	Days to flowering	Days to Maturity	Plant height (cm)	No.of Primary branches/ plant	No.of Sec. branches/ plant	Length of Main Shoot (cm)	No. of siliqua on main Shoot	No.of siliqua/ plant	No.of seeds/ siliqua	1000-seeds weight (g)	Yield/ plant (g)
Varuna	-0.94**	0.16	-3.55**	-0.17	-0.54	-0.47	0.86*	-13.38	0.24	-0.01	0.22
RS-3	3.36**	4.79**	13.15**	0.47**	1.65**	0.60	-5.55**	34.44**	-0.50**	-0.09**	0.74**
PYSR-3	0.84**	0.57	6.67**	0.13	-0.61	0.05	-2.06**	-22.49**	0.16	0.09**	-0.37
Prakash	3.69**	6.06**	13.08**	-0.09	0.24	1.45**	-3.84**	-2.64	-0.80**	-0.01	-0.15
Pusabold	-1.60**	-1.80**	-4.40**	-0.02	1.09**	-1.69**	1.90	-20.90**	0.20	0.02	-0.08
PR-1D	-2.09**	-3.69**	-14.65**	-0.24	0.65	1.31**	5.94**	11.36	0.16	0.02	-0.07
B-85	-3.27**	-6.10**	-10.31**	-0.09	-0.31	-1.25**	1.75**	13.62	0.54**	-0.03	-0.30
EM (gi)	±0.20	±0.42	±1.37	±0.10	±0.39	±0.48	±0.38	±7.46	±0.17	±0.03	±0.19
EM (gi-gj)	±0.31	±0.64	±2.10	±0.15	±1.04	±0.74	±0.58	±11.39	±0.27	±0.04	±0.29

sca effects in desirable direction for 1000 - seed weight were also recorded in PYSR -3 x B-85, Pusabold x B -85, Varuna x PR -1D, Varuna x RS -3, RS-3 x PR-1D, Varuna x PYSR -3, RS -3 x B-85 and PYSR - RS -3, RS-3 x PR-1D, Varuna x PYSR -3, RS -3 x B-85 and PYSR -3 x Pusabold. The best combination for yield/plant was PYSR-3 X Prakash followed by PR-1D x B-85 and RS-3 PYSR-3.

DISCUSSION

Significant variances due to gca and sca for the days to flowering and maturity, plant height, length of main shoot, primary branches/plant, siliquae on main shoot and 1000-seed weight revealed the importance of both additive and non additive gene actions for these traits. The relative magnitude of gca and sca variances showed the predominance of additive and aditive x additive gene effects for all these traits, except 1000-seed weight. Predominance of additive gene action for these characters in Indian mustard have ben reported by singh (1973); Yadava *et al.*, (1976); Rehman *et al.*, (1977); Chanhan and Singh (1979); and Duhoon *et al.*, (1979). High sca variance for 1000-seed weight suggested that this character is predominantly controlled by non-additive genes. Similar results were obtained by Sharma (1975); Kashi Ram *et al.*, (1976) Labana *et al.*, (1978); Yadav *et al.*, (1979) and Govil *et al.* (1981). It was further noticed that secondary branches/plant, siliquae/plant, seeds/ siliqua and yield/plant were solely governed by additive genes. Importance of additive gene action tended to suggest that any standard selection procedure may be adopted for the improvement of these characters.

The results of present investigation revealed that Pusabold, PR - 1D and B -85 may be used as donor parents in the varietal hybridization programme for the development of early maturing and dwarf varieties of mustard as these varieties have negative gca effects and the characters are under pre-dominantly additive genetic control. Thus, sufficient improvement can be made by simple selection from the hybrid population. It was further evident from the results that the improvement in yield components like number of primary and secondary branches/plant, and siliquae/plant could be brought about by using RS -3 as a parent which has high positive gca effect for these characters. Similarly, Prakash and PR-1D may be used as donor parents in the hybridization for the improvement of length of main shoot. Other varieties which are likely to transmit other desirable characters like siliquae on main shoot and seeds/siliqua are PR -1D and B-85, respectively. Strain PYSR -3 may be used as donor parent in hybridization for the improvemwent in 1000 - seed weight. Among the parents tested, RS -3 was found good general combiner for yield/plant. A broad based population can be created by hybridization using above varieties which would serve as source populations for development of early maturing and high yielding varieties by standsrd selection procedures.

Sca estimates suggested that RS- 3 x PYSR -3, PYSR-3 x Prakash; PR-1D x B-85, PYSR-3 x B-85; Pusabold x B-85; Varuna x RS-3; Varuna x PR-1D, Pusabold x PR-1D; Varuna x Prakash; RS-3 x B-85 and Prakash x B-85 are the best combinations and may be used for exploiting sca effects through further breeding programme for producing superior types. It was observed that good general combiners usually showed high sca effects in cross combinations. The crosses where poor x poor and poor x high general combiners produced high sca efects may be attributed due to the presence of genetic diversity in the form of heterozygous loci for specific traits. The above crosses have desirable attributes and their exploitation in future breeding programme would be of immense value.

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Inheritance of quantitative traits in soybean

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ABSTRACT

A diallel cross analysis of soybean comprised of 6 parents, 15 F_1's and 15 F_2's were evaluated at two locations(Jabalpur having medium to heavy loamy soil and Badnawar with heavy black cotton soil). Results indicated that three characters viz; days to 50% flowering, days to maturity and plant height exhibited the important role of non-additive genetic variance while the other yield contributing components showed equal contribution of both additive and dominance genetic variances. Heritability estimates showed higher values in F_1 population for all the traits and the highest heritability value was observed forbiological yield/plant followed by 100 seed weight and days to maturity.

Key words :*Glycine max*; Soybean; Gene action; Inheritance; Quantitative traits

INTRODUCTION

The knowledge of gene action and type of genetic variances present in the population plays an important role in devising the suitable breeding approaches in the crop improvement programme. Such variance components studies, particularly in hybrids (F_1) and its segregating population (F_2) when tested across locations, provide more useful inferences about the type of gene action. Therefore, an attempt was made to know the nature and magnitude of gene action in soybean. *(Glycine max L)*

MATERIALS AND METHODS

Six varieties of diverse geographicial origin (JS-2, JS 75-1 and Kilitur from M.P.; T-49 from U.P. and Improved Pelican and Cocker Stuart from U.S.A.),were crossed in all possible combinations, excluding reciprocals. Six parents, 15 F_1 s and 15 F_2s were grown in a RCBD with three replications under two diverse agroclimatic conditions viz., (i) Jawaharlal Nehru Krishi Vishwa Vidyalaya Research Farm, Jabalpur, having high rainfall (1000 - 1500 mm) with medium clay soils and (ii) Cotton Research Station, Badnawar Dist.(Dhar) with

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moderate rainfall (800 - 1000 mm) and heavy black cotton soil during karif 1981. The sowing was done in single row plots each with 3 meters row length having row and plant spacings of 50 cm and 15 cm, respectively . One row of each parent and F_1 and three rows of each of F_2s were planted in each replication. Observations were recorded on 10 randomly selected competitive plants on 10 quantitative traits viz; days to 50% flowering, days to maturity, plant height, number of primary branches/plant, number of pod bearing nodes/plant, number of pods/plant, biological yield/plant, number of grains/plant, grain yield/plant and 100 -seed weight. The estimation of genetic components of variance using numerical analysis was done as per procedure given by Jinks and Hayman (1953) and Hayman (1954). The heritability (narrow sense) was calculated.(Mather and Jinks,1971).

RESULTS AND DISCUSSION

The results revealed that the estimates of additive genetic component(D) were positive and highly significant for days to 50% flowering, biological yield/plant, number of grain /plant, grain yield/plant and 100 - seed weight in both the generations, suggesting that the additive genetic component played an important role in the expression of these traits.

The effects of non-additive genes H_1 were in higher magnitude as compared to the additive gene effects (D). The estimates of dominant component (H_1) showed positive and significant values for days to maturity,plant height,number of pod bearing nodes, biological yield/plant, grain yield/plant and 100-seeds weight in both the generations, suggesting the important role of dominant genes in the expression of these characters.

The estimates of dominant component (H_2) indicated that the estimates of H_2 were smaller than H_1 in both the generations for all the characters. Similarly, the values of the F_1 generation were also of lower magnitude as compared to their corresponding F_2 values in both the dominant component of variances (viz, H_1 and H_2), suggesting that the segregating generation (F_2) possessed higher values as compared to F_1 generation. The results indicated that four characters (viz, days to 50% flowering, biological yield/plant, grain yield/plant and 100-seed weight) exhibited positive and highly significant dominant effects in F_1 and F_2 populations.

The positive and negative estimates of H^2 indicated mean direction of dominance and recessive genes towards positive and negative sides, respectively. The results showed that five characters(viz; days to 50% flowering days to maturity, biological yield/plant,number of

Table 1 : Polled estimates of genetic components of variances of crosses grown at Jabalpur and Badnawar .

genetic components of vari.	generation	days to 50% flowering	Days to Maturity	Plant Height	No. of Primary bra./pl.	No.of pod bearing nodes
D	F_1	32.79**	11.91	632.90	0.48	387.30
	F_2	29.36*	20.81*	500.30	0.23	915.80
H_1	F_1	173.50**	40.83*	1940.00*	2.70**	1979.00**
	F_2	642.60	205.50*	9361.00*	9.28	11460.00**
H_2	F_1	145.00**	29.27	1316.00	2.35**	1623.00
	F_2	535.70**	135.70	6832.00	8.80	10330.00**
h^2	F_1	1.19	2.99	-11.32	0.03	-41.13
	F_2	2.88	0.79	- 2.71	-0.09	- 2.88
F	F_1	32.48	21.19	755.40	0.61	366.70
	F_2	68.10	70.80	1515.00	0.33	1951.00
$(H_1/D)^{1/2}$	F_1	2.30	1.85	1.75	2.37	2.26
	F_2	4.68	3.14	4.33	6.29	3.54
$(H_2/4H_1)$	F_1	0.21	0.18	0.17	0.22	0.20
	F_2	0.21	0.16	0.18	0.24	0.23
$\frac{(4DH_1)1/2 + F}{(4DH_1)1/2 - F}$	F_1	1.55	2.85	2.03	1.73	1.53
	F_2	1.66	3.36	2.08	1.25	1.86
Heritability	F_1	18.43	34.59	32.79	12.87	16.61
	F_2	4.84	13.27	5.95	2.38	8.53
E	F_1	1.02	0.72	28.26	0.29	83.18
	F_2	0.68	0.33	14.19	0.17	78.71

different characters in F_1 and F_2 populations of diallel

No. of pod/ plant.	Biological yield/plant. (g)	No.of grains/plant.	Grain yield/ plant. (g)	100 seed weight. (g)
3697.80*	1854.80*	13130.00**	145.30**	13.41*
3773:00	1817.00**	17610.00*	82.15**	14.85*
7615.00**	2019.00*	38240.00	316.80*	33.98*
41070.00	6154.00*	159100.00	774.60**	209.60**
6063.00*	1698.00*	28960.00	258.50*	24.79*
3424.00	5305.00	126600.00	667.20**	167.30**
-105.65	588.27	613.70	9.67	-0.10
438.86	7.86	1778.36	11.07	-0.21
1703.00	1656.80	11340.00	120.80	10.39
8004.00	2314.00	33560.00	100.00	30.60
1.68	1.04	1.71	1.48	1.59
3.22	1.84	3.01	3.07	3.76
0.20	0.21	0.13	0.20	0.18
0.21	0.22	0.20	0.21	0.20
1.46	2.50	1.68	1.78	1.64
1.95	2.06	1.93	1.50	1.75
26.47	48.95	28.45	33.74	35.10
10.05	27.62	12.07	10.35	7.60
394.70	392.70**	1531.00	22.33	0.30
172.50	230.90	686.10	9.39	0.38

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

grains/plant and grain yield/plant) possessed positive effects in F_1 and F_2 generations, indicating the mean direction of dominance as well as excess of dominant genes in the expression of these characters. On the other hand, plant height , number of pod bearing nodes and 100-seed weight exhibited the values in negative direction, showing the excess of recessive genes for these traits, in F_1 and F_2 generations.

The estimates of mean degree of dominance viz; $(H_1 / D)^{1/2}$ indicated that all the characters possessed the value of mean degree of dominance greater than one in both the generations, suggesting the presence of over dominance. The estimates of F_1 generation had the lower values of dominant genes over the F_2 generation in all the characters.

The deviation of $H_2 / 4H_1$ from the theoretical value (0.25) manifested unequal distribution of genes showing positive and negative effects. The results exhibited that number of primary branches/plant and biological yield/plant had the proportion of dominant genes with positive effects in F_1 and F_2 generations equal to 0.25, suggesting symmetrical distribution of positive genes in the expression of these traits.

The heritability (narrow sense) estimates indicated that all the characters had the higher magnitude of heritability estimates in F_1 as compared to F_2 generation. The highest heritability estimates in F_1 was recorded for biological yield/plant (48.95%) followed by 100-seed weight (35.1%), days to maturity (34.59%), grain yield/plant (33.74%), plant height (32.79%) and number of grains/plant (28.45%). On the other hand , the lowest heritability values in F_1 was observed for number of grains/pod (8.14%) and number of primary branches/plants (12.87%). Similarly the highest heritability estimates in F_2 was recorded for biological yield/plant (27.63%), followed by days to maturity (13.27%) number of grains/pods (12.92%), number of grains/plant (12.07%), and number of pods/plant (10.05%). All other characters had heritability values of lower magnitude in positive direction.

The experimental, findings of the present studies indicated the significant role of both additive and non-additive genetic variances for days to 50% flowering, biological yield/plant, grain yield/plant and 100-seed weight. Results of Jyang and Bak (1977) showed partial dominance for days to 50% flowering. Substantial contribution of dominance variance was observed for days to maturity and plant height which was in confirmation of the results reported by Leffel and Weiss (1958), while Hanson and Weber (1961) reported the important role of additive genetic variance for this trait. On the other hand, Bhatade *et al* (1977), found the existstance of additive genetic variance for plant height. Number of pod bearing nodes showed the significant role of non-additive variance which was not in agreement with the results reported by Singh *et al*(1974) Number of pods/plant and biological yield/plant exhibited equal contributions of both additive and non-additive genetic components while Singh *et al* (1974), showed dominance variance for this trait. The other two important traits viz; grain yield/plant and 100-seed weight showed equal contribution of both additive and dominance variances which was not in confirmation with the results reported by Hanson and Weber (1961), Bhatade *et al* (1974). confirmed the results of the present findings for 100-seed weight.

An overall observations of these studies indicated that the developmental traits such as days to 50% flowering and days to maturity showed a very high magnitude of dominance variance. Hence, the improvement of these traits in these populations will be possible by practicing the selection in the late generation. Majority of the yield attributes and yield showed the equal contribution of both additive and dominance components of variances. Therefore, the improvement in seed yield in these populations may be possible by following pedigree selection aimed at the development of suitable high yielding genotypes of soybean.

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Combining ability and genetic architecture of oil content in linseed

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ABSTRACT

The inheritance of oil content was studied through a 10 x 10 dailiel set. Both additive and non-addiitive components of genetic variation were significant. Parents namely *Neelum, Hira, EC 41583 and NPhyb42 exhibited significant positive* gca effects and the use of these parents for evolving inherently superior genotypes are advocated. As a few cross combinations also showed significant positive sca effects intermaating of early generation promising segregants is also suggested.

Key words : Combining ability; Genetic architecture; *Linum usitatissimum.*

INTRODUCTION

Linseed *(Linum usitatissimum L)* is an important oilseed crop of India. The oil content in the existing cultivars varies from 35 to 48 percent. Hence, it is worthwhile to generate basic genetic information to formulate strategies for improving the oil content in Linseed which is the real and most desirable end product.

MATERIALS AND METHODS

Ten genotypes of linseed viz; Neelum, Hira, EC 41583, NP.86, EC 22604, Afg.11, B 67, NP 78, NPhyb 42 and A 7-1-1 differing widely in morphological characteristics were crossed in all possible combinations (excluding reciprocals). All the parents and their 45 F_1 s and 45 F_2s, were grown in a RBD with three replications at the experimental farm of C.S.A U. of Agriculture and Techonology, Kanpur. Spacing was maintained 45 cm between and 10 cm with rows. The bulk seed sample of each progeny collected at the time of harvesting from all the replications was used for analysing oil content. The angular transformed data were further utilised for statistical analysis. The analysis of general and specific combining ability (gca and sca) variances and effects was done according to Griffings (1956) method II model I. The estimates of genetic components namely D, H_1, H_2, h^2, ©F and E alongwith different ratios were obtained using the method

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suggested by Hayman (1954)

RESULTS AND DISCUSSION

The analysis of variance suggested the presence of sufficient amount of genetic variability with respect to oil content among the progenies including parents, F_1 s and F_2 s.

Table 1 : Analysis of variance for comnining ability for oil content in linseed.

Source	d.f.	Mean sum of squares	
		F_1	F_2
General Comnining ability (gca)	9	4.23**	5.02**
Specific Combining ability (sca)	45	0.88**	2.03**
gca / sca		4.80	2.47
Error	108	0.02	0.02

** Significant at $P = 0.01$

The mean sum of squares for general combining ability and specific combining ability were found to be highly significant in both the generations indicating that both additive and nonadditive gene effects were important for oil content (Table 1). Magnitude of general combining abiliy variances were much higher than specific combining ability variances, indicating preponderence of additive gene action for the expression of this trait.

The estimates of D, H_1 ,H_2,h^2 , F and E along with different proportions have been presented in Table-2. The genetic parameter©D, which measures the variance due to additive genetic effects was significant. H_1 , which measures the variance due to dominance component was also significant. Between the two components, the magnitude of H_1 was relatively magnitude of H_1 was relatively higher than the corresponding D component. Further, the ratio $(H_1/D)^{0.5}$, which measures the average degree of dominance also confirmed the presence of over dominance. The significant positive value of ©F, indicated the presence of more number of dominant genes involved in its inheritance. It was further confirmed when the ratio $(4DH_1)^{0.5}$ +F and $(4DH_1)^{0.5}$ -F attained the value of 1.64 which is more than unity. This suggested that the dominant genes were more frequently distributed than

Table 2: Estimates of genetic components and their ratios for oil content in linseed.

Components	F_1		F_2		Ratios	F_1	F_1
D	2.34	±0.47	2.35**	±0.95	$(H_1/D)^{0.5}$	1.21	3.95
H_1	3.48**	±1.01	36.82**	±8.14	$H^2/4H$	0.22	0.19
H_2	3.18**	±0.86	28.22**	±6.91	$\frac{(4DH_1)^{0.05}+F}{(4DH_1)^{0.05}-F}$	1.64	1.78
h^2	0.72	±0.57	2.14	±1.15	h^2/H^2	0.22	0.07
F	1.39	±1.10	5.27	±4.41	Heritability	49.26	30.65
E	0.08	±0.14	0.06	±0.28			

* Significant at P=0.05; ** Significant at P=0.01

the recessive genes. The ratio H_2 and $4H_1$ deviated from theoretical value of 0.25,revealing thereby the asymmetrical distribution of positive and negative genes among the parents. The ratio h^2/H_2 was found significantly less than unity, suggesting thereby that one major gene group is possibly controlling the inheritance of this character.

The heritability in narrow sense was observed to be high. The estimation of gca and sca with respect to parents, F_1 s and F_2 s has been presented in Table 3. The parent Ec41583 exhibited the highest gca effect followed by NP hyp 42 and Neelum. A sigficant positive association of gca effects and array means was observed but contrary to this, no association was recorded between gca effects and *per se* performance. The results with respect to the absence of correlation between gca and *per se* performance have been reported by Nanda and Gupta (1967), Yadava and Gupta(1975) and Kumar *et al.* (1984).

An analysis of sca revealed that only 21 cross combinations exhibited significantly positive sca effect for oil content. The cross EC 22604 x NP78 possessed the highest sca effect (2.61). Whereas the minimum sca effect was recorded for a cross NP86 x NP hyb 42(0.08). Five cross combinations with high sca effects in that order included Neelum x NP78, Neelum x A7-1-1, Hira x EC 22604,Hira x Afg 11, NP86 x Afg 11 and Np 86 x NP78. It was observed that most of the crosses

Table 3: Estimates of gca effects (diagonal), sca efects (above diagonal) in F_1 and (below diagonal)sca effects in F_2 for oil content in linseed.

	Neelam	Hira	EC 41583	NP86	EC 22604	Afg11	B67	NP78	NP hyb 42	A 7-1-1
Neelum	0.24**	-0.05**	-0.07**	-0.69**	-0.90**	-0.46**	1.39**	0.70**	-0.50**	0.29**
Hira	0.81**	0.11**	-0.12**	-0.53**	0.17**	-0.63**	1.65**	-0.60**	-0.19**	-0.18**
EC 41583	0.32**	1.02**	1.30**	0.36**	-0.01**	-0.60**	0.70**	-1.47**	0.39**	1.00**
NP 86	-1.68**	0.86**	-1.47**	-0.27**	-0.42**	-0.31**	-0.66**	-1/30**	0.08**	0.30**
EC 22604	-0.89**	0.21**	0.93**	-0.67**	-0.14**	-0.58**	-1.17**	2.61**	0.34**	0.01
Afg 11	0.12**	1.90**	-1.37**	0.21**	-1.13**	-0.46**	-0.76**	1.91**	-0.79**	-0.02
B 67	-0.93**	-1.40**	-0.47**	1.21**	-0.44**	-0.70**	-0.39**	-0.46**	-1.46**	-0.52**
NP 78	0.23**	-0.87**	-0.70**	1.01**	-0.09**	1.95**	-0.04**	-0.41**	-2.09**	0.46**
NP hyp 42	1.57**	-0.63**	-1.32**	0.04**	1.36**	-2.85**	-0.12**	-2.85**	0.62**	0.47**
A 7-1-1	0.71**	-0.96**	-0.41**	-0.54**	-3.07**	-1.52**	-0.12**	2.41**	-0.06**	-0.60**

SE $(g_1) = 0.01$ SE $(g_1 - g_1) = 0.02$ SE $(s_{ij}) = 0.02$

** Significant at P = 0.01

involving the best nicking parent, EC 41583 and NPhyb 42, had low or negative sca efects in F_1 and F_2 generations, indicating lack of genetic diversity of oil content in these parents. Considering the relative importance of additive and non-additive gene effects for the expression of this trait it seems desirable that such breeding programme may be formulated for improving oil content in linseed that may mop up the fixable gene effects and at the same time maintain considerable amount of heterozygosity for exploiting the dominance effect. Intermating of selects in early generations possibly through biparently mating, can be used for exploiting both the types of gene action. This would not only break the undesirable linkage groups but also increase genetic plasticity through evolution of diverse recombinents.

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Dormancy in kernals of spanish and virginia bunch varieties of groundnut

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ABSTRACT

Investigation on 82 varieties of Spanish and Virginia bunch type groundnut was made to find out the extent of dormancy present after 3,10,20,30,40 and 50 days rest period. Considerable variability in seed dormancy was observed among varieties within the Spanish and Virginia groups. The Virginia bunch varieties or their crosses viz; G-201, IC GS-6, Robout-33-1 and (TMV-10xRobout-33-1)-2 were more dormant as compared to most of the Spanish types tested. Among the Spanish varieties, RSHY-6, IC GS-21, IC GS-30, IC GS-57, TG-9 and TG-17 were the promising dormant strains which can be utilized in the crossing programme for introducing dormancy into the released high yielding but non-dormant cultivars.

Key words :Dormancy; Virginia; Spanish; Bunch types; Rest period; *Arachis hypogaea*

INTRODUCTION

In groundnut (*Arachis hypogaea*), the kernels of Spanish and Valencia bunch types are usualy non-dormant, whereas those of Virginia bunch and runner varieties are dormant (Rao, 1976). The non-dormant character in Spanish and Valencia bunch types is considered a serious agricultural defect due to considerable loss of produce resulting from sprouting of nuts in the field or in the stack on threshing floor. Accordingly the *kharif* crop becomes unfit as seed (Seshadri, 1961). The sprouting is more in case of heavy soils with greater water retention capacity. About 20-50 per cent loss in bunch groundnut pod yield has been reported due to *in situ* germination (Reddy, 1982; Nagarjun and Radder, 1983). In the Spanish bunch type, cultivars possessing 3-4 weeks dormancy will be able to save the field losses due to *in situ* sprouting when the mature crop is caught in untimely rains. Hence it is essential to introduce dormancy in the non-dormant bunch varieties to prevent sprouting of pods/kernels in the field at maturity.

Lack of dormancy in bunch types has been described as an inherent property of seed and does not primarily depend on soil conditions

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(Hull,1937; Lin and Lin,1971; Weiss,1983). Occurence of seed dormancy is reported on a few dormant Spanish bunch strains (Patil,1973; Patil and Chandra Mouli, 1978) but periodical data on extent of dormancy present during the rest period (storage) is lacking for most of the varieties developed at various centres. Hence as a first step towards introducing dormancy into the recommended high yielding varieties, it was considered useful to study the promising varieties of Spanish bunch groundnuts to know the extent of dormancy present in them.

MATERIALS AND METHODS

During the summer, 1982-83 and 1983-84 and *kharif*,1983-84 seasons 82 varieties of bunch groundnut were screened for seed dormancy after 3,10,20,30,40 and 50 days storage as pods after harvest. These varieties comprised of four Virginia bunch types, five cross derivatives between Spanish and Virginia bunch and 73 Spanish bunch types sown in various breeding trials for yield evaluation. The source of varieties are indicated in the various tables.

The material was harvested by the plant breeding section in a phased manner depending upon the maturity. After harvest the pods were allowed to dry for two days on the plants in sunshine. On the third day, fully mature pods were picked and a part of them were immediately shelled for germination test. Rest of the pods collected in cloth bags were dried again for 4-5 days to ensure complete drying and safe storage at room temperature.

The germination test, at three days after harvest was conducted at $27\pm1°$ C for each variety, in three replications of 20 kernels each wrapped in rolls of sterilized germination paper soaked in distilled water. The germination count was recorded after six days.

The varieties giving approximately 70 per cent germination were considered non-dormant and were eliminated from further study. Remaining varieties were tested for germination after 10 days rest period. Subsequent germination tests for varieties giving less than 70 per cent germination were done at 10 days intervals till the varieties recorded 70 per cent germination.

The data were subjected to statistical analysis.

RESULTS AND DISCUSSION

Among the Spanish bunch varieties studied for presence of seed dormancy, 17 cultivars proved to be non-dormant giving 70-100 per cent germination three days after harvest. Thirty four varieties giving 70

Table 1 : Spanish bunch type varieties of groundnut showing 70 per cent or more germination after 3,10 and 20 days rest period

Sr. No.	Variety	Source	Germination (%) after rest period (days).
1.	2.	3.	4.
			3 days
	Summer, 1982-83		
1.	CGC-1	AICRPO Coord. Unit	70.4 (88.7)
2.	GG-2 (J-1)	Junagadh (Gujarat)	68.4 (86.5)
3.	CD (P=0.05)		9.1
	Kharif.1983		
4.	DH-12	Dharwad (Karnataka)	70.1 (88.4)
5.	DH-13	"	70.1 (88.4)
6.	Phule Pragati (JL-24)	Jalgaon (Maharashtra)	77.9 (95.6)
7.	OG-52-1	Chiplima (Orissa)	91.5(100.0)
	CD (P=0.05)		12.6
	Summer, 1983-84		
8.	CGC-3	AICRPO Coord. Unit	60.8 (76.2)
9.	CGC-4018	"	63.9 (80.7)
10.	ICGS-43	ICRISAT, Hyderabad	57.9 (71.8)
11.	ICGS-50	"	72.5 (91.0)
12.	ICGS-52	"	66.3 (83.8)
13.	ICGS-53	"	84.3 (99.1)
14.	OG-35-1	Chiplima (Orissa)	56.8 (70.1)
15.	RSHY-2	RRS, Hyderabad	91.5(100.0)
16.	TCG-1706	Tirupatti (AP)	62.3 (78.4)
17.	TCG-1707	"	64.8 (81.9)
18.	TCG-1708	"	60.1 (75.1)
	CD (P=0.05)		8.9
			10 days

Summer, 1982-83

1. AH-814-1	Aliyarnagar (TN)	63.4 (80.0)
2. CO-1	"	70.1 (88.4)
3. DH-320	Dharwad (Karnataka)	72.9 (91.4)
4. DH-330	"	75.9 (94.1)
5. S-206	Raichur (Karnataka)	79.2 (96.5)
6. JH-107	Junagadh (Gujarat)	67.7 (85.6)
7. JH-171	"	63.5 (80.1)
8. JH-223	"	71.4 (89.8)
9. JH-257	"	70.7 (89.1)
CD (P=0.05)		11.8
Kharif, 1983		
10. J-2 (28-4-1)	"	67.9 (85.9)
11. (GAUG-IxChico)-16-3	"	67.4 (85.2)
12. (GAUG-IxChico)-4-2	"	98.7 (100.0)
13. (GAUG-IxRajval.)-56/1-3	"	91.5 (100.0)
14. (TNV-10xChico)-B_1 -1	"	62.3 (78.4)
15. (TMV-10xChico)-B_1-2	"	66.2 (83.8)
16. (JH-89xR-33-1)-E-1	"	75.2 (93.5)
17. (JH-89xNCAC-962)-E_1-2	"	80.6 (97.3)
18. (JH-89xR-33-1)-P_5-3	"	89.7 (100.0)
19. (JH-171x55-437)-B_4-1	"	91.5 (100.0)
20. (NCAC-274xChico)-B_2-1	"	98.7 (100.0)
21. (MKS-7xR-33-1)-L-B_1-4	"	91.5 (100.0)
CD (P = 0.05)		12.9
Summer, 1983-84		
22. AH-8446	Aliyarnagar (TN)	73.4 (91.8)
23. CGC-4	AICRPO Coord.Unit	59.1 (73.6)
24. (GDMxJ-11)-1-Rose	Junagagh (Gujarat)	69.2 (87.4)
25. (GDMxJ-11)-1-8	"	74.1 (92.5)
26. (3-5xUS-12-A)-32-7	"	82.5 (98.3)
27. (3-5xUS-12-A)-101-1	"	91.3 (100.0)
28. GAUG-1	"	69.2 (87.4)
29. J-11	"	63.8 (80.6)
30. ICGS-2	ICRISAT, Hyderabad	68.4 (86.5)
31. ICGS-3	"	73.4 (91.8)
32. ICGS-26	"	60.3 (75.4)
33. ICGS-59	"	98.7 (100.0)
34. Kisan	Chiplima (Orissa)	84.3 (99.1)

	CD (P=0.05)		11.6	
			20 days	
	Summer, 1982-83			
1.	ICGS-15	ICRISAT, Hyderabad	72.5	(91.0)
2.	RSHY-1	RRS, Hyderabad	59.7	(74.5)
3.	RSHY-3	"	57.5	(71.1)
4.	TG-3	BARC, Tromby (Maharashtra)	73.8	(92.2)

1	2	3	4	
5.	X-1-21B	Kadiri (AP)	62.4	(78.6)
	CD (P=0.05)		8.7	
			20 days	
	Summer, 1983-84			
6.	CGC-2	AICRPO Coord.Unit	61.2	(76.8)
7.	CGC-7	"	71.6	(98.9)
8.	RSHY-4	RRS, Hyderabad	67.4	(85.2)
9.	ICGS-12	ICRISAT, Hyderabad	66.8	(84.5)
10.	ICGS-37	"	57.7	(71.5)
11.	ICGS-44	"	59.9	(73.5)
	CD (P =0.05)		12.5	

Figures outside parenthesis are angular transformed values and those in parenthesis are re-transformed values.

Table 2 : Germination pattern of Spanish and Varginia bunch type varieties of groundnut after 3 to 50 days rest period.

Sr. No.	Variety	Source	Germination (%) after rest period (days). 3	10	20	30	40	50
1	2	3	4	5	6	7	8	9
	Summer, 1982–83							
1.	ICGS-6*	ICRISAT, Hyderabad	9.7 (2.8)	16.2(7.8)	45.9 (51.6)	62.6 (78.8)	–	–
2.	TG-17	BARC, Trombay (Maha rastra)	13.2 (5.2)	19.5(11.1)	33.2 (30.0)	66.5 (84.1)	–	–
	C D (P =0.05)		9.1	11.8	8.7	NS	–	–
	Summer, 1983–84							
3.	DH-8	DHARWAD (Karnataka)	33.0 (29.6)	35.2 (33.2)	46.9 (53.3)	55.1 (67.2)	–	–
4.	Kadiri-3 (R-33-1)*	Kadiri (AP)	22.8 (15.0)	28.8 (23.2)	52.9 (63.5)	88.2 (99.9)	–	–
5.	TG-9	BARC, Trombay(Maharastra)	1.25(0.1)	25.0 (17.9)	37.2 (36.6)	60.1 (75.1)	–	–
6.	(TMV-10xR-33-1)-2*	Junagadh(Gujarat)	1.25(0.1)	22.6 (14.8)	51.9 (61.9)	68.7 (86.8)	–	–
7.	ICGS-1	ICRISAT, Hyderabad	5.1 (0.8)	25.2 (18.1)	50.0 (58.7)	59.7 (74.6)	–	–
8.	ICGS-4	"	27.5 (21.3)	33.2 (30.0)	48.8 (56.6)	66.2 (83.8)	–	–
9.	ICGS-5	"	7.1 (1.5)	34.2 (31.6)	42.1 (44.9)	70.7 (89.1)	–	–
10.	ICGS-11	"	1.25(0.1)	10.9 (3.5)	54.9 (67.1)	61.9 (77.8)	–	–
11.	ICGS-19	"	1.25(0.1)	27.6 (21.5)	53.9 (65.3)	75.2 (93.5)	–	–
12.	ICGS-21	"	1.25(0.1)	10.9 (3.6)	29.8 (24.7)	43.1 (46.6)	56.9 (70.3)	–
13.	ICGS-30	"	1.25(0.1)	1.25(0.1)	1.25(0.1)	22.8 (15.0)	70.5 (88.9)	–
14.	ICGS-33	"	1.25(0.1)	41.1 (43.2)	52.1(62.3)	84.3 (99.0)	–	–

Table 2 (Continued):

1	2	3	4	5	6	7	8	9
15.	ICGS-35-1	ICRISAT,Hyderabad	1.25(0.1)	31.9 (27.9)	53.8(65.2)	57.0 (70.3)	-	-
16.	ICGS-44-1	"	12.9 (5.0)	18.0 (9.6)	54.8(66.8)	64.7 (81.7)	-	-
17.	ICGS-51	"	1.25(0.1)	12.9 (5.0)	18.4(10.0)	77.9 (95.6)	-	-
18.	ICGS-57	"	1.25(0.1)	31.8 (27.7)	37.0(36.3)	44.0 (48.3)	53.8 (65.2)	60.7 (76.0)
19.	G-201*	Manipuri	1.25(0.1)	5.1 (0.8)	12.9(5.0)	18.4 (10.6)	37.2 (36.6)	59.4 (74.0)
20.	RSHY-6	RRS Hyderabad	1.25(0.1)	1.25(0.1)	1.25(0.1)	26.6 (19.9)	37.2 (36.6)	51.9 (62.0)
	CD (P = 0.05)		8.9	11.6	12.5	12.0	12.3	10.9

* Virginia bunch varieties

Figures outside parenthesis are angular transformed values and those in parenthesis are re-transformed values.

per cent or more germination at 10 days rest period indicated presence of 3-9 days dormancy. The more dormant 11 varieties reached 70 per cent germination after 20 days storage. (Table 1).

Considerable dormancy was observed in 16 Spanish bunch and 4 Virginia bunch varieties, recording 70 per cent germination after 30-50 days storage . Among these varieties the most promising dormant Spanish types giving 62.0 to 88.9 per cent germination after 40-50 days rest included IC GS-21, IC GS-30, IC GS-57 and RSHY-6 (Table 2).

The Virginia bunch varieties or their crosses viz; G-201, ICGS-6, Robout-33-1 and (TMV-10 x R-33-1)-2 were more dormant than most of the Spanish bunch types tested (Table 1 and 2). Of the Virginia bunch varieties tested, G-201 had the longest dormancy with only 10.6 per cent germination upto 30 days and requiring 50 days rest period to reach 70 per cent germination (Table 2).

The results demonstrated availability of Spanish bunch types like RSHY-6,IC GS-21 IC GS-30, IC GS-57, TG-9 and TG-17 with dormancy in kernels, to the extent present in Virginia bunch varieties. These can be utilised for introducing dormancy in high yielding but non-dormant cultivars like Co-1, GG-2, Kisan, Phule pragati (JL-24), S-206 and DH 330 which dare recommended for cultivation.

A considerable variability in seed dormancy period was observed among varieties within the Virginia and Spanish groups. Genetic differences in seed dormancy within strains and botanical groups of groundnut have been demonstrated by different investigators (Hull, 1937; Lin and Chen, 1969; Sobhan and Khandakar, 1980). Lin and Chen (1969) studied 56 cultivars of groundnut and divided them into four classess, non-dormant types, dormant for 2-4 weeks, dormant for 5-8 weeks and dormant for more than 9 weeks. In reciprocal crosses involving varieties with differing intensities of dormancy, F_2 and F_3 behaviour was monogenic with D symbolizing the dominant gene controlling seed dormancy (Lin and Lin, 1971). Hull (1937) has reported that under conditions obtaining in the U.S., rest peiod of Spanish and Valencia types ranged from 9 to 50 days. He assumed multigenic control of, "Seed conditions necessary to rest", with a normal frequency distribution. Marked transgressive segregation over the dormant parent occured in four crosses.

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Combing ability in Indian mustard
1. some developmental traits

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ABSTRACT

An eight parent diallel including reciprocal crosses was grown in three environments and the data obtained on different developmental traits viz; days to first flowering, 50% flowering and maturity, plant height, primary branches, secondary branches and total inflorescence per plant were subjected to combining ability analysis for different environments as well as pooled over the environments. It was revealed that both GCA and SCA variances were significant for these traits but GCA was more important. Sensitivity to change in environment was observed for GCA, SCA and reciprocals. However, GCA was more sensitive to such changes. Assessment of parents and crosses in a number of environments are advocated.

Key words : Combining ability; Environment - combining ability interaction; gene effects diallel; Indian mustard

INTRODUCTION

The analysis of combining ability is used to assess the nicking ability of genotypes and thus, helps in identifying parents those are likely to be successful to get desirable segregants in a hybridization programme. Genetic evaluation is made to know the nature of genetic variation present in the base population through various genetic parameters. An understanding of the susceptibility of these genetic parameters to change in environment is of great importance to a breeder to initiate a successful breeding programme. The present study deals with the estimates of the combining ability effects in three environments for a number of developmental traits in Indian mustard (*Brassica juncea*(L) Czern and Coss.)

MATERIALS AND METHODS

Eight cultivars of Indian mustard (*Brassica juncea* (L.) Czern and Coss.) were selected and crossed in all possible combinations including reciprocals. Fiftysix crosses thus obtained were grown along with eight parents in three different environments provided by locations and sowing dates i.e.E_1, (Hisar, normal sown); E_2, (Hisar, late sown); and E_3, (Bawal,normal sown). The plantings were done in a RBD Design with

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three replications in each environment. There were single row plots; 5 m long spaced 30 cm apart and 15 cm between plants within a row.

The observations for days to first flowering, 50% flowering, maturity,plant height (cm), primary branches, secondary branches and total inflorescence per plant were recorded on 5 randomly selected plant. The data were subjected to analysis of variance and combining ability analysis (Method I, Model II of Griffing 1956) in different environments as well as pooled over environments for each characters.

RESULTS AND DISCUSSION

The mean squares due to general combining ability (GCA) were significant for all the characters studied in all the environments whereas the mean squares associated with specific combining bility (SCA) were non-significant for days to maturity, primary branches and secondary branches per plant in E_1 ; for plant height in E_2, and for days to maturity in E_3 (Table 1) thus, indicating the importance of both additive as well as non-additive gene effects for these traits and presence of significant genotypes X environment interactions. Significant reciprocal mean squares were recorded in all the environments for days to first and 50% flowering whereas, for days to maturity, it was significant in E_1 and E_2 and for plant height and *primary branches in* E_1.

From pooled analysis of variance (Table 2), it was observed that both GCA and SCA mean squares were significant for days to first and 50% flowering, plant height, secondary branches and total inflorescence per plant, whereas, for primary branches and days to maturity only GCA mean squares were significant. The earlier reports of Labana et al. (1975), Yadav et al.(1976) and Kumar et al.(1982), reported similar results. However, those studies were in single environment.

Mean squares associated with reciprocals were significant for days to first flowering, 50% flowering and maturity along with plant height. Labana *et al.* (1978) also reported reciprocal effects for seed yield and some of its components.

Environment X GCA interactions were significant for days to first flowering, 50% flowering , maturity and plant height whereas, SCA x Environment interactions were significant for days to first and 50% flowering, plant height and primary branches. However, mean squares associated with reciprocal x Environment were significant for days to 50% flowering and maturity, and total inflorescence per plant. Therefore, the change in environment showed selective sensitivity of

GCA and reciprocal effects. The studies on relative environment (Jinks and Stevans, 1959 and Brease, 1969) indicated that dominance component has been more, equal or less sensitive to environmental change than the additive component. On the basis of the extent of sensitivity of the genetic parameters to the environment along with the reciprocal differencees, it was observed that assessment of parents and crosses in one or few environments will not help in identification of parents/crosses which are equally good on the basis of GCA and SCA over a number of environments. Also the characters specific influence of GXE interactions on reciprocal effects shall create ambiguity while assessing suitable combinations and order effects.

GCA was also predominant for days to first flowering, 50% flowering and maturity and plant height in all the environments except for days to maturity in E_2 as revealed by GCA/SCA ratio (Table 3). However, SCA was more important for branching behaviour. This was further confirmed by general predictability ratio (20^{-2} g / 20^{-2}g + 0^{-2} s) as suggested by Baker *et al.* (1978) (Table 3). Closer this ratio to unity greater will be the predictability based on GCA alone. It may be emphasized here that although the importance of GCA for these characters was also revealed by GCA/SCA ratio but predictability ratio further clarified that the performance of the progeny for only to maturity could be predicted on the basis of GCA of the parents. As expected, the value of predictions based on early generation performance will be high if the genetic variance of the characters in question was relatively free from non additive effects and the predicted improvement can be effectively realized. This was further confirmed by hertability (Hn) estimates.

Narrow sense heritiability was high for days to first and 50% flowering, days to maturity and plant height. Thus, it appeared that desirable response to selection would be achieved for these traits. These results are similar with the earlier observations (Labana *et al.*, 1980, Chaudhary and Sharma, 1982) for different traits.

On the examination of GCA effects and *per se* performance it was revealed that none of the parental geno type has desirable GCA and *per se* performance for all these traits. The parental genotype varuna was the best general combiner for earliness followed by RH30 and Pusa Bold. RLM 198 was found to be good general combiner for plant height primary branches and total inflorescence per plant (Table 4).

Study of SCA effects of the crosses revealed that the crosses having significantly high SCA effects involved good, average and poor general combining parents. Among the crosses selected for earliness, Prakash x Varuna was the best cross having high negative SCA effects

Table 1 : ANOVA for combining ability F_1s in three environments.

Source of variation	D.f.	Env.	No.of days to first flowering.	No.of days to 50% flowering.	No.of days to maturity	Plant height	No.of primary branches/ plant.	No.of second branches/ plant.	No.of total inflo./ plant.
General	7	E1	672.76**	742.33**	15.41**	1949.17**	2.00**	13.61*	39.52**
combining		E2	84.87**	77.16**	9.20**	719.94**	3.24**	23.15**	35.34**
ability		E3	239.99**	220.70**	6.70**	889.88**	3.77**	10.23**	32.62**
Specific	28	E1	18.66**	19.46**	1.16	82.21**	0.39	9.55	18.23**
combining		E2	4.93**	3.57**	2.77**	33.44	0.52**	7.22**	21.30**
ability		E3	9.96**	9.32**	0.97	91.39**	1.38**	7.22**	21.30**
Reciprocals	28	E1	39.00**	39.45**	4.18**	75.86**	0.48*	7.83	13.73
		E2	6.53**	5.35**	5.63**	28.31	0.43	2.66	15.50
		E3	4.95**	5.29**	0.81	37.46	0.58	3.75	9.42
Error	126	E1	7.70	6.71	2.68	34.78	0.27	9.06	8.87
		E2	1.34	0.94	0.35	22.53	0.33	2.62	10.92
		E3	1.86	1.98	1.23	45.45	0.47	2.86	6.15

* Significant at P = 0.05; ** Significant at P = 0.01

Table 2 : Combining ability analysus of F_1s pooled over environments

Source	GCA	SCA	Rec.	Env.	Env.xGCA	Env.xSCA	Rec.x Env.	Error
D.F	7	28	28	2	14	56	56	378
Characters:								
1.No.of days to first flowering	834.24**	17.69**	30.97**	177.45**	81.70**	7.93**	9.77**	3.66
2. No.of days to 50% flowering	850.60**	15.99**	31.76**	1062.85**	95.00**	8.18**	9.16**	3.21
3. No. of days to maturity.	25.42**	1.55	6.24**	9135.65**	2.96**	1.38	2.19*	1.42
4. Plant height	3180.57**	110.15**	80.87**	12818.45**	189.20**	48.45**	30.38	34.22
5. No.of primary branches per plant.	8.18**	1.01**	0.58*	3.03**	0.42	0.64**	0.46	0.36
6. No. of Secondary branches per plant	37.25**	15.76**	4.92	187.99**	4.87	4.12	4.66	4.52
7. No. of total inflorescenc per plant.	90.81**	36.24**	13.04	345.10**	8.34	11.26	12.80	8.65

* Significant at P = 0.05; ** Significant at P = 0.01

Table 3 : GCA/SCA ratio, Heritability and General Predictability ratio for F_1s in three environments for different characters.

Env.	Components	No.of days to first flowering	No.of days to 50 % flowering	No.of days to maturity	plant height	No.of Primary branches/plant.	No.of Sec. branches/ plant.	No.of Total infloresence per plant.
	gca/sca							
E_1		3.79	3.60	39.5	2.52	0.91	0.23	0.20
E_2		1.45	1.63	0.3	3.99	0.96	0.28	0.15
E_3		1.84	1.86	34.0	1.15	0.23	0.11	0.13
Pooled		3.69	4.14	11.53	2.59	0.75	0.81	0.19
	Predictability ratio							
E_1		0.88	0.87	0.98	0.83	0.64	0.32	0.29
E_2		0.74	0.76	0.38	0.89	0.66	0.36	0.23
E_3		0.78	0.79	0.90	0.70	0.31	0.17	0.20
Pooled		0.88	0.89	0.95	0.83	0.60	0.26	0.27
	Heritability (H_n)							
E_1		81.66	82.54	95.00	74.42	36.06	6.82	17.32
E_2		67.92	71.09	33.63	72.59	40.90	26.17	12.48
E_3		74.92	74.58	35.73	53.59	22.99	11.30	14.60
Pooled		85.44	86.88	65.93	78.12	49.24	20.56	22.09

Table 4: The general combining ability effects and per se performance (in parenthesis) of Parents of some developmental traits based on pooled analysis.

Parents	No.of days to first flowering.	Days to 50% flowering.	Days to maturity	Plant height	No.of primary branches per plant	Sec.Branches per plant	Total Inflo. plant.
Prakash	4.33** (76.77)	4.46** (82.44)	0.82** (133.55)	5.21** (164.50)	0.06 (4.85)	-0.18 (7.88)	-0.37 (14.56)
RH 30	-3.99** (61.77)	-4.38** (66.63)	-0.45** (130.74)	-8.16** (143.60)	-0.49** (5.25)	0.97** (7.88)	-1.62** (14.97)
Pusa Bold	-4.53** (61.00)	-4.38** (66.33)	-0.41** (131.78)	-9.21** (139.37)	-0.43** (4.42)	-1.19** (5.81)	1.53** (10.73)
RLM29	4.66** (77.55)	4.62** (83.55)	0.77* (133.78)	8.91** (174.78)	0.37** (5.78)	0.32 (7.95)	0.51 (15.36)
Varuna	4.54** (64.33)	4.58** (69.77)	0.84** (130.33)	9.91** (145.75)	0.52** (4.76)	0.54** (8.89)	1.05* (16.13)
RIK 78-6	0.19 (64.33)	0.19 (69.77)	0.20 (131.22)	0.98 (149.71)	0.39** (5.08)	1.39** (6.87)	2.15** (12.64)
RLM-198	4.84** (78.33)	4.79** (83.44)	0.75** (132.78)	10.94** (176.47)	0.31** (5.68)	0.41 (6.88)	0.63 (13.88)
UUR 751	0.56* (63.77)	0.33 (70.33)	0.84** (130.00)	0.52 (151.54)	0.29** (4.97)	0.74** (7.59)	1.29** (13.32)
SE (gi)	±0.25	±0.23	±0.15	±0.78	±0.08	±0.28	±0.39

TABLE 5 : Some Selected crosses on the basis of sca effects and mean performance (in Parenthesis) pooled over environments for different traits.

Sr.No.	Crosses	No.of days to first Flowering	No.of days to 50 % Flowering	No.of days to Maturity	Plant height (cm)	No.of Primary branches per plant	No.of Sec.Bran ches/ plant	No.of- Inflore- scence/ plant.
1.	Prakask x Varuna	-3.07**	-2.76*	-0.83	0.77	-0.39	-0.40	-0.68
		(63.83)	(70.00)	(131.00)	(159.89)	(4.71)	(8.33)	(15.32)
2.	Prakask x RLM-198	0.26	-0.42	0.39	2.77	0.60*	1.97*	2.96*
		(76.55)	(81.72)	(133.83)	(182.00)	(6.53)	(12.17)	(20.66)
3.	Prakash x UUR -751	-0.01	0.49	-0.28	6.18*	6.61*	0.97	1.40
		(70.88)	(77.60)	(131.55)	(175.02)	(6.54)	(11.51)	(19.76)
4.	Pusa Bold x RLM -29	-2.69*	-2.77*	0.01	2.49	0.26	0.66	1.33
		(64.55)	(70.33)	(132.22)	(165.34)	(5.77)	(9.77)	(17.74)
5.	RLM -29 x Varuna	0.03	-0.25	-0.38	3.37	0.29	2.41*	3.65*
		(67.27)	(72.66)	(131.38)	(166.24)	(5.70)	(12.21)	(20.54)
6.	S.E. (Sci j)	±1.19	±1.11	±0.74	±3.65	±0.34	±1.32	±1.80

* Significant P = 0.05; ** Significant P = 0.01

for days to first flowering, 50% flowering and maturity (Table 5). The cross Prakask x UUR 751 was the best for higher plant height and included a good and an average combiner. The cross was also found to be the best for number of primary branches per plant. Prakash x RIM 198 was the best for branching behaviour since it was having high estimates of SCA effects and *per se* performance for primary branches, secondary branches and total inflorescence per plant.

From practical point of view, high SCA of crosses alone will not lead to much improvement unless it is coupled with high *Per se* performance. Therefore, selection of crosses for further breeding programme may be based on higher value of both of these parameters. Interestingly, relative ranking of at least the best crosses envisaged a direct correspondance between *per se* and sca (Table 5). However, significant reciprocal effect present in some of the characters investigated, further suggested the need to study the performance of the cross In both the directions. This will facilitate to recognise the potential combinations which can give rise to better performing progenies.

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Analysis of genetic diversity in bunch groundnut

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ABSTRACT

Genetic diversity was determined by using *multivariate analysis* (D^2 *statistic*), among the 83 bunch groundnut genotypes which were selected at random having wide geographic distribution and sown in "/Randomised Complete Block Design" with three replications during *Kharif* 1981-82 at Regional Research Station, Dharwad.

Clustering pattern tresulted in grouping of 83 genotypes into 9 distinct clusters irrespective of their geographic isolation. Pod yield was found to be potential,sources of divergence at inter cluster level. The sources of differentition were different at inter and intra-cluster levels. Crossing programme is suggested between various genotypes for different characters by indetifying potential parents based on cluster means and genetic diversity.

Key words Genetic diversity ; Multivariate analysis ;*Arachis hypogaea*

INTRODUCTION

Estimation of genetic divergence has been emphasized by several workers as it permits precise comparision among all possible pairs of populations in any given group before effecting acutal crosses. The choice of diverse parents with good general combining ability for components of yield has helped in achieving substantial genetic advance in self pollinated as well as cross-pollinated crops (Griffing, 1956).

In past, ecogeographic diversity has been regarded as a reasonable index of genetic diversity (*Vavilov,* 1926). Thus, the cultivars from widely seperated localities have been usually included in the hybridization programme presuming the presence of genetic divergence and maximum likelihood of recovering promising segregants. As per expectation, this has not yielded very satisfactory and consistent results, since it was reported later that there does not exist any parallelism between geographic distribution and genetic diversity (Murty and Anand, 1966; Sangha, 1973).

Since last two decades, with the development of advanced biometric techniques, multivariate analysis based on Mahalanobis's D^2 statistic

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have been put to good use for discriminating divergent populations Sangha (1971, 1973), Shwe *et al* (1972) and Sandhu and Sangha (1974) reported such studies on groundnut.

MATERIALS AND METHODS

The experimental material consisting of 83 bunch genotypes of groundnut *(Arachis hypogaea* L.) obtained from 18 different countries were sown during *kharif*, 1981-82 at Regional Research Station, Dharwad, in a Randomised Complete Block Design with three replications. Each experimental plot/genotype consisted of three 5m long rows. Only one kernel per hill was sown at spacing of 30cm between rows and 10cm within rows. All the recommended package of practices were followed. Five competative plants from the middle row of each experimental plot were randomly chosen for recording the observations viz., number of primary branches/plant and number of developed pods/plant. Other triats like days to 50 percent flowering, shelling per cent, oil content and pod yield (kg) were recorded on plot basis. Oil content in kernels was recorded by NMR technique.

The mean values of the genotypes in each replication were used for the analysis of variance. The significance of the differences among all the genotypes was tested by F-test using the error variance.

The genetic diversity of 83 groundnut genotypes was estimated by using Mahalanobis's D^2 statistic, (Rao, 1952).

Percentage contribution of individual characters towards total divergence was determined as follows:

In all the genotypic combinations, each character was ranked on the basis of $d_i = Yi^j - Yi^k$ values. Rank 'I' was given to the highest mean difference and rank 't' is the total number of characters under study.

The ranks were totalled for each D^2 component over all the combinations and the rank totals were obtained.

$$\text{Percent contribution of character} = \frac{N(X) \times 100}{3403}$$

Where,

N(X) = number of genotypic combinations which were ranked first for the character 'X' out of total genotypic combinations of 3403 (all possible combinations of 83 genotypes).

RESULTS

A generalised distance (D^2) was calculated for each pair of genotypes, among the 3403 possible combinations. About 97.65 per cent of D^2 values were significant at 0.05 level of probability.

All the 83 genotypes were grouped into nine clusters in such a way that genotypes within each cluster had smaller D^2 value than those in other clusters that is, average intracluster distance did not exceed 100. Table 1 lists the genotypes in each of the nine clusters. Clustering pattern revealed the formation of cluster I by 13 genotypes of wlhich three were from U.S.A., two each from Argentina, Chile and India. One each shared by Brazil, Israel, Mauritius and Sudan. Cluster II being the largest of all the clusters consisted of 38 genotypes represented by cultures from most of the countries except from Mexico and Mauritius. Cluster III had 12 genotypes whereas cluster IV consisted of four genotypes one each from Argentina, China, India and Sudan. Cluster V had two genotypes one each from Argentina and Mexico. Eight genotypes were grouped in cluster VI while four different cultures *viz.*, EC-10274, EC-22451, EC-24396 and Ah-7789 formed cluster-VII. The two genotypes, EC-21140 from Sudan and EC-24383 from Argentina were found clustered seperately to represent VIII and IX clusters respectively.

Inter and intra-cluster average D^2 values have been presented in Table 2 and pictorially represented by cluster diagram in Fig.1.

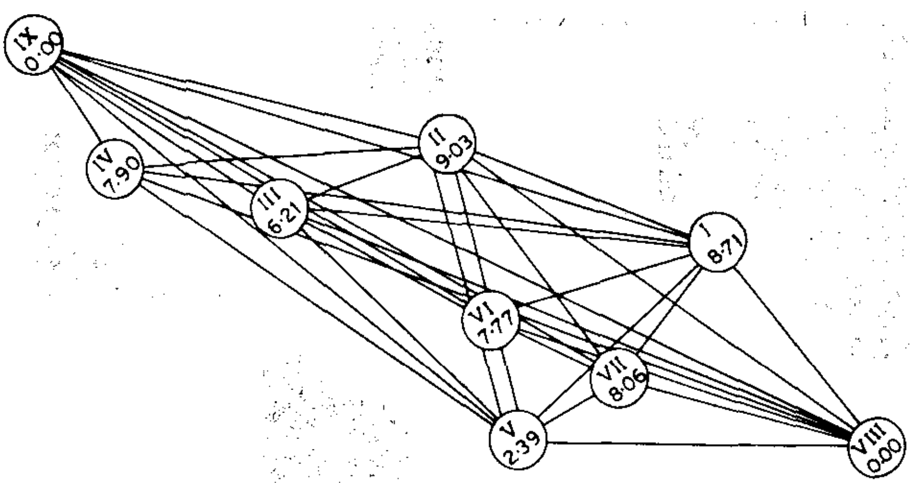

Fig.1 **AVERAGE INTER-AND INTRA**-CLUSTER DISTANCE (D) AMONG 83 GENETYPES OF GROUNDNUT

Table 1 : Composition of clusters based on D^2 statistic of 83 genotypes of groundnut

Cluster	No. of genotypes	Genotypes
I	13	EC-35999, EC-66117, EC-66137, EC-35993, EC-21736, EC-21144, EC-100713, EC-38604 EC-38006, EC61819, JL-14, JL-8, WJR-322.
II	38	EC-24431, EC-24419, EC-21775, EC-21125, EC-21139, EC-24421, EC-21624, EC-80864, EC-99672, EC-21138, EC-89009, EC-27132, EC-27088, EC-24395, EC-16431, EC-24436, EC-21122, EC-99671, EC-21141, EC-103584, EC-34431 EC-24375, EC-103588, EC-21147, EC-61908, EC-24445, EC-38603, Ah-6689, Tatui, Ah-7174, Ah-7315, Ah-6742, Ah-7326, Ah-7146, Roxo, WJR-789, WJR-795, WJR-389.
III	12	EC-60875, EC-42550, EC-80861, EC-21140, EC-36000, EC-47131, EC-24420, EC-24374, Ah-54, Ah7146[a], Ah-6747, Tatui.
IV	4	EC-24425, EC-21143, Dh-3-30, Ah-7389
V	2	EC-24425[a], EC-39544
VI	8	EC-21145, EC-36007, EC-61889, EC-75994, EC-39345, EC-21132, Ah-7790, WJR-362
VII	4	EC-10274, EC-22451, EC-24396, Ah-7789
VIII	1	EC-21140
IX	1	EC-24383

Considering the intra-cluster distance, cluster-II which constituted of 38 genotypes from different countries revealed the maximum genetic diversity (81.59) among themselves, where as cluster V comprising of two genotypes showed least divergence (5.71) among its constituents. Neverthless, cluster-VIII and cluster IX had no intra-cluster distance (Zero) as they were represented by a single genotype each. With regard to inter-cluster distance, it was noted that clusters VIII and IX were more distantly related with intercluster distance of 6566.71. Cluster V revealed the less divergence relationship with cluster VII (144.09) and VI (114.38). Clusters IV and IX (176.78), I and VII (179.40), III and IV (192.73), VI and VII (206.38) and II and III (212.24) were moderate with respect to genetic divergence as indicated by the D values in parenthesis.

Table 2 : Intra and intercluster D^2 values among different clusters.

Cluster	I	II	III	IV	V	VI	VII	VIII	IX
I	75.81	952.63	1805.97	2981.22	312.21	292.27	179.40	341.80	4411.71
II		81.59	212.24	662.52	612.36	361.40	672.91	2074.86	1383.49
III			38.51	192.73	774.36	883.22	1339.36	3249.53	611.47
IV				62.38	1564.80	1721.03	2328.50	4744.10	176.78
V					5.71	114.38	114.09	884.51	2653.82
VI						60.43	206.38	937.03	2823.92
VII							64.95	469.82	3633.24
VIII								0	6566.714
IX									0

The cluster means for the seven characters studied are depicted in Table 3, from which one can ascertain a marked inter-cluster variation. Clusters IX, II and III had low mean values for days to 50 per cent flowering (37.67, 38.33 and 38.33 days respectively) indicating that they are comprised of early maturing genotypes. The late flowering genotypes were found in clusters VIII (45.33 days), VII (43.83 days) and V (42.16 days). Among the cultures evaluated, genotypes like EC-21147, Ah-7326, EC-21132, Tatu and Ah-7174 flowered earlier while EC-21140, Ah-7789, EC-22451, EC-102740 and EC-24396 were late in flowering.

The mean number of primary branches per plant was maximum in cluster V (6.56) but it remained more or less same in all other clusters except in cluster IX which had comparatively high mean value of 6.13 primary branches per plant. Some of the cultures like WJR-389, EC-24425[a], EC-42550, EC-24375 and EC-21143 were found to be superior for this trait while others like WJR-795, EC-24425, EC-21141, EC-39345 and Ah-7174 had comparatively less number of primary branches.

Number of developed pods per plant recorded was highest in cluster IX (13.13) followed by clusters IV(12.41), V(11.83) and VII(11.80). Cluster VIII had the lowest number of developed pods per plant (8.67). The superiority of this important trait was noted in genotypes like Ah-7789, Dh-3-30, Tatui, Ec-21143 and Ec-21122. On the other hand EC-27132, EC-24421, EC-35999, EC-24425 and EC-21141 genotypes were inferior for this character. With respect to shelling percentage, cluster V occupied the top position (75.08%) followed by cluster VIII (73.86%) while it was lowest in cluster IX (70.70%). The remaining clusters showed almost similar trend except in cluster III (71.40%) which had relatively low shelling percentage. Shelling percentage was recorded to be higher in some genotypes like EC-24420, EC-21147, EC-38603, Ah-7789 and EC-75994 while it was lowest in some other genotypes like EC-80864, EC-21145, EC-22451 and EC-39544. Oil content was found to be highest in cluster IV (44.90%) followed by cluster VII (44.84%) and it was lowest in cluster IX which had 42.50% oil content. Thus it is evident that there was no much variation for oil content and shelling percentage. However, among the cultures tested, EC-21147, EC-38603, EC-24419 and WJR-795 had high oil content compared to genotypes like EC-99671, Roxo, EC-21122 and WJR-389 which were low in oil content.

Cluster VII had fairly high (36.77g) 100-kernel weight followed by clusters V (35.30g) and VIII (34.91g) while it was least in cluster IX (27.81g). Cluster IV also showed low 100-kernel weight (27.94g) but it was moderate in clusters I (33.17g), III (32.198), II (32.12g) and VI

Table 3 : Cluster means for different characters in groundnut

Clusters	Characters						
	Days to 50 Per cent flowering	No.of primary branches per plant	No.of developed pods per plant.	Pod yield (kg/plot)	Shelling percentage	Oil content (%)	100-Kernel weight (g)
I	39.077	5.359	9.580	0.535	72.35	44.12	33,168
II	38.334	5.172	10.169	0.830	72.70	44.00	32.122
III	38.833	5.516	10.711	0.747	71.40	43.96	32.192
IV	39.330	5.650	12.415	0.967	73.30	44.90	27.937
V	42.165	6.565	11.830	0.750	75.08	43.28	35.305
VI	39.333	5.216	9.784	0.647	73.15	44.50	30.894
VII	43932	5.400	11.797	0.697	72.33	44.84	36.770
VIII	45.330	5.130	8.670	0.580	73.86	43.40	34.910
IX	37.670	6.30	13.130	1.030	70.70	42.56	27.810

(30.89g). Such of the genotypes as WJR-322, EC-102740, EC-89009 and EC-24445 had high test weight compared to others like EC-36007, EC-24436, EC-21143, JL-14 and Ah-7339 which had comparatively low 100-kkernel weight among the genotypes evaluated. The most productive cluster was IX which was represented by a sngle genotype EC-24383 with highest yield record of 1.030kg pod yield per plot followed by clusters IV (0.967kg), II (0.830 kg), V (0.750kg) and III (0.747 kg). Clusters I and VIII showed low pod yield with cluster mean values of 0.535 kg and 0.580 kg. respectively, whereas, it was moderate in clusters VI (o.647) and VII (0.647kg). The genotypes superior for pod yield were EC-24383, EC-24425, Dh-3-30, EC-21143 and Ah-7389 while cultures like JL-8, EC-38604, EC-21736, EC-35993 and EC-21144 were low yielding among the 83 cultures tested.

The proportion of contribution of each character to the total divergence was different. Pod yiald was the single largest contributor (88.01%) followed by days to 50 per cent flowering (7.26%), number of primary branches (2.23%), number of developed pods (1.67%), 100-kernel weight (0.68%), shelling% (0.09%) and oil content was the lowest contributor (0.06%) towards genetic divergence. It was appearent that pod yield was the only major contributor to the differences among the different genotypes, supplemented by the moderate contribution of days to 50 per cent flowering.

DISCUSSION

From the clustering pattern of 83 groundnut genotypes it was observed that none of the clusters was solely constituted by the genotypes which had their origin from the same geographical area. In other words, the genotypes collected from 18 different countries have been clustered randomly irrespective of their origin which gave an evidence that geographic diversity is not a reasonable index of genetic diversity (Sangha, 1971, 1973; Shwe *et al.*, 1972; Sandhu and Sangha, 1974). Thus, geographic diversity, though important, may not be the only factor in determining genetic divergence and the factors other than geographic diversity such as genetic drift, selection pressure and environment may be responsible for differential grouping of genotypes (Sangha, 1971). This may be partly because of the cultivation of genotypes having common origin, in different countries through plant introductions. In some cases varieties originated at the same place may also have different architecture and like-wise certain cultivars may possess similarity with respect to some characters though they had their origin at different centres. The possible reason may be the difference in selection pressure applied on different components at various geographical areas which might coincide resulting in clustering together of genotypes which are being originated at different centres or otherwise included in different clusters. The other possibility is that the varieties with same geographic origin could have undergone modifications in their characteristics under stress conditions such as growing the same cultivar under rainfed conditions, under irrigation, saline soils etc., which in strict sense is an accumulation of variability in the cultures due to natural selection even at a single location. This leads to suggest that the selection of a parent material for hybridization merely based on geographic diversity may be arbitary and erraneous.

Considering the above criteria, crossing programme is suggested between the various genotypes for improvement of different characters by identifying the potential parents based on the cluster means and genetic diversity between them to obtain more heterosis in F_1's or better segregants in F_2 progenies. For example, EC-24374 and WJR-389 in cluster II, EC-60875, EC-42550, EC-97131, EC-24374, Ah-6747 and TATUI in cluster III, EC-24425, EC-21143 and Dh-3-30 in cluster V and EC-24383 in cluster IX were found to have high yielding potential. Thus, crossing among these genotypes of different clusters is sggested to improve yield. Similarly, for improvement of oil content, crossing between the divergent and potential genotypes like EC-24419, EC-21147, EC-38603 and WJR-795 in cluster II; EC-35999, EC-66117 and WJR-322 in cluster I, EC75994, EC-59345 and EC-21132 in cluster VI and EC-24383 in Cluster IX, is suggested to obtain better segregants in F_2 provided there is no sterility.

It was noted from the inter-cluster divergence that pod yield was the potential factor for divergence (88.01%) followed by days to 50 per cent flowering and number of developed pods while in case of intra-cluster divergence, components like number of developed pods, days to 50 per cent flowering and 100-kernel weight contributed most towards divergence. Thus, the forces of differentiation appear to be different at inter and intra-cluster levels as suggested by Sangha (1971) and Sandhu (1974).

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Stability analysis of pod yield in bunch groundnut

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ABSTRACT

Eight promising bunch genotypes were evaluated for their stability of pod yield performance over four locations in Karnataka State representing varying environmental conditions. Stability differences were assessed on the bases of linear regression of genotypes on environmental index and deviation from linear function along with their mean performances. The Variety Dh-8, had good stability and high level of performance for pod yield and hence it was concluded that Dh-8 was the suitable variety available in the materials evaluated for their stability performance.

Key words: Groundnut ; Stability analysis ; Pod yield ; *Arachis hypogaea*

INTRODUCTION

Groundnut (*Arachis hypogaea L.*) contributes nearly 40 per cent of the vegetable oil in India. Thus, edible oil economy in India would be related to quantum of groundnut production. Although the genetic potential of 25-30q/ha have been demonstrated, the unit area production on national basis has remained constant at 8-9q/ha for several years. Varietal component being the major contributor for high yields, seems to be not performing consistently under fluctuating enviornment conditions. It is, therefore, necessary to develop varieties having wide adaptability so as to obtain yield levels of 25-30q/ha.

Yield stability has been defined as a value of unity for the regression of genetype on the environmental index with a small mean square deviation from regression. Thus the stable genotypes should have the ability to show minimum interaction with the environments in which they are grown (Eberhart and Russel, 1966). Paroda and Hayes (1971) suggested that the liner regression should simply be considered as a measure of response of a genotype, whereas, the deviations around the regression line is a measure of stability. In groundnut also, genotype x environmental interactions and stability parameters for

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yield and yield components have been reported by several workers (Singh *et al* 1975; Yadava and Kumar, 1978;1979a,b; Shorter and Norman,1983) to determine the consistency of various genetypes across the locations and years.

In the present study, an attempt has been made to investigate the stability in pod yield of eight promising genotypes developed from this centre in Karnataka.

MATERIALS AND METHODS

Eight promising bunch genotypes developed at RRS, Dharwad namely Dh-8,Dh-14, Dh-15, Dh-16, Dh-17, Dh-18, Dh-19 and Dh-3-30 were evaluated for their performancee at Dharwad Bangalore, Bagalkot and Bailhongal Locations in Karnataka. The experiment and conducted during *Kharif* 1983-84 in a RCBD with three replications. Each genotype was sown on a plot of 5 x 0.9m with a spacing of 30 x 10cm. The experimental plot was fertilized with 25:50:25 kg NPK/ha at the time of sowing. All other recommended agronomic packages were followed at each location. After harvesting, data on pod yield were recorded per plot and were converted into yield per hactare for statistical analysis.

Data collected were subjected to analysis of variance. Stability parameters were computed according to the method suggested by Eberhart and Russel (1966)

RESULTS AND DISCUSSION

Environments in which the genotypes were tested represented a broad geographical area with varying environmental conditions. The pooled analysis of variance (Table-1) showed significant genotype x environment interaction. The significant genotype x environment interaction indicated that the genotypes responded differently, relative to each other, to a change in environment. Further, both the enviornment (linear) and the genotype x environment (linear) components of variation, were highly significant. The significant genotype x enviornment (linear) interaction indicated that the stability parameter, regression coefficient (b) estimated by the linear component of the response to a change in environment, was different for various genotypes under study. Another component of variation for stability, variance due to pooled deviations, was also highly significant which indicated that differences in stability for pod yield among the genotypes was due to both the linear and deviations from the linear function.

Table 1 : Analysis of variance for pod yield of eight bunch groundnut genotypes tested in four environments

Source of variation	df	Sum of Squares	Mean Squares
Genotypes	7	75.88	10.840**
Genotypes x environment	21	139.94	6.664**
Environment (Linear)	1	2126.37	2126.370**
Genotype x environment (Linear)	7	73.02	10.431**
Pooled deviations	24	57.65	2.402**
Pooled error	64	10.67	0.1667

** Indicate significant difference from the pooled error mean square at 0.01 level of probability

The mean yields at the individual environments (table2) ranged from 9.02q/ha at Bagalkot to 30.30 q/ha at Dharwad. This difference was mainly because of their wide range of environmental conditions primarily resulting from varying amounts of precipitation. Since Dharwad is in transitional zone of Karnataka, it had most favourable environment leading to higher yield levels. On the other hand Bagalkot represents the dry belt (less precipitation) of Northern Karnataka and hence poor yields are not uncommon in that region. The mean yield over four environments was highest for the entry Dh-8 with 19.68 q/ha while Dh-15 was the highest yielding genotype in the most favourable environment.

Table 2: Mean yields and estimates of stability parameters for eight bunch genotypes of groundnut tested in four environments.

	Location				Mean yield	Regression coefficent	Deviation Mean Square
Geno type	Dharwad	Banga lore	Bagal kot	Bailh ongal	q/ha	(bi)	(S^2_d)
Dh-14	27.70	13.52	7.50	10.00	14.68	0.95	0.50
Dh-15	36.65	18.96	9.54	12.45	19.15	1.24*	1.98
Dh-16	33.05	23.08	6.19	8.45	17.69	1.32*	7.09**
Dh-17	28.09	15.56	6.56	12.44	15.66	0.96	1.02
Dh-18	29.17	21.30	9.87	11.11	17.86	0.96	0.13
Dh-19	26.85	19.02	11.87	12.44	17.54	0.74	2.57
Dh-3-30	31.02	19.02	8.66	11.11	17.45	1.07	3.22*
Dh-8	30.09	18.52	11.89	18.22	19.68	0.78	2.71
Mean	30.30	18.63	9.02	12.03	17.46	-	-

*,** Significant at the 0.05 and 0.01 levels of probability respectively

Estimates of regression coefficients and the deviation mean squares (Table -2) showed a wide range of values. The phenotypic stability of the genotype was measured by three parameters. namely, mean perfornance over the environments, linear regresion and deviations from regression function. A stable genotype should have high mean and high linear regression (b) and deviation mean square (S^2d:) as small as posible (Eberhart and Russel, 1966). In the Present investigtion,since all the three parameters viz; mean performance, linear regression and deviation from the regression function were found to be significant, the genotype were evaluated by considering all the three parameters. It is evident that Dh-8 had the hoghest mean value of 19.63 q/ha which linear regression (b) value of 0.78. Thus, the top performance of Dh-8 and its regression value being not significantly different from unity suggest that Dh-8 is the most desirable genotype for its pod yield performance. Similar observations have also been made on this genotype in the trials conducted at locations of peninsular zone of India under All India Co-ordinated Varietal Research Project on oilseeds during *Kharif* 1983 and 1984. Because of its superior performance over local variety (Dh-3-30), Dh-8 has been released in Karnataka State for general cultivation in Northern districts of Karnataka in May 1984.

The genotype Dh-15 also gave high mean pod yield (19.15 q/ha) but the regression coefficient (b=1.24) was significantly different from unity (Table 2) indicating its below average stability because of its linear response to change in environment. This genotype seems to be specially adapted to favourable environments. Although Dh-16 genotype had slightly above average yield with 17.69 q/ha, both regression coeficient (b=1.32) and deviation mean square (S^2_d: = 7.09) were significantly different from 7 unity and zero respectively indicating wide fluctiations to change in environment. Dh-18 and Dh-19 genotype had above average yield levels of 17.86 q/ha and 17.54 q/ha respectively with regression coefficients (b-0.96 and 0.74 respectively) not significantly different from unity and non-significant deviation mean square values suggesting that they too had good stability of performance and wider adaptability. Hence they have been included in All India Co-oridinated trials during *Kharif* 1984 and 1985.

Although, Dh-14 and Dh-17 genotypes had linear response equal to unity(Bi-0.95and 0.96 resp.) and non-significant deviation from linear function, their mean performance was not high (Table 2). These two genotypes apparently posses good stability responding least to changes in environment conditions. However, their poor means performance indicated better adaption to only adverse environmental conditions. The variety Dh-3-30 had the mean value (17.45 q/ha) slightly lesser than average yield level (17.46 q/ha) with linear regression equal to **unity** but the mean square deviations were significantly different from **linear** function indicating its below average stability.

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Economics of recommended practices for oilseed crops in dryland farming

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ABSTRACT

Analysis of cost and returns was worked out for Recommended Practices *vis-a-vis* Traditional Practices for groundnut, mustard, sesamum, linseed, safflower and castor crops grown in different regions of the country. The percentage of increase of yield due to Recommended Practices varied from 4.4 to 77.8 in groundnut, 62.1 to 190.5 in mustard, 23.4 to 80.0 in sesamum, 168.8 to 218.2 in linseed, 47.8 to 246.7 in safflower and 71.4 to 173.9 in castor in different regions. The total cost and gross returns were higher in Recommended Practices in case of all crops at all centres. By and large the benefit-cost ratio was higher in recommended practices in case of all crops at most of the centres. The additional benefit-cost ratio due to Recommended Practices was worked out and this indicated that the recommended technology was more profitable and viable. The recommended dryland practices created more human/bullock labour employment potentialities in all crops at different centres.

Key words: Benefit-cost ratio; Dryland farming; Productivity; Economic response; Profitable.

INTRODUCTION

The oil seed crops occupy about 10 per cent of total cultivated area. Ninety two per cent of the area under oilseeds is rainfed, which contributes to about 90 per cent of the total oilseed production in the country. The low productivity of oil seeds in our country is attributed to poor crop management. Use of low quality seeds, absence of fertilizer plant protection measures including weed control are some of the factors responsible for low and uneconomic crop yields. Poor resource base of dryland farmers is yet another reason for low productivity. Lack of wherewithals of production, undependable supply of inputs and shear lack of creditworthiness stand in the way of adoption of improved agronomic practices.

Therefore, the study on the economics of recommended practices in dryland areas was undertaken. The main approach in this study has been to estimate the biological and economic responses of the innovations of researc developed at different co-operating centres of Central Research Institute of Dryland Agriculture.

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MATERIALS AND METHODS

Data available from research plots were considered unsuitable for drawing valid conclusion because of small plots size, controlled conditions and very high management level. Acceptable information could, therefore, be had from the large plot (0.4 hectare or more) demonstrations with recommended practices on the farmers' fields with their management. For the purposes of comparison, the control (Traditional Practices) plots under similar/identical soil and location conditions were selected. Demonstration plots and control plots belonging to the same farmers were preferred. The demonstrations were conducted at farmers' fields utilizing recommended dryland technology by the staff of Drought Prone Area Programme (DPAP). The demonstrations conducted during 1976-77 to 1979-80 were considered and the data were collected in the prescribed proforma with the help of the staff of Pilot Project/DPAP. The data collected from number of demonstrations/control plots varied between 48 to 82 at different centres. The tabular analysis method was followed in analysing the data. The wage rate prevailed in the region for human/bullock labour and actual price if purchased or estimated value for home produced seed, FYM, fertilizer and pesticides etc., were considered for computing the data. The interest on working capital was considered as 14 per cent and land rent was estimated as 2.5 per cent of the value of the land. The farm gate prices were considered for main and by-products of the test crops.

RESULTS AND DISCUSSION

The data collected from the farmers on economics of traditional *vis-a-vis* recommended practices in drylands from 12 regions covering six crops have been used for economic analysis to know the profitability and viability.

Yield: The biological response is the first indicator to know the improvement in the productivity. Recommended practices increased the yield in all crops in all regions (Table 1). However, it varied in different proportions. Though percentage of increase in yield of groundnut was very high at Nagaur due to recommended practices compared to Rajkot, Bangalore and Ranchi, the actual increase in yield was 0.7 q/ha at Nagaur as against 3 to 4.8 q/ha at other centres and the increase was slightly higher in recommended practices. This low productivity in recommended practices at Anantapur might be due to drought/water stress for the crop. The yield increase or percentage of increase in yield due to recommended practices was remarkable in mustard. The improvement in productivity due to recommended practices in case of sesamum was appreciable but the yield was very low in

Table 1 : Oilseed crops yield at different locations

Crop	Centre	Practices: Traditional (q/ha)	Practices: Recommended (q/ha)	Increase in yield due to recommended practices (q/ha)	% of increase
Groundnut	Nagaur	0.9	1.6	0.7	77.8
	Anantapur	4.5	4.7	0.2	4.4
	Rajkot	6.9	9.9	3.0	43.5
	Bangalore	7.1	11.3	4.2	59.2
	Ranchi	9.5	14.3	4.8	50.5
Mustard	Hissar	6.6	10.7	4.1	62.1
	Varanasi	2.1	6.1	4.0	190.5
Sesamum	Nagaur	1.0	1.8	0.8	80.0
	Jodhpur	4.7	5.8	1.1	23.4
Safflower	Bellary	1.6	4.4	2.8	175.0
	Bijapur	1.5	5.2	3.7	246.7
	Solapur	2.3	3.4	1.1	47.8
Linseed	Varanasi	1.6	4.3	2.7	168.8
	Ranchi	1.1	3.5	2.4	218.2
Castor	Nagaur	1.4	2.5	1.1	78.6
	Anantapur	1.4	2.4	1.0	71.4
	Hyderabad	2.3	6.3	4.0	173.9

traditional practices. Recommended practices established superiority over traditional in safflower. Castor and linseed are not edible oils but have commercial value. In these crops also, the recommended practices were proved better than traditional practices.

Economic Response: The recommended practices included improved seed, fertilizer application and use of pesticides apart from some improvement in agronomic practices, but traditional practices consists of local seed, inadequate dose of farmyard manure without use of fertilizer/pesticides and no proper weeding. Thus, the recommended

Table 2: Average cost and returns per hectare under traditional Vs. recommended practices (Rupees)

S.No.	Name of the Crop and Centre		Labour Cost: Human	Labour Cost: Bullock	Labour Cost: Total	Material Cost: Seed	Material Cost: Manure/fertility	Material Cost: Plant protection	Material Cost: Total	Interest on working capital and land rent	Total cost	Gross Returns	Benefit-Cost Ratio
1	2		3	4	5	6	7	8	9	10	11	12	13
1) Groundnut	Nagaur	R	97	80	177 (16)	509	309	28	846 (74)	108 (10)	1131 (100)	1381	**1.22**
		T	91	67	158 (21)	509	-	-	509 (68)	83 (11)	750 (100)	689	**0.92**
	Anantapur	R	210	139	349 (32)	250	328	53	631 (57)	109 (10)	1089 (100)	1384	**1.27**
		T	175	127	302 (30)	294	289	12	595 (60)	86 (9)	983 (100)	1379	**1.40**
	Rajkot	R	419	199	618 (41)	416	161	43	620 (41)	279 (18)	1517 (100)	2650	**1.75**
		T	435	213	648 (40)	337	285	41	663 (42)	281 (18)	1592 (100)	1855	**1.17**
	Bangalore	R	635	314	949 (49)	418 (20)	485	-	903 (100)	81 (4)	1933 (100)	2585	**1.34**
		T	594	315	909 (50)	327	499	-	826 (46)	75 (4)	1810 (100)	1759	**0.97**

	Ranchi	R	NA	NA	NA	NA	NA	NA	NA	—	1756	3175	1.81
		T	NA	NA	NA	NA	NA	NA	NA	—	963	1900	1.97
2) Mustard	Hissar	R	275	293	568	21	161	82	264	309	1141	3201	2.81
					(50)				(23)	(27)	(100)		
		T	NA	NA	NA	NA	NA	NA	NA	—	903	1980	2.19
	Varanasi	R	294	170	464	26	285	76	387	38	889	2163	2.43
					(52)				(44)	(4)	(100)		
		T	166	155	321	23	-	-	23	34	378	741	1.96
					(85)				(6)	(9)	(100)		
3) Sesamum	Nagaur	R	110	94	204	15	131	23	169	55	428	705	1.65
					(47)				(40)	(13)	(100)		
		T	100	81	181	15	-	-	15	43	239	395	1.65
					(76)				(6)	(18)	(100)		
	Jodhpur	R	264	97	361	27	212	41	280	142	783	2274	2.90
					(46)				(36)	(18)	(100)		
		T	242	97	339	27	-	36	63	128	530	1841	3.47
					(64)				(12)	(24)	(100)		
4. Safflower	Bellary	R	—	—	240	20	276	57	353	74	667	1012	1.52
					(36)				(53)	(11)	(100)		
		T	—	—	202	13	41	-	54	67	323	383	1.19
					(63)				(17)	(20)	(100)		
	Bijapur	R	NA	NA	NA	NA	NA	NA	NA	—	532	1345	2.53
		T	NA	NA	NA	NA	NA	NA	NA	—	273	416	1.52

	Solapur	R	92	100	192 (28)	47	218	81	346 (50)	149	687 (100)	966	1.41
		T	95	95	190 (37)	46	110	34	190 (37)	141 (26)	521 (100)	654	1.26
5) Linseed	Varanasi	R	223	131	354 (45)	59	321	24	404 (51)	35 (4)	793 (100)	1446	1.82
		T	127	100	227 (81)	36	-	-	36 (13)	18 (6)	281 (100)	500	1.78
	Ranchi	R	NA	NA	NA	NA	NA	NA	NA	-	667	1096	1.64
		T	NA	NA	NA	NA	NA	NA	NA	-	430	358	0.83
6) Castor	Nagaur	R	84	64	148 (27)	39	247	37	323 (59)	75 (14)	546 (100)	658	1.21
		T	87	58	145 (64)	34	-	-	34 (15)	49 (21)	228 (100)	406	1.78
	Anantapur	R	80	69	149 (29)	27	216	35	278 (54)	85 (17)	512 (100)	574	1.12
		T	50	60	110 (27)	25	190	-	215 (53)	79 (20)	404 (100)	351	0.87
	Hyderabad	R	224	141	385 (43)	66	190	44	300 (34)	206 (23)	891 (100)	1601	1.80
		T	176	109	285 (49)	49	22	11	82 (15)	210 (36)	577 (100)	555	0.96

Note: i) Parentheses indicate percentages of respective items over total cost
ii) R – Recommended Practices
iii) T – Traditional Practices

practices require additional investment to increase the productivity in crops of drylands. The analysis of costs and returns was carried out to know the capital investment pattern under traditional and recommended practices.

Cost of cultivation, as expected, was higher in case of recommended practices for all crops in all regions (Table 2). The pattern of capital investment on different items varied between two practices. The loss was incurred in groundnut at Nagaur and Bangalore, castor at Anantapur and Hyderabad and linseed at Ranchi in case of traditional practices. The benefit-cost ratios were also higher in majority of cases where recommended practices followed compared to traditional practices.

Table 3: Additional Benefit-cost Ratio due to Rrcommended Technology (Rupees/hectare)

S.No.	Crop	Centre	Additional Cost	Additional Returns	Additional Benefit-Cost Ratio
1)	Groundnut	.. Nagaur	381	692	1.82
		Anantapur	106	5	0.05
		Bijapur	404	1200	2.97
		Rajkot	(-)75	795	10.60
		Bangalore	123	826	6.72
		Ranchi	793	1275	1.61
2)	Mustard	.. Hissar	238	1221	5.13
		Varanasi	511	1422	2.78*
3)	Sesamum	.. Nagaur	189	310	1.64
		Jodhpur	253	433	1.71
4)	Safflower	.. Bellary	344	629	1.83
		Bijapur	259	929	3.59
		Solapur	166	312	1.88
5)	Linseed	.. Varanasai	512	946	1.85
		Ranchi	237	738	3.11
6)	Castor	.. Nagaur	318	252	0.79
		Anantapur	108	223	2.06
		Hyderabad	314	1046	3.33

Table 4: Employment potential due to Recommended Practicses (days/ha)

S.No.	Crop	Centre	Human Labour: Re-commended	Human Labour: Tra-di-tional	Human Labour: Dif-ference	Human Labour: % of in-creased in recom-mended	Bullock Labour: Re-com-mended	Bullock Labour: Tra-di-tional	Bullock Labour: Dif-ference	Bullock Labour: % of in-creassed in recom-mended
1)	Groundnut	Nagaur	18	17	1	6	5	4	1	25
		Anantapur	74	60	14	23	14	13	1	8
		Bangalore	165	145	20	14	34	30	4	13
		Ranchi	99	105	(-)6	(-)6	17	14	3	21
2)	Mustard	Hissar	38	37	1	3	17	16	1	11
		Varanasi	75	43	32	74	21	19	2	11
3)	Sesamum	Nagaur	23	21	2	10	5	4	1	25
		Jodhpur	50	47	3	6	8	6	2	33
4)	Safflower	Bellary	56	42	14	33	13	12	1	8
		Bijapur	41	35	6	17	17	12	5	42
		Solapur	16	15	10	10	5	4	1	25
5)	Linseed	Varanasi	53	37	16	43	17	12	5	42
6)	Castor	Nagaur	19	17	2	12	5	4	1	25
		Anantapur	24	18	6	33	7	6	1	17
		Hyderabad	86	69	17	25	22	18	4	22

Analysis of additional cost and returns: Analysis of additional cost and returns / benefits due to recommended practices over traditional (farmers) practices was worked out. (Table-3)

As explained earlier, the recommended practices incurred additional expenditure. The additional returns were also derived. To know the rate of returns/profitability, the benefit-cost ratio was worked out. The recommended technology was found to be more profitable and viable in all crops at all centres except in Groundnut at Anantapur and Castor at Nagaur. The additional benefit-cost ratios were higher (>5) in groundnut at Rajkot and Bangalore and mustard at Hissar. The additional benefit-cost ratio was more than 3 in safflower at Bijapur, linseed at Ranchi and castor at Hyderabad. In other cases it varied between 1.61 to 2.97. This clearly indicated that recommended technology was profitable in drylands.

Gainful labour employment: Economics apart, the relative employment enhancing potential of recommended practices has also to be a criterion of choice, particularly in dryland areas in view of the low level employment opportunities. The crop/regionwise detailed data pertaining to average number of days of employment (days per hectare) under two situations are given in Table 4 for human and bullock labour separately.

Averaging the data over years for crops at each location, it is noticed that the employment potential in recommended practices was remarkably higher than in traditional practices in drylands. The percentage increase was as high as 32 in human labour and 42 in bullock labour due to additional labour requirement for sowing, weeding, thres ing etc. Thus the recommended practices in drylands provided gainfull/more employment compared to traditional practices which have been in vogue since decades.

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Response of rainfed safflower to fertilizer application in sole and sequence cropping systems in black soils

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ABSTRACT

Experiments were conducted during *kharif* 1979 and *rabi* 1979-80 in rainfed black soils to study the response of safflower to nitrogen and phosphorus application in fallow-safflower and sorghum-safflower cropping systems. Results obtaind showed that safflower responded positively to applied nitrogen and phosphorus in both the cropping systems. In sole safflower system, safflower had also the advantage of higher nitrogen availability from soil consequent on fallowing in *kharif* season. However, no significant difference in seed yield was observed between these two cropping systems. Addition of N in sole safflower system helped the crop for vegetative growth alone resulting in lower harvest index. Response to phosphorus application and phosphorus removal data of safflower revealed that fallowing has also increased soil P availability to the crop.

Key words Cropping systems, *kharif* fallowing, nutrient recuperation, *fertilizer response*.

INTRODUCTION

Under traditional practices in rainfed black soils, safflower is grown as sole crop in *rabi* keeping the land fallow in *kharif* leading to inefficient utilisation of natural resources. These soils are capable of sustaining 200 per cent cropping intensity. Sorghum [*Sorghum bicolor* (L.) Moench] safflower *(Carthamus tinctorius* L.) double cropping system proved most remunerative (Reddy and Reddy, 1979). However, the advantage of *kharif* fallowing in nutrient recuperation and its subsequent impact on safflower yield requires to be quantified for better fertilizer management. Fallowing has earlier been shown to increase the soil N availability (Viets Jr.,1971). On the other hand, the extent of residual effect of fertilizer application to sorghum under rainfed conditions needs evaluation independently. The present studies were, therefore, initiated to evaluate the above situations and to determine the nitrogen and phosphatic fertilizers

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requirement for safflower under mono and double cropping systems.

MATERIALS AND METHODS

The experiments were conducted on rainfed black soils (95–105 cm soil depth) of Koheda village (Hayatnagar Block of Ranga Reddy District), Andhra Pradesh during *kharif* 1979 and *rabi* 1979–80. The soils (p^H8.2) were low in available N (131 to 189 Kg./ha) and the available P_2O_5 was 16.6, 21.4 and 36.7 kg/ha for the three sites used as replicates. The P fixation capacities of the soils were found to vary between 46 to 53 per cent.

The first crop of sorghum (CSH-6) was sown in June 1979 and was harvested in September 1979. Uniform dose of 60 kg N/ha was added in two splits and the P_2O_5 content of the soil was adjusted to 40kg/ha by adding calculated dose of fertilizer, taking into account, the soil test values and P fixation capacities of the soils. Parts of the plots were kept fallow to study the effect of fallowing. Thus two cropping systems, *viz.*, fallow-safflower (S-1) and sorghum-safflower (S-2) were tried in these investigations. Safflower (Manjira) was sown in 2nd week of October in strip-plot design covering both fallow and sorghum plots with five N-P_2O_5 (kg/ha) treatments (0-0; 20-0; 20-15; 40-0; and 40-30). Safflower was harvested in February 1980. During the crop growth period 343.3 and 52.6mm rainfall were received for sorghum and safflower respectively. The experiments were replicated in three sites with large gross plot sizes (varying from 144 to 720 sq.m. for safflower). Harvesting was done by crop cutting method and the data were statistically analysed. The comparison of different characters between the cropping systems were made by paired 't' test (Table-1). The paired 't' tests within the treatments were all found to be significant except for the seed yield.

Table 1 : Comparison of the cropping systems for various characters

Characters	Mean value of the systems		Paired 't' test
	S-1	S-2	
1) Seed yield (q/ha)	6.99	6.04	NS
2) Straw yield (q/ha)	23.68	16.25	SIG
3) Harvest index (per cent)	23.0	26.1	SIG
4) N uptake (kg/ha)	37.83	26.81	SIG
5) P uptake (kg/ha)	2.75	2.31	SIG

NS = Non-significant S-1 = Fallow - Safflower cropping system
SIG = Significant S-2 = Sorghum - Safflower cropping system

Nitrogen in plant samples was estimated by using Technicon Auto - Analyser following the indo-phenol blue colour development method. The correlation co-efficient between this method and the micro-kjeldhal method was found to be 0.99. P in plant materials was estimated by the method described by Jackson (1967).

RESULTS AND DISCUSSION

Yield and nutrient uptake by sorghum: The grain yield; N and P removal among the three sites were almost uniform probably because of adjustment of P fertilizer *dosages* based on soil test values and uniform dose of nitrogen application. The grain yield of sorghum varied between 18.9 and 21.0 q/ha, the average being 19.7 q/ha. Average N and P uptake were 61.5 and 10.4 kg/ha respectively.

Effect of previous cropping systems on safflower: No significant difference in seed yield of safflower was obtained between S-1 and S-2 cropping systems (Table 2). It suggests that no gain is achieved by fallowing as far as safflower seed yield is concerned. However, there was more vegetative growth in safflower after fallow compared to the treatment where it was preceded by sorghum resulting in significant increase in straw yield and significantly less harvest index in fallow-safflower system. This may possibly be due to increase in nitrate nitrogen content of soil in fallow condition. Increase in nitrate nitrogen content in black soils by 4.5 and 18.7 kg/ha due to fallowing over cropping with sorghum in 0-15 and 15-30 cm soil depth, respectively, have been observed by Das and Rao (in press).

Table 2 : Seed and straw yield, and harvest index of safflower as affected by cropping systems, N and P application

Treatment ($N - P_2O_5$ kg/ha)	Seed yield (q/ha)		Straw yield (q/ha)		Harvest index (%)	
	S-1	S-2	S-1	S-2	S-1	S-2
1) 0 - 0	5.63	4.51	20.65	12.88	21.3	25.3
2) 20 - 0	6.95	5.26	24.32	14.16	23.0	24.4
3) 20 - 15	6.43	6.29	24.01	16.85	21.6	25.7
4) 40 - 0	7.47	6.30	23.24	19.39	24.8	26.5
5) 40 - 30	8.51	7.87	26.19	17.99	24.4	28.6
Average	6.99	6.04	23.68	26.25	23.0	26.1

SEm ±1 (P=0.05)			
	Cropping system	1.04	NS
	Fertilizer doses	0.38	1.15

Further, the soil moisture available to safflower crop may be greater in fallow-safflower system compared to sorghum-safflower system (Anonymous 1978). In the safflower growing period 52.6mm rainfall was received in 7 rainy days. Thus the stored profile moisture assumed more importance for sustaining the crop. Due to more vegetative growth in fallow plots, there might have been more transpiration losses during the crop growth period and thus at the reproductive stage, the moisture availability might have been the same in both the cropping systems inspite of higher moisture storage in fallow soils at the sowing time. Therefore additional seed yield could not be obtained in fallow plots.

Response to N & P applications: In S-1 system, application of fertilizers increased the seed yield of safflower upto the 40 and 30 kg/ha N application of and P_2O_5 respectively. The responses observed were 6.6 and 4.6 kg grain/kg N applied @ 20 & 40 kg levels respectively. The response to P_2O_5 application which was significant only at 30 kg/ha along with 40 kg N/ha, was found to be 3.4 kg grain/kg of applied P_2O_5 (Table 2).

In case of S-2 system the response to N application by safflower was observed when coupled with P_2O_5 application. This must have been due to the low available phosphorus status of the soils (19.7 to 20.7 kg P_2O_5/ha) as observed before safflower seeding. At higher dosages (treatments 4 and 5) significant increase in seed yield was noticed due to N and combined N and P applications. The kg grain yield per kg of N applied @ 40 kg N/ha was similar to systems S-1 i.e., 4.4. However, the response to per kg P_2O_5 applied was higher in S-2 than in S-1 system which were 6.8 and 5.0 kg grain/kg P_2O_5 applied @15 and 30kg P_2O_5 respectively. As in S-1, the treatment 40 kg N and 30 kg P_2O_5 per hsctare has produced the highsst yield of safflower in S-2.

Table - 3 : N and P removal by safflower as affected by cropping systems, N and P applications

Treatments ($N-P_2O_5$ kg/ha)		N removal (kg/ha)		P removal (kg/ha)	
		S-1	S-2	S-1	S-2
1)	0 - 0	30.74	17.71	2.30	1.85
2)	20 - 0	39.31	22.42	3.03	1.91
3)	20 - 15	33.80	27.75	2.55	2.38
4)	40 - 0	38.12	32.35	2.75	2.30
5)	40 - 30	47.22	33.85	3.15	3.14
	Average	37.83	26.81	2.75	2.31

Nitrogen and phosphorus uptake: The nutrient content and uptake studies revealed that in S-1 cropping system, the N content in both seed and straw of safflower was generally higher than in S-2 cropping system. Within the given cropping system, the N content in both seed and straw did not differ between the treatments. Consequently, the N uptake in safflower was much higher under S-1 (37.8 kg/ha) than S-2 (26.8 kg/ha)(Table 3).

Though the P content in safflower did not differ between S-1 and S-2 systems, the total uptake was found to be higher in S-1 (2.7 kg/ha) than S-2 (2.3 kg/ha) system due to more straw yield.

Table-4: Economics of fertilizer application in safflower under sole and sequence cropping systems

Particulars	Cropping systems	
	Sole (S-1)	Sequence(S-2)
Economic value of produce (Rs/ha) of safflower without any fertilizer application	1970	1578
Economic value of produce(Rs/ha) of safflower with application of 20 kg N/ha	2432	1841
Cost of 20 kg N/ha (Rs)	96	96
Additional benefit due to application of 20 kg N/ha (Rs.)	462	263
Additional benefit: cost ratio of N application @ 20 kg/ha	2612	2205
Cost of 40 kg N/ha (Rs.)	192	192
Additional benefit due to application of 40 kg N/ha (Rs)	644	627
Additional benefit: cost ratio of N application @ 40 kg/ha	3.3	3.2
Economic value of produce (Rs/ha) of safflower with application of 15kg P^2O^5 over 20 kg N/ha	2250	2201

Cost of 15 kg P^2O^5 (Rs.)	81	81
Additional benefit due to application of 15 kg P^2O^5/ha over 20 kg N/ha (Rs.)	Nil	360
Additional benefit: cost ratio of P^2O^5 application @ 15 kg/ha	Nil	4.4
Economic value of produce(Rs/ha) of safflower with application of 30 kg P^2O^5/ha over 40 kg N/ha	2978	2754
Cost of 30 kg P^2O^5 (Rs)	162	162
Additional benefit due to application of 30 Kg P^2O^5 /ha over 40 kg N/ha (Rs)	364	549
Additional benefit cost ratio of P^2O^5 application @ 30 kg/ha	2.2	3.4

Price of produce and fertilizers: Safflower seed=Rs.350/q, fertilizer N=Rs.4.80/kg, fertilizer P^2O^5 = Rs.5.40/kg.

Economics of fertilizer application: Application of nitrogen to safflower was found to be profitable at all the levels tried. Results obtained showed that the additional benefit due to nitrogen application varied between Rs.263.00 to Rs.644.00/ha (Table 4). Additional benefit: cost ratios of 4.8 and 2.7 were obtained due to application of nitrogen @ 20 kg/ha under S1 and S2 cropping systems respectively. The corresponding values for 40 kg N/ha were being 3.3 and 3.2. The results suggest that application of nitrogen @ 20 kg/ha is more economic in terms of return per rupee invested than applying nitrogen @ 40 kg/ha in sole–safflower cropping system. However, under S2 system the return is more if the nitrogen is applied @ 40 kg/ha. No additional benefit was recorded due to phosphorus application @ 15 kg P_2O_5/ha over nitrogen application @ 20 kg/ha under S1 system. Under the S2 system the same treatment resulted in additional benefit of Rs.360.00/ha and benefit : cost ratio of 4.4. Application of P_2O_5 @ 30 Kg/ha resulted in additional benefit of Rs.364.00 and Rs.549.00/ha over 40 kg N/ha alone under S1 and S2 cropping systems respectively. The benefit : cost ratios in these cases were 2.2 and 3.4. The data on economic analysis further stress on the need of phosphorus application to safflower under S2 cropping system.

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Studies on heterosis and inbreeding depression in selected cross combination of sunflower

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ABSTRACT

Ten Sunflower hybrids derived from five cytoplasmic male sterile lines and two restorer lines, nine F_2's were planted alongwith seven parents in a randomised block design during summer 1984 to estimate heterosis and inbreeding depression. Average heterosis varied from -7.7% for days to flowering to 192.4% for seed yield. Percentage contribution of number of filled seeds, leaf area, head diameter and 100-seed weight towards expression of heterotic effect for seed yield was to the extent of 37.7, 20.7, 15.2 and 9.7 per cent respectively. Heterosis for oil content and number of leaves was low. Seed yield and number of filled seeds showed marked inbreeding depression. Days to flowering, seed weight and number of leaves had lower magnitude of inbreeding depression.

Key Words: Sunflower; *Helianthus annuus*; heterosis; inbreeding depression; seed yield and component characters

INTRODUCTION

Amongst several edible oilseed crops cultivated in the country, sunflower *(Helianthus annuus* L.) offers scope for commercial exploitation of heterosis utilising cyto-restorer system. In heterosis breeding programme, knowledge on extent of heterosis and inbreeding depression is not only helpful to identify high yielding hybrid cultivars but also substantiates the nature of heterosis. In sunflower, such studies are scanty. In the present study, an attempt has been made to estimate the extent of heterosis and inbreeding depression for seed yield and component characters in selected cross combinations.

MATERIALS AND METHODS

Five cytoplasmic male sterile lines, viz., CMS-89, CMS-234, CMS-302, CMS-307 and CMS-308 and two fertility restorer lines (RHA-274 and RHA-801) were crossed in all possible combinations. All the resultant 10 F_1's and their F_2's (except CMS-89 x RHA-274 cross) were planted alongwith seven parents in randomised complete block design with four replications during summer 1984. The analogs of female parents (B lines) were planted in lieu of CMS lines. Each replication contained

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one row (4.5 m length) each of parents and hybrids, and two rows of F_2 generation. A spacing of 60x30 cm was adopted. Data on seed yield per plant, head diameter, number of filled seeds/head, 100 seed weight, plant height, stem diameter; number of leaves per plant, leaf area per plant, days to flowering and oil content were recorded in each replication on five random competitive plants in parents and F_1's, while for F_2 generation 25 plants were considered. Oil content was determined using NMR-Spectrometer (Model 20 pi). Plot means were used to calculate average heterosis and inbreeding depression.

RESULTS AND DISCUSSION

The mean performance of parents, hybrids and F_2 generation for seed yield and component characters is presented in Table 1. Amongst parents, CMS-302 recorded highest yield followed by CMS-234B. The cross CMS-308 x RHA-274 gave the highest seed yield per plant (45.8 g) followed by CMS-308 x RHA-801 (41.9 g). The F_2 generation of the cross CMS-234 x RHA-274 gave lowest seed yield of 15.7 g. Lowest number of filled seeds per plant and highest test weight was recorded in parent CMS-307. In case of hybrids, two crosses, viz., CMS-89 x RHA-801 and CMS-89 x RHA-274 had the highest number of filled seeds but lowest seed test weight of 2.9 g. CMS-302 had the highest oil content of 42.9 per cent amongst the parents while in hybrids the cross CMS-302 x RHA-801 was top with 44.9 per cent oil. In F_2 generation, the highest and lowest mean oil content were recorded for the cross 302 x RHA-801 (44.1 per cent) and CMS-308 x RHA-274 (29.6 per cent) respectively.

An examination of the data on the degree of average heterosis revealed that it varied from -7.7% for days to flowering to as high as 192.4% for seed yield per plant (Table 1). The degree of heterotic effect was of higher magnitude for component characters like number of filled seeds, leaf area, head diameter and seed weight and of lower magnitude for oil content, number of leaves per plant, plant height and stem diameter. Inbreeding depression was highest for sed yield followed by number of filled seeds, head diameter, leaf area and plant height. It was of lower magnitude for days to flowering, seed weight and oil content.

As early as 1959, Grafius opined that heterosis for seed yield can be accounted through heterosis expressed for component characters. Although information on heterosis for seed yield in relation to component characters is available in food crops, such knowledge is lacking in sunflower. In the present study, it is evident that heterosis for seed yield can be mainly attributed to the manifestation of heterosis in four component characters, viz., number of filled seeds

Table. Mean performance of parents, F_1's, F_2'S and average heterosis (%) and inbreeding depression (%) for seed yield and ancillary characters

Generation	Seed yield per plant (g)	Head diameter (cm)	No. of filled seeds per head	100 seed weight (g)	Plant height (cm)
(1)	(2)	(3)	(4)	(5)	(6)
Parents					
CMS 89 (P_1)	10.8	10.4	120.6	2.0	125.3
CMS 234 (p_2)	18.3	10.9	463.8	3.8	129.0
CMS 302 (p_3)	24.0	13.6	780.0	3.3	133.6
CMS 307 (p_4)	6.1	12.4	71.2	8.0	116.5
CMS 308 (p_5)	9.6	8.1	338.7	2.8	130.5
RHA 274 (p_6)	8.7	7.8	484.7	1.8	105.2
RHA 801 (p_7)	4.8	5.8	222.8	1.6	85.8
Mean	11.8	9.9	401.0	3.3	118.0
Hybrids					
P_1xP_6	32.9	15.7	1144.2	2.9	154.7
P_2xP_6	32.9	13.2	655.0	3.9	142.5
P_3xP_6	31.9	13.4	740.4	4.3	139.6
P_4xP_6	31.1	14.1	535.4	5.8	142.6
P_5xP_6	45.7	17.3	686.7	5.4	152.9
P_1xP_7	34.7	16.1	1186.8	2.9	142.7
P_2xP_7	29.8	12.5	755.6	3.5	136.7
P_3xP_7	25.2	13.2	747.9	3.3	124.4
P_4xP_7	38.9	15.0	610.4	6.3	124.2
P_5xP_7	41.9	14.9	773.0	5.3	142.0
Mean	34.5	14.6	849.0	4.3	140.3
F_2 generation					
P_1xP_6	-	-	-	-	-
P_2xP_6	15.7	11.6	469.6	4.2	132.4
P_3xP_6	19.5	11.0	495.6	3.9	111.8
P_4xP_6	18.5	11.6	367.4	5.0	121.7
P_5xP_6	17.9	11.3	349.3	5.0	124.0
P_1xP_7	18.1	11.4	631.9	2.9	123.4
P_2xP_7	21.6	11.6	568.2	3.8	113.6

P_3xP_7	17.8	11.4	488.5	3.6	109.2
P_4xP_7	20.4	11.9	343.4	5.9	106.9
P_5xP_7	20.2	11.1	481.5	4.2	117.6
Mean	18.8	11.4	466.1	4.2	117.9
CD (P=0.05)	10.54	2.45	196.51	0.92	15.10
Average heterosis (%)	192.4	47.5	117.7	30.3	18.9
Average inbreeding depression (%)	45.5	21.9	45.1	2.3	16.0

Table (Contd.)

Stem diameter (cm)	No. of leaves/ plant	Leaf area per plant (cm^2)	Days to 50% flowering	Oil content (%)
(7)	(8)	(9)	(10)	(11)
1.7	19.1	2384	81.0	34.3
1.3	20.6	1457	63.0	40.3
1.6	16.8	1691	59.0	42.9
1.5	17.9	1884	62.0	21.1
1.4	16.2	1314	62.0	41.0
1.2	15.4	1116	60.2	37.8
0.9	13.5	873	58.7	38.9
1.4	17.4	1531	63.7	36.6
1.7	21.7	2875	66.5	41.6
1.5	19.2	1752	56.0	42.9
1.6	18.0	1919	56.2	43.5
1.7	22.0	3081	58.0	32.1
1.9	21.0	3124	64.5	35.1
1.8	20.3	2901	63.7	42.5
1.6	19.3	2024	55.7	42.8
1.6	16.5	1792	56.0	44.9
1.7	19.4	3247	54.5	32.8
1.8	17.7	2508	56.5	42.3
1.7	19.5	2522	58.8	40.1

1.4	19.3	1943	58.0	41.7
1.4	15.8	1502	55.0	42.7
1.4	19.2	2134	59.7	31.3
1.5	17.6	2147	59.7	29.6
1.5	20.0	2614	62.2	42.6
1.4	17.5	1863	55.7	42.9
1.3	15.1	1576	56.0	44.1
1.5	18.0	2489	57.2	31.7
1.4	18.4	2127	60.2	37.0
1.4	17.9	2044	58.2	38.2
0.29	2.90	790	2.05	4.12
21.4	12.1	64.7	-7.7	9.6
17.6	8.2	18.9	1.0	4.7

(111.7 per cent), leaf area per plant (64.7 per cent), head diameter (47.5 per cent) and seed weight (30.3 per cent). The results of earlier studies by Putt, 1965, Seetharam *et al.*, 1977; Singh *et al.*, (1978) may be cited in support of this observation.

Percentage contribution of component characters towards the seed yield was worked out considering the seven yield contributing characters. This has revealed that the four characters, viz., number of filled seeds, leaf area, head diameter and test weight contributed to the extent of 37.7, 20.7, 15.2 and 9.7 per cent respectively. The contribution of these characters towards the yield is more than 80%. The other components - plant height, number of leaves and stem diameter had relatively lower contribution. Though the heterotic effect for number of leaves was of lower magnitude, the high heterotic effect exhibited in total leaf area per plant may be ascribed to increased leaf size in hybrids. Heterosis for oil content was of lower magnitude which suggest to include parental lines having high oil content. Negative heterosis for days to flowering implied earliness in hybrids over their parents.

Most striking inbreeding depression was exhibited for seed yield (45.5%) and number of filled seeds/head (45.1%) followed by head diameter (21.9%), leaf area/plant (18.9), stem diameter (17.6%) and plant height (16.0%). In general, the characters which showed high heterotic effect had maximum inbreeding depression, thereby confirming the importance of non-additive genetic component for these traits.

In another study, Giriraj *et al.* (1985) reported 24.1 to 43.5% inbreeding depression for seed yield in three sunflower hybrids. Days to flowering, 100-seed weight, oil content and number of leaves per plant had comparatively lower magnitude of inbreeding depression indicating thereby that these characters were controlled by additive gene effects. Schuster (1970) also reported least inbreeding depression for seed weight and oil content. In population breeding, the parents of such of those hybrids which had shown low inbreeding depression for economic traits could form initial material. The study has pointed out the possibility of identifying such material.

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Weed competition studies in castor

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ABSTRACT

Weed competition during the first 60 days period of crop growth in castor was critical under nipped and no-nipping conditions. The seed yields with weed free environment throughout crop period did not differ significantly from weed free field upto 60 days. The net returns were highest with weed free condition upto 60 days. The weed density was low after 60 days of crop period, as revealed from percent control of weeds in weed free condition upto 60 days. The seed yields and shoot dry matter with no-nipping condition was highest, due to primary and secondary branches resulting in more number of spikes in addition to terminal spike. Seed weight was maximum with niping practices, and the crop duration was 120 days compared to 180 days with no-nipping condition

Key words; Weed competition; Castor

INTRODUCTION

Castor (*Ricinus communis L*) is one of the important non-edible oilseed crops. It is cultivated mostly on low fertility shallow soils having low moisture retention capacity. The low average yield of 605 kg.ha^{-1} (Yadava, 1984) is because of weed competition and several other factors. The weed menace gets aggravated in this crop due to wider spacing (Weiss, 1971). The reduction in crop yields due to crop-weed competition ranged from 30-35% (Kondap *et al.*, 1983). The cultural practice like nipping adopted in castor reduces the duration and as well presents a considerable variation in crop canopy, which encourages weed development. Weed free condition till harvest may give higher yield, but is followed due to high cost involvement. It becomes necessary, therefore, to determine the critical stage of crop weed competition (Kasasian and Seeyave, 1969). Any delay in weeding can reduce the yield substantially, even though the subsequent weedings are carried out successfully. Hence, the present sudy was conducted to determine the critical period of weed competition in castor.

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MATERIALS AND METHODS

Field experiments were conducted for two *kharif* seasons at the Agricultural College Farm, A.P.Agricultural University, Hyderabad. In the first year, ten weed control (5 each of having weed and weed free) periods were tested in two separate experiments, one with nipped and the other with no-nipped condition, in RBD with three replications. To get more precise information, this experiment was laid out in split plot design in the second year with weed control treatments in main plots, and nipping and no-nipping practice in sub-plots replicated thrice. The soil was sandy loam with 307.6 kg ha^{-1} available nitrogen, 19 kg ha^{-1} available P_2O_5 and 316.8 kg ha^{-1} available K_2O and pH 7.5. The castor seeds (Var. Aruna) were sown in rows spaced at 60 cm in the last week of July. The crop was fertilized with 60 N, 40 P_2O_5 and 40 K_2O kg ha^{-1}. The duration of crop was 120 and 180 (three pickings) days under nipped and no-nipped conditions, respectively.

In nipping practice, auxillary buds were removed (nipped) after the emergence of primary spike, coinciding with 35 days of crop age. This was repeated twice at weekly intervals. The sampling of weeds was done from a quadrat of 0.5 m^{-2}. The economics of each weed control practice was calculated, taking into consideration the number of labourers required for weeding and the prevailing labour wages, and also the market price of the castor seed.

RESULTS AND DISCUSSION

The predominant weeds observed in the experimental area were *Amaranthus polygamus* Linn., *Celosia argentea* Linn., *Digera arvensis* Forsk., *Lagasca mollis* Ca V., *Tridax procumbens* Linn., *Acanthospermum hispidum* D.C., *Euphorbia hirta* Linn., *Trianthema portulacastrum* Linn. (among dicots), *Digitaria sanguinalis* L., *Panicum isachne* Roth., *Dactyloctenium aegyptium* Beauv., *Cynodon dactylon* Pers., *Cyperus rotundus* Linn., and *Commelina benghalensis* Linn.(among monocots).

Effect of Weed control periods:

The influence of different weed free intervals at harvest in both the years revealed that per cent control of weeds considerably improved with extension of weed free period from 20 to 80 days (Table 1). Weed number drastically reduced with increase of weed free condition from 40 to 60 days of crop age, as evident from steep increase in per cent control of weeds in two years under niped and no-nipped condition and ranged from 33-58% compared to any other equal interval of 20 days. The weed density was highest in unweeded check till harvest in both the years, except in no-nipped condition in the first year. Weed density

Table-1 : Economics and weed growth as influenced by weed control invervals and nipping practice in castor.

Treatments	Nipping: Weed Control Year 1	Nipping: Weed Control Year 2	Nipping: Weed Dry Weight (Kg ha^{-1}) Year - 2, 60 DAS	Nipping: Weed Dry Weight (Kg ha^{-1}) Year - 2, Harvest	Nipping: Weed Index (%) Year1	Nipping: Weed Index (%) Year2	Nipping: Net returns (Rs ha^{-1}) Year1	Nipping: Net returns (Rs ha^{-1}) Year2	Nipping: Net returns (Rs ha^{-1}) Mean	No-Nipping: Weed Control (%) Year 1	No-Nipping: Weed Control (%) Year 2	No-Nipping: Weed Dry weight (Kg ha^{-1}) Year - 2, 60 DAS	No-Nipping: Weed Dry weight (Kg ha^{-1}) Year - 2, Harvest	No-Nipping: Weed Index (%) Year1	No-Nipping: Weed Index (%) Year2	No-Nipping: Net returns (Rs ha^{-1}) Year1	No-Nipping: Net returns (Rs ha^{-1}) Year2	No-Nipping: Net returns (Rs ha^{-1}) Mean
Weed free period (DAS)																		
20	13.9	12.5	830	880	18.5	24.2	605	1372	989	0.0	19.4	810	850	32.5	24.3	1770	2947	2359
40	15.2	25.0	680	730	11.7	17.9	690	1285	988	26.3	25.2	660	700	9.7	13.3	1515	3295	2405
60	73.5	57.0	400***	630	3.2	5.4	716	1520	1118	56.8	59.4	350**	750	4.7	4.2	1518	3610	2564
80	83.9	71.8	-	500	1.2	0.0	522	1504	1013	81.1	67.7	-	600	0.0	1.2	1549	3532	2541
Till harvest	100.0	100.0	-	0.0	0.0	0.0	405	1312	859	100.0	100.0	0.0	0.0	0.0	0.0	1330	3455	2393
No Weeding Period (DAS)																		
20	100.0	100.0	630*	0.0	11.2	29.4	217	369	293	100.0	100.0	640*	0.0	14.5	23.3	804	2199	1502
40	100.0	100.0	1260**	0.0	29.4	47.8	(-)77	(-)57	(-)67	100.0	100.0	1110**	0.0	25.1	46.2	564	1078	821
60	100.0	100.0	1450	0.0	38.3	71.5	(-)113	(-)708	(-)411	100.0	100.0	1400	0.0	35.8	71.5	(-)95	(-)220	(-)158
80	100.0	100.0	1360	0.0	56.2	73.5	(-)335	(-)478	(-)405	100.0	100.0	1300	0.0	34.6	77.6	670	(-)267	202
Till Harvest	0.0	0.0	1420	980	61.0	73.9	0.0	0.0	0.0	9.0	0.0	1370	930	59.2	81.6	0.0	0.0	0.0

DAS = Days After Sowing

*, **, *** Indicate dry weight of weeds at 20, 40 and 80 days of crop period, respectively.

at harvest in weed free interval till 20 days exceeded the unweeded check throughout in no-nipped condition of the first year. The overall weed control percentage with weed free condition only for first 20 days was poor indicating that maintaining weed free check for a short period of 20 days was not sufficient to reduce weed density.

In weed free series, the biomass of weeds increased from 60 days after sowing to harvest, which was due to late emergence of weeds after initial weed free condition and there after their continued active growth even at later stages of crop growth. But in unweeded check the biomass of weeds was highest at 60 days after sowing and reduced at harvest. This trend was due to continuous weed growth from initial stages of crop and most of the weed species completing their active growth by 60 days.

The seed yields were significantly influenced due to crop weed competition under nipping and no-nipping (Table 2). The mean seed yield, dry matter production and 1000-seed weight in two years under nipping and no-nipping were highest with weed free (entire crop period) treatment. The seed yield was reduced by 20.9%, 25.5% and 14.4% by allowing the weeds to compete for 20 days, from 20 to 40, 40 to 60 and 60 to 80 days, respectively. The highest decline in seed yield was between 40 and 60 days of crop and thereafter declined. Maintaining weed free condition 60 days from sowing did not improve the yield much over no weeding throughout and gave negative returns, except in first year under no-niped condition. Lowest seed yield, shoot dry matter and 1000-seed weight were observed under unweeded check throughout crop period but the dry matter accumulation of weeds was highest. The seed yield under unweeded condition for first 20 days of crop was comparable with corresponding period with weed free check but the net returns were much lower.

Under weed free series, it was observed that maintenance of weed free environment upto 60 days was essential for obtaining higher net returns in niped and no-nipped conditions. Weeding thereafter was found to be unprofitable as there was no significant difference in seed yield even by maintaining weed free environment until harvest. The net returns per hectare was less, as the expenditure incurred on weeding after 60 days was more than the cost of extra seed yield obtained.

Effect of nipping practice :

Nipping practice did not cause variation in per cent control of weeds, weed density and weed index (Table 1). The dry matter production in plants was almost reduced by half due to prevention of primary and secondary branches by nipping the auxillary buds. Seed

Table-2 : Effect of weed control intervals, nipping practice on growth and yield of castor.

Treatment	Nipping							No-nipping						
	Dry matter (Kg ha^{-1})		1000-Seed weight (g)		Seed Yield (Kg ha^{-1})			Dry matter (Kg ha^{-1})		1000-Seed weight (g)		Seed Yield (Kg ha^{-1})		
	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2	Mean	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2	Mean
Weed free series														
20 DAS	2120	2310	172.5	181.7	985	1129	1057	4170	4080	170.8	176.6	1264	1826	1545
40 DAS	2780	2960	176.3	188.1	1067	1222	1145	5210	5130	174.7	176.6	1690	2093	1892
60 DAS	3050	3480	178.7	188.7	1170	1409	1290	5680	5460	176.0	181.8	1784	2312	2048
80 DAS	3320	3540	180.6	190.4	1195	1505	1350	6360	5480	178.0	186.0	1899	2383	2141
Till harvest	3550	3580	184.9	197.5	1209	1489	1349	6720	5520	183.8	184.8	1872	2413	2143
No Weeding series														
20 DAS	2640	2440	175.3	186.3	1073	1051	1062	5270	4200	176.4	174.8	1601	1850	1726
40 DAS	1490	1660	173.0	175.9	853	778	816	4210	4020	175.3	173.3	1402	1299	1351
60 DAS	1280	1400	169.1	173.7	746	425	586	3600	3700	171.6	160.9	1202	688	945
80 DAS	1180	1240	160.8	165.3	526	394	462	3300	3240	168.3	150.0	1224	540	882
Till harvest	940	1010	157.9	150.5	471	388	430	2680	2580	157.0	148.6	764	455	610
C.D. (P=0.05)	301	363	10.8	17.6	217	132		319	363	NS	17.6	390	132	

DAS = Days After Sowing

development and its weight were better with nipping, but the seed yield was more with no-nipping. This increase in seed yield was mainly due to increased number of spikes on primary and secondary branches in addition to terminal spike on main shoot. Even though more number of weedings were required because of longer duration of the crop under no-nipping condition, however, the net returns was high in this practice.

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Short Communications

Genetic behaviour of oil and protein in Indian mustard

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Rapseed and mustard being second major source of edible oil in the country and having good amount of protein needs immediate attention for improvement of both oil and protein contents alongwith seed yield. The vegetable oil is the main source of energy in vegetarian diet. Because of lack of basic information on genetics of oil and protein contents in this crop, it is necessary to know the gentic make-up of oil and protein in order to incorporate them into the breeding programme systematically. The present study was undertaken to know the gene effects for oil and protein contents in Indian mustard *(Brassica juncea* (L). Czern & Coss.).

The material for this study comprised of six parents, 15 F_1s, 15 F_2s, and 30 back crosses (15B_1s and 15B_2s). Of these materials, the oil content (%) was estimated by Soxhlet method. Meal was subjected to semi-micro-Kheldahl's method of nitrogen estimation. The protein (%) with mean was estimated by multiplying the nitrogen content with 6.25. Gene effect were studied by using generation mean analysis proposed by Hayman (1958). Scaling tests (A, B and C) proposed by Mather (1949) and Hayman and Mather (1955) were applied for partitioning crosses into interacting and noninteracting.

Significant differences were observed among generation means of each cross for the characters under study. The scaling tests indicated the failure of additives-dominance model for all the 15 crosses showing presence of non-allelic interaction for oil content. The genetic variation of this character was determined by all the three genetic variations-additive, dominance and epistatic ($\hat{i}, \hat{j}$ and $\hat{L}$). Eleven crosses showed additive effects (Table 1). Dominance effects were significant for 14 crosses. Out of these, seven crosses exibited positive values of dominance effect, but most of the crosses showed higher negative valuaes of dominance X dominance. Additive X additive effects were significant in 13 crosses, eight being positive. Dominance X dominance interactions were significant for eleven crosses. All the six components of generation mean were significant for seven

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Table 1: Estimates of component of generation mean for oil content in Indian mustard.

Cross	Gene effect					epistasis	
	m	d	h	i	j	l	
$P_1 \times P_2$	33.70** ±0.48	1.79* ±0.87	18.43** ±2.65	16.41** ±3.61	4.86** ±1.92	-16.6** ±4.10	D
$P_1 \times P_3$	38.09** ±0.14	4.52** ±0.87	-5.58** ±1.08	-7.45** ±1.83	-6.20** ±1.85	16.96** ±3.85	D
$P_1 \times P_4$	40.53** ±0.67	2.40* ±1.10	-6.74* ±3.34	-17.78** ±3.32	7.96** ±2.29	26.27** ±5.30	D
$P_1 \times P_5$	39.59** ±0.67	4.17** ±0.97	-8.20** ±3.30	-9.90** ±3.35	9.77** ±1.98	12.28** ±4.88	D
$P_1 \times P_6$	35.80** ±0.45	0.94 ±0.91	8.63** ±2.63	6.74** ±2.59	1.72 ±1.84	-8.83** ±4.18	D
$P_2 \times P_3$	36.07** ±0.76	-0.92 ±0.61	-6.76** ±0.33	-7.24* ±3.31	-0.29 ±1.56	23.76** ±4.00	D
$P_2 \times P_4$	41.17** ±0.60	2.35** ±0.80	-13.53** ±2.00	-11.30** ±2.00	6.58** ±2.20	6.72 ±4.13	D
$P_2 \times P_5$	37.49** ±0.56	0.06 ±0.44	-0.90 ±2.48	-4.66 ±2.43	0.26 ±1.43	16.66** ±3.02	D
$P_2 \times P_6$	40.28** ±0.54	-1.73** ±0.47	-11.07** ±2.44	18.42** ±2.40	-4.90** ±1.24	31.04** ±5.03	D
$P_3 \times P_6$	36.22** ±0.84	-4.13** ±0.50	9.30* ±3.54	9.02* ±3.51	-11.25** ±1.19	-12.63** ±4.04	D
$P_4 \times P_5$	34.85** ±1.05	-6.64** ±0.53	15.97** ±4.41	13.26** ±4.34	-15.02** ±1.27	-6.96 ±4.97	D
$P_4 \times P_6$	33.93** ±0.10	-2.11** ±0.79	15.63** ±1.73	11.34** ±1.64	-7.55** ±1.70	0.60 ±3.30	C
$P_5 \times P_6$	34.81** ±0.44	-1.64 ±0.91	8.40** ±2.65	9.71** ±2.55	-4.85** ±1.86	-14.37** ±2.32	D

1. RNS3 (P_1), 2. RCU10 (P_2), 3. Varuna (P_3), 4. RNS12 (P_4),
5. RLM198 (P_5,6.R75-1(P6)

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

Epistasis: D=Duplicate; C=complimentary.

Table 2: Estimates of component of generation mean for protein content Indian mustard.

Cross	Gene effects					Espistasis	
	m	d	h	i	j	l	
$P_1 x P_2$	31.96** ±0.46	2.83** ±0.80	10.91** ±2.59	9.73** ±2.44	5.73** ±1.70	-16.52** ±4.07	D
$P_1 x P_3$	31.77** ±0.44	4.90** ±0.45	16.58** ±2.05	16.50** ±2.01	9.99** ±1.05	-31.25** ±2.71	D
$P_1 x P_4$	33.33** ±0.93	4.53** ±0.93	9.12** ±1.94	8.06** ±1.91	8.43** ±1.97	-24.29** ±3.82	D
$P_1 x P_5$	33.79** ±0.40	-1.42 ±1.93	-2.58 ±2.54	-4.77 ±2.46	0.15 ±1.97	13.04** ±4.26	D
$P_1 x P_6$	31.97** ±0.46	-2.96** ±0.86	16.17** ±1.77	10.76** ±2.53	5.61** ±1.91	-9.71** ±4.23	D
$P_2 x P_4$	33.06** ±0.46	3.07** ±0.58	5.95** ±2.24	5.53* ±2.20	9.45** ±1.33	-15.31** ±3.07	D
$P_2 x P_5$	33.35** ±1.44	5.03** ±0.84	6.39 ±4.97	6.25 ±6.87	13.01** ±1.80	-11.24 ±6.02	D
$P_2 x P_6$	32.60 ±0.17	-4.52** ±0.20	6.81** ±0.99	6.98** ±0.80	8.80** ±0.95	-15.70** ±1.58	D
$P_3 x P_4$	37.81** ±1.24	3.28** ±1.50	-8.56 ±5.84	-9.26 ±5.81	5.75 ±3.05	-3.81 ±3.87	C
$P_3 x P_5$	33.30** ±1.24	4.34** ±1.50	9.70** ±3.84	8.14* ±5.81	11.50** ±3.05	11.57** ±4.11	C
$P_4 x P_5$	37.27** ±0.73	0.45 ±0.87	-16.90** ±3.50	-15.66** ±3.41	2.73 ±1.87	12.77** ±4.82	D
$P_4 x P_6$	32.82** ±1.01	3.99** ±0.46	10.39** ±4.24	9.04* ±4.17	8.92** ±1.31	-19.00** ±4.71	D

* Significant at P=0.05 ** Significant at P=0.01
Epistasis: D = Duplicate; C =complimentary

crosses. Fourteen crosses showed duplicate type of **epistasis and** only one indicated complementary epistasis.

The additive x additive effects were positive in most of the crosses for oil content. Dominance effects were also positive and significant in seven crosses. But in the positive effects in most of the crosses were nullified by corresponding negative value of dominance x dominance. Both additive and non-additive effects were observed in some corsses. Additive effects were reported by Singh and Sinha (1967) in yellow *Sarson* while Yadava *et al.* (1981) reported both the additive and non-additive gene effects in Indian mustard.

In case of protein content, the scaling tests revealed the presence of non-allelic interactions in 12 crosses. Additive effects were significant for 10 crosses (Table 2) Most of this crosses exhibited positive values. The estimates of dominance effects were signifi;ant in nine crosses and eight showed positive expression. The additive x additive effects were significant for nine crosses. Out of them, eight crosses showed positive values. The significant gene interaction due to additive x domoinance was observed for nine crosses. Ten crosses showed significant values of dominance x dominance interactions. Seven crosses showed nigative values and three crosses exhibited positive and significant values. Ten crosses showed duplicate type of epistasis, whereas two crosses exhibited complementary epistasis.

Eight crosses exhibited significant and positive values of additive gene effects. Additive x additive effects were also significant in eight crosses. The positive values of additive x additive effects supported that additive effects were responsible for the inheritance of protein. Although dominance effects were significant and positive in nine crosses but it was nullified due to the presence of dominance x dominance interactions having negative values. The crosses, P_3 x P_5, had significant and positive values for all six components of digenic epistasis. It indicates the involvement of both the additive and dominance gene effects in controlling the inheritance of protein.

The present findings indicated that oil and protein contents in Indian mustard were controlled by varying proportion of additive and dominance gene effects. In such situation the use of reciprocal recurrent selection would be fruitful for effective utilization of both types gene effects.

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Physical properties of linseed as affected by nitrogen, phosphorus and potash

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Linseed *(Linum Usitatissimum L.)* is an important oilseed crop used in the manufacture of paints, varnish, linoleum, oil cloth and similar products. Its oil cake is a good source of organic manure. In Madhya Pradesh alone linseed contributes nearly 22% of acreage and about 10% of country's production.

No published authentic information is available on physical properties of any linseed variety. Also no information is available on the physical properties of grain which are affected by the different doses of N, P, K during cultivation.

Therefore, the present study was undertaken to know the different physical properties of linseed grown under different N P K doses.

JL-23-10 variety of linseed was used for the study. Following fertilizer treatments were given:

(a) Nitrogen levels (three) - 0, 20, 40 kg/ha.
(b) Phosphorus (P_2O_5) levels (three) -0, 20, 40 kg/ha.
(c) Potash (K_2O) levels (two) - 0, 20, kg/ha.

Three dimensions viz., length (L), breadth (B) and thickness (T) of the 30 randomly selected seeds were measured using a vernier caliper with least count of 0.01 mm. Size and sphericity was calculated using following formulae

Size = $(L \times B \times T)^{1/3}$, mm
Sphericity = Size/Largest dimension

Physical balance was used to determine weight, 1000 - grain weight and to calculate the bulk density (BD) and true density of the grains. True density (TD) was measured by finding the true volume of 100 g of grains. True volume was calulated by measuring displaced kerosene in a measuring cylinder when 100 g of grains were poured in it. Bulk

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Table 1 : Dimensions, size and sphericity of linseed grains

N-P-K (kg/ha)	Length (mm)	Breadth (mm)	Thickness (mm)	Size (mm)	Sphericity (mm)
0- 0- 0	4.48	2.35	1.02	2.21	0.492
0- 0-20	4.87	2.37	0.95	2.22	0.456
0-20- 0	4.85	2.40	1.03	2.29	0.471
0-20-20	4.74	2.44	1.08	2.32	0.489
0-40- 0	4.81	2.36	0.96	2.22	0.461
0-40-20	4.58	2.30	0.96	2.16	0.472
20- 0- 0	4.67	2.32	1.00	2.21	0.474
20- 0-20	4.58	2.33	0.98	2.18	0.477
20-20-20	4.76	2.38	0.98	2.23	0.469
20-40- 0	4.96	2.47	1.00	2.30	0.465
20-40-20	4.82	2.56	0.98	2.29	0.482
40- 0- 0	4.77	2.48	0.97	2.25	0.473
40- 0-20	4.76	2.38	0.98	2.23	0.469
40-20- 0	4.75	2.38	1.02	2.26	0.476
40-20-20	4.85	2.40	1.07	2.32	0.478
40-40- 0	4.62	2.30	1.00	2.20	0.476
40-40-20	4.74	2.35	0.95	2.19	0.463
SD	0.120	0.070	0.110	0.050	0.090
SE± m	0.028	0.015	0.026	0.012	0.021
CV %	2.530	2.940	11.110	2.240	19.030

density (BD) was measured by finding the weight of 100ml of grains.

Porosity per cent was calculated by following relationship (Dev *et al.*, 1982):

$$\text{Porosity, per cent} = \frac{TD - BD}{TD} \times 100$$

Where,

TD = True density of the grains, g/ml

BD = Bulk dsnsity of the grains, g/ml

Angle of repose was calculated by making the regular heap by droppig the linseed through a funnel over a smooth surface. The height and diameter of the heap were measured by scale and steel tape. Angle of repose was calculated as follows:

Table 2: True density, bulk density, porosity 1000 grains weight and angle of repose of linseed grains

N-P-K (kg/ha)	True density (g/ml)	Bulk density (g/ml)	Porosity (percent)	Weight of 1000 grains (g)	Angle of repose (degrees)
0- 0- 0	1.18	0.700	40.68	6.50	22°08'
0- 0-20	1.17	0.704	39.83	6.75	22°05'
0-20- 0	1.15	0.708	38.43	7.00	21°47'
0-20-20	1.14	0.715	37.28	6.80	21°09'
0-40- 0	1.16	0.712	38.62	7.10	21°20'
0-40-20	1.17	0.713	39.06	7.00	20°59'
20- 0- 0	1.18	0.708	40.00	7.10	20°41'
20- 0-20	1.12	0.714	36.25	7.25	20°57'
20-20- 0	1.12	0.713	36.34	7.33	20°45'
20-20-20	1.14	0.710	37.71	7.30	20°20'
20-40- 0	1.10	0.714	35.09	7.20	20°05'
20-40-20	1.14	0.716	37.19	7.50	19°54'
40- 0- 0	1.11	0.720	35.13	7.80	19°45'
40- 0-20	1.10	0.733	34.27	7.83	19°48'
40-20- 0	1.13	0.718	36.46	7.75	19°20'
40-20-20	1.09	0.721	33.85	8.00	18°51'
40-40-0	1.12	0.711	35.80	8.25	18°39'
40-40-20	1.08	0.725	32.87	8.30	18°30'
SD	0.006	0.030	1.910	0.500	1.000
SE± m	0.001	0.007	0.450	0.118	0.230
CV %	0.840	2.650	5.180	6.820	4.890

$$\text{Angle of repose, (degrees)} = \tan^{-1}\left(\frac{\text{height}}{\text{radius}}\right)$$

From Table 1 it is evident that of 18 treatments, the minimum and maximum individual length (L) breadth (B) and thickness (T) were 4.48mm, 2.30 mm and 0.95 mm and 4.96 mm, 2.56 mm and 1.08 mm, respectively. The coefficient of variation for B and T has been higher than that of L. It signifies that plumbness of linseed has been affected by N, P and K. While going for an average it appears to be 20-40-20 (N-P-K). As seen from Table 1, size variation is there with variation in N, P and K doses but the difference did not reach the level of significance. Sphericity also showed variation but with no significant difference.

Variation in BD, TD, porosity per cent, 1000 grains weight and angle of repose reveals that statistically there is no significant difference (Table 2) 1000 grains weight has shown increasing trend with increase in N, P and K doses. Angle of repose has decreased with increased N, P and K doses. It means the surface roughness and thus flow characteristics improved with increased application of N, P and K.

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Evaluation of fertilizer requirements for Indian mustard

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Field experiments were conducted in Bhiwani, Bawani Khera, Tosham, Charkhi Dadri, Badhara and Siwani blocks of Bhiwani districts during 1980-81 and 1981-82 to determine the fertilizer requirements of mustard. In each block, five villages were selected randomly and experiment was conducted in each village with the following treatments, $N_0P_0K_0$, $N_{20}P_0K_0$, $N_{40}P_0K_0$, $N_{60}P_0K_0$, $N_{20}P_{20}K_0$, $N_{40}P_{20}K_0$, $N_{60}P_{20}K_0$, $N_{40}P_{40}K_0$, $N_{60}P_{40}K_0$ and $N_{60}P_{40}K_{20}$.

Where N, P and K stand for N, P_2O_5 and K_2O, while figures in suffix indicate the level of nutrients applied in kg/ha. The sources of N, P, K were calcium ammonium nitrate, single superphosphate and muriate of potash respectively. All the fertilizers were drilled at sowing 5 cm below the seed. One pre-sowing irrigation was given to ensure better germination. One protective irrigation was also given during the month of December. The experiment was conducted in randomised block design with Indian mustard *(Brassic Juncea* L.) Prakash as a test variety.

Soils of experimental fields were normal in salt content and reaction, very low to low in organic matter (0.05 to 0.45%) and available N (20-70ppm) low to medium in available P (1.5 to 4.5 ppm) and medium to high in available K (90-322 ppm). The soil analysis was done using the standard procedures as described by Chopra and Kanwar(1982).

The distribution of rain fall is given below:

RAIN-FALL DISTRIBUTION

Month	Rainfall(mm)during		Month	Rainfall(mm)during	
	1980-81	1981-82		1980-81	1981-82
July	131.5	68	November	5.0	9.0
August	135.0	Nil	December	18.0	Nil
September	Nil	Nil	January	34.0	28.0
October	Nil	Nil	February	13.0	12.0

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Table 1 Economics (Rs./ha) and yield (g/ha) of mustard under different fertilizer treatments.

Treatment	Cost of ferti- lizer	1980–81				1981–82			
		Yield	Value of addl. yield	Net profit	Net profit per rupee investment	Yield	Value of addl. yield	Net profit	Net profit per rupee investment
$N_0P_0K_0$	-	7.1	-	-	-	6.3	-	-	-
$N_{20}P_0K_0$	93.4	9.8	1350.00	1256.00	13.45	8.5	1100.00	1006.6	10.78
$N_{40}P_0K_0$	186.8	11.7	2300.00	2113.2	11.31	9.8	1750.00	1563.2	8.37
$N_{60}P_0K_0$	280.2	13.1	3000.00	2719.8	9.71	11.0	2350.00	2069.8	7.39
$N_{20}P_{20}K_0$	218.2	12.6	2750.00	2531.8	11.60	10.7	2150.00	1931.8	8.85
$N_{40}P_{20}K_0$	311.6	14.1	3500.00	3118.4	10.01	11.8	2750.00	2438.4	7.82
$N_{60}P_{20}K_0$	405.0	15.5	4200.00	3795.00	9.37	13.33	3500.00	3095.0	7.65
$N_{40}P_{40}K_0$	436.4	16.4	4650.00	4213.6	9.65	13.4	3550.00	3113.6	7.31
$N_{60}P_{40}K_{20}$	529.8	17.8	5250.00	4820.2	9.09	15.0	4350.00	3820.2	7.21
$N_{60}P_{40}K_{20}$	575.8	18.6	5750.00	5174.2	8.99	15.6	4650.00	4074.2	7.07
C. D. (P= 0.05)		0.57				0.40			

Prices (Rs./kg) N = 4.67, P_2O_5 = 6.24, K_2O = 2.30, Mustard = 5.00

The total rainfall received was 1520 mm in 1980-81 and 117 mm in 1981-82.

The yields were of high magnitude during the year 1980-81, as compared to 1981-82 (Table 1). There was low magnitude of response to applied fertilizer in 1981-82 which had a direct relationship with the rainfall distribution pattern. Rains received in the latter part of August during 1980-81 were beneficial for the growth and development of this crop and also the rains received at the time of flowering during that year contributed largely for an increased in yield. Responses due to fertilizer application under various treatments were significant during both the years. Increase in yield over control with the application of 20, 40 and 60 kg N/ha was of the order of 38, 64 and 84 per cent during 1980-81 and 35, 55 and 74 per cent during 1981-82 respectively. This indicated that nitrogen alone led to marked increase in the yield as the soils were deficient in organic matter and available N.

Application of phosphorus in combination with nitrogen significantly and consistently enhanced the grain yield of mustard.

Table 2. Response of mustard/kg applied nutrient.

Treatment	1980-81	1981-82
20 kg N over control	13.5	11.0
40 kg N over control	11.5	8.75
60 kg N over control	10.0	7.83
20 kg P_2O_5 over 20 kg N	14.0	11.0
20 kg P_2O_5 over 40 kg N	12.0	10.0
20 kg P_2O_5 over 60 kg N	12.0	11.5
40 kg P_2O_5 over 40 kg N	11.75	9.0
40 kg P_2O_5 over 60 kg N	11.75	10.0
20 kg K_2O over 60 kg N + 40 kg P_2O_5	4.00	3.00

Application of 20 kg P_2O_5/ha in combination with 20, 40 and 60 kg. N/ha enhanced the yield of mustard by 28,20 and 16% in 1980–81 and 26, 20 and 20% in 1981–82 over the corresponding basal doses of N, respectively. The increase due to 40 kg P_2O_5/ha was 40 and 35 % in 1980–81 over the basal doses of 40 and 60 kg N/ha, respectively. The corresponding increase in 1981–82 was 37 and 53% over the doses of N.

Per unit response of mustard to applied nutrient decreased with the increasing levels of N during 1980–81 and 1981–82 (Table 2). The increase were 13.5, 11.5 and 10.0 kg/kg N in 1980–81 and 11.0, 8.75 and 7.83 kg/kg N in 1981–82 at graded doses of 20, 40 and 60 kg N/ha, respectively. The values for phosphorus at 20 kg P_2O_5/ha were 14.0 and 12.0 kg/kg P_2O_5 in 1980–81 and 11.5 and 10.0 kg/kg P_2O_5 in 1981–82 over 20 and 40 kg N/ha, respectively.

The increase due to application of K was 4.00 kg/kg K_{20} in 1980–81 and 3.0 kg/kg K_2O in 1981–82 over the basal dose of 60 kg N + 40 kg P_2O_5/ha.

Economics of fertilizer application in mustard was worked out. The minimum profits of Rs. 1256.60 in 1980–81 and Rs. 1006.60/ha in 1981–82 were obtained by application of 20 kg N/ha alone (Table 1). Whereas the maximum profits of Rs. 5174.20 in 1980–81 and Rs. 4072.20/ha in 1981–82 were obtained with the highest dose of 60 kg N + 40 kg $P_{20}O_5$ + 20 kg K_2O/ha. Increasing doses of nitrogen and phosphorus resulted an increase in net profit while the profit on per rupee of investment decreased with the increasing doses.

Phosphorus application markedly increased the net profit in mustard. Table–1 indicates that with the investment of Rs. 124.80 on 20 kg P_2O_5/ha, the net profit obtained were of the order of Rs. 1275.20, Rs. 1005.20 and Rs. 1076.20/ha in 1980–81 and Rs. 925.20, Rs. 875.20 and Rs. 1025.20/ha in 1981–82, respectively over the profits obtained due to 20, 40 and 60 kg N/ha alone. Further by investing Rs. 249.60 on 40 kg P_2O_5/ha the net profits of the order of Rs. 2101.40/ha in 1980–81 and 1750.40/ha in 1981–82 were obtained over the application 60 kg N per hectare alone.

The investment of Rs.46/ha on the application of 20 kg K_2O/ha enhanced the net profit by Rs. 354 in 1980–81 and Rs. 254 in 1981–82.

It is clear from the results obtained that application of phosphorus alongwith nitrogen is an indispensable pre-requisite for obtaining the increased yield of mustard under the prevailing soil conditions of this region. Tomar et al (1980) also reported that combined application of N and P was the key factor for maximising the yield and profits in mustard under unirrigated conditions.

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Gynomonoecism in niger

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Niger *(Guizotia abyssinica Cass)* is highly cross-pollinated entemophilous plant with protandrous incompatibility. The breding methods, for improvement of yield in Niger, are similar to those followed in other allied cross-pollinated crops, particularly sunflower. Studies have revealed that harnessing of heterosis increases yield and oil-content in the Indian mustard (Yadava *et al.*, 1974; Rawat, 1975; Trivedi, 1980). A large number of hybrid varieties were produced through the development of cytoplasmic male sterile lines in sunflower. Exploitation of heterosis on commercial basis is not feasible in niger through hand pollination because of the tedious process involved in this method and nonavailability of male sterile lines or gynomonoecious condition. The present report on the male sterility or gynomonoecious condition is the first of its kind observed in niger crop. This may be exploited in commercial hybrid seed production after certain modifications and standardization.

During *kharif* 1983, one male sterile plant in gynomonoecious condition was observed in the population of niger variety N-5 at Birsa Agricultural University Farm, Kanke (Ranchi). This plant was phenotypically alike the other fertile normal plants, but had large sized buds. Critical examination of the capitulum revealed that whole capitulum was homomorphic with only pistillate florets. The centrally situated bisexual, tubular disc-florets found in normal condition, were all modified into ligulate pistillate florets with bifid or tetrafid stigmas. Androecium was either absent or rudimentary in development. Although in some of these central florets empty reniform anthers, devoid of pollen grains, were observed, but selfing failed to produce any seed in them. Neverthless, on open pollination, 25 half-sibbed seeds were obtained.

All the half-sibbed seeds produced from this plant were sown in the next generation by dibbling at a distance of 30 cm in the month of September 1984. Only 18 seeds out of 25 seeds germinated. They were vigorous in growth. Nine of them showed homomorphic ligulate gynomonoecious condition and rest produced heteromorphic capitulae with a outer whorl of 8-10 pistillate ray florets and inner centripetal whorls of tubular bisexual disc-florets. Segregation pattern into two

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types of capitulae thus indicated to be of genetic in nature. Its exact genetic nature needs confirmation. Sibbing with the normal segregates of the progeny, selfing and half-sibbing would be done in order to asertain the nature of inheritance and genetics of male sterility for commercial production of hybrid seeds.

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Association analysis of characters in sunflower

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Information on the extent of association between the various component characters and grain yield to formulate suitable selection criteria will go a long way in improvement programmes. An investigation was undertaken in order to assess genotypic and phenotypic correlations betwen yield and its components as well as between different components themselves and the direct and indirect influence of the various components on the yield in sunflower (*Helianthus annuus L*).

The material comprised of six inbreds developed from six varieties viz., EC 100101, HS 301, EC 93617, EC 97919, EC 22237 and EC 109293. A diallel cross among these inbreds was made in 1976 winter season producing 30 F_1's (Direct and reciprocals). All the 30 F_1's along with their parents were raised during summer, 1977 in a RBD, replicated four times. Single row plots consisting of 15 plants for each F_1 hybrid was adopted. Cultivation practices recommended for this crop were followed. A spacing of 45 cm between rows and 22.5 cm between plants in the row was adopted. Irrigation was given as and when necessary. Five plants were selected at random from each experimental plot and observations were recorded on diameter of head, seed set(%), yield per plant, 1000 seed weight, and plot yield. Phenotypic and genotypic variances and covariances were calculated by utilizing the mean square values and mean sum of products from the analysis of variance and covariance tables. These variances and covariances were used to calculate phenotypic and genotypic correlation of coefficients as suggested by Johnson *et al* (1955 a and b).

The genotypic correlation co-efficients were highly significant in all cases except between seed set and 1000 seed weight. The genotypic correlation coefficients were greater than the respective phenotypic correlation coefficientss in all cases. The phenotypic correlation coefficients were significant between (i) diameter of head and yield per plant as well as plot yield, (ii) yield per plant and plot yield and (iii) 1000 seed weight and plot yield (Table 1).

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Table 1: Phenotypic (p) and Genotypic(G) correlation coefficients among five characters for hybrids and parents:

Character		Percentage of seed set	Yield per plant	1000 seed weight	Plot Yield
Diameter of head	P	0.0678	0.6303**	0.2413	0.6320**
	G	0.5075**	0.7846**	0.8653**	0.8496**
Perccentage of seedset	P	-	0.2072	0.1024	0.1289
	G	-	0.7042**	0.0724	0.6214**
Yield per plant	P	-	-	0.2730	0.7668**
	G	-	-	0.7990**	0.9553
1000 seed weight	P	-	-	-	0.3440*
	G	-	-	-	0.7001**

* significant at P=0.05; ** significant at P=0.01

The diameter of head had positive and significant association with seed set, yield per plant, 1000 seed weight and plot yield at genotypic level, whereas at phenotypic level it had positive and significant associations with yield per plant and plot yeild only. Chandra and Anand (1977) reported positive and significant association between diameter of head and yield and positive association of head diameter with seed weight. Pathak (1977) reported both yield per plant and plot yield had significant and positive association with diameter of head, seed set and 1000 seed weight at genotypic level.

The results of path coefficient analysis (Table 2) revealed that the yield per plant exerted maximum direct positive effect on plot yield followed by percentage of seed set. The diameter of head and 1000 seed weight exhibited negative and low direct effect on plot yield. The most important characters that greatly affected the plot yield either through direct or indirect effects appear to be the yield per plant and seed set.

Varshney and Singh (1977) reported that diameter of head and seed filling directly affected the yield while 1000 seed weight influenced yield indirectly. The low positive residual effect indicated that most

Table 2: Path coefficients* - Direct effects (underlined) and indirect effects.

	Diameter of head	Percentage of seed setting	1000 Seed weight	Yield per plant	Plot
Diameter of head	-0.2612	0.3547	-0.0099	0.7661	0.8497
Percentage of seed set	-0.1326	0.6988	-0.0089	0.0641	0.6214
1000 seedweight	-0.2049	0.4921	0.0126	0.6807	0.9553
Yield per lant	-0.260	0.0506	-0.0097	0.8853	0.7002

Residual = 0.1799

* Genotypic corelation coefficients were used for estimating the path coefficients.

of the important yield components which are responsible for yield were included.

In the present investigation, diameter of head, yield per plant and 1000 seed weight had significant and positive associations with plot yield. Yield per plant contributed the highest positive effect on yield. Diameter of head and 1000 seed weight had negative association and exerted negative direct effect on plot yield.

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Effect of p sources and methods of application on yield and quality of groundnut "gaug 10" under rainfed condition

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Phosphorus is one of the major nutrient needed in adequate quantity in available form for obtaining maximum crop production and number of metabolic functions (Nair *et al.*, 1970). The soils of Saurashtra are generally poor to medium in available phosphorus and efficiency of phosphatic fertilizer utilization by crop plants is also low owing to the fixation of applied phosphates within a very short period of application rendering 71% unavailable. Therefore, this study was undertaken to findout the effect of different sources and methods of application on the yield and quality of groundnut (*Arachis hypogaea* L) under Saurashtra condition. A field experiment was conducted at Central Research Farm, Junagadh in *Kharif*, 1983.

The soil was clayey (medium black calcareous)with pH 7.8, low in available nitrogen (225 kg ha^{-1}) and phosphorus (6 kg ha^{-1}) and high in available potasium (340 kg ha^{-1}). The hot water soluble sulphur was 19 ppm. The treatment consisted of two sources and eleven methods of application. The details are :

Sources (S) : Single super phosphate (SSP)- S_1 ; Diammonium phosphate(DAP)-S_2.

Methods of application (M) :

M_1 - All basal placement at 5 cm depth; M_2 - All basal placement at 10 cm depth; M_3 - All placed 10 cm away from seed furow; M_4 - All band placement after 30 days of sowing; M_5 - All band placaement after 45 days of sowing; M_6 - 1/2 as M_1 + 1/2 as M_4; M_7 - 1/2 as M_1 + 1/2 as M_5; M_8 - 1/2 as M_1 + 1/2 foliar after 30 days; M_9 - 1/2 as M_1 + 1/2 foliar after 45 days; M_{10} - 1/2 as M_1 + 1/2 foliar in two splits after 30 and 45 days; M_{11} - 1/2 as M_1 + 1/2 foliar in four splits after 30, 45, 60 and 75 days.

The absolute control and P deficient control were also run. The treatments were replicated thrice in a factorial RBD . 25 kg P_2O_5 ha^{-1}

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Table 1 : Effect of sources (S) and methods of P application (M) on the pod, haulm and oil yield

Methods of application	Pod yield (kg ha^{-1})			Haulm yield (kg ha^{-1})			Oil yield (kg ha^{-1})		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
M_1	1185	1064	1116	2518	2209	2364	385	358	371.5
M_2	991	849	920	2241	2028	2134	326	293	309.5
M_3	900	859	880	1909	1887	1898	301	291	296.0
M_4	884	942	913	2114	2048	2081	291	325	308.0
M_5	1095	919	1007	2250	1940	2095	382	275	328.5
M_6	741	1148	944	1972	2204	2088	251	395	323.0
M_7	1044	1139	1092	2208	2356	2282	369	390	379.5
M_8	764	831	798	2120	2333	2227	260	272	266.0
M_9	890	859	850	2083	2273	2178	284	281	282.5
M_{10}	847	676	762	1727	1602	1664	290	219	254.5
M_{11}	912	662	787	1681	1574	1627	306	218	262.0
Mean	928	903	–	2075	2041	–	313	302	–
	S	M	SxM	S	M	SxM	S	M	SxM
SEm ±	19	44	62	21	48	69	7.4	17.4	24.5
C D (P=0.05)	NS	126	178	NS	139	196	NS	49.4	69.9

was applied after calculating on the basis of recovery percentage as proposed by Krishnamoorthy *et al.* (1963). The phosphorus level for 25 kg P_2O_5 ha^{-1} comes to 37 kg P_2O_5 ha^{-1}. The Ca and S supplied by SSP at phosphorus level was added through outer source as gypsum in DAP treatments while nitrogen suplied by DAP at 37 kg P_2O_5 ha^{-1} was applied to SSP treatments through urea. The variety "GAUG 10" of groundnut was sown on 1-7-83 and crop duration was 118 days.

The mean effect of sources and methods of application on pod and haulm yield (table 1) showed that the sources did not show significant effect on both yields. Similar non-significant effect was also observed by Parmar and Buhecha (1980). The methods of P application had significantly influenced the pod as well as haulm yields. The M_1 method of application gave significantly higher pod (1116 kg ha^{-1}) and haulm (2364 kg ha^{-1}) yields over others except M_7 which was at par. The control versus rest was found signifiant.

The interaction effect of sources and methods of P application was found significant (table 1) for both pod and haulm yields. The highest pod (1185 kg ha^{-1}) and haulm (2518 kg ha^{-1}) yields were recorded under the treatment S_1M_1 but the pod yield was at par with S_1M_5, S_1M_7, S_2M_1, S_2M_6 and S_2M_7 and superior over other treatments. Similar results were reported by Singh *et al* (1974). The failure of the split P application to influence yield even when the second application was at 30 and 45 days after sowing was surprising in view of the known high P fixing (71%) capacity of soil. The foliar application decreased the yield of groundnut which support the result of Dahatonde and Rahate (1974) who have observed in summer groundnut.

It is evident from the Table 1 that the sources did not influenced the oil yield while method of P application had influenced significantly. The highest oil yield (371.5 kg ha^{-1}) was observed under treatment M_7. The interaction effect was also found significant. The control versus rest was found significant for oil yield.

It can be concluded from the above study that the yield levels of groundnut as basal (complete) application either through SSP or DAP as well as complete band placement after 45 days of sowing and application of P in two splits i.e. 1/2 basal + 1/2 band placement after 45 days of sowing through SSP and 1/2 basal + 1/2 band placement after 30 or 45 days of sowing through DAP were at par.

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Mutagenic effectiveness and efficiency of gamma rays and ethyl Methanesulphonate in Indian mustard

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Mutagenic effectiveness is a measure of the frequency of mutations induced by unit dose of a mutagen while mutagenic efficiency gives the proportion of mutations in relation to other associated undesirable biological effects such as gross chromosomal aberrations, lethality and sterility induced by the mutagen in question (Konzak, *et al.*, 1965). The usefulness of any mutagen in plant breeding depends not only on its mutagenic effectiveness but also on its mutagenic efficiency. The efficiency and effectiveness of ethyl methanesulphonate (EMS) in relation to gamma rays in Indian mustard [*Brassica juncea* (L.) Czern & Coss] was studied.

Two varieties of mustard, viz., Varuna and Prakash were treated with gamma rays, EMS and gamma rays + EMS.

Gamma rays : Seeds of both the varieties were irradiated with 40, 60, 80, 100 and 120 kR doses of gamma rays in a 2000 - curie ^{60}Co gamma cell at the Genetics Division, I.A.R.I., New Delhi.

EMS : Seeds were treated wih freshly prepared 0.4, 0.6, 0.8, 1.0 and 1.2 per cent aqueous solution of EMS (Eastman Kodak Chemicals, U.S.A.) for 6 and 12 hrs with intermittent shaking at 28 $\pm$ 2°C.

Gamma rays + EMS : Following irradiation with 40 and 60 kR of gamma rays the seeds were post treated with 0.4 and 0.6 per cent aqueous solution of EMS for 6 and 12 hrs in the manner described above.

The irradiated material was sown in the field after 24 hrs of treatment. Seeds treated with EMS and gamma rays + EMS were thoroughly washed in running water and were sown in the field along with untreated seeds of each variety as control during *Rabi* 1980-81. Surviving plants were recorded at the time of maturity in the field and was expressed as

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Table 1 : Mutagenic effectiveness and efficiency of gamma rays and EMS in mustard var. Varuna.

Mutagen	Dose	Lethality (%) (L)	Pollen sterility (%) (S)	Mutated families (%) (Mf)	No. of mutants per 100 M_2 families (M)	Mutagenic effectiveness		Mutagenic efficiency			
						Mf/tc(or)kR	M/tc(or)kR	Mf/L	M/L	Mf/s	M/S
Gamma rays	40 kR	13.40	-	8.75	65.71	0.214	1.642	0.639	4.903	-	-
	60 kR	-	11.32	2.86	17.14	0.047	0.265	0.62[illegible]	-	0.253	1.514
	80 kR	13.80	21.10	8.57	54.28	0.107	0.718	0.621	3.933	0.406	2.575
	100 kR	18.10	19.25	11.43	71.43	0.114	1.399	0.631	3.946	0.593	3.710
	120 kR	22.10	30.80	5.71	25.71	0.047	0.214	0.258	1.163	0.185	0.835
Mean						0.106	0.844	0.537	3.486	0.359	2.158
EMS	0.4% for 6 hrs	7.75	18.50	5.71	37.14	2.379	15.475	0.736	4.792	0.309	2.007
	0.6% for 6 hrs	11.82	33.35	14.28	80.00	3.966	22.222	1.208	6.768	0.428	2.398
	0.8% for 6 hrs	61.40	22.75	11.43	71.43	2.381	14.831	0.186	1.163	0.502	3.139
	1.0% for 6 hrs	67.70	37.50	5.71	31.43	0.951	5.238	0.084	0.464	0.152	0.891
	0.4% for 12 hrs	27.45	30.80	5.71	37.14	1.189	7.737	0.208	1.206	0.185	1.206
	0.6% for 12 hrs	40.40	44.95	8.57	34.28	1.190	4.761	0.212	0.848	0.191	0.763
Mean						2.009	11.714	0.439	2.540	0.294	1.734
Gamma rays + EMS	40 kR + 0.6% for 6 hrs.	56.75	29.84	2.86	14.29	-	-	0.050	0.252	0.096	0.479
	60 kR + 0.4% for 6 hrs.	48.44	10.65	5.71	37.14	-	-	0.118	0.767	0.536	3.486
	60 kR + 0.6% for 6 hrs.	64.70	19.90	2.86	17.14	-	-	0.044	0.265	0.144	0.861
Mean								0.071	0.428	0.259	1.608

Table 2 : Mutagenic effectiveness and efficiency of gamma rays and EMS in mustard var. Prakash.

Mutagem	Dose	Lethality (%) (L)	Pollen sterility (%) (S)	Mutated families (%) (Mf)	No. of mutants per 100 M2 families (M)	Mutagenic effectiveness		Mutagenic efficiency			
						Mf/tc(or)kR	M/tc(or)kR	Mf/L	M/L	Mf/S	M/S
Gamma rays	40 kR	18.34	9.15	2.86	20.00	0.072	0.500	0.146	1.091	0.312	2.186
	60 kR	4.93	16.50	8.57	42.86	0.143	0.714	1.738	8.693	0.519	2.598
	80 kR	5.65	18.50	8.57	34.28	0.107	0.428	1.517	0.067	0.463	1.852
	100 kR	29.12	25.00	11.43	80.00	0.114	0.600	0.392	2.747	0.457	3.200
Mean						0.109	0.561	0.951	4.478	0.453	2.459
EMS	0.6% for 6 hrs	27.84	18.75	11.43	57.14	3.175	15.872	0.411	2.052	0.609	3.047
	1.0% for 6 hrs	45.80	36.00	8.57	60.00	1.428	10.000	0.187	1.310	0.238	1.666
	0.4% for 12 hrs	66.14	24.98#	8.57	54.28	1.785	11.308	0.129	0.821	0.343	2.173
	0.6% for 12 hrs	73.95	29.11	11.43	60.00	1.587	8.333	0.154	0.811	0.393	2.016
Mean						1.994	11.378	0.228	1.248	0.395	2.237
Gamma rays + EMS	40 kR + 0.6% for 6 hrs	63.00	14.35	8.57	51.43	-	-	0.136	0.816	0.597	3.583
	60 kR + 0.4% for 6 hrs	32.75	12.58	8.57	51.43	-	-	0.262	1.570	0.681	4.088
	60 kR + 0.6% for 6 hrs	34.49	7.10	2.86	14.28	-	-	0.083	0.414	0.402	2.011
	40 kR + 0.4% for 12 hrs.	52.77	24.28	2.86	17.14	-	-	0.054	0.325	0.118	0.706
Mean								0.134	0.781	0.449	2.597

percentage of control. Mean pollen sterility was determined on the basis of acetocarmine stainability. Selfed seeds of M_1 plants were harvested separately and were grown as individual M_2 families in separate lines during *Rabi* 1981-82. The treated and control materials were screened for the frequency of chlorophyll mutations in M_2 generation. Mutation frequency was estimated as percentage of segregating M_1 plant progenies and number of mutants per 100 M_2 families (Gaul, 1964). Both mutagenic effectiveness and efficiency were determined using the formulae of Konzak *et al.* (1965). Mutagenic effectiveness was measured by the percentage of mutated families as well as number of mutants per 100 M_2 families and each divided by the dose of mutagen while mutagenic efficiency was measured by the percentage of mutated families as well as number of mutants per 100 M_2 families and each divided by either lethality or sterility.

Mutagenic effectiveness was highest in EMS treatments (Table 2). Mutagenic effectiveness of EMS based on percentage of mutated families and number of mutants per 100 M_2 families were 3.966 and 22.222, respectively as against the maximum values of 0.214 and 1.642 in gamma rays treatments. When the mean values of effectiveness were considered, EMS was found to be 14 to 20 times more effective than gamma rays.

Mutagenic effectiveness calculated as M/tc or kR was higher than that calculated as Mf/tc or kR in gamma rays as well as EMS treatments of both the varieties. Mutagenic effectiveness was higher at lower doses.

Mutagenic efficiency was higher in gamma rays treatments as compared to the EMS treatments. Mutagenic efficiency calculated as M/L or M/S was higher than that calculated as Mf/L or Mf/S. Like effectiveness, efficiency was also relatively high at lower doses.

Monti (1968) reported that in peas the effectiveness of diethyl sulphate was 3 to 4 times greater than that of X-rays. Similar observations were also made by other workers (Blixt, 1964; Heringa, 1964; Wellensiek, 1965). Nerkar (1976) also reported that the alkylating agents were much more effective than gamma rays. However, gamma rays were more efficient than the alkylating agents. Siddiq and Swaminathan (1968) and Prasad (1972) reported similar order of efficiency of these mutagens in rice and wheat, respectively. EMS induced a high frequency of undesirable effects such as lethality and sterility because of which it was less efficient. If the toxic effects of EMS could be minimised by using suitable modifying factors (pH), its efficiency can certainly be improved.

Both mutagenic effectiveness and efficiency were higher at lower doses of gamma rays and EMS. Because higher doses of mutagen cause injury, lethality and sterility at a faster rate than mutations (Konazak*et al.*,1965).

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Genetical analysis of groundnut

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Most of the groundnut *(Arachis hypogaea* L.) cultivars evolved in India are a result of selection; only a few are evolved through hybridization. In spite of extensive breeding efforts, there is a wide gap between the potential yield and average actual yield. In recent years, improved cultivars are extensively used in hybridization because they possess many favourable genes which may complement each other in hybrid combinations. Besides, the inter-sub-specific crosses are likely to result in superior hybrids because the desirable attributes are clustered separately in such botanical groups. In the present study, the prepotency of some commercial cultivars was, analysed for pod yield and four other related characters in F_1 and F_2 generations of crosses involving virginia and spanish.

Following cultivars which have been found promising in certain groundnut growing regions in India were selected:

ssp. *hypogaea* Krap. et. Rig. var. *hypogaea*
Virginia runner: GAUG 10, M 13, Karad 4-11
Virginia bunch : Latur 33, TMV 10, TG 1

ssp. *fastigiata* Waldron var. *vulgaris* Harz
Spanish : J 11, GAUG 1, SB XI, TG 3, Kisan, Jyoti, MH 1

Five tester virginias were crossed with seven spanish and one virginia bunch lines during 1981 to produce 40 F_1 hybrids. All the F_1s and parents were sown in a randomized block design with two replications during the rainy season 1982. The entries were sown in single rows of 2 m length with a spacing of 60 cm between rows. The spacing between plants was 10 cm. At maturity, five random plants in each row were selected for recording five observations (Table 1).

During the rainy season 1983, 40 F_2s and parents were sown in a randomized block design with 3 replications. Each entry was sown in 4 rows of 3 m length with plant to plant spacig of 15 cm. Observations on 30 F_2 plants from each cross were recorded. Analysis of variance and estimates of combining ability effect were made by the method given by Kempthorne (1957).

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Table 1: Analysis of variance for combining ability

Source	D.F.		MEAN SUM OF SQUARES									
			Height of main stem		Lengh of primary branch		Number of primaries		Number of mature pods		Pod weight	
	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
Testers	4	7	101.36**	172.43**	360.22**	210.62**	0.16	0.62	93.63**	9.14**	73.98**	5.50**
Lines	7	7	82.92**	85.98**	105.16**	151.34**	1.76**	4.96**	21.13**	5.13**	19.63**	2.23
Testers x lines	28	28	36.29**	32.17**	71.48**	52.18**	0.91**	2.91**	50.32**	5.61**	39.58**	4.73**
Error	39	78	6.25	7.29	12.98	9.49	0.31	0.72	2.54	1.79	2.72	1.55
δ^2 GCA			4.30	4.98	12.40	6.61	0.01	-0.01	0.54	0.08	0.56	-0.04
δ^2 SCA			15.02	8.30	29.25	14.23	0.30	0.73	23.89	1.27	18.43	0.97

** Significant (P=0.01)

Table 2: Estimates of general combining ability effects of testers and lines

	Height of main stem		Length of primary branch		Number of primaries		Number of mature pods		Pod weight	
	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
Testers										
GAUG-10	1.02	2.79**	2.03	3.08**	0.02	0.24	1.84**	0.66*	2.67**	0.56*
M 13	-2.79*	-2.84**	-3.52*	-3.92**	-0.08	0.08	-4.18**	-0.61*	-2.96**	-0.48
Karad 4-11	3.14**	-0.08	7.44**	0.81	0.05	-0.14	1.47*	0.68*	1.41*	0.47
Latur 33	-2.37*	-2.47**	-3.49*	-2.18*	-0.12	-0.06	0.57	-0.33	-0.58	-0.30
TMV-10	1.01	2.61**	-2.47*	2.20*	0.13	-0.12	0.30	-0.39	-0.53	0.24
Lines										
J 11	-0.11	-2.15**	-2.18	-3.49**	0.30	-0.57*	0.93	-0.39	-0.22	-0.31
GAUG 1	0.98	0.37	1.64	2.59**	0.02	0.71**	-1.67**	0.51	-1.32*	0.28
SB XI	-1.03	-4.38**	-2.64*	-5.38**	-0.52**	-0.79**	-1.89**	-0.90*	-2.68**	-0.57
TG 3	5.62**	1.05	7.30**	0.39	-0.42*	-0.01	1.89**	0.09	1.05*	0.03
Kisan	0.50	1.55*	-0.36	1.40	0.02	-0.49*	0.57	-0.27	0.59	-0.21
Jyoti	0.04	3.40**	-2.14	4.40**	0.80**	0.49*	0.10	-0.29	1.51**	-0.07
MH 1	-1.11	0.83	-0.69	0.85	0.05	0.03	-0.59	0.32	1.03*	0.17
TG 1	-4.79**	-0.67	-0.95	-0.75	-0.23	0.62*	1.82**	0.95*	0.57	0.68*
SE testers ±	0.49	0.43	0.70	0.49	0.11	0.14	0.31	0.21	0.32	0.20
SE lines ±	0.64	0.57	0.93	0.65	0.14	0.18	0.41	0.28	0.42	0.26

* Significant (P=0.05) ; ** Significant (P=0.01)

The analysis of variance for combining ability (Table 1) showed significant differences for all the traits, in both the generations, in testers and lines, except for number of primaries in testers in both the generations and pod weight in F_2 in the case of lines. The tester x line interaction components were significant in both F_1 and F_2 progenies. The sum of squares due to testers were generally higher than the lines; there is, thus, a scope for making improvement in spanish cultivars.

Though both additive and non-additive genetic variances were involved in the inheritance of all characters, non-additive variance predominates in most of the crosses. Thus, conclusions based on the performance in F_3 may be more precise. Besides, all the three generations should be grown in the same season. Specific combining ability variances, in general, were lower in magnitude in the F_2s as compared with those in the F_1s. This decrease in the segregating F_2 generations of inter-sub-specific crosses may be due to segregation of parental types as has been reported by Coffelt (1974), Wynne (1975), Ashri (1976 a) and Balaiah, *et al.* (1977).

Among the testers, GAUG 10 exhibited highest GCA effects for pod number and weight in F_1 and F_2 generations followed by Karad 4-11 (Table 2). These parents also had higher SCA effects and *per se* performance indicating greater transmissibility of high pod yield by number and weight. Among lines only TG 1, a virginia bunch, was good general combiner for pod number and weight. All the three general combiners are adapted to this agro-climate. It is, therefore, proposed to select adaptive and specific varieties as testers in regional hybridization programme.

Among the specific crosses of virginia runner with spanish, GAUG 10 x MH 1, GAUG 10 x TG 3, GAUG 10 x TG 1, M 13 x GAUG 1, M 13 x SB XI, Karad 4-11 x MH 1 gave high significant SCA effects and their mean performance for pod number and weight was also high. Crosses of virginia bunch with spanish, in general, were not promising. The crosses, Latur 33 x J 11 and Latur 33 x Jyoti though gave good performance in F_1, their performance in F_2 was not encouraging.

This study defines the role of inter-sub-specific hyridization in groundnut improvement and also has value in selecting specific cultivars as parents in future hybridization though the F_1 and F_2 generations were grown in two different years in rainy seasons. Additional studies over environments and generations are further needed to exploit both additive and non-additive gene actions in augmenting germplasm and their effective utilizations in groundnut improvement.

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Incidence of phytomyza horticola as imfluenced by different levels of potassium and sulphur on Indian mustard

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Pea leaf miner, *Phytomyza horticola* Goureau is an important insect pest of *Brassica* crops in India. The common practice to control this pest being the use of insecticides, the problems associated with their excessive use are also ever increasing. Therefore, integrated control is now gaining momentum. This method includes the use of cultural practices as one of the important component (Kalra *et al.*, 1983). Some practices like application of nitrogen(N), phosphorous(P) and potassium(K) (Kundu and Pant, 1967) and sulphur(S) (Atwal, 1955), as plantnutrients, have been reported to influence the incidence of various insect pests on different host plants. However, no information is available on the influence of K and S on the incidence of *P. horticola* on mustard. An experiment, therefore, was conducted during *'Rabi'*, 1983-84 and 1984-85, to study the effect of various levels of K(0,50,100, 150 and 300 ppm) and S (0, 30, 60, 90 and 180 ppm) (as plant nutrients) and their combinations, on the incidence of this insect on B. *juncea* (L) Czern & Coss. The recommended doses of N (40 ppm) and P (15 ppm) were also applied to soil in pots kept in screen house.

Different levels of K and S significantly affected the number of leaves and leaf miner population. As the level of S increased, the number of leaves per plant also increased (15.97 in S_0 and 57.3 in S_{180}) (Table 1). On the other hand high level of K decreased the number of leaves (36.17) in K_0 and 32.10 in K_{300}), implying thereby that more the amount of S is added to the soil, more vegetative growth of Indian mustard will be recorded.

Leaf miner population, 67 days after sowing was significantly higher on the plants grown under high level of S (13.25/leaf in S_{180}) as compared to S_0 (1.22/leaf) (Table 2). Earlier Le Roux (1959) also reported a linear increase in number of progeny of *Tetranychus telarious* (L) on cucumber plants. On the contrary, Atwal (1955) recorded slow development of *Plutella xylostella* on cabbage plants to which ammonium sulphate and potassium sulphate were applied. Number of leaf miner was lowest in treatment K_{300} (3.70/plant) as compared to

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Table 1: Average number of leaves on the mustard plant grown under different levels of K(ppm) and S(ppm) as plant nutrients (65 days old crop)

	K_0	K_{50}	K_{100}	K_{150}	K_{300}	Av.
S_0	55.5*	53.5	43.5	54.5	34.5	15.97
S_{30}	77.5	111.5	66.5	64.5	56.5	27.10
S_{60}	107.5	136.5	84.5	95.5	77.5	33.43
S_{90}	148.5	109.5	92.5	99.5	128.5	38.57
S_{180}	153.5	151.5	194.5	155.5	204.5	57.30
Av.	36.17	37.37	32.10	33.30	32.20	

C.D (P=0.05) K-2.28; S-2.28; KxS-5.11

* Total of five observations

6.47/plant in K_0. This is in line with the observations recorded on *Planococcus citri* (Risso) on cacao (Fennah, 1959), *Therioaphis maculata* (Buckt) on alfalfa (Mc Murtry, 1962) and *Schizaphis graminum* (Rond.) on sorghum (Schweissing and Wilde, 1972). However, levels K_{100}, K_{150} and K_{300} were statistically at per, which is quite in line with the observations earlier recorded by Daniels (1958) while working with *Toxoptera graminum* on winter wheat. Similar results were observed on 85 days old plants as for sulphur treatments. However, the leaf miner population on plants getting different levels of K were statistically similar.

Positive correlation of sulphur application was revealed with the number of leaves on the plant and number of leaf miners per leaf (Table 3). When the crop was 67 days old, a negative correlation existed between K application and number of leaf miners per leaf.

It could, therefore, be implied that higher is the level of sulphur in soil, more is the attack of *P.horticola* expected and the vice-versa in the case of potassium levels in the soil.

Table 2: Average number of leaf miner/leaf on mustard plant grown under different levels of K (ppm) and S (ppm) as plant nutrients.

Treatment	67 days old crop					Average	85 days old crop					Average
	K_0	K_{50}	K_{100}	K_{150}	K_{300}		K_0	K_{50}	K_{100}	K_{150}	K_{300}	
S_0	11.5*	8.5	3.5	2.5	4.5	1.22	7.5	6.5	6.5	2.5	7.5	1.22
S_{30}	12.5	9.5	9.5	17.8	7.5	2.27	11.5	3.5	5.5	16.5	9.5	1.86
S_{60}	21.7	14.5	20.5	9.5	19.5	3.43	12.5	8.5	10.5	5.5	11.5	1.94
S_{90}	46.5	35.5	31.5	26.5	26.5	6.66	16.5	20.5	15.5	14.5	12.5	3.18
S_{180}	69.5	112.5	61.2	53.5	34.5	13.25	50.5	46.5	22.5	21.5	15.5	6.26
Average	6.47	7.22	5.05	4.39	3.70		3.94	3.42	2.42	2.42	2.26	
	C.D. (P=0.05) K-217, S-217, KxS-4.55						K-N.S., S-1.60, KxS - N.S.					

* Total of five observations.

Table 3: Correlation matrix.

Independent factors		Dependent factors		
Potassum	Sulphur	No.of leaves/ plant	No.of leaf miners per leaf (days old crop)	
			67	85
1.000		-0.0867	-0.2335*	-0.1538
	1.000	0.8416*	0.6353*	0.5293*
		1.000	0.5282*	0.4089*
			1.000	0.5493*
				1.000

*Significant at P=0.05
(tab. r at P=0.05)= 0.2335

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Effect of graded levels of nitrogen, prosphorus and plant spacings on sunflower

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Sunflower (*Helianthus annuus* L.), a promising oilseed crop that was introduced to India in the recent past to mitigate the shortage of edible oil, is popularly cultivated in India because of its photo and thermo insensitivity and higher seed multiplication ratio. In India, average per hectare yield of sunflower is very low (522 kg/ha) compared to its highest average per hectare yield of 2209 kg/ha in Italy. Optimum plant population and fertilizer application are the most important factors for increasing the yield of Sunflower. The beneficial effect of nitrogen and phosphorus on Sunflower was well documented (Singh *et al.* 1973 and Gaur *et al.* 1973). Plant population of 56,000 - 98,000/ha at Hyderabad (Vijayalakshmi *et al.* 1975) and 55,000/ha at Aliyanagar in Tamilnadu (Ramaswamy *et al.* 1974) were found optimum. In view of the paucity of experimental data in India the present study was undertaken to find out the effect of nitrogen, phosphorus and plant spacings on Sunflower.

The experiment was conducted during rainy seasons (*Kharif*) of 1980-81 and 1982-83 at the Agricultural Research Institute farm, Rajendranagar, Hyderabad. The experimental soil was Sandy loam (pH : 8.4) in 1980-81 and Clay loam (pH:8.0) in 1982-83. The soils were low in available nitrogen and medium in available phosphorus and rich in available potassium. The experiment was laid out in 3^2 X 2 confounded factorial design with four replications. The treatments comprised of three levels of nitrogen (40, 80 and 120 kg/ha) and three levels of Phosphorus (30, 60 and 90 kg P_2O_5/ha) and two plant spacings (60 X 45 cm,and 60 X 60 cm, corresponding to a plant population of 37, 037 and 27, 278 plants/ha). The crop was sown with the subject variety EC 68414 on 18 and 29 August and harvested on 25 November and 7 December, during two seasons, respectively. One-third of nitrogen and full dose of phosphorus as per treatments, were applied at the time of sowing as urea and single super phosphate respectively. The remaining two-thirds nitrogen was applied 30 days after sowing. A common basal dose of 30 kg K_2O/ha as muriate of potash was applied. The crop received 171 mm and 235 mm of rainfall in two seasons, respectively and weather was by and large congenial for crop growth.

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Table 1 : Sunflower seed and oil yield as influenced by levels of nitrogen, phosphorus and plant spacings

Treatments	Seed yield (kg/ha) 1980-81	Seed yield (kg/ha) 1982-83	Pooled	Oil yield (kg/ha) 1980-81	Oil yield (kg/ha) 1982-83	Pooled
Nitrogen : (kg N/ha)						
40	1170	987	1080	461	393	427
80	1336	1072	1204	513	419	466
120	1316	1153	1253	500	438	469
S.E.$\pm$	51.1	61.2	40.7	20.8	10.8	15.2
C.D.5%	NS	120	85.4	NS	22.6	32.0
Phosphorus : (kg P_2O_5/ha)						
30	1255	1044	1150	486	409	448
60	1305	1070	1180	510	424	467
90	1263	1079	1171	493	423	458
S.E.$\pm$	51.1	61.2	40.7	25.8	10.8	15.2
C.D.5%	NS	NS	-	NS	NS	-
Spacing :						
60 X 45 Cm	1348	1139	1244	531	449	490
60 X 60 Cm	1200	1002	1101	462	392	427
S.E.$\pm$	41.7	49.9	35.1	22.9	9.4	13.1
C.D.5 (P=0.05)	117	84.6	73.6	48.2	19.5	27.5

Effect of Nitrogen:

The highest seed yield was obtained with 120 kg N/ha which did not prove superior over 80 kg N/ha (Table1). Pooled data of two years indicated a significant yield increase upto 80 kg N/ha which gave 12% of higher yield over 40 kg N/ha. Similar yield increase due to 80 kg N/ha was also observed by Srinivas, 1974. The non-significant yield differences noticed during 1980-81 might be due to the loss of applied nitrogen as leaching with rain water on account of sandy texture of soil. The levels of nitrogen did not affect any yield components in any year except in case of head diameter (1980-81) and 1000 seed weight (1982-83) where the differences were significant (Table- 2). Increased 1000 seed weight reflected in higher seed yield due to 80 kg N/ha in 1982-83.

Table 2 : Yield components of Sunflower as influenced by levels of nitrogen, phosphorus and plant spacings

Treatments	Head diameter (cm)		No.of filled seeds/head		1000 seed weight (g)		Oil percentage	
	80-81	82-83	80-81	82-83	80-81	82-83	80-81	82-83
Nitrogen : (kg N/ha)								
40	13.6	12.2	726	610	57.3	52.0	39.4	39.8
80	14.8	12.4	832	620	62.0	56.0	38.4	39.1
120	14.8	12.6	846	740	60.0	56.8	38.0	38.0
S.E.±	0.4	0.38	37.2	64.2	2.44	0.38	0.37	0.23
C.D.5%	0.8	NS	NS	NS	NS	0.8	NS	0.5
Phosphorus : (Kg P_2O_5/ha)								
30	13.8	11.8	826	680	59.0	55.0	38.7	39.2
60	14.2	12.4	818	690	57.7	55.3	39.1	39.7
90	14.6	12.5	823	710	62.3	55.4	39.0	39.2
S.E.±	0.4	0.38	37.2	64.2	2.44	0.38	0.37	0.23
C.D.(5%)	0.8	NS	NS	NS	NS	NS	NS	NS
Spacing :								
60 X 45 Cm	13.6	12.8	838	770	56.9	54.0	39.0	39.3
60 X 60 Cm	14.8	13.9	807	760	62.5	53.0	38.5	39.1
S.E.±	0.33	0.34	30.4	51.2	1.99	0.26	0.3	0.2
C.D.5 (P= 0.05)	0.7	0.8	NS	NS	3.9	NS	NS	NS

The percentage oil decreased with increasing levels of nitrogen in 1982-83, while the differences of the same trend in 1980-81 were not significant (Table2). Maximum oil content of 39.8 per cent was recorded with 40 kg N/ha. Similarly, highest accumulation of oil at 40 kg N/ha (Shaik Mohammed and Ramarao, 1981) and 50 kg N/ha (Ramaswamy et al. 1974) was also reported earlier. The oil yield (kg/ha) also increased upto 80 kg N/ha in 1982-83 and in pooled data which was due to corresponding higher seed yield (Table- 2).

Effect of phosphorus:

Phosphorus levels had no significant influence on seed yield per hectare, oil percentage, oil yield and other yield components in both the seasons (Table 1 & 2). This is in conformity with the findings obtained at Bangalore and Bhavanisagar (Tamilnadu) (ICAR, 1983). the non-response to applied phosphorus in rainy season may be attributed to excess soil moisture resulting in impaired aeration and restricted root penetration (Simpson, 1965) and medium fertility status of the experimental site.

Effect of plant spacing:

Plant spacing of 60 X 45 cm (37, 037 plants/ha) gave significantly superior yield per hectare over 60 X 60 cm spacing (27, 278 plants/ha) in both the seasons and in pooled data as well (Table-1). From the pooled analysis, it is evident that plant spacing of 60 X 45 cm recorded significantly higher yield of 1625 kg/ha over 60 X 60 cm spacing (1448 kg/ha). This consistent yield response to closer spacing was due to higher plant population than wider spacing (60 X 60 cm) resulting in lower plant population. Higher seed yield with closer spacing compared to wider spacing was also observed by Roy et al. 1977. There was significant increase in head diameter due to wider spacing than closer spacing in both the seasons (Table2). Oil percentage did not differ due to plant spacings, however, closer spacing (60 X 45 cm) produced more oil yield per hectare owing to increased seed yield per hectare.

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Emergence and flowering behaviour of bunch groundnut germplasm under environmental stress in winter

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In view of increasing demand of edible vegetable oils in India, cultivation of groundnut *(Arachis hypogaea* L.) in winter season is also to be encouraged, besides regular cultivation in rainy and summer seasons. The first step, therefore, would be intensive evaluation of germplasm collection for identification of germplasm which do better in winter. This search needs to be based not on evidence of productivity alone, but on the effect of environmental stress on seedling emergence and flowering since, at present, these two characters limit the extensive cultivation of groundnut in the winter season. The resources belonging to ssp. *fastigiata* Waldron var. *vulgaris* Harz. "spanish" and var.*fastigiata* "valencia" were subjected to cold under field conditions and their behaviour as related to emergence and flowering were studied and reported here.

From the national groundnut collection, 500 spanish and 192 valencia germplasm accessions were culled out at random, from the fresh harvest made in November 1984. The accessions were then sown in the field on December 21, 1984 in 2 m rows, spaced 45 cm apart. In each row, 20 seeds of uniform size of an accession were dibbled at a spacing of 10 cm and immediately irrigated. To ensure optimum moisture congenial for emergence, the field was irrigated again after 8 days. Subsequent irrigations were spaced at an interval of 12-15 days. The emergence count was initiated soon after the first emergence and continued upto 25 days. Days to flower initiation and to 50% flowering, in each accession, were recorded.

Both the varietal collections (spanish and valencia) showed considerable range in initial and 50% seedling emergence. Majority of entries took about 15 to 18 days for initial seedling emergence in both the varietal groups. Only a few entries (about 5-6%) took 20 to 26 days for 50% seedling emergence. This delay in seedling emergence as against 4 to 6 days in rainy season and 8 to 10 days in summer season may be due to low temperature (Table 1) in winter.

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Table 1: Mean monthly temperature (^{o}C) in winter (1984-85)

Month	Atmosphere		Soil*	
	Min.	Max.	Morning	Evening
December	9.8	31.4	19.2	32.8
January	9.0	29.0	18.4	31.8
February	10.2	32.2	19.0	36.2

*5 cm depth

Though the collection was not individually examined for viability before sowing, the seedling emergence percentage of the sampled accessions was high under field condition, ranging from 70 to 100 per cent (Table 2). A routine test of germination for each accession may also be undertaken in the laboratory before being exposed to low temperature under field condition so that the field evaluation technique is carefully augmented for large scale evaluation of germplasm for cold tolerance. Branch (1978) reported variability in germination percentage in the sampled groundnut germplasm under severe cold stress.

Among the environmental factors which were not congenial for normal growth of groundnut crop during the winter were low temperature and its duration (Table 1). The temperature, however, was not low to cause injury to the crop during vegetative growth but the crop remained dormant at 4 to 6 leaves stage for a duration of about 45 days and then commenced active growth followed simultaneously by flowering as soon as the spring temperatures were suitable. Flowering initiation began 52 days after sowing and continued upto 70 days whereas 50% flowering in majority of accessions ranged from 60 to 70 days. Thus, the cultivars responded differently to cold conditions in winter as was evident in the range and frequency distribution (Table 2). Gutstein (1974) also reported considerable variability in groundnut under cold conditions. But in groundnut the flowering behaviour in winter is more dependent on photoperiod sensitivity and thermo-sensitivity than the cold tolerance alone. It is, therefore, necessary to take care of these parameters in the field evaluation.

Table 2: Frequency distribution, **mean and coefficient** of variation (C.V.) **values in bunch groundnut** germplasm collection

Class interval	Number of accessions	
	Spanish	Valencia
Days to initial seedling emergence		
13–14	57(11.4)	33(17.2)
15–16	184(36.8)	104(54.2)
17–18	236(47.2)	54(28.1)
19–20	23(4.6)	1(0.5)
Mean	16.4	15.6
C.V.	9.3	13.3
Days to 50% seedling emergence		
16–17	34(6.8)	13(6.8)
18–19	99(19.8)	64(33.3)
20–21	340(68.0)	103(53.7)
22–23	19(3.8)	6(3.1)
24–26	8(1.6)	6(3.1)
Mean	20.1	19.6
C.V.	7.2	13.2
Emergence percentage		
45–50	2(0.4)	2(1.0)
51–60	17(3.4)	14(7.3)
61–70	59(11.8)	36(18.8)
71–80	152(30.4)	56(29.2)
81–90	180(36.0)	62(32.3)
91–100	90(18.0)	22(11.4)
Mean	83.0	78.9
C.V.	12.6	17.6

Class interval	Number of accessions	
	Spanish	Valencia
Days to initial flowering		
52–54	128(25.6)	69(35.9)
55–57	171(34.2)	44(22.9)
58–60	83(16.6)	29(15.1)
61–63	58(11.6)	25(13.1)
64–66	49(9.8)	23(12.0)
67–69	10(2.0)	2(1.0)
70–72	1(0.2)	0(0.0)
Mean	57.4	56.7
C.V.	7.5	12.7
Days to 50% flowering		
54–56	8(1.6)	2(1.0)
57–59	30(6.0)	3(1.6)
60–62	40(8.0)	26(13.5)
63–65	104(20.8)	47(24.5)
66–68	138(27.6)	65(33.9)
69–71	79(15.8)	24(12.5)
72–74	49(9.8)	10(5.2)
75–77	46(9.2)	15(7.8)
78–80	6(1.2)	0(0.0)
Mean	67.2	65.9
C.V.	7.4	12.0

Figures in parenthesis indicate percentage

The flowering behaviour and seedling emergence appears an adequate screening test of a large collection of bunch groundnut for cold resistance under field-planting supplemented with additional information on seed characteristics (viz., quality, viability and size) and the role of photo-thermo-sensitivity. Further, since the climatic sequences are not same each time, field evaluation of a large varietal collection is required to be pursued over years and locations.

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Variability studies of some quantitative characters in sunflower

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In view of its potentiality as a source of edible oil for human consumption, sunflower *(Helianthus annuus* L) has become an important oil seed crop. No concentrated efforts have been made for amelioration of this crop. Information on the nature and extent of genetic stocks, heritability, genetic advance is a prerequisite for framing any selection programme. The present study includes the results obtained on these aspects.

Thirty six genotypes of sunflower belonging to different agro-climatic regions of the world were grown in a RBD with three replications during the *Kharif* season of 1978. Each plot consisted of one row with 6m. The row to row and plant to plant spacing were 60 and 30cm, respectively. Observations were recorded on ten randomaly selected plants for days to full blooming, days to maturity, number of leaves, stem diameter (cm), head diameter (cm), plant height (cm), 100-seed weight (g), yield of filled seeds per plant(g), percentage of filled seeds and oil content (%). Genotypic coefficients of variation were estimated according to the method outlined by Burton(1952). The method suggested by Hanson *et al.*(1956) was used for estimating the heritability. Expected genetic advance was estimated as per the formula suggested by Lush(1949) and Johnson *et al.* (1955).

The data revealed that the varietal differences for all the characters studied, were highly significant (Table 1). It was observed that the range was wide for plant height, while limited range was noticed in case of stem diameter. The heighest SE value was also noticed for plant height and the least SE value in case of stem diameter. Similarly phenotypic and genotypic variances were also high for plant height and low for the stem diameter (Table 2).

Yield of filled seeds/plant, 100-seed weight and head diameter had high genotypic coefficient of variation with high heritability estimates (Table 3). Ramesh (1976) have reported the similar results

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Table 1: Phenotypic variability in the ten characters

Character	Range	Mean	SE±
Days to full blooming	112.00–120.19	120.19	1.15
Daya to maturity	128.66–144.33	137.15	0.99
Number of leaves	25.24–39.66	33.07	1.33
Stem diameter	1.59–2.48	1.96	0.09
Head diameter	10.95–23.08	15.81	0.71
Plant height	116.13–222.26	169.77	4.04
100-seed weight	4.07–7.81	5.55	0.35
Yield of filled seed/plant	20.63–46.76	30.38	2.48
Percentage of filled seeds	53.13–71.60	65.08	2.59
Oil content(%)	29.79–40.47	35.08	0.27

Table 2: Estimates of phenotypic, genotypic and error variances

Character	Phenotypic variance	Genotypic variance	Error variance
Days to full blooming	15.95	13.94	2.01
Days to maturity	14.48	13.00	1.48
Number of leaves	15.62	12.96	2.66
Stem diameter	0.10	0.01	0.09
Head diameter	9.77	9.01	0.76
Plant height	491.82	467.33	24.49
100-seed weight	1.52	1.33	0.19
Yield of filled seeds/plant	88.37	79.11	9.26
Percentage of filled seeds	24.39	14.32	10.07
Oil content(%)	3.96	3.85	0.11

in sunflower. The high heritability values for yield of filled seeds/plant and 100-seed weight are also followed by high genetic advance. However, in case of days to maturity, head diameter, plant height and oil content, the expected genetic advance was not in proportion to the high heritability values observed. Johnson *et al* (1955) also reported that the higher estimate of heritability need not be associated with higher values of genetic advance. In the present study, high heritability alongwith high genetic advance has been

Table 3: Estimates of genotypic Coefficient of variation, heritability percent and genetic advance

Character	Genotypic Coefficient of Variation	Heritability percent	Genetic advance in percent of mean
Days to full blooming	3.10	87.39	5.94
Days to maturity	2.62	87.78	5.13
Number of leaves	10.88	82.97	20.42
Stem diameter	5.10	10.00	3.32
Head diameter	18.98	92.22	37.55
Plant height	12.73	95.02	25.56
100-seed weight	20.77	87.50	40.03
Yield of filled seed/plant	29.27	89.52	57.06
Percentage of filled seeds	5.81	58.71	9.17
Oil content (%)	5.59	97.22	11.36

observed for yield of filled seeds/plant, and 100-seed weight showing that these characters can be improved by following appropriate breeding methodlogy.

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Response of rainfed sunflower to nutrient application in vertisols

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Sunflower *(Helianthus annuus* L) is the fast developing oilseed crop of India. Area under this crop is rapidly increasing year after year in rainfed vertisols. Drainage is a serious problem in these soils. There is sufficient need to develop suitable technology for saving this crop when affected by continuous rains as sunflower does not stand water stagnation. Application of N,P_2O_5 and K_2O has marked influence on sunfloer when applied at the beginning of flowering and at seed formation stages in infertile sandy soils (Galgoczy 1967). But, Robinson (1973) did not find response due to foliar spray at various growth stages of sunflower on a fertile silt loam soil. Though there was differential response of sunflower to application of nutrients in various types of soils, information with regard to the effect of nutrients applied after continuous rains that too after flowering was relatively meagre. Such studies in vertisols on which sunflower crop to a great extent is cultivated in India are scanty. It was, therefore, felt necessary to findout the response of sunflower affected by continuous rains to nutrient application at late stages of the crop.

Sunflower variety 'Morden' severely affected by continuous rains was sujected to this study during rainy season of 1983. Two experiments, one each on two growth stages of the crop were laid out in RBD with eight treatments replicated thrice, at the Agricultural Research Institute, Rajendranagar. The treatments were T_1 (Control: urea, super phosphate and muriate of potash @20:40:40 kg N,P_2O_5 and K_2O/ha were applied as basal and top dressing of urea @ 20 kg N/ha was done on 28 and 22-day after sowing in the first and second experiments, respectively. No further application of nutrients was done in this treatment. This was common for all treatments). Spraying of nutrient solutions on the plants @ 500 L/ha was done in T_2 (T_1 + borax, 0.1%); T_3 (T_1 + ammonium molybdate, 0.05%); T_4 (T_1 + sodium molybdate, 0.05%); T_5 (T_1 + ferrous sulphate, 0.5%); T_6 (T_1 + potassium sulphate, 0.2%); and T_7 (T_1 + urea, 2%). In the last treatment (T_8) T_1 + top dressing of urea @ 10 kg N/ha was done. The plot size was 20.16 m^2. Sowing was done on July 22 and August 5 in experiment-I and II, respectively. When the crop was at seed filling stage in the first experiment and flowering and pollination stage in the second, treatments were imposed

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Table 1: Seed yield in kg/ha of rain affected sunflower as influenced by nutrient application after flowering.

Nutrient	Expt.I	Expt.II	Pooled
Control (No application)	440	375	408
Borax	427	429	428
Ammonium molybdate	424	435	430
Sodium molybdate	501	312	407
Ferrous sulphate	458	406	432
Potassium sulphate	496	434	420
Urea spary	502	444	473
Urea top dressing	550	385	468
C.D. (P=0.05)	70	25	36

on September 30. From sowing till imposition of treatments. Rainfall of 615 and 404 mm received in 32 and 25 rainy days for crop of 70 and 56 days respectively. After imposition of treatments, within a span of one week there was a rainfall of 96.1 mm spread over three rainy days. Soil was under saturation during most of the crop period in both the experiments. The slope was 0.3% in the first and 0.9% in the second experimental plots.

Soils of the first and second experimental sites were high and medium in available phosphorus, respectively. Both fields were clay loam containing medium available nitrogen, high available potash, and low organic carbon with a pH of 7.83 to 7.99 and EC of 0.43 to 0.51 m mhos/cm and were non-saline. Crops in the first and second experiments were harvested on October 21 and 26 respectively.

Experimental results (Table 1 and 2) indicated a positive response of sunflower to application of urea either by spray or through top dressing. In experiment-I, where the field was level (0.3% slope), top dressing with 10 kg N/ha gave superior seed yield of 550 kg/ha followed by 502 kg/ha produced in foliar spray of urea, but these yields are at par (Table 1). Increased production in this treatment was due to more seed yield, more number of filled seeds per head and more 1000-seed weight (Table 2). In experiment-II, where the field was *slopy (0.9% slope) foliar spray of 2% urea supplementing 4.6 kg N/ha* recorded significantly increased yield of 444 kg/ha. Higher 1000-seed weight, more filled seeds and more seed yield per head reflected in higher seed yield per hectare in these treatments. Top dressing of urea did not result in higher yield in this case.

Table 2: Yield attributes of rain-affected sunflower as influenced by nutrient application after flowering

Nutrient	Yield per plant, g			Seed number per head: filles			Seed number per head: unfilled			1000 seed weight, g			Plant population/ plot		
Experiment	I	II	Mean	I	II	Mean	I	II	Mean	I	II	Mean	I	II	Mean
Control (No application)	9.6	16.5	13.0	185	278	232	136	223	180	33.3	41.4	37.4	111.3	84.6	98.0
Borax	9.5	17.8	13.7	169	372	270	121	119	120	34.0	47.2	40.6	108.3	87.0	97.7
Ammonium molybdate	9.9	18.5	14.2	145	360	252	86	110	98	34.0	47.5	40.8	108.8	86.4	97.6
Sodium molybdate	10.1	15.6	12.9	177	318	247	159	135	147	35.1	42.0	38.6	108.3	83.3	98.8
Ferrous sulphate	10.1	17.4	13.8	178	314	246	126	187	157	34.8	45.9	40.4	108.3	84.0	96.2
Potassium sulphate	9.9	15.9	12.9	189	256	222	126	207	167	32.7	48.2	40.5	108.3	86.4	97.4
Urea spray	10.4	18.6	14.5	203	321	262	176	256	216	32.4	49.2	40.8	111.3	84.0	96.7
Urea top dressing	11.5	17.1	14.3	304	308	306	118	218	168	35.6	45.2	40.4	109.4	84.0	96.7
C.D. (P=0.05)	1.6	1.9		26	22		31	10		N.S.	2.6		N.S.	N.S.	

N.S. = not significant

Gaur *et al.* (1975) reported higher seed yield when 25% N was applied to soil and 75% to foliage than the total N aplied to soil. Beneficial effect of nitrogen application to to sunflower at sowing and bud stages were reported by Gaur *et al.* (`73), Singh *et al.* (1973) and chauhan (1979). In case of first experiment, besides 20 kg N/ha applied each time as basal and top dressing on 28th day after sowing, an additional dose of 10 kg N/ha top as dressing 21 days before harvesting resulted in 25% increased seed yield.

Urea spray, produced 14 and 18% higher seed yield in I and II experiments respectively, indicating beneficial effect of spray in both level and undulating land. Pooled data exhibited a significant increase in seed yield due to application of urea eighter by spray or through top dressing. These results show that yields could be partly retrieved through later aplications of N even at late stage of the crop namely flowering, pollination and seed filling stages in case of sunflower affected by rains.

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Outcrossing studies in safflower

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An understanding of the breeding behaviour of a crop form prelude to the improvement programmes. Though the commercial varieties of safflower (carthamus tinctorius L) are essentially self pollinated, available evidence suggests wide range of genetic variation in the germplasm for the degree of outcrossing. This is highly influenced by both the enviornment and genotype. In order to estimate the outcrossing per cent in safflower, an experiment was conducted during 1983-'84 and 1984-'85 crop seasons at Agricultural Research Institute, A.P.A.U., Hyderabad to find out the extent of outcrossing, which would help in characterising the lines in order to formulate the breeding procedures.

The variation in floret colour viz., yellow/yellow, yellow/orange, organge/orange, light yellow/light yellow and white/white was made use to identify the deviant types in the immediately succeeding generations. Among the floret colours yellow/yellow is dominant over others.

The culture, APRR-3 having yellow/yelow floret colour was chosen as dominant parent. Nine recessive parents viz., Manjira, A-1, No.83, Co.1, BS-544, SF-961, SF-53-3, WA 300 and S-4 selected, were sown on November 3, 1983 in single rows of 3 m length with APRR-3 on either side of each parent and replicated thrice. All the cultural operations were carried out as per the recommended schedule. On maturity the seeds were harvested from each recessive line seperately. The seed materials so obtained from each parent were sown on November 8, 1984 in 40 rows of 5m to ensure a population of 800 to 1000.

After flowering each plot was divided into three equal parts and the deviant types with yellow/yellow floret colour were counted in all the segments individually. The extent of out crossing expressed as per cent is presented in table 1. The number of yellow types varied considerably in the genotypes which ranged from 47 (WA-300) to 176 (No.83).

Accordingly the outcrossing per cent varied from 5.97 in WA-300 to 21.89 in No. 83. Similar variation for outcrossing was reported by

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Table 1. The differences in outcrossing among nine safflower genotypes

Entry	Recessive floret Colour	Number of plants: Recessive floret Colour	Number of plants: Dominent floret Colour	Out crossing per cent
Manjira	Y/O	740	104	12.32
A-1	Y/O	579	128	18.10
No-83	Y/O	628	176	21.89
Co.1	O/O	728	61	7.73
BS-544	O/O	619	96	13.42
SF-961	O/O	525	114	17.84
S-4	LY/LY	739	109	12.85
SF-53-3	W/W	765	79	9.36
WA-300	W/W	740	47	5.97

Kadam and Patnakar (1942) where it ranged from 1.09% to 28.2%. Under Nebrasca conditions, the range for outcrossing was as wide as 0 to 100% (Claassen, 1950). As per Marsal-Diaz and Ceron-Diaz (1972) the outcrossing per cent was 82 to 93 in thin hull types where the anther dehiscence is delayed. The differences in the extent of outcrossing have been attributed to the activity of insect pollinations, the honey bees. The genotypic differences in the proportion of staminate florets (Ramachandram and Goud, 1982) were shown to influence the extent of outcrossing apart from the bees activity in the vicinity. Thus, the present observations confirmed existance of wide variation in the outcrossing per cent within the genetic stocks of the safflower germplasm. Such studies if continued to characterise the germplasm for the extent of out crossing,would facilitate to reorient the breding programmes accordingly.

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Inheritance of faint orange flower colour in groundnut

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Spontaneous as well as induced mutations for flower colour are rare in groundnut (*Arachis hypogaea* L.). Hays (1933) recorded different flower colours in groundnut including white, the deep colour being monogenic dominant to pale colour. Kumar and Joshi (1938) reported a spontaneous white flower coloured mutant in 'Poona local' groundnut. Acording to Kumar and Joshi (1943) orange flower colour as incompletely dominant over white giving F_2 ratio, 1 orange; 2 faint orange; 1 white. Habib *et al* (1970) also reported white flower groundnut mutant.

Desale (1985) reported a faint orange flower coloured mutant in groundnut. This was crossd as a male parent with the groundnut genotype JL-24, with orange flower colour. F_1 plants were with orange flower colour. F_2 segregation was confirmed in F_3. The results of segregation in F_2 and F_3 are presented in table 1.

Table 1 : Segregation for flower colour in groundnut.

Generation	Families	Orange	Faint orange	Total	x^2	P
F_2 (3:1)	-	76	22	98	0.3503	.50-80
F_3	7	Bred true	-	-	-	-
	5	111	34	145	0.1862	.50-80
	3	-	Bred true	-	-	-
F_3 Families	-	-		-	0.4304	.50-80

The segregation thus showed that the faint orange flower colour in this case was monogenic recessive to orange. The inheritance of faint orange flower colour reported here is thus different from that reported by Kumar and Joshi (1943).

The mutant gene for faint orange flower colour is symbolised as 'oflr'.

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Effect of nitrogen levels and rhizobium inoculation on nodulation and pod yield in groundnut

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It is recognised that a small amount of supplementary nitrogen fills the gap of nitrogen supply before the operation of nodule nitrogen fixation. On the contrary reduction in nodule formation and nitrogen fixation occur when higher doses of mineral nitrogen are applied (Dart, 1974). According to More *et al.*, (1981) inoculation of *Rhizobium* reduced mineral nitrogen requirement of groundnut crop. The present practice prevailing in Saurashtra (Gujarat), is to apply 12.5 to 25.0 kg N/ha without *Rhizobium* inoculation (Reddy, 1982). This paper deals with the response of Spanish (GAUG 1) groundnut to *Rhizobium* inoculation at different levels of fertilizer nitrogen.

A field experiment was conducted during rainy season 1981 and summer 1982 on a medium black calcarious soil low in N with pH 8.0 at Junagadh. Nitrogen in the form of urea at four levels viz., 0, 6.25, 12.50 and 25.00 kg/ha with an uniform dose of superphosphate (40 kg P_2O_5/ha) were applied as a basal dose. *Rhizobium* strain NC 92 was inoculated as liquid inoculum in the furrow and the seeds of spanish variety GAUG 1 were sown. The experiment was laid out in split plot design with nitrogen levels as main-treatment and *Rhizobium* inoculation as sub-treatment with four replications. A sub-plot consisted of 10 row of 3 m length at spacing of 30 x 10 cm. Data were collected on five randomly selected plants at 2 stages of the plant growth on nodule number, nodule dry weight (mg/plant) and plant dry weight (g/plant). At maturity plants in central rows were harvested and the pod yield (kg/ha) was recorded.

The perusal of data (Table 1) indicated that increase in nitrogen levels showed corresponding reduction in nodule number and nodule dry weight on 30 days of crop growth during the rainy season. However on 60 days of crop growth, there was no difference in the nodule number. On the other hand significant difference in nodule number due to *Rhizobium* inoculation was observed at 60 days of crop growth. At all levels of applied nitrogen, the *Rhizobium* inoculation produced more number of nodules as compared to the respective uninoculated control. No significant difference was observed on the nodule dry weight either due to nitrogen levels or due to *Rhizobium* inoculation at 60 days growth. Significantly higher plant dry weight at 30 days was recorded

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Table 1: Effect of nitrogen levels and *Rhizobium* inoculation on nodulation, dry weight of plants and pod yield of groundnut (*Kharif* 1981 & Summer 1982).

Nitrogen levels (kg/ha)	Rhizobium Treatment	Nodule number/plant				Plant dry weight (g/plant)				Pod yield (kg/ha)	
		Kharif 1981		Summer 1982		Kharif 1981		Summer 1982		Kharif 1981	Summer 1982
		30DASE	60DASE	30DASE	60DASE	30DASE	60DASE	30DASE	60DASE		
0	I	49.8	111.3	6.0	43.0	2.3	10.3	2.4	8.7	702.3	1743.3
	UI	50.6	101.5	7.8	39.0	2.3	10.5	2.3	9.2	659.3	1898.0
6.25	I	47.8	118.8	8.5	38.5	2.6	9.9	2.6	11.2	677.3	1906.0
	UI	46.5	104.3	4.2	29.7	2.4	10.5	2.4	9.3	705.0	1722.0
12.5	I	42.4	139.5	6.0	41.8	2.6	13.0	2.6	11.1	740.3	2022.0
	UI	41.5	55.8	7.5	35.5	2.6	10.8	2.6	8.5	640.8	2015.0
25	I	37.8	103.3	4.3	38.8	3.3	9.7	3.2	9.0	794.3	2310.0
	UI	34.5	97.0	4.2	36.5	3.0	10.4	3.0	11.6	652.8	2044.0
CD (P=0.05)	N levels	7.3	NS	NS	NS	0.4	NS	NS	NS	NS	122.1
	Rhizobium	NS	7.20	NS	4.3	NS	NS	NS	NS	NS7	NS
	Interaction	NS	16.9	NS	NS	NS	2.1	NS	NS	86.0	186.7

DASE = Days After Seedling Emergence ; I = Inoculated ; UI = Uninoculated; NS = Nonsignificant

only at 25 kg N/ha.

During the summer, 1982 number of nodules were less the 10 per plant at 30 days of crop growth. Even at 60 days of crop growth, nodule number was less than those formed during rainy season. This difference was perhaps due to variations in the soil temperature during *Kharif* and Summer seasons. Similar observations were recorded by Nambiar and Dart (1980). Due to assured timely irrigation in Summer, however, nodules remained active for longer period. Soil moisture plays an important role in turgidity and activity of nodules (Sutton, 1983). Though no significant change in nodule number was observed at higher levels of fertilizer application, *Rhizobium* inoculation improved nodule number on 60 days of crop growth. There was no appreciable change in the dry weight of plants at the two stages of plant growth.

Rhizobium application improved the pod yield at all levels of nitrogen except at 0 and 6.25 kg N/ha during summer and rainy seasons respectively. Application of 25 kg N/ha and *Rhizobium* resulted in a higher pod yield during both the seasons. However, there was no significant difference between 12.5 and 25.0 kg N/ha when inoculated with *Rhizobium* during rainy season. There was no significant differnce in the nitrogen levels or *Rhizobium* improved the pod yield. These results clearly indicated that response to *Rhizobium* inoculation was possible when a basal dose of nitrogen was available. During summer season however, application of 25 kg N/ha significantly improved pod yield. Here again *Rhizobium* inoculation boosted the pod yield. Light basal dose of nitrogen (10-25 kg/ha) is recommended as a means of stimulating seedling growth prior to effective nodulation (More *et al.*, 1981 and Martinzer, 1980).

According to More *et al.*, (1981), 5 kg N/ha could be saved by *Rhizobium* inoculation in bunch groundnut crop. Though results of the present study did not indicate on economy in mineral nitrogen on inoculation of *Rhizobium*, it could be proposed that application of 12.5 kg N/ha during rainy season and 25.0 kg N/ha during summer alongwith *Rhizobium* inoculation for obtaining higher yield, in bunch groundnut varieties in Saurashtra region of Gujarat. This practice would have impact in this region where summer groundnut cultivation is rapidly increasing in recent years in view of the higher and stable yield.

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Impact of improved production technology on castor genotypes

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Castor *(Ricinus communis.* L) is an important oilseed crop of India. The oil extracted is useful in variety of industrial and domestic use and as such it has great export potential. The castor production in the country has increased from 1.46 lakh tonnes in 1972-73 to 4.06 lakh tonnes in 1983-84 in an area of 6.37 lakh hectares. There is an ample scope to increase the productivity of this crop under dryland conditions. Singh (1983) reported that among the *kharif* crops on arid soils under dryland conditions castor gives highest yield with higher water use efficiency. Technology has been developed on various production aspects of castor at various research centres. Time has come to convince the farmers regarding the importance of these production factors individually and in combination. Improved cultivation practices found to increase the yield of groundnut by 41%, rapeseed-mustard by 34%, sesame by 85%, safflower by 51-78% and niger by 69% (Reddy, 1985; Rao *et al.*, 1985). Hence this trial was initiated with the objective to assess the impact of individual components of improved production technology on castor under rainfed conditions.

A trial was conducted at the Directorate of Oilseeds Research farm, Rajendranagar during *kharif*, 1980 and 1981. The improved package of practices followed were (i) seed rate @12 kg/ha, (ii) spacing: 60x30 cm, (iii) fertilizer dose: 60 N:40 P_2O_5: 40 K_{2O} kg/ha where 1/2 N was applied at sowing and remaining 1/2 30 days after sowing coinciding the moisture availability. (iv) plots were kept weed free till 45 days after sowing by 2 hand weedings. Local practices consisted of seed dropping in furrow and one interculture after 30 days of sowing. The trial was laid out in split plot design with varieties in main plots and production practices in subplots. The data in Table 1 reveal that the varieties did not vary significantly inrespect of seed yield and this was true with variety x production factor interaction also. But production factors found to influence the seed yield of castor genotypes significantly. However, among the varieties Bhagya gave highest yield (991 kg/ha). Treatment using all the package of practices gave highest yield (991 kg/ha) followed by 60x45 cm spacing treatment with all other package of practices (850 kg/ha). Local practices realised lowest seed yield (340 kg/ha). Among the production

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Table 1: Impact of Package of Practices on the yield of Castor

Treatments	Seed yield (kg/ha) Aruna 1980–81	Aruna 81–82	Aruna Mean	Gauch-1 1980–81	Gauch-1 81–82	Gauch-1 Mean	Bhagya 1980–81	Bhagya 81–82	Bhagya Mean	Average productivity (kg/ha)	% increase over control	Cost: benefit ratio
T_1 Local practices	411	314	362	384	290	337	370	274	322	340	–	1:1.20
T_2 All package of practices	1174	815	994	1178	878	1028	1102	800	951	991	191	1:2.14
T_3 Treatment No.(2) but 60x45cm spacing	1076	776	926	1009	708	858	917	617	767	850	150	1:1.90
T_4 Treatment No.(2) Minus fertilizers	745	556	650	696	499	597	674	473	573	607	84	1:1.72
T_5 Treatment No.(2) Minus weed control	741	443	592	740	446	593	693	414	553	579	70	1:1.34
T_6 Treatment No.(2) minus insect and disease control	366	314	340	388	316	352	411	295	353	348	2	1:0.61
T_7 Treatment No.(2) but N through split	1027	733	880	953	655	804	953	624	788	834	142	1:1.43
T_8 Treatment No.(2)+ mulching	971	616	793	927	526	727	935	590	762	761	124	1:1.37
Mean	827	571	699	797	539	668	769	640	704			

	Varieties 1980	Varieties 1981–82	Production factors 1980–81	Production factors 1981–82	Varieties X Production factors 1980–81	Varieties X Production factors 1981–82
SEm ±	44.4	33.1	70.2	63.0	153.9	131.0
CD (P=0.05)	NS	NS	214.6	192.0	NS	NS

NS = Non Significant.

factors, insect pest and disease control found to have considerable effect in increasing seed yields followed by weed control and fertilizer application (607 kg/ha). In both the crop seasons the semilooper incidence was severe. Hence, the yield reduction was drastic. Rao *et al* (1985) noted seed rate, fertilizer application and plant protection as the critical factors for increasing oilseed yield on farmer's level. Use of full package of practice increased seed yield of castor by 191% over control and also gave highest cost: benefit ratio (1:2.14). Lowest cost: benefit ratio was due to non practice of insect pest and disease control (1:0.61). Hence it can be concluded that practicing of improved production technology in castor certainly has greater impact in increasing seed yields. Critical production factor in reducing castor yields in order of merit were insect pest and disease control, weed control and fertilizer application.

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A mosaic disease of niger

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Niger *(Guizotia abyssinica* cass.) is one of the most potential unexploited oilseed crops of India, cultivated mainly on marginal and submarginal lands. In general disease occurrence is relatively low in this crop. However, during 1984-85 at Directorate of Oilseeds Research, Rajendranagar, Hyderabad a mosaic disease was observed with 1-3% incidence. The characteristic symptoms were mosaic mottling of the leaves followed by moderate stunting of plants.

The virus culture collected from the field was established in the glass house by inoculating the healthy niger plants var. IGP-76. For mechanical sap inoculation, the inocula were prepared by grinding the infected leaves in mortor by adding chilled 0.01 M phosphate buffer (pH 7) containing 0.02M mercaptoethanol. The test plants dusted with celite (400 mesh) were inoculated by conventional leaf-rub method with a small muslin cloth soaked in inoculum. Immediately after the inoculation, the leaves were washed with tap water. For aphid transmission studies, healthy colonies of *Aphis gossypii* Glov, *A.craccivora* Koch. and *Uroluucon compositae* Theobald (=*Dactynotus carthami*) were raised on chillies, groundnut and safflower plants respectively. While transmission studies, aphids were given preliminary fasting period of 1 h and acquisition and incoulation periods for 15 min each. Five niger plants var IGP-76were used as test plants and 10 aphids were released on each plant. After 15 min of inoculation period, the test plants were sprayed with 0.05% monocrotophos. For seed transmission studies, seeds were collected from the preflowering infected niger plants from field as well as from infected plants raised in glasshouse. The physical properties were studied by following the standard procedures (Noordam, 1973) and *Chenopodium amaranticolor* Coste et Reyn was used as the test plant.

The virus was mechanically sap transmitted. Typical mosaic mottling symptoms were produced on niger 12-15 days after inoculation in the glasshouse. The host range was confined to the members belonging to Compositae, Solanaceae, Cucurbitaceae, Chenopodiaceae and Amarantaceae. Mosaic mottling symptoms were also produced on *Cucumis sativus* L., *C.melo* L., *Luffa acutangula* Roxb, *Nicotiana tabacum* L, var. white Burley, N.t. var. Xanthi-nc, *Nicotiana rustica* L., *physalis floridana* Rydb, *Capsicum annuum* L., *Solanum melongena* L., *Helianthus*

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annuus L.,*Zinnia elegans* Jacq and *Gomphrena globosa* L, Initial mosaic mottling followed by shoe string symptoms were produed on *Nicotiana glutinosa* L. On *C.amaranticolor* and *C.quinoa* willd necrotic local lesions were produced between 7-9 days after inoculation. The results on the physical properties indicated that the virus was inactivated between 60 to 65°C and at the dilution of 10^{-3} to 10^{-4}. At room temperature it was active for 72 h only. Out of the three aphid species tested, A.*gossypii* and *U.compositae* transmited this disease in non-persistent manner and the percentage of transmission was 40 and 60 respectively. A total of 712 niger plants were raised from the infected seed and none showed mosaic mottling symptoms. No virus could be isolated from seedlings when back indexed on *C.amaranticolor*, therby indicating that the virus was not seed-borne in niger.

The results on host range, vector transmission and physical properties are closely resembling to cucumber mosaic virus. A perusal of the literature on plant viral diseases (Sastry 1980, Kolte 1985) indicates that there is no record of any virus disease on niger either from India or elsewhere. Therefore, this report constitutes a new record. Studies on electron-microscopy and serology are in progress.

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Effect of pigeonpea plant population and row arrangement in groundnut pigeonpea inter-cropping

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A field trial was conducted to study the effect of varying plant populations and row arrangements of pigeonpea (*Cajanus cajan* L) at sole crop optimum populations of groundnut (*Arachis hypogiea* L) at the Agricultural College Farm, Rajendranagar, Hyderabad during *Kharif* 1984. The experimental design was RBD replicated thrice with 12 treatments. Groundnut and pigeonpea were inter-cropped with sole crop optimum population of groundnut (3,33,000 plants ha^{-1}) and 100, 75 and 50 per cent populations of pigeonpea (60,000, 45,000 and 30,000 plants ha^{-1}) at three different row arrangements (4:1, 5:1 and 6:1). Traditional inter-cropping combination (8:1) was also taken for comparison along with two sole crop treatments (Table 1). In sole crop treatments spacing of 30 x 10 cm for groundnut and 60 x 27.8 cm for pigeonpea was adopted. In all intercrop treatments uniform inter-row spacing of 30 cm was kept for groundnut. Pigeonpea rows were sown as per row arrangement by skipping groundnut rows. The expected sole crop optimum populations of groundnut and varying populations of pigeonpea at different row arrangements were obtained by adjusting only intra-row spacing. The test varieties were Robot 33-1 (groundnut) and ICP 1-6 (pigeonpea). The soil was sandy clay loam with 7.8 pH, 274 kg ha^{-1} available nitrogen, 26.0 kg ha^{-1} available P_2O_5 and 306 kg ha^{-1} available K_2O. Recommended dose of 20 kg N, 40 kg P_2O_5 and 20 kg K_2O ha^{-1} was uniformly applied to all treatments as basal dose. The crops were sown on July 3, 1984 and groundnut and pigeonpea were harvested 124 and 198 days of sowing respectively. The total rainfall during crop period was 376.4 mm, which was all received during groundnut crop period, against normal rainfall of 750 mm in this region.

The groundnut yields (pod and haulm) were significantly reduced in all inter-crop treatments irrespective of varying pigeonpea populations and row arrangements. The reduction in groundnut pod yields ranged from 19.1 to 33.4 per cent with no appreciable difference among row arrangements or plant densities of pigeonpea. The probable reason for not finding such difference might be due to moisture stress from early

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Table 1 : Groundnut and pigeonpea yields, monetary returns and LER as influenced by plant populations and row arrangements in groundnut/pigeonpea intercropping.

Treatments		Pod yield of base crop (G'nut) (Kg/ha)	Haulm yield of base crop (G'nut) (Kg/ha)	Grain yield of inter-crop (Pigeonpea)	Stalk yield of inter-crop (P'pea) (Kg/ha)	Total production in pod equivalents of (G'nut) (Kg/ha)	Gross monetary returns/ Rs/ha	Land equivalent ratio.
T_1 Sole Groundnut		1346	3564	—	--	1346	5918	1.00
T_2 Sole Pigeonpea		--	--	838	2337	723	3124	1.00
T_3 Groundnut:Pigeonpea	4:1(100:100)	897	2843	711	1846	1510	6650	1.52
T_4 " "	4:1(100: 75)	973	3186	574	1490	1468	6500	1.41
T_5 " "	4:1(100: 50)	952	3057	482	1243	1368	6055	1.29
T_6 " "	5:1(100:100)	1089	3306	699	1797	1693	7446	1.65
T_7 " "	5:1(100: 75)	1062	3223	550	1468	1537	6778	1.45
T_8 " "	5:1(100: 50)	1065	3291	452	1207	1455	6435	1.33
T_9 " "	6:1(100:100)	1019	3198	687	1766	1612	7103	1.58
T_{10} " "	6:1(100: 75)	962	3081	581	1508	1463	6465	1.41
T_{11} " "	6:1(100: 50)	905	3008	480	1220	1320	5851	1.24
T_{12} " "	8:1(100:100)	1025	3201	603	1696	1545	6830	1.48
C D (P=0.05)		220	206	122	225	243	965	0.21

stage resulting in less vegetative growth of pigeonpea without much adverse shade effect of pigeonpea at higher plant populations or close row arrangements.

The grain and stalk yield of pigeonpea were significantly less in inter-cropping compared to sole crop of pigeonpea. Among the intercrop treatments, pigeonpea with 100 per cent plant density produced significantly more grain yield than 50 per cent population.

However, when total production was considered in terms of groundnut pod equivalents, 100:100 per cent population of groundnut and pigeonpea inter-crop gave the highest total production of 1,693 and 1,612 kg ha^{-1} in 5:1 and 6:1 row arrangements respectively (Table 1), which were significantly superior to 100:50 population at 4:1 and 6:1 row arrangements and sole crop of groundnut and pigeonpea. The percent increase in total production due to 100:100 percent population in 5:1 row arrangement was 23.8 and 28.3 over 100:50 per cent population in 4:1 and 6:1 row arrangements and 25.8 and 134.2 over sole groundnut and pigeonpea respectively. Although the groundnut pod equivalents in 100:75 population at different row arrangements were less but not significantly different from 100:100 per cent population.

The 100:100 per cent population of groundnut and pigeonpea inter-cropping in 5:1 row arangement gave a maximum gross monetary returns of Rs. 7,446 ha^{-1} which was Rs. 2,528 and 4,322 more ha^{-1} than sole groundnut and pigeonpea respectively. The gain in gross monetary returns over other inter-crop treatments ranged from Rs. 343 to 2,595 ha^{-1}. Reddy *et al.* (1977) also obtained an additional profit of Rs. 2,000 to 2,500 ha^{-1} when groundnut was inter-cropped with pigeonpea compared to pure groundnut. The land equivalent ratio was also highest (1.65) with 100:100 population of groundnut and pigeonpea in 5:1 row arrangement closely followed by 100:100 population with LERs of 1.58, 1.52 and 1.42 in 6:1, 4:1 and 8:1 row arrangements respectively (Table 1). The yield advantage in terms of LER due to 100:100 per cent population in 5:1 row arrangements was 20 to 41 per cent more than other inter-crop treatments of 100:75 and 100:50 per cent populations.

The above results suggest that population proportion of groundnut and pigeonpea inter-cropping with 100:100 would be more profitable irrespective of row arrangements than 100:50 population proportion and sole crops.

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New record of some insect pests and biotic agents on sesamum

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A number of insect pests have been recorded on Sesamum (*Sesamum indicum* L.). Check list of sesamum insect pests in India have been published by Nayar *et al.*(1982) and Mathur *et al.* (1985). A detailed study on the pest complex of sesamum with JT.7 variety during *Kharif* 1983 and 1984 in Delhi revealed a number of new insect pests and biotic agents. Details have been presented in Table 1.

Interestingly pests like leafhoppers, *Empoasca terminatus* Dist. and *Exibianus* sp. semilooper, *Plusia orichalcea* F; coreid bug, *Clavigralla gibbosa* Spinola; red cotton bug, *Dysdercus koenigii* (F), blister beetle, *Mylabris pustulata* (Thnb.); grey weevil, *Myllocerus undecimpunctata maculosus* Desbr; black beetle, *Cyrtozemia cognata* Marsh were recorded for the first time in the world. White fly, *Bemisia tabaci* Genn. which was reported from Nigeria (Rheeneu, 1973) appeared for the first time under Delhi agroclimatic condition.

Among the biotic agents, parasitoids *Trichogramma* sp. and *Zygobothria* sp. were recorded parasitising *Acherontia Styx* Westwood eggs and larvae, respectively in the field for the first time. Egg parasitisation by *Trichogramma* sp. was as high as 93.44% while the tachinid, *Zygobothria* sp. parasitised upto 95.45% larvae in field on sesamum crop.

The yellow wasp, *Polistes hebreaus* and a staphilinid beetle (unidentified) was also observed for the first time predating on larvae of *Antigastra catalaunalis* (Dup.).

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Table-1: New insect pests and biotic agents on Sesamum in India

	Common name	Scientific name	Ctop stage	stage of host	host
	Insect pests				
1.	Leaf hoppers	*Empoasca terminatus* Dist. *Exibianus* F.	Vegetative to pod formation stage	Regular	Major
2.	Semilooper	*Plusia orichalcea* F.	-do-	-do-	Minor
3.	Coreid bug	*Clavigralla gibbosa* Spinola	Active vegetative stage	-	Stray
4.	Red cotton bug	*Dysdercus koeenigii* (F)	Active Vegetative to maturity stage	Regular	Minor
5.	Blister beetle	*Mylabris pustulata* (Thnb.)	Flowering to pod formation stage	Regular	Minor
6.	Grey Weevil	*Myllocerus undecimpunctatus maculosus* Desor.	Active vegetative stage	--	Stray
7.	Black Beetle	*Cyrotozemia cognata* Marsh	Active vegetative to pod formation stage	Regular	Minor
8.	White fly	*Bemisia tabaci* Genn.	-do-	Sporadic	Minor
	Biotic Agents				
	Parasitoids				
1.	Trichogrammatids	*Trichogramma* sp.	Active vegetaive to flowering stage.	Eggs	*Acherontia Styx* West
2.	Tachinid fly	*Zygobothria* sp.	Active vegetative to pod formation stage	Larvae	-do-
	Predators				
1.	Yellow wasp	*Polistes hebreaus* F.	Reproductive stage of crop.	Larvae	*Antigastra catlaunalis* (Dup)
2.	Staphilinid beetle	Unidentified	Flowering to pod formation stage	Larvae	-do-

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