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INHERITANCE OF ALBINISM IN CERTAIN CROSSES OF GROUNDNUT (*Arachis hypogaea* L.)

H.D. UPADHYAYA[1] and K.GOPAL
University of Agricultural Sciences, Dharwad, Karnataka

ABSTRACT

Observations on F_2 and F_3 generations in crosses involving spanish bunch and virginia bunch/runner groundnuts confirmed that albinism is controlled by duplicate loci interacting with another locus in an epistatic manner. The Chi-square test of the observed frequencies indicated a good fit to the ratios expected on this genetic model.

Keywords: Peanut; Chlorophyll deficiency; Loci; Epistasis; Zygotic lethal.

INTRODUCTION

Albinism or chlorophyll deficiency is a deleterious character often observed in segregating generations of groundnut crosses involving varieties of different botanical types. Several groundnut workers have suggested that this character is controlled by duplicate (Patel *et al.*, 1936; Hull, 1937; Katayama and Nagatomo, 1963), triplicate (Badami, 1928; Dwivedi *et al.*, 1984) or quadruplicate factors (Tai *et al.*, 1970). However, Coffelt and Hammons (1971) reported the F_2 phenotypic ratio of 60 green, 3 albino and 1 zygotic lethal having triple recessive. The present study deals with the inheritance of albinism in crosses involving groundnut genotypes belonging to spanish (*A. hypogaea* ssp. *fastigiata* var. *vulgaris*) and virginia (*A. hypogaea* ssp. *hypogaea* var. *hypogaea*) groups.

MATERIAL AND METHODS

The F_1 and F_2 generations of 11 crosses between spanish (KRG 1, S 206, TMV 2, Dh 3-30, GBFDS 92, GBFDS 206) and virginia (TG 7, NC Ac 343) genotypes were initially studied. These were grown in the field during the 1988/89 postrainy and the 1989 rainy season, respectively. Frequencies of green and albino plants were recorded within seven days after emergence of seedlings in the crosses. All albino plants died within 15-20 days after emergence. The remaining green plants in the F_2 populations segregating for albinism character, were harvested separately. Four of these crosses (KRG 1 x NC Ac 343, KRG 1 x GBFDS 92, S 206 x GBFDS 206 and TMV 2 x GBFDS 206) had at least one hundred and eighty F_2 plants with number of pods sufficient to grow F_3 progenies. In all, 720 F_3 progenies of these crosses were raised in the field during the 1989/90 postrainy season. The number of non-segregating and segregating progenies for albinism was recorded in each cross. In segregating progenies the number of green and albino plants was counted within seven days after emergence.

The F_2 and F_3 data were subjected to chi-square test to test the goodness of fit of different di- and tri-genic ratios.

1. Present address : Genetic Enhancement Division, ICRISAT, Patancheru 502 324, A. P.
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RESULTS AND DISCUSSION

All F_1 plants in crosses were green. Of the 11 F_2 crosses only seven viz. KRG 1 x GBFDS 206, KRG 1 x NC Ac 343, KRG 1 x GBFDS 92, S 206 x GBFDS 206, TMV 2 x GBFDS 206, Dh 3-30 x GBFDS 206 and KRG 1 x TG 7, segregated for albinism. The F_2 data of these crosses were subjected to chi-square tests to test the goodness of fit of three genetic ratios (Table 1). The Chi-square values for the digenic ratio of 15 green:1 albino plants were highly significant for KRG 1 x GBFDS 206 and S 206 x GBFDS 206 crosses. Total and pooled chi-square were also highly significant for this ratio. None of the seven crosses individually or when pooled together showed a good fit to the trigenic ratio of 63 green:1 albino, indicating its failure in these crosses. However, when these F2 data were analyzed for a ratio of 60 green:3 albino, (derived from 60 green:3 albino:1 zygotic lethal), chi-square values for the individual crosses as well as the total and pooled were non-significant, indicating a good fit to this ratio.

Five out of seven crosses had also non-significant chi-square values for the ratio of 15 green:1 albino but in four such cases the values were higher than that of the 60 green:3 albino ratio. This indicated that goodness of fit was more in favour of 60:3 ratio than 15:1.

Based on 60:3 and 15:1 green vs. albino plants in F_2, the observed ratios of segregating and non-segregating F_3 progenies of four crosses (KRG 1 x NC Ac 343, KRG 1 x GBFDS 206, S 206 x GBFDS 206 and TMV 2 x GBFDS 206) were tested for goodness of fit for 36:24 and 7:8 non segregating vs. segregating ratios, respectively (Table 2). The ratio of non-segregating and segregating F_3 progenies gave a good fit in favour of 60:3 green vs. albino plants ratio in F_2. Subsequently each segregating F_3 progeny was tested for 60:3, 12:3, 15:1 and 3:1 green vs. albino plant ratios. Based on a 60:3 green vs. albino plants F_2 ratio these progenies are expected to occur with a ratio of 8:8:4:4: for 60:3, 12:3, 15:1 and 3:1 green vs. albino plant ratios. In all the four crosses a good fit for this distribution was observed in Chi-square tests (Table 3).

Table 1. Chi-square tests for different di-and tri-genic ratios in F_2 generations of seven crosses segregating for green and albino seedlings.

Cross	Number of plants		χ^2 values		
			Green: Albino		
	Green	Albino	15:1	60:3[d]	63:1
KRG 1 x GBFDS 206	763	30	8.24**	1.68NS	25.42**
KRG 1 x NC Ac 343	576	36	0.14NS	1.69NS	74.25**
KRG 1 x GBFDS 92	626	29	3.71NS	0.16NS	34.95**
S 206 x GBFDS 206	1118	44	12.03**	2.44NS	37.37**
TMV 2 x GBFDS 206	980	53	2.21NS	0.31NS	85.51**
Dh 3-30 x GBFDS 206	54	3	0.09NS	0.03NS	5.08*
KRG 1 x TG 7	119	5	1.04NS	0.15NS	4.92*
Total (7 d. f)			27.46**	6.46NS	267.50**
Pooled (1 d. f)	4236	200	22.96**	0.63NS	250.32**
Heterogeneity (6 d. f)			4.50NS	5.83NS	17.18**

[d] derived from a 60 green:3 albino:1 zygotic lethal ratio.

* and ** Significant at $p = 0.05$ and 0.01, respectively. NS = Non-significant.

Table 2. Chi-square tests for expected ratios of non-segregating and segregating F_3 progenies based on 60:3 and 15:1 F_2 ratios of green: albino plants.

Cross	Number of F_3 Progenies		F_3 ratios	
			Non-segregating: Segregating	
	Non-segregating (green)	Segregating (green and albino)	36:24[a]	7:8[b]
KRG 1 x NC Ac 343	105	75	0.21^{NS}	9.84^{**}
KRG 1 x GBFDS 206	113	67	0.58^{NS}	18.77^{**}
S 206 x GBFDS 206	118	61	2.62^{NS}	26.66^{**}
TMV 2 x GBFDS 206	98	82	2.31^{NS}	4.38^{*}
Total (4 d. f)			5.72^{NS}	59.65^{**}
Pooled (1 d. f)	434	285	0.04^{NS}	54.18^{**}
Heterogeneity (3 d. f)			5.68^{NS}	5.47^{NS}

a = Expected F_3 ratio of non-segregating and segregating progenies based on an F_2 ratio of 60 green:3 albino plants.
b = Expected F_3 ratio of non-segregating and segregating progenies based on F_2 ratio of 15 green:1 albino plant.
* and ** significant at P = 0.05 and 0.01, respectively; NS = Non-significant.

Table 3. Chi-square tests for a ratio of 8:8:4:4 for the F_3 progenies segregating for 60:3, 12:3, 15:1 and 3:1 ratios of green and albino plants.

Cross	Total number of segregating progenies	Number of progenies segregating for				
		Green: Albino				
		60:3	12:3	15:1	3:1	χ^2 ratios
KRG 1 x NC Ac 343	75	23	22	13	17	2.16^{NS}
KRG 1 x GBFDS 206	67	21	18	16	12	3.07^{NS}
S 206 x GBFDS 206	61	18	19	10	14	1.80^{NS}
TMV 2 x GBFDS 206	82	21	29	12	20	4.70^{NS}
Total (12 d. f)						11.73^{NS}
Pooled (3 d. f)		83	88	51	63	7.35^{NS}
Heterogeneity (9 d.. f)						4.38^{NS}

Ns = non-Significant.

The *chlorophyll* production under this genetic model is controlled by duplicate loci (A and B) interacting with a third locus (L) in an epistatic manner. The presence of one dominant allele at either A or B locus ensures normal chlorophyll production independent of recessiveness/dominance at L locus. The double recessive condition of both A and B and at least one dominant allele at the L locus (aabbL-) results in albino seedlings. Triple recessive (aabbll) are zygotic lethal. The results of this study and the one reported by Coffelt and Hammons (1971) reveal that Albinism in groundnut is controlled by two *duplicate loci* interacting with a third locus in epistatic manner and resulting into an F_2 ratio of 60 green:3 albino:1 zygotic lethal.

LITERATURE CITED

Badami, V.R.K. 1928. *Arachis hypogaea* (the **groundnut**). Ph.D. Thesis, University of Cambridge. pp 337-347.

Coffelt, T.A. and Hammons, R.O. 1971. Inheritance of albino seedling character in *Arachis hypogaea* L. *Crop Sci.* 11:753-755.

Dwivedi S.L., Nigam, S.N., Pandey, S.K. and Gibbons, R.W. 1984. Inheritance of albinism in certain interspecific and intersubspecific crosses in groundnut (*Arachis hypogaea* L.). *Euphytica* 33:705-708.

Hull, F.H. 1937. Inheritance of rest period of seeds and certain other characters in peanut. *Univ. Florida Agri. Expt. Stn. Tech. Bull.* 314, 46, pp.

Katayama, Y. and Nagatomo T. 1963. Crossing experiments in various strains of peanut. *Bull. Fac. Agri. Uni. Miyazaki* 9:99-126.

Patel, J.S., John, C.M. and Seshadri, C.R. 1936. Inheritance of characters in groundnut, *Arachis hypogaea*. *Ind. Acad. Sci. Proc.* 3:214-233.

Tai., Yai-Po., Kirby, J.S. and Matlock, R.S. 1970. Chlorophyll mutations in peanuts, *Arachis hypogaea* L. II. Genetic analysis. *Agron. Abst.* p 21.

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ANALYSIS OF HARVEST INDEX IN GROUNDNUT

V.K. SHARMA and S.K. VARSHNEY
Department of Plant Breeding, Rajendra Agricultural University, Pusa - 848 125, Bihar.

ABSTRACT

Seven bunch, two semispreading and nine spreading varieties/lines of groundnut (*Arachis hypogaea* L.) were evaluated for harvest index and other related traits. Harvest index ranged from 15.09 to 38.51 per cent with a mean value of 25.76 per cent. High heterogenity for harvest index was observed among the varieties within growth habits. Genetic variability, broad sense heritability and genetic advance as per cent of mean were found high for harvest index and its component traits. Pod yield per plant, and pods per plant and shelling percentage showed significant positive correlation with harvest index. In addition to these traits, kernels per pod and secondary branches per plant had high positive direct effect, whereas, primary branches per plant attributed negative direct effect on harvest index. Improvement in harvest index with an ultimate objective of improvement in yield could be achieved by increasing pods per plant, kernels per pod, shelling percentage and secondary branches per plant.

Key words: Harvest index; Variability; Heritability; Correlation; Path coefficient.

INTRODUCTION

Harvest index is an important physiological index that provides an useful measures of source to sink relationship (Donald, 1962). In fact, major break-through in grain yield in cereal crops has been achieved as a result of improvement in source to sink relationship without an increase in total dry matter production (Donald and Hamblin, 1976). Improvement in harvest index reflects increased physiological activities leading to more efficient mobilization and translocation of photosynthates to the organs of economic importance. Past evidences have demonstrated that yield improvement in groundnut in the short term could be achieved through changing the pattern of growth and judicious partitioning of phytomass (Duncan *et al.*, 1978; Sinha and Swaminathan, 1984). In this context, the present study reports the harvest index status of promising groundnut varieties/lines of different growth habits, its relationship with other related traits and also their implication in achieving higher harvest index with an ultimate objective of improvement in pod yield.

MATERIAL AND METHODS

Eighteen varieties/lines of groundnut comprising seven bunch, two semi-spreading and nine spreading types were evaluated in Randomized Complete Block Design with three replications at research farm of Tirhut College of Agriculture, Dholi. Each entry was raised in 3 rows of 5.1 m length spaced 30 cm apart with 15 cm plant distance within a row. Ten random plants were tagged in each entry over replications and data were recorded for number of primary branches per plant, number of secondary branches per plant, number of pods per plant, number of kernels per pod, 100-kernel weight (g), shelling percentage, pod yield per plant (g) and biological yield per plant (g). The harvest index was determined as the ratio of pod yield

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to biological yield and expressed in percentage. Coefficient of variability (Burton and Devane, 1953), broad sense heritability and genetic advance (Lush, 1949; Johnson *et al.*, 1955) were computed for harvest index and component characters. Correlation coefficients between different traits were calculated following Snedecor and Cochran (1967) and path analysis following Dewey and Lu (1959).

RESULTS AND DISCUSSION

Significant differences among the entries were seen from analysis of variance for all traits. Wide range of variation was observed (Table 1) in respect of pod yield per plant (4.84 g to 17.04 g), biological yield per plant (19.51 g to 59.40 g) and harvest index (15.09% to 38.51%). The phenotypic coefficient of variability (PCV) was higher than genotypic coefficient of variability (GCV) in all these traits, though, the magnitude of differences were found comparatively narrow for biological yield per plant and harvest index. The extent of genetic variability was observed to be maximum for pod yield per plant (30.05%) followed by biological yield per plant (22.86%) and harvest index (20.36%). The estimates of broad sense heritability (BSH) coupled with genetic advance (GA) as per cent of mean were also considerably high indicating thereby that variability in these traits were largely accounted by fixable components and considerable improvement in these traits could be achieved through selection (Johnson *et al.*, 1955; Krishnamurthy *et al.*, 1986).

The habitual variation among the varieties had negligible effect on harvest index since very low magnitude of differences in harvest index values were observed between growth habits (Table 2), however, marked differences were noticed for pod yield per plant (17.48% and 14.98%) and biological yield per plant (19.39% and 15.35%) as a result of change in growth habit from bunch to spreading and semi-spreading to spreading types. Interestingly, varieties within the growth habits exhibited high heterogenity in respect of harvest index in bunch (15.09% to 38.51%) and spreading (19.58% to 31.83%) groups,

Table 1. Extent of variability in three traits of groundnut

Traits	Range	Mean	PVC	GCV	BSH (%)	GA (%)
Pod yield/plant	4.84-17.04	10..54±1.11	35.20	30.05	72.92	52.87
Biological yield/plant	19.51-59.40	40.81 ±2.39	25.01	22.86	85.56	43.12
Harvest index	15.09-38.51	25.76 ±1.86	23.88	20.36	72.68	35.75

Table 2. Harvest index status of three growth habits in groundnut

Growth habits	Pod yield/plant (g)		Biological yield/plant (g)		Harvest index (%)	
	Range	Mean	Range	Mean	Range	Mean
Bunch	4.84-17.04	9.67	19.51-54.79	37.08	15.09-38.51	26.36
Semi-spreading	8.57-11.20	9.88	38.22-38.54	38.38	22.08-28.96	25.52
Spreading	8.20-16.16	11.36	33.18-59.40	44.27	19.58-31.83	25.34

whereas, comparatively low variability was observed in semi-spreading group (22.08% to 28.96%). This may be due to the fact that only two varieties were included in the present study. Further, grouping of varieties on the basis of deviation of harvest index values from mean (Table 3) failed to exhibit any definite relationship between growth habits of varieties and harvest index status since few varieties from each of bunch, semi-spreading and spreading groups registered higher harvest index values. Velu and Gopalakrishnan (1985) also observed high heterogenity among the varieties within the habit with respect to harvest index. In the present investigation, the varieties/lines, namely, G 201, C 336, ICGS-48, Robut 33-1 and RG-4 exhibited above average harvest index values in descending order.

Pertinent data on mean performance of five different groups of entries constituted on the basis of harvest index values (Table 4) displayed that pod yield per plant, pods per plant and shelling percentage gradually increased *with the increase of harvest index from very low* to moderatly high and then declined, however, harvest index still increased due to reduction in biological yield per plant. It indicated that the absolute value of harvest index is sometimes misleading hence the high harvest index should be coupled with the high values of other yield components while selecting superior genotypes. Similarly 100-kernel weight also

Table 3. Assessment of entries on the basis of harvest index values in groundnut

Harvest index (HI) groups	Description of different Harvest index (HI) groups	Entries in different groups
Very low	HI one or more S.D. unit below the mean	AK 12-24
Low	HI below S.E. limit of the mean	Big Japan, DGM82-1, Kuber, JL-24, BP-1
Medium	HI around the mean within S.E. limit	M13,C335, S230, CGS-5, C188, CSMG-12
Moderately high	HI greater than S.E. limit of the mean	C 336, Robut 33-1, RG-4, ICGS-4, ICGS-48
High	HI one or more S.D. unit higher than mean	G 201

Table 4. Mean performance of entries in different harvest index groups

Traits	Very low	Low	Medium	Moderately High	High
Primary branches/plants	5.43	6.06	5.82	5.71	5.37
Secondary branches/plant	12.00	17.19	17.00	17.35	18.47
Pods/plant	7.20	10.57	11.30	17.50	9.87
Kernels/pod	1.90	1.95	1.91	1.90	2.30
100-kernel weight (g)	27.97	36.75	44.79	36.14	30.20
Shelling percentage	66.30	70.13	71.19	72.16	68.83
Pod yield/plant (g)	4.84	8.70	10.99	13.56	7.55
Biological yield/plant (g)	31.99	41.73	41.93	44.56	19.51

showed a rising trend with the increase of harvest index from very low to medium and then a gradual reduction was observed with higher harvest index values. Secondary branches per plant and kernels per pod increased, where as, primary branches per plant decreased with the increase of harvest index as also evidenced by its negative correlation and direct effect on harvest index. Primary branches were observed to be positively associated with biological yield (Sharma, 1988) without any significant increase in pod yield.

Correlation studies also elucidated the same trend of interrelationship in the sense that harvest index had significant positive correlation with pod yield per plant, pods per plant and shelling percentage (Table 5). Qadri and Khunti (1983) and Kamala Thirumalaisamy and Ramanathan (1988) also observed significant positive correlation between harvest index and pod yield per plant. The observation worth mentioning in the present study was existence of significant positive correlation among the traits which showed significant positive correlation with harvest index. The relationship, therefore, indicated the possibility of improving harvest index in groundnut by increasing pod yield, pod number and shelling percentage.

Table 5. *Correlation* coefficients between different traits in groundnut

Combination of traits	Correlation coefficients
Harvest index - Pods/plant	0.61**
Harvest index - Pod yield/plant	0.59*
Harvest index - Shelling percentage	0.47*
Pod yield/plant - Pods/plant	0.85**
Pod yield/plant - Shelling percentage	0.54*
Pod yield/plant - 100-kernel weight	0.54*
Pods/plant - Shelling percentage	0.48*

* Significant at 5 per cent level

** Significant at 1 pler cent level

Path analysis indicated maximum positive direct effect of pods per plant followed by kernels per pod, pod yield per plant, shelling percentage and secondary branches per plant on harvest index (Table 6). Negative direct effect towards harvest index was attributed only by primary branches per plant. The traits exhibiting high direct effect for harvest index also exhibited high degree of positive correlation with harvest index except kernels per pod and secondary branches per plant. The positive indirect effects of most of the traits were observed mainly through pod yield per plant and pods per plant. The residual effect of factors was high suggesting thereby that considerable amount of variation manifested in harvest index remained unaccounted by other characters not measured in the present study. Based upon the result obtained from correlation studies in conjunction with path analysis is that improvement in harvest index could be achieved if plant architecture in groundnut is redesigned with more emphasis on increasing number of pods per plant, number of kernels per pod, shelling percentage and number of secondary branches per plant in addition to pod yield while maintaining a proper balance for number of primary branches per plant without adversely affecting the yield. Chatterjee and Sengupta (1984) also pleaded for reduction in number of primary branches for achieving high harvest index in Indian mustard.

LITERATURE CITED

Burton, G.W. and Devane, E.H. 1953. Estimating heritability in tall fescue (*festuca arundinacea*) from replicated clonal material. *Agron.J.*, 45: 478-481.

Table 6. Direct (diagonal) and indirect effects of different traits on harvest index in groundnut

Traits	*Primary branches/ plant*	*Secondary branches/ plant*	*Pods/plant*	*Kernels/ pod*	*100-kernel weight*	*Shelling percentage*	*Pod yield/plant*	*Correlation with Harvest index*
Primary branches/plants	-0.15	0.04	0.04	-0.05	0.00	-0.02	0.05	-0.10
Secondary branches/plant	-0.06	0.10	0.10	0.08	0.00	0.00	0.09	0.29
Pods/plant	-0.02	0.02	0.38	-0.03	0.00	0.06	0.19	0.61
Kernels/pods	0.02	0.02	-0.03	0.36	0.00	0.00	-0.02	0.35
100-kernels weight	-0.04	0.03	0.03	-0.07	0.00	0.04	0.12	0.13
Shelling percentage	0.03	0.00	0.18	0.01	0.00	0.13	0.12	0.47
Pod yield/plant	0.03	0.04	0.32	0.04	0.00	0.07	0.22	0.59

Residual effect = 0.64

Chatterjee, S.D. and Sengupta, K. 1984. Harvest index and ideotype analysis in Indian mustard. *J. Oilseeds Res.*, 1:137-145.

Dewey, D.E. and Lu, K.H. 1959. A correlation and path coefficient analysis of components of crested wheat grass seed production. *Agron.J.*, 51:515-518.

Donald, C.M. 1962. In search of yield. *J. Aust. Inst. Agri. Sci.*, 28:171-178.

Donald, C.M. and Hamblin, J. 1976. The biological yield and harvest index of cereals as agronomic and plant breeding criteria. *Adv. Agron.*, 28:361-405.

Duncan, W.G., Mc Cloud, D.E., Mc Graw, R.L. and Boote, K.J. 1978. Physiological aspects of peanut yield improvement. *Crop Sci.* 18:1015-1020

Johnson, H.W., Robinson, H.F and Comstock, R.E. 1955. Estimates of genetic and environmental variability in Soybeans. *Agron.J.*, 47:314-318.

Kamala Thirumalaisamy and Ramanathan,T. 1988. Relationship of total biomass and harvest index with yield in groundnut. *Madras Agric. J.*, 75:299-301.

Krishanmurthy, B., Satyanarayana, J., Subramaniam, D., Satyanarayana, G. and Reddy, N.S. 1988. Genetic variability for certain physiological characters in the three botanical groups of groundnut. *Andhra Agric. J.*, 33:97-100.

Lush, J.L. 1949. Heritability of quantitative traits in farm animals. Proc. 8th Int.,Cong.Genetics. *Hereditas* (Suppl.)., 356- 357.

Qadri, M.I. and Khunti, V.P. 1983. Studies on correlation and path coefficient on yield and its components in bunch type of groundnut. *Legume Res.*, 6: 94-96.

Sharma,V.K. 1988. Genetic analysis of yield and its components in groundnut (*Arachis hypogaea* L.) genotypes in sole crop and intercropped with maize. Unpublished M.Sc.(Ag) Thesis, Rajendra Agric. Univ., Bihar, Pusa.

Sinha,S.K. and Swaminathan, M.S. 1984. New parameters and selection criteria in plant breeding pp. 1-31 *In* crop breeding a contemporary basis. Ed., Vose, P.B. and Blixt, S.G. Pregamon Press, Oxford.

Snedecor, G.W. and Cochran,W.G. 1967. Statistical methods, 6th ed. Iowa State Univ. Press, Iowa,USA.

Velu, G. and Gopalakrishnan, S. 1985. Habitual and varietal variation in yield, harvest index and quality characters of groundnut. *Madras Agric.J.*, 72:518-521.

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EPIDEMIOLOGY OF SESAMUM PHYLLODY DISEASE

B. SRINIVASULU[1] and P. NARAYANASAMY
Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore - 641 003.

ABSTRACT

Sesamum crops sown in January, February and March recorded high incidence of phyllody disease with a maximum and minimum being in the crops sown in 1st March (75.8%) and 1st October (9.6%) respectively. Sesamum crops sown during 1st January to 15th April recorded high leafhopper population. The significant positive correlation between phyllody incidence and maximum temperature and sunshine hours and a negative correlation with relative humidity was observed. Phyllody incidence was not related to the leafhopper population *per se*. Maximum temperature exerted a favourable influence on leafhopper population. Increase in maximum temperature by 1^0C resulted in increase in phyllody disease and leafhopper population upto 0.98 percent and 1.7 units respectively.

Keywords : Epidemiology; Phyllody

INTRODUCTION

Phyllody is the most destructive disease of sesamum transmitted by leafhopper vector, *Orosius albicinctus* Distant. In some tracts phyllody causes crop losses as high as 99 per-cent in yield (Marimuthu *et al.*, 1973). It is estimated that an increase in phyllody incidence by one per cent lead to a decrease in the sesamum yield by 8.4 per cent (Murugesan *et al.,* 1978). The knowledge on the factors influencing and subsequent spread of the disease is *sine qua non* for developing an effective disease management system. A study was carried out at Agricultural College and Research Institute, Coimbatore to assess relationship between incidence of disease and leafhopper vector with certain important weather factors and the results are presented in this paper.

MATERIAL AND METHODS

The field experiment was laid out in a Randomized Block Design with 24 treatments viz., fortnightly sowing for one year from the second fortnight of June 1989 to first fortnight of June 1990, replicated twice. Sesamum variety, TMV 3 was sown on 1st and 15th of every month. Data on the per cent phyllody incidence and vector population were recorded at weekly intervals. The vector population was recorded from ten randomly selected plants in each replication.

The phyllody incidence at 60, 75 and 90 DAS were correlated with leafhopper population and weather factors prevailing at 15 to 22, 30 to 37 and 37 to 45 DAS. Whereas, the leafhopper population was correlated with each weather factor prevailing seven days earlier.

RESULTS AND DISCUSSION

Maximum per cent phyllody incidence (75.8%) and leafhopper (25.0) were recorded in the crop planted in 1st March 1990. The phyllody incidence however, was on par with the disease incidence recorded in the crops planted in 15th March (73.7%), 13th February (70.2%) and 15th January (65.8%). The lowest incidence of

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1.All India Coordinated Pulses Improvement Project, Main Centre, Regional Research Station, Lam, Guntur - 34, A.P.

9.6 per cent phyllody disease was recorded in crop planted in 1st October and a sudden increase in incidence to the extent of 22.1 pei cent was noted in next crop sown on 15th October (Table 1). Variation in the incidence of the sesamum phyllody disease during different seasons have been reported (Rhind and Bathein, 1933; Su, 1932; Pal and Pushkarnath, 1935; Sellamal *et al.*, 1973). Sellamal *et al.* (1973) also observed the disease incidence to be high in the crops sown between mid October to mid March under Tamil Nadu conditions. The significant positive correlation between phyllody incidence and maximum temperature and sunshine hours, corroborate the earlier observations. A significant negative correlation existed between phyllody incidence and relative humidity. However, Pal and Pushkarnath (1935) reported that humidity did not influence the disease incidence. Rhind *et al.* (1937) obtained no correlation with total rainfall.

It was observed that phyllody incidence and leafhopper population were not significantly related. No correlation between phyllody incidence and leafhopper population was observed by Sellamal *et al.* (1973). Even a single inoculative leafhopper could transmit the SPD MLO (Srinivasulu, 1991) which showed a resistant relationship. Hence, it is quite likely that a single inoculative adult leafhopper may inoculate varying number of sesamum plants and such a situation might lead to the absence of a significant positive correlation between the vector population *per se* and disease incidence.

The analysis revealed that the multiple correlation co-efficient (R) was significant. This indicated that as a whole the independent variables had significant effect on phyllody incidence. The co-efficient of determination

Table 1. Effect of time of sowing on incidence of phyllody and leafhopper population

Sl. No.	Treatment	Phyllody incidence	Mean leaf-hopper population
1	15th June, 89	11.3 (19.63)i	14.5
2	1st July, '89	19.5 (26.21)hi	12.5
3	15th July, '89	16.1 (23.64)hi	11.5
4	1st August '89	16.2 (23.73)hi	8.0
5	15th August '89	13.7 (21.72)i	6.5
6	1st September '89	12.1 (20.21)i	8.0
7	15th September '89	10.1 (18.49)i	6.5
8	1st October '89	9.6 (18.65)i	9.5
9	15th October '89	22.1 (28.03)hgi	7.0
10	1st November '89	20.1 (26.64)hi	10.5
11	15th November '89	28.9 (32.38)fgh	11.0
12	1st December '89	37.8 (37.67)efg	5.5
13	15th December 89	42.7 (40.51)def	7.5
14	1st January 1990	60.3 (50.94)abcd	13.0
15	15 January 1990	65.8 (54.21) ab	12.5
16	1st February 1990	67.3 (55.12)ab	14.5
17	15th February 1990	70.2(56.73)ab	19.5
18	1st March 1990	75.8(60.53)a	25.0
19	15th March 1990	73.7(59.15)a	22.5
20	1st April 1990	62.2 (52.06)abc	17.5
21	15th April 1990	66.7(54.76)ab	18.0
22	1st May 1990	53.2(46.83)abcd	9.5
23	15th May 1990	46.7(43.11)cde	12.0
24	1st June 1990	42.8 (40.77)def	9.0
C D (P = 0.05)		10.46	0.96

Figures in parentheses are Arc sine transformed values in Columns, the figures followed by same letters do not differ significantly.

(R^2) indicated that the independent variables were responsible to the extent of 72, 61 and 58 per cent for the phyllody incidence at 60, 75 and 90 DAS respectively. The observations suggest that a combination of several weather factors might be necessary for high level of disease incidence.

As indicated by the 't' values, the partial regression co-efficient (b) values were significant only in case of three variables i.e., maximum temperature (^{0}C), relative humidity at 7.22 A.M.(%), and sun shine hours. In terms of standardised partial regression co-efficients, these three variables occupied first three ranks. The corresponding partial regression co-efficients obtained for these three variables indicated that in the case of maximum temperature a unit change was capable of affecting the change in the phyllody incidence at 60, 75 and 90 DAS to the tune of 0.64, 0.86 and 0.98 respectively and in case of relative humidity at 7.22 A.M. a unit decline was capable of increasing phyllody incidence at 60, 75 and 90 DAS to the extent of 0.42, 0.48 and 0.52 units respectively provided other variables were kept constant.

A unit change in sunshine hours was also capable of changing phyllody incidence at 60, 75 and 90 DAS to the extent of 0.39, 0.36 and 0.41 units respectively.

The multiple regression equation obtained with nine variables is given below to predict phyllody incidence at different growth periods of sesamum plants.

a) Phyllody incidence at 60 DAS

$$Y = 53.61829 + 0.6423X_1 - 0.2770X_2 - 0.4275X_3 - 0.3074X_4 + 0.2167X_5 - 0.1760X_6 - 0.3321X_7 + 0.3971X_8 + 0.2761X_9$$

b) Phyllody incidence at 75 DAS

$$Y = 61.10298 + 0.8621X_1 - 0.1868X_2 - 0.4892X_3 - 0.3519X_4 - 0.1862X_5 + 0.1925X_6 + 0.2475X_7 - 0.3618X_8 + 0.2438X_9$$

c) Phyllody incidence at 90 DAS

$$Y = 47.90378 + 0.9804X_1 - 0.3642X_2 - 0.5732X_3 - 0.3215X_4 - 0.2763X_5 - 0.2176X_6 + 0.2661X_7 + 0.4152X_8 + 0.2156X_9$$

The multiple regression equation obtained with eight weather factors is given below to predict leafhopper population at different growth periods of sesamum plants.

a) Leafhopper population at 7 DAS

$$Y = -23.00561 + 1.7123X_1 + 0.4672X_2 - 0.0276X_3 - 0.3749X_4 - 0.0343X_5 - 0.0765X_6 + 0.1243X_7 + 0.4762X_8$$

b) Leafhopper population at 15 DAS

$$Y = -19.98835 + 0.9765X_1 + 0.4878X_2 - 0.1762X_3 - 0.4853X_4 - 0.1283X_5 + 0.0921X_6 + 0.1476X_7 + 0.5121X_8$$

c) Leafhopper population at 30 DAS

$$Y = -17.32217 + 1.5862X_1 + 0.9762X_2 + 0.2108X_3 - 0.3121X_4 - 0.4218X_5 - 0.0963X_6 - 0.1965X_7 + 0.6710X_8$$

where,

X_1 = Maximum temperature (^{0}C);
X_2 = Minimum temperature (^{0}C);
X_3 = Relative humidity at 7.22 AM (%);
X_4 = Relative humidity at 2.22 PM (%);
X_5 = Total rainfall (mm);
X_6 = Rainy days;
X_7 = Wind velocity (km/h);
X_8 = Sunshine hours;
X_9 = Leaf hopper population (number).

The total leafhopper population for the entire crop period ranged from 5.5 (1s December) to 25 numbers (1st March). Crops planted from 1st January till 15th April recorded high population of leafhopper (Table 1). It is interesting to note that the positive correlation between leafhopper population and maximum temperature lends support to the above observations. Harrisson (1983) while discussing the influence of climate and weather on vector borne virus diseases stated that the vector population and activity were highly influenced by the weather. He considered that vector activity was more important than vector number, and that air movement and temperature, greatly affected the activity of the vectors. The favourable effect of temperature was possibly reflected in the phyllody disease incidence which showed positive relationship with maximum temperature. This inference is amply supported by the findings of earlier workers (Rhind and Bathein, 1933; Su, 1932; 1933; Sellamal *et al.*, 1973). The analysis revealed that the multiple correlation co-efficient (R) was significant. This indicated that as a whole the independent variables had significant effect of leafhopper population. The co-efficient of determination (R^2) indicated that the independent variables were responsible to the extent of 68, 73 and 53 per cent changes in leafhopper population at 7, 15 and 30 DAS respectively.

The 't' values recorded, indicated that the partial regression co-efficient (b) values are significant only in case of one variable i.e., maximum temperature. In terms of standardised partial regression co-efficients this variable occupied first rank. The corresponding partial regression co-efficient obtained for this independent variable indicated that in the case of maximum temperature a unit change is capable of affecting the change in the leafhopper population at 7, 15 and 30 DAS, to the extent of 1.7, 0.97 and 1.5 units respectively provided other variables are kept constant.

LITERATURE CITED

Harrisson, B.D. 1983. Epidemiology of plant virus diseases. *In* : plant virus epidemiology. The spread and the control of insect borne diseases (ed.R.T.Plumb and M.Threst). Oxford London, Black Well Scientific Publications. VII. PP. 377.

Marimuthu, T., Mchanraj, D. and Rangasamy, M. 1973. An assessment of crop loss due to phyllody of sesamum *Labdev. J. Sci. Technol.* 11 : 78 - 80.

Murugesan, M., Shanmugam, N., Menon, P.P., Arokiaraj, A., Dhamu, K.P. and Kochubabu, M. 1978. Statistical assessment of yield loss of sesamum due to insect pests and diseases. *Madras Agric. J.* 65 : 290 - 295.

Pal, B.P. and Pushkarnath. 1935. Phyllody : a possible virus disease of sesamum. *Indian J. agric. Sci.*. 5 : 517 - 522.

Rhind, D. and Bathein, U. 1933. The classification of Burmese sesamum (*Sesamum orientale* L.) *Indian J. agric.* Sci. : 3 : 478 - 495.

Rhind, D., Odella, F.D. and Su, U.T. 1937. Observations on phyllody of sesamum in Burma. *Indian J. agric. Sci.* : 7 : 823 - 840.

Sellamal, M., Ramakrishnan, C., Kandasamy, T.K. and Murugesan, M. 1973. Forecasting phyllody disease of sesamum. *Madras agric. J.* 60 : 492 - 495.

Srinivasulu, B. 1991. Studies on phyllody disease of sesamum (*Sesamum indicum* L.) with special reference to disease resistance. Ph.D. thesis, submitted to Tamil Nadu Agricultural University, Coimbatore, pp. 171.

Su, M.T. 1932. Report of the Mycologist, Burma, Mandalay for the year ended upto 31st March 1932: 4

Su, M.T. 1933. Report of the Mycologist, Burma, Mandalay for the year ended upto 31st March, 1933 : 12

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HETEROSIS IN SOME INTERVARIETAL CROSSES OF RAPESEED (*Brassica napus*)

HARI SINGH, V.S. MALIK and D. SINGH
Department of Plant Breeding, CCS Haryana Agricultural University, Hisar 125 004

ABSTRACT

Heterosis analysis in 21 diversed crosses revealed that HNS 9002 x N 20-7 (Canadian x Japanese) cross expressed highest heterosis over better parent (N 20-7) by a margin of 34%. This cross also expressed high positive heterosis for seed yield components like primary and secondary branches, pods on main shoot and seed per pod. Another cross (HNS 9005 x N 20 -7) exhibited appreciable heterosis over better parents (HNS 9005) for seed yield as well as oil content. These crosses were found to be promising for exploitation of heterosis. Parent N 20-7 developed from Japanese material Norin 20 was a promising parent for exploitation in the hybrid breeding programme.

Keywords: Rapeseed; Heterosis; Better parent; *Brassica napus*.

INTRODUCTION

Gobhi Sarson *(B.napus* L.) has shown good adaptation under Indian conditions. The crop being free from white rust disease and high oil yield possess future promises in this country. Although a good number of promising selection have been developed in this crop suitable for our conditions yet its yield is not significantly better to make a case for replacement of most adapted species *B. Juncea* L. Czern & Coss.

The hybrid breeding programme in oilseed Brassicas has been initiated at country level. But it has been observed that hybrid development in *B. Juncea* will take considerable time in developing CMS lines and restorers as well as perfecting the seed production programme for feasible production and exploitation of hybrid vigour commercially. However, in rapeseed three line system is readily available and commercial hybrids have become reality (Shiga 1976, Shiga and Baba 1973, Thompson 1972). It was, therefore, viewed necessary to evaluate the available lines in their hybrid combinations with respect to extent of heterosis for seed yield and other desirable characters.

MATERIAL AND METHODS

Seven available promising lines of *Gobhi sarson* established and selected from exotic base material were involved in all possible combinations except reciprocals. The set of 21 F_1 hybrids along with 7 parents were grown in an experiment during 1992 winter season at CCS Haryana Agricultural University, Hisar to assess the extent of heterosis in respect of various characters. The 28 entries (21 + 7) were grown in Completely Randomised Block Design with three replications. Each entry represented a single row of 5 metre length, row to row and plant to plant distance within row was kept at 30 and 15 cm, respectively. Observations were recorded on 10 plants for the characters viz., plant height, primary and secondary branches

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per plant, main raceme length, siliquae on main raceme, seed yield (g) per plant, 1000-seed weight (g) and oil content (%) (by NMR). The heterosis over mid parental values and over better parent for various characters was calculated as per Rai (1978) as follows.

$$HMP = \frac{F_1\,Mean - Mean\,of\,both\,the\,parents}{Mean\,of\,both\,the\,parents} \times 100$$

$$HBP = \frac{F_1\,Mean - Better\,parent\,mean}{Better\,parent\,mean} \times 100$$

Where,

HMP is Heterosis over mid parental values (%)

HBP is Heterosis over better parent (%)

RESULTS AND DISCUSSIONS

The results on heterosis percentage both over mid parental value and over better parent in respect of seed yield and other important characters in 21 F_1 crosses have been presented in Table 1 and the mean performance of seven parents in Table 2. The perusal of Table 1 revealed that there was no worthwhile heterosis either for increased or decreased plant height. For primary branches 10 crosses exhibited positive heterosis over mid parental value ranging from 4.11% (2 x 6) to 23.38% (2 x 3). Only five crosses showed positive heterosis over better parent ranging only from 1.6 to 17.78% (3 x 6). Range for positive heterosis for secondary branches per plant was, however, higher ranging from 1.03 to 52.11% (2x3) over mid parent and 5.12 to 17.39 per cent (2 x 3) over better parent. Siliquae on main raceme exhibited higher values of heterosis both in positive and negative directions. Crosses 3 x 4, 3 x 7 and 4 x 7 exhibited higher values of heterosis over mid parental value (203.7, 125.64 and 54.09 per cent) and over better parent values (115.78, 91.30 and 23.68 per cent, respectively). Seed yield is the main criteria for heterosis breeding. The results indicated 10 hybrids expressing positive heterosis ranging from 10.71 to 40.32 per cent over mid parental value and 5.91 to 34.00 per cent over better parent value. Only three hybrids namely, 3 x 7 (40.32 and 34.00%) fol-

Table 2. Mean values of quantitative characters of the seven parental lines used in a 7 x 7 diallel in rapeseed

Parents	Plant height	Primary branch	Secondary branch	Siliquae on main raceme	Main raceme length	Seed yield per plant	Seed per siliqua	Oil content (%)
Midas	182.30	7.20	9.45	62.60	69.40	10.30	20.48	44.40
HNS 8809	169.70	4.60	1.60	74.10	83.80	10.00	23.40	45.00
HNS 9002	137.80	2.50	1.60	49.60	74.40	3.20	23.82	44.40
HNS 9003	173.90	5.20	3.80	67.80	88.30	10.00	26.34	45.00
HNS 9005	170.70	5.30	3.50	72.60	74.40	12.00	22.82	44.30
HNS 9007	149.00	5.10	4.40	60.00	88.50	7.50	23.24	44.70
N20-7	139.78	3.90	2.30	49.10	67.70	9.40	22.54	43.00

Table 1. Heterosis estimates over better and mid parent in rapeseed for various characters

Cross	Plant height		Primary branch		Secondary branch		Siliqua on main raceme		Seeds per Siliqua		Seed yield		Oil content	
	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP
1 x 2	-1.79	2.44	-5.25	-8.52**	0.84	-17.36**	13.12	-33.86**	21.12	10.79**	8.73	6.79	24.06	16.32**
1 x 3	1.23	1.13	5.87	-7.04**	3.09	-30.55**	-0.45	-41.79**	11.54	7.79**	37.77	-9.7	15.48	7.38**
1 x 4	-0.67	-1.13	-9.93	-12.01**	-27.41	--37.50**	-29.81	-50.79**	10.71	-1.13	2.7	1.45	6.96	-4.93**
1 x 5	1.24	1.13	-9.23	-12.12**	-0.8	-12.50**	18.91	-18.51**	-15.02	-17.87**	17.48	9.16	12.51	6.74**
1 x 6	1.24	1.13	-6.79	-15.30**	-0.81	-15.27**	-43.68	-58.73**	-7.47	-15.73**	-14.04	-25.72**	4.48	-1.72**
1 x 7	-5.72	-6.04*	12.48	- 0.65	-9.9	-30.55**	-60.85	-75.66**	23.26	21.75**	19.28	14.07	4.88	0.08
2 x 3	2.45	0.09	23.38	11.78**	52.11	17.39**	168.75	168.75**	-6.82	-12.05**	115.9	42.5**	-8.89	-99.69**
2 x 4	0.45	-0.22	-5.87	-7.01**	14.28	7.69**	44.44	2.63	-12.95	-15.17**	-11.72	-11.94	-23.2	-27.56**
2 x 5	0.56	0.56	-17.8	-18.10**	-15.15	-20.75**	-11.76	-35.71**	-18.2	-22.79**	-58.18	-61.66**	-11.0	-12.13**
2 x 6	-0.34	-1.11	4.11	2.23**	1.03	-3.92**	-76.66	-84.09**	-14.79	-15.14**	-25.71	10.	21.86	21.45**
2 x 7	-1.45	-1.78	13.12	3.12**	-3.52	-10.86**	-23.07	-34.78**	-29.76	-17.3**	-13.4	10.0	-0.39	-2.22**
3 x 4	1.14	-1.11	-5.22	-15.06**	-3.89	-28.84**	203.7	115.78**	16.53	7.36**-	-26.78	-51.74**	0.95	-3.87**
3 x 5	0.67	0.00	12.47	1.64*	25.69	-7.54**	-7.84	-32.85**	19.22	19.22**	-26.97	-53.75**	10.2	7.89**
3 x 6	1.01	0.90	22.38	17.78**	7.89	-19.60**	-23.33	-47.72**	-1.32	-7.21**	84.11	31.33**	1.14	-0.08
3 x 7	0.22	-0.11	8.54	7.80**	28.12	5.12**	125.64	91.30**	40.32	34.0**	110.31	40.95**	2.32	-0.41
4 x 5	0.69	0.90	-2.72	-3.62**	-23.8	-24.52**	-36.98	-39.47**	22.8	13.13**	2.04	-6.25	-11.3	-17.23**
4 x 6	-0.34	-1.11	-2.01	-25.87**	-24.27	-25.0**	-9.57	-15.90**	-7.87	-9.85**	-14.52	-25.37**	-3.43	-9.11**
4 x 7	-2.34	-2.67	5.8	-4.60**	-29.67	13.46**	54.09	23.68**	-1.79	-13.25**	7.45	3.98	-5.64	-12.45**
5 x 6	3.29	1.00	-2.15	-8.37**	-26.92	-28.3**	-54.43	-59.09**	-0.94	-6.86**	-20.51	-35.41**	6.99	6.02**
5 x 7	-1.12	-1.57	4.05	-5.38**	-14.13	-25.47**	-55.17	-62.85**	33.56	27.55**	-2.89	-31.25**	10.05	9.37**
6 x 7	-1.49	-2.93	3.15	-0.06	4.44	-7.84**	-19.4	-38.63**	17.6	5.91**	-0.59	-10.63	-11.2	-12.56**

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

lowed by 5 x 7 (33.56 and 27.55 per cent) and 1 x 7 (23.26 and 21.75 per cent) were promising. Parent 7, a selection from Japanese introduction, N 20-7 is a worthwhile material for hybrid breeding programme. It belongs to early maturing group (130 days). These hybrids which express heterosis more than 20 per cent, quite high degree for useful consideration, were quite important. It was interesting to note that seed per siliqua showed heterotic response of worthwhile consideration. Three crosses namely, 2 x 3 (115.90 and 42.50%), 3 x 7 (110.31 and 40.95%) and 3 x 6 (110.31 and 40.95%) expressed highest heterosis both over mid parental value and better parent, respectively. High heterosis in rapeseed have been reported by Shiga (1976) and Singh *et al.* (1988). Seven crosses expressed positive and significant heterosis over better parent for oil content. Among these 2 x 6 and 1 x 2 were most promising.

Based on over all crosses 3 x 7 (HNS 9002 x N 20-7), was adjudged as best cross for seed yield heterosis as well as possessing high and positive heterosis for primary and secondary branches, siliquae on main raceme and seeds per siliqua. However, from seed yield and oil content point of view it was followed by 5 x 7 (HNS 9005 x N 20-7). These are two hybrids of worthwhile use commercially by converting their parental lines in to cytoplasmic male sterile and restorer lines as per the method advocated by Shiga (1976 and 1980); Shiga and Baba (1971 and 1993) and as per the method suggested by Thompson (1972). All the seven parents showed desirable genetic diversity as judged from their mean values in respect of various characters (Table 2).

LITERARTURE CITED

Rai, B. 1978. Heterosis Breeding , Agro Biological Publications, New Delhi.

Thompson, K.F. 1972. Cytoplasmic male sterility in oilseed rape. *Heredity*, 29: 253-257.

Shiga, T. 1976. Studies on heterosis breeding cytoplasmic male sterility in rape seed *Brassica napus* L. *Bull. Nat. Indt. Agric . Sci. Series* D. No.27 .101 PP.

Shiga, T. 1980. Male sterility and cytoplasmic differentiation. Brassica crops and Wild Allies biology and breeding. *Japan Sci.Soc. Press* Tokyo. pp. 205-221.

Shiga, T. and Baba, S. 1971. Cytoplasmic Male Sterility in rape plants *(Brassica napus)*. *Jap. J. Breed.* 21:16-17.

Shiga, T. and Baba, S. 1973. Cytoplasmic male sterility in oilseed rape *(Brassica napus)* and its utilisation to breeding. *Jap. J. Breed.* 23: 187-197.

Singh, H., Singh, D. and Lather, V.S. 1988. Extent of heterosis in relation to genotypic diversity in Indian x Exotic crosses of rape seed *(Brassica Campestris* L.) *Genet. Iber.*. 40: 95-105.

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HETEROSIS AND COMBINING ABILITY IN SESAME*

U.G. FATTEH, N.A. PATEL, F.P. CHAUDHARI, C.J. DANGARIA and P.G. PATEL
Oilseeds Reseach Section, Gujarat Agricultural University, Sardarkrushinagar, Gujarat

ABSTRACT

Extent of heterosis and combining ability were studied in a diallel cross of sesamum for yield and yield components. Heterosis in yield was influenced by branches per plant and capsules per plant. The best hybrid combination for grain yield was TMV 3 x HT 1 which showed heterosis over better parent to the extent of 68.94 per cent. Combining ability analysis showed the predominant role of non-additive gene action in the inheritance of number of effective branches per plant, number of capsules per plant, seed yield per plant and 1000 grain weight. Plant height, number of seeds per capsule and length of capsule indicated equal importance of both additive and non-additive. For days to flowering, days to maturity and oil per cent additive gene action was important. The differences due to maternal effects were also significant for all the traits studied. The parents PT 64 and HT 1 were good general combiners for yield per plant and some of its components. The *per se* performance of parents for various characters was, in general, not related to their *gca* effects. The crosses TMV 3 x HT 1, PT 64 x C 1013 and HT 1 x TMV 3 were found to be best combinations for most of the yield components. Biparental mating system was suggested to harvest genetic variability prevailed in the material under study.

Keywords : Sesame; Heterosis; Combining ability;

INTRODUCTION

Sesame (*Sesamum indicum* L.) is one of the important, multi-season and multi-purpose oilseed crop grown throughout tropics and subtropics. Critical choice of parents in a breeding programme is important, particularly if the aim is to improve quantitative characters like yield and its components. The present study was thus carried out to estimate heterosis and combining ability of selected sesame cultivars for quantitative traits.

MATERIAL AND METHODS

Eight diverse varieties / cultivars viz., Mrug 1, PT 64, PT 65, GT 1, TC 25, HT 1, C 1013 and TMV 3 were crossed in all possible combinations. The trial with parents and 56 crosses (including reciprocals) was laid out in Randomised Block Design with three replications during *kharif* 1992. The plot consisted of a single row of 3 metres for parents and crosses. The planting distance between and within the row was 45 and 20 cm, respectively. Five plants from each row, selected randomly, were used to record observations on days to flower, plant height, number of effective branches per plant, number of capsules per plant, length of capsule, number of seeds per capsule, days to maturity, yield per plant, 1000 grain weight and oil content. Heterosis was estimated by the method suggested by Hayes *et al.* (1965). The analysis of combining ability was done according to the Model I and Method I of Griffing (1956).

RESULTS AND DISCUSSION

Heterosis

Heterosis over mid and better parent exhibited a wide range for grain yield and important yield attributes (Table 1). For grain yield per plant 13

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out of 56 crosses showed significant positive heterosis over better parent. TMV 3 x HT 1 and PT 64 x TC 25 showed maximum heterosis over better parent and also ranked first and second for their mean yield performance. Such crosses can be exploited in future breeding programmes to improve grain yield in sesamum. The magnitude of heterosis and heterobeltiosis were higher for number of branches per plant (154.12% and 54.50%) followed by number of capsules per plant (108.14% and 88.65%) and yield per plant (86.81% and 68.94%). The high value of heterosis for these traits may be due to dominance or epistasis or both. None of the crosses showed significant negative heterosis for earliness. As regard to test weight 31 out of 56 crosses showed significant heterosis but the extent of heterosis was moderate. For oil content GT 1 x TMV 3 and C 1013 x PT 65 showed significant positive heterosis over better parent but the extent of heterosis was limited. A correspondence for heterosis was noted for number of branches per plant, number of capsules per plant and grain yield per plant. The observed heterosis in grain yield appeared to be due to high heterotic manifestation in number of branches per plant and number of capsules per plant. The results of the present study are in agreement with the findings of Srinivas and Singh (1981) and Singh *et al.* (1986).

Combining ability

The ANOVA for combining ability (Table 2) revealed that the general combining ability (*GCA*), specific combining ability (*SCA*) and reciprocal mean squares were significant for all the characters. This indicated that all the three i.e., additive, non-additive gene action and maternal effects were important for the characters studied. In general, the variances due to *GCA* were larger than those due to *SCA* for all the traits, except number of capsules per plant and yield per plant, indicating the significance of additive genetic variance in their inheritance. Contrary to this, the reciprocal variances were smaller than *SCA* variances for all the characters, except days to flowering, revealing limited significance of the later.

Low values of $2\sigma^2 g/(2\sigma^2 g + \sigma^2 p)$ (Table 2) for number of effective branches per plant, number of capsules per plant, yield per plant and 1000 grain weight indicated the predominant role of non-additive gene effects in the expression of these characters, as was also reported by Dixit (1976), Fatteh *et al.* (1982), Chaudhari *et al.* (1984a), Dora and Kamala (1987) and Ramalingam *et al.* (1990). For other attributes viz., plant height, number of seeds per capsule and length of capsule, both additive and non-additive gene effects were equally important. These results are in agreement with those of Thanki (1984) and Khorgade *et al.* (1988). Greater role of additive genetic variance were evident for days to flowering, days to maturity and oil per cent which agrees with the report of Fatteh *et al.* (1982) and Khorgade *et al.* (1989).

The perusal of the mean performance of the parents and their *GCA* effects (Table 3) revealed that *per se* performance of the parents was not a clear indicator of their *GCA* effects. The estimate of *GCA* effects showed that parent PT 64 and HT 1 were good general combiners for yield per plant. The estimates of GCA for effective branches per plant was the highest in TMV 3 followed by TC 25. The varieties *viz.*, PT 64 followed by HT 1 and TC 25 were good general combiners for number of capsules per plant. In case of length of capsules the highest *GCA* was recorded by PT 64 followed by PT 65 and GT 1. Similarly Mrug 1, PT 64, HT 1 and C 1013 for number of seeds per capsule : PT 65, PT 64, HT 1 and GT 1 for 1000

Table 1. Range and top 2 hybrids with heterosis (%) over mid-parent (MP) and better parent (BP), their SCA effects and mean performance for different characters in sesamum

Characters	Range		Best Crosses	Heterosis*		*sca* effect	Mean	S.E. ± for heterosis	
	Mid parent	Better parent		Mid parent	Better parent			Mid parent	Better parent
Days to initial flowering	-7.32 to 12.95	-2.94 to 23.97	PT 64 x C 1013	-7.32	--	-1.35*	44.33	**0.71**	**0.82**
			Mrug l x HT 1	-5.47	--	-1.02*	40.33		
Plant height	-24.60 to 30.25	-15.71 to 59.08	TMV3 x PT 64	-24.60	-13.09	-11.77**	67.73	**2.98**	**3.44**
			Mrug 1 x GT 1	-18.24-	-15.71	-2.40-	82.93		
No.of effective branches\plant	-25.55 to 154.12	-43.75 to 57.50	PT 64 x TC 25	154.12	54.29	1.33**	7.20	0.50	0.58
			PT 64 x C 1013	150.00-	52.17	1.75**-	7.00		
No.of capsules per plant	-57.76 to 108.14	-59.72 to 88.65	TMV 3 x HT 1	108.14	88.65	18.37**	88.67	2.10	2.43
			PT 64 x TC 25	83.51	46.78	17.83**	76.03		
Length of capsule	-17.73 to 10.31	-24.91 to 10.08	HT 1 x GT 1	10.31	10.08	0.05	**2.66**	0.06	0.07
			PT 65 x TMV 3	9.73	--	0.04	**2.48**		
No.of seeds\capsule	-24.89 to 20.17	-28.18 to 16.32	PT 64 x C 1013	20.17	16.52	7.89**	**78.38**	1.76	2.04
			C 1013 x PT 64	17.51	13.94	-0.87	**76.65**		
Days to maturity	-3.62 to 6.49	-0.77 to 11.72	PT 65 x HT 1	-3.62	---	-1.15**-	88.67	0.75	0.87
Yield per plant	-54.28 to 86.81	-56.02 to 68.94	TMV 3 x HT 1	86.81	68.94	2.54**	14.30	0.58	0.67
			PT 64 x TC 25	83.85	45.40	2.49**	13.32		
1000 seed weight	-14.42 to 23.14	-17.56 to 19.52	TMV 3 x PT 65	23.14	11.95	0.18**	3.72	0.06	0.07
			TC 25 x HT 1	21.25	19.52	0.11**	3.49		
Oil per cent	-5.55 to 5.96	-9.75 to 2.41	GT 1 x TMV 3	5.96	2.41	1.07**	51.63	0.19	0.23
			C 1013 x PT 65	4.93	1.12	1.11**	50.09		

* P = 0.01 and -, Crosses with desired significant heterosis were not available.

Table 2. ***Analysis of variance for combining ability for yield and its components***

Source	D.F.	Days to initial flowering	Plant height (cm)	No. of effective branches/ plant	No. of Capsules per plant	Length of capsule (cm)	No. of seeds/ capsule	Days to maturity	Yield per plant (g)	1000-grain weight (g)	Oil per cent
General combining ability	7	77.902**	550.834**	2.673**	206.264**	0.096**	110.74**	75.784**	6.085**	0.208**	14.489**
Specific combining ability	28	2.268**	87.084**	1.417**	256.903**	0.015**	20.533**	4.407**	6.919**	0.055**	0.897**
Reciprocals	28	2.802**	33.006**	1.153**	105.873**	0.006**	13.550**	2.242**	3.145**	0.024**	0.536**
Error	126	0.333	5.933	0.169	2.953	0.002	2.071	0.038	0.226	0.002	0.025
Predictability ratio	--	0.834	0.456	0.201	0.091	0.480	0.424	0.701	0.099	0.329	0.675

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

Table 3. Mean performance and general combining ability effects in a 8 x 8 diallel in sesame

Entry Character	Sources	Mrug 1	PT 64	PT 65	GT 1	TC 25	HT 1	C 1013	TMV 3	S.E. (gi) ±
Days to initial	Mean	45.33	48.67	52.33	45.67	40.33	40.00	43.33	44.0	-
flowering	*GCA*	0.16	1.70**	3.29**	0.14	-2.23**	-3.57**	-0.86**	1.37**	0.135
Plant height (cm)	Mean	96.00	101.73	83.53	90.40	81.60	77.07	60.60	77.93	--
	GCA	2.14**	7.57**	6.17**	-5.37	1.54**	0.11	-0.10	-1.86**	0.570
No. of effective	Mean	4.93	1.00	4.20	4.60	4.67	5.00	4.60	5.33	--
branches/plant	*GCA*	-0.05	-0.60**	0.08	-0.33**	0.20*	0.06	-0.15	0.79**	0.096
Length of capsule	Mean	38.53	51.80	38.20	57.60	31.07	38.20	27.00	47.0	--
(cm)	*GCA*	-1.99**	7.10**	-1.70**	-2.67**	1.05**	2.59**	-4.23	-0.15	0.402
No. of seeds/cap	Mean	2.66	2.86	2.51	2.41	2.48	2.40	2.22	2.36	--
sule	*GCA*	0.04**	0.10**	0.05**	0.05**	0.01	-0.40**	-0.07**	-0.13**	0.011
No. of	Mean	73.25	67.27	63.45	64.40	64.60	71.85	63.18	61.38	--
seeds/capsule	*GCA*	1.53**	1.44**	-0.34	0.67	0.45	0.70*	1.83**	-6.28**	0.337
Days to	Mean	89.67	95.33	97.33	89.67	85.33	86.67	87.67	90.00	--
maturity	*GCA*	-0.024	2.53**	3.17**	0.01	-2.04**	-2.33**	-2.35**	1.26**	0.144
Yield per	Mean	7.40	9.16	7.16	9.90	5.33	6.85	6.89	8.47	--
plant(g)	*GCA*	-0.22**	1.19**	-0.13	-0.53**	0.19	0.43**	-0.82**	-0.11	0.111
1000 seed	Mean	3.23	3.26	3.32	3.23	2.92	2.84	2.99	2.72	--
weight (g)	*GCA*	0.02	0.05**	0.15**	0.05**	0.06**	-0.01	-0.22**	-0.11**	0.011
Oil per cent	Mean	50.37	50.39	49.53	50.42	49.02	49.85	45.94	47.04	--
	GCA	0.75**	0.29**	0.33**	0.44**	0.24**	0.53**	-2.22**	-0.36**	0.037

[able 4. **Estimate of *SCA* effects in certain promising corsses of sesame for yield and its component (Mean values in parenthesis)**

Crosses / haracter	Mrug 1 x TMV 3	PT 64 x GT 1	PT 64 x TC 25	PT 64 x C 1013	PT 65 x TC 25	PT 65 x HT 1	TC 25 x C 1013	TC 25 x TMC 3	HT 1 X TMV 3	PT 64 x Mrug 1	GT 1 X Mrug 1	HT 1 x Mrug 1	TMV 3 x Mrug 1	Ht1 x PT 65	TMV 3 x HT 1
ays to flowering	0.88**	-0.93*	-0.56	0.73*	1.19**	0.53	-1.33**	-0.22	-0.56	0.00	1.50**	0.83*	1.00*	0.50	-0.83*
	(47.0)	(46.67)	(44.33)	(46.67)	(45.67)	(45.33)	(40.00)	(43.67)	(43.67)	(48.33)	(47.00)	(42.00)	(49.00)	(46.33)	(42.00)
ant height	5.09**	-2.18	7.01**	12.79**	7.50**	5.37**	-0.05	6.40**	9.36**	-4.20*	3.83*	2.90	0.30	2.00	-0.27
	(90.07)	(92.73)	(104.07)	(96.40)	(106.40)	(95.60)	(78.20)	(93.33)	(93.87)	(86.67)	(83.87)	(88.73)	(91.67)	(99.67)	(93.33)
). of effective anches/plant	0.12	0.52*	1.33**	1.75**	0.88**	-0.08	0.25	-0.26	1.58**	0.03	1.20**	0.30	0.27	0.07	0.90**
	(5.67)	(3.80)	(7.20)	(7.00)	(6.93)	(5.07)	(5.53)	(6.33)	(6.60)	(4.60)	(6.20)	(5.13)	(6.20)	(5.20)	(8.40)
). of capsules per nt	16.77**	8.20**	17.83**	19.56**	5.58**	8.08**	4.25**	3.00**	24.29**	6.67**	4.83**	9.40**	5.13**	7.87**	18.37**
	(55.07)	(53.80)	(76.03)	(67.07)	(52.60)	(44.67)	(50.07)	(52.60)	(51.93)	(56.40)	(39.53)	(46.93)	(63.33)	(60.40)	(88.67)
ngth of capsule	0.02	-0.03	0.02	0.15**	0.04	0.07*	-0.01	0.05	0.07*	0.03	0.06	0.00	-0.11**	0.07*	-0.07*
	(2.54)	(2.53)	(2.74)	(2.73)	(2.56)	(2.51)	(2.48)	(2.48)	(2.47)	(2.70)	(2.75)	(2.40)	(2.32)	(2.65)	(2.32)
. of seeds/capsule	-2.22*	-2.43**	4.13**	7.89**	-0.65	1.93*	-0.58	0.38	-1.19	-1.40	-0.89	0.44	0.11	0.64	1.73
	(59.27)	(63.07)	(76.33)	(78.33)	(69.20)	(68.00)	(70.42)	(60.58)	(57.85)	(68.29)	(68.47)	(66.53)	(59.49)	(69.29)	(61.31)
ys to maturity	0.35	-1.01**	2.54**	-0.65	1.72**	-1.15**	-1.59**	-1.86**	1.60**	-0.17	0.83	0.00	0.33	3.00**	-1.50**
	(93.00)	(92.33)	(95.33)	(92.00)	(94.33)	(88.67)	(86.00)	(89.00)	(94.00)	(93.67)	(92.33)	(89.00)	(93.67)	(94.67)	(91.00)
0 seed weight	-0.04	-0.05	-0.18**	0.03	-0.05	-0.06*	-0.08**	0.22**	0.04	-0.04	0.09**	-0.03	-0.06	0.31**	-0.02
	(3.13)	(3.10)	(3.33)	(3.01)	(3.38)	(2.97)	(2.87)	(3.34)	(3.13)	(3.40)	(3.37)	(3.15)	(3.01)	(3.59)	(3.00)
content	0.38**	0.18	0.14	0.31**	0.66**	-0.27**	-0.77**	0.65**	0.50**	-0.19	-0.36**	-0.07	1.09**	-0.34**	-0.68**
	(48.90)	(49.99)	(49.89)	(47.11)	(50.58)	(50.15)	(45.75)	(49.86)	(50.57)	(49.94)	(46.96)	(50.55)	(51.09)	(49.47)	(49.21)
ld/plant	2.73**	1.27**	2.49**	3.57**	0.95**	1.31**	0.83**	0.90**	3.57**	1.34**	0.95**	1.51**	1.09**	1.01**	2.54**
	(9.18)	(9.34)	(11.32)	(12.50)	(9.77)	(8.48)	(9.05)	(9.54)	(9.23)	(10.49)	(7.36)	(8.92)	(11.36)	(10.50)	(14.30)

seed weight : while all parents except C 1013 and TMV 3 were good general combiners for oil content. In case of days to flowering and maturity, TC 25, HT 1 and C 1013 recorded highest desirable *GCA* effects. For plant height GT1, C 1013 and TMV 3 were desirable combiners. High *GCA* effects are related to additive gene effects or additive x additive effects (Griffing, 1965 and 1954b) which represent the fixable genetic components of variance. In view of this PT 64 and HT 1 appeared to be worthy for exploitation in breeding programmes aimed at yield improvement through component characters.

In contrast to *GCA*, *SCA* effects represent dominance and epistatic components of variation which are non-fixable. The estimates of *SCA* effects and mean values (Table 4) revealed that the hybrid TMV 3 x HT 1 had a good specific combining ability and high *per se* performance for grain yield per plant, although, the hybrids PT 64 x C 1013 and HT 1 x TMV 3 showed the highest estimate of SCA effect for this character.

The cross combinations PT 64 x GT 1, PT 64 x TC 25, PT 65 x HT 1, PT 64 x Mrug 1, HT 1 x Mrug 1 and HT 1 x PT 65 involved at least once or both good general combining parent for grain yield and its components. The cross Mrug 1 x TMV 3 was the second best with regards to *SCA* effects eventhough both parents are poor general combiners for grain yield. Since most of these crosses involved at least one good general combiner in their parentage, they could be expected to throw transgressive segregants in the later generations. The adoptation of biparental approach in these crosses is expected to generate transgressive segregants. The further exploitation of such segregants would throw lines possessii high yielding ability.

LITERATURE CITED

Chaudhari, F.P., Shah, R.M. and Patel, I.D. 1984 Heterosis and combining ability in sesamum. *India J. Agric. Sci.*, 54 : 962- 966.

Dora, K.B. and Kamala, T. 1987. Combining ability in sesame. (*Sesamum indicum* L.). *Indian J. Agric. Sci.*, 57 : 774-788.

Dixit, R.K. 1976. Inheritance of yield and its components in sesame. *Indian J. Agric. Sci.*, 46 : 187-191.

Fatteh, U.G., Shah, R.M. and Bodar, D.G. 1982. Studies on combining ability in sesame. *Madras Agric. J.*, 69 : 145-150.

Griffing, B. 1965a. Concept of general and specific combining ability in relation to diallel crossing system. *Aust. J. Biol. Sci.*, 9 : 463-493.

Griffing, B. 1956b. A generalised treatment of the use of diallel crosses in quantitative inheritance. *Heredity*, 10 : 31-50.

Hayes, H.K., Immer, F.R. and Smith, D.C. 1965. Methods of plant breeding. McGraw-Hill New York. pp. 52-65.

Khorgade, P.W., Patil, M.M. and Narkhede, M.N. 1988. Line X tester analysis for combining ability in sesame. *J. Maharashtra Agric. Uni.*, 13 : 67 - 70.

Khorgade, P.W., Deshmukh, A.V., Narkhede, M.N. and Raut, S.K. 1989. Combining ability for yield and its components in sesame. *J. Maharashtra Agric. Uni.*, 14 : 164-166.

Ramalingam, A., Muralidhar, V. and Mohamed Sheriff, N. 1990. Combining ability studies in sesame. *J. Oilseeds Res.*, 7 : 75- 77.

Shrivas, S.R. and Singh, S.P. 1981. Heterosis and combining ability in sesamum. *Indian J. Genet.*, 41 : 1-4.

Singh, V.K., Singh, H.G. and Chauhan, Y.S. 1986. Heterosis in sesame. *Farm Scinence J.* 1 : 65 - 69.

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GENETICS OF SILIQUA CHARACTERS IN CROSSES OF INDIAN COLZA

S.K.VARSHNEY

Department Of Plant Breeding, Tirhut College of Agriculture, **Dholi Muzaffarpur-843** 121

ABSTRACT

Siliqua length, girth and beak length were studied in F_1 and F_2 generations of four crosses of Indian Colza *(B.Campestris* L. Var.Yellow *Sarson)*. Expression of these characters was predominantly due to additive gene action. Variance in F_2 generation was more in crosses involving parents with different locule number. Few genes control the expression of these quantitative characters. High heritability was observed for all characters with genetic advance up to 26%. Siliqua length and girth may be used in selection criteria in early generations.

Keywords: Genetics; Siliqua length; Girth; Beak length; Indian Colza.

NTRODUCTION

ndian Colza (*Brassica campestris* L.var yellow *arson*) is an important oilseed crop among rassicas due to its high oil content. In this pecies seed per siliqua is positively associated ith seed yield (Anand *et al.*, 1975; Ramanujam nd Rai, 1963). The siliqua length and girth ffect the seed weight and number of seeds/siliua (Chay & Thurling, 1989; Foss, 1988) in rassica species. It should be possible to select r siliqua characters and obtain a correlated eld response but there is little information available on the inheritance of these attributes in Indian colza. Hence the study was made to assess the variation and inheritance of siliqua characters in four crosses of yellow sarson involving six parental lines.

MATERIAL AND METHODS

The four crosses viz., RAUYS-3 x DYS-1, RAUYS-3 x PYS-6, RAUYS-2 x PYS-6 and 9Y x YSIK-742 involving 6 parents viz., RAUYS-3, DYS-1, PYS-6, RAUYS-2, 9Y and YSIK-742 were studied. The F_1 and F_2 populations together with parents were grown in a Randomized Block Design with 3 replications at Tirhut College of Agriculture, Dholi Research Farm during 1983-84. Plots of parents and F_1's were a single 5m row while there were 5 rows of F_2's. Row to row and plant to plant distances were 30 and 10 cm, respectively. Observations were recorded on 100 and 500 Siliquae chosen at random from 10 random plants from parents and F_1's and 50 random plants from F_2's in each replication respectively.

Expected means corresponding to additive gene action were computed with the method used by Burton (1951) and the minimum number of genes controlling the expression of character were estimated by the formula suggested by Wright and used by Burton (1951). Heritabilities (broad sense) and genetic coefficients of variance were computed by the method of Burton (1951) and genetic advance as per Allard (1960).

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RESULTS AND DISCUSSION

The characteristics of the parents involved in the 4 crosses studied have been given in Table 1 and the observed and expected means and variances of siliqua length, siliqua girth and beak length for F_1 and F_2 populations are presented in Table 2. The observed mean values for siliqua length ranged from 5.13 to 5.96 cm in F_1 and 4.41 to 5.50 cm in F_2. The observed and expected F_1 means were in close agreement for the crosses RAUYS-3 x PYS-6 and 9Y x YSIK-742 indicating the additive gene action. While for cross RAUYS-3 x DYS-1 the observed mean was significantly different from expected mean, thereby indicating the non-additive gene action. While in F_2 generation for RAUYS-3 x DYS-1 and RAUYS-3 x PYS-6 both means are close together where as other two crosses RAUYS-2 x PYS-6 and 9Y x YSIK-742 the observed and expected means were significantly different.

For siliqua girth, the observed and expected means were in close agreement in RAUYS-3 x DYS-1 and RAUYS-3 x PYS-6. While in other two crosses both were significantly different (Table 2). However, in F_2 it was only significantly different in cross 9Y x YSIK-742 and in other three both were same. The range for this character was 1.80 to 2.63 cm in F_1 and 1.92 to 2.70 cm in F_2 indicating that variation increases in F_2 generation. The siliqua beak length varies from 1.60 to 1.97 cm in F_1 crosses while it was 1.03 to 1.76 cm in F_2 populations. The observed and expected means were in close agreement in all crosses both in F_1 and F_2 except in 9Y x YSIK-742 in F_1. This clearly revealed the importance of additive gen action for expression of siliqua beak length.

The considerable variance was observed in F_2 in all crosses for all three siliqua characters (Table 2). The variance in F_2 was 5.24 times more for siliqua length to the corresponding F_1 variance, for siliqua girth it was 3.54 times larger and for siliqua beak length 3.9 times more to the corresponding variances in F1's. For siliqua length the variance ranged from 0.002 to 0.006 indicating very little difference among the F_1's of the various crosses. In F_2 it ranges from 0.028 to 0.145 and increase in variance was maximum in cross RAUYS-3 x

Table 1. Characteristics of parents involved in four crosses of yellow sarson

Parents	No. of locules	Characters				
		Position of siliqua	Siliqua length (cm)	Siliqua girth (cm)	Beak length (cm)	No. of seeds/ siliqua.
RAUYS-3	Tetralocular	Upright	5.33±0.11	2.70 ± 0.25	1.81 ± 0.06	27.10
DYS-1	Tetralocular	Upright	5.70 ± 0.17	2.87 ± 0.12	1.87 ± 0.17	29.30
PYS-6	Bilocular	Upright	5.47 ± 0.35	2.23 ± 0.24	1.58 ± 0.02	19.51
RAUYS-2	Tetralocular	Pendent	6.33± 0.12	2.90 ± 0.11	2.10 ± 0.10	32.03
9Y	Bilocular	Upright	4.80 ± 0.15	1.90 ± 0.11	1.20 ± 0.06	16.80
YSIK-742	Bilocular	Upright	5.50 ± 0.10	2.20 ± 0.23	1.15 ± 0.03	21.57
C.D. 5%						4.07
C.D. 1%						5.40

PYS-6 (tetralocular x bilocular) followed by RAUYS-2 x PYS-6 (tetralocular x bilocular) as compared to RAUYS-3 x DYS-1 (tetralocular x tetralocular) and 9Y x YSIK-742 (bilocular x bilocular) indicating, thereby, that more variation obtained in crosses involving diversed parents based on locule number.

For siliqua girth the range of variance obtained in F_2 from 0.040 to 0.054 with maximum increase in the crosses involving tetralocular and bilocular parents (RAUYS-3 x PYS-6) as compared to only tetralocular (RAUYS-3 x DYS-1) and bilocular parents (9Y x YSIK-742).

Thus for siliqua length and girth the variation among F_2 segregates of a cross depends upon the locule number of siliqua of the parents involved in a particular cross. For Siliqua beak length, in F_2 the variance ranged from 0.014 to 0.040. However, in this case the maximum variance was observed in the crosses involving, parents with same locule number.

The minimum number of genes controlling different siliqua characters are presented in Table 2. Minimum number of genes controlling siliqua length ranged from 0.06 to 2.29 in four crosses. This range was from 0.22 to 1.51 for siliqua girth and 0.19 to 3.03 for siliqua beak length. High broad sense heritability was estimated in all crosses for different characters except in cross RAUYS-3 x PYS-6 for beak length where moderate heritability was observed (Table 2). However, the average heritability estimates are high for all three characters. Selection based on heritability estimates (broad sense) has to be used carefully.

The estimates of expected genetic advance (% of mean) and genetic coefficient of variability together with heritability (Table 3) indicated that some gain under selection may be achieved by selection of plants with more siliqua length among the segregates of cross RAUYS-3 x PYS-6 and for siliqua girth in crosses RAUYS-3 x PYS-6 and 9Y x YSIK-742. However, a balance has to be made while selecting for higher siliqua length and siliqua girth and not to select for higher siliqua beak length. Higher siliqua beak length is not a desirable character as it does not contain seeds. On an average, 7.99% and 17.10% genetic gain in siliqua length and siliqua girth, respectively were found in all the crosses studied.

It is observed from the literature that very little efforts have been made to study the genetic variation in siliqua characters viz., siliqua length, siliqua girth and siliqua beak length, though the presence of considerable variability particularly in siliqua length and siliqua girth may influence the seed number which is positively correlated with seed yield (Ramanujam & Rai, 1963) and harvest index (Varshney *et al*, 1986) in yellow sarson. Foss (1988) reported that best multivalved lines had twice as many seeds per pod as normal bivalved types, with no reduction in seed size in *Brassica Juncea*. In spring rape pod length was correlated positively with seed weight per pod but negatively with number of pods per plant (Chay and Thurling, 1989). Pod length was stable than seed yield and its component under different sowing dates and plant densities. Present investigation also, indicated that siliqua length and siliqua girth had high heritability with moderate and high genetic advance and coefficient of variability for these two characters respectively. The cross RAUYS-3 x PYS-6 for siliqua length and RAUYS-3 x PYS-6 and 9Y x YSIK-742 for siliqua girth are particularly exploited and better segregants have been

Table 2. **Mean, variance (in F_1 and F_2 populations) and minimum number of genes for siliqua characteristics in Indian colza.**

Cross		Siliqua length						Minimum number of genes
		F_1			F_2			
		Observed mean (cm	Calculated arit-hmetic mean (*cm*)	Variance	Observed mean (cm)	Calculated arithmetic mean (*cm*)	Variance	
1.	RAUYS-3 x DYS-1	5.73 ± 0.12	5.51	0.005	5.50 ± 0.01	5.62	0.028	1.28
2.	RAUYS-3 x PYS-6	5.57 ± 0.26	5.40	0.006	5.21 ± 0.22	5.48	0.145	0.06
3.	RAUYS-2 x PYS-6	5.96 ±0.03	5.90	0.002	5.33 ±0.01	5.93*	0.044	2.23
4.	9Y x YSIK-742	5.13 ±0.03	5.15	0.003	4.14 ± 0.10	5.14**	0.030	2.29
				Siliqua Girth				
1.	RAUYS-3 x DYS-1	2.63 ± 0.12	2.78	0.006	2.75 ± 0.01	2.70	0.048	0.22
2.	RAUYS-3 x PYS-6	2.47 ± 0.13	2.46	0.001	2.17 ± 0.14	2.46	0.054	0.51
	RAUYS-2 x OYS-6	2.33 ± 0.03	2.56*	0.003	2.20 ± 0.02	2.41	0.049	1.51
	9Y x YSIK-742	1.80 ± 0.07	2.05*	0.002	1.67 ± 0.06	1.92*	0.040	0.71
				Siliqua beak length				
	RAUYS-3 x DYS-1	1.97 ± 0.03	1.84	0.003	1.67 ± 0.09	1.90	0.027	0.19
	RAUYS-3 x PYS-6	1.70 ± 0.06	1.67	0.010	1.76 ± 0.05	1.69	0.032	0.29
	RAUYS-2 x PYS-6	1.77 ± 0.03	1.84	0.003	1.68 ± 0.04	1.80	0.014	3.03
	9Y x YSIK-742	1.60 ± 0.06	1.17*	0.010	1.03 ± 0.06	1.38	0.049	1.51

Table 3. Estimates of heritability, expected genetic advance and genetic co-efficient of variability for siliqua characteristics in Indian colza.

Cross	Heritability (broad sense)			Expected genetic advance (% of mean)			Co-efficient of variability (%)		
	Siliqua length	Siliqua girth	Beak length	Siliqua length	Siliqua girth	Beak length	Siliqua length	Siliqua girth	Beak length
ꝛAUYS-3 x)YS-1	79.35	87.62	88.08	4.95	14.19	16.18	2.99	7.87	9.07
ꝛAUYS-3 x 'YS-6	95.88	96.90	69.13	13.91	18.81	15.02	7.32	10.45	11.09
ꝛAUYS-2 x 'YS-6	94.78	93.34	77.70	6.93	16.58	10.29	3.63	8.99	6.42
Y x YISK -742	89.00	93.76	75.06	6.16	18.83	26.29	3.68	10.89	16.32
/lean	89.75	92.90	77.49	7.99	17.10	16.94	4.40	9.55	10.72

selected for these characters and now under multilocation testing programme. The number of genes controlling these characters are also less. So a worthwhile improvement through selection is possible in these characters. Gamble (1962) pointed that if the number of genes are greater in the inheritance of the attribute, opportunity for the influence by the environment became greater. As yield is a complex polygenic character (Grafius, 1959) and selection based on single plant basis for yield is ineffective. The information gained through this investigation indicated that selection may be exerted on siliqua length and girth in early segregating generation for improvement in seed yield.

LITERATURE CITED

Allard, R.W. 1960. Principles of plant breeding. John Wiley, New York

Anand, I.J., Singh, J.N. and Khanna P.P. 1975. Interrelationships and diversity in Indian colza. *Indian J.Agri.Sci.* 45:253-258.

Burton, G.W. 1951. Quantitative inheritance in pearl millet (*Pennisetum glaucum*). *Agron. J.* 43:409-417.

Chay, P. and Thurling, N. 1989. Variation in pod length in spring rape (*Brassica napus*) and its effect on seed yield and yield components. *J. Agric. Sci.* 113(2):139-147.

Foss, R.A. 1988. Breeding *Brassica Juncea* for increased number of seeds per pod using multivalvularity. *Cruciferae News Letter* No.13:28.

Gamble, E.E. 1962. Gene Effect in corn (*Zea mays* L.) III Relative stability of the gene effects in different environments. *Can.J.Pl.Sci.* 42:628-634.

Grafius, J.E. 1959. Heterosis in barley. *Agron. J.* 51:551-554.

Ramanujam, S. and Rai, B. 1963. Analysis of yield components in *Brassica campestris* var.yellow *Sarson. Indian J.Genet & Pl. Breeding.* 23:312-319.

Varshney, S.K., Rai B. and Singh B. 1986. Componental analysis of harvest index and seed yield in Brassica oil seeds. *Indian J. Agric. Res.* 20(3):129-134.

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IMPACT OF ABIOTIC FACTORS ON THE POPULATION DYNAMICS OF MUSTARD APHID, *Lipaphis erysimi* (KALT.) (HOMOPTERA : APHIDIDAE).

AJAI SRIVASTAVA, HARVIR SINGH[1] and HIRA LAL THAKUR
Oilseeds Research Station, HPKV, Kangra - 176 001.

ABSTRACT

The mustard aphid, Lipaphis erysimi (Kalt.) was noticed towards the end of December on flowering stage of mustard crop. The range of maximum temperature 15.8 to 24.7^{0}C, minimum temperature 10.2 to 16.0^{0}C and relative humidity 61 to 65% prevailing in February was found conducive for the rapid multiplication of aphid on Indian mustard, *Brassica juncea* (L.) czorn. & cosson. Besides this, good rainfall in January upto middle of February was the main factor for spurt in aphid population while the rainfall in the last week of February or Ist week of March had the deleterious effect on it.

Keywords: Population; Dynamics; Aphid.

INTRODUCTION

Rapeseed-mustard are one of the important oleiferous crops and constitute the major source of edible oil for the human consumption and cake for animals. Every effort is being made to raise the productivity of these crops by adopting modern agricultural practices such as use of high yielding varieties, heavy manuring and assured irrigation in order to meet the growing demand of oils. More than three dozen of pests are known to be associated with various phenological stages of rapeseed- mustard crops in India (Singh & Singh, 1983 and Bakhetia & Sekhon, 1989). The loss in grain yield due these pests varies greatly within Brassicae; being 35.0 - 73.3% under different agroclimatic regions with a mean loss of 54.2% on all India basis (Bakhetia & Sekhon, 1989). The climatic factors such as temperature, rainfall, relative humidity, saturation deficit and sunshine usuallly influence the insects greatly (Kisimoto and Dyck, 1976, Singh and Singh, 1989 and Bishnoi *et al.*, 1992). The information on the seasonal incidence of insect pests of Brassicae crops, particularly mustard aphid, *Lipaphis erysimi* (Kalt.) in relation to various weather parameters is scanty. Therefore the present studies were undertaken so as to provide an ample opportunity to face the aphid challenge by manipulating the manageable ecological parameters in the form of planting or harvesting time adjustment, varietal selection, correct timing of pesticidal application besides other management practices.

MATERIAL AND METHODS

Present studies were conducted at Oilseeds Research Station, Himachal Pradesh Krishi Vishvavidyalaya, Kangra, during the rabi season of 1990-91 and 1993-94. The trial was conducted in four replications with plot size 4.5 m^2. The occurrence of mustard aphid and its

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1. Haryana Agricultural University, Hisar - 123 004

population build up was recorded at weekly intervals and corresponding meteorological data were obtained from the Agro-meteorological observatory situated in the vicinity of experimental plots. The population of mustard aphid was observed on 40 plants at random (10 cm central twig) of mustard variety, Varuna as per Singh and Singh, 1989. Correlation coefficient between the population of aphids and ecological parameters were calculated.

RESULTS AND DISCUSSION

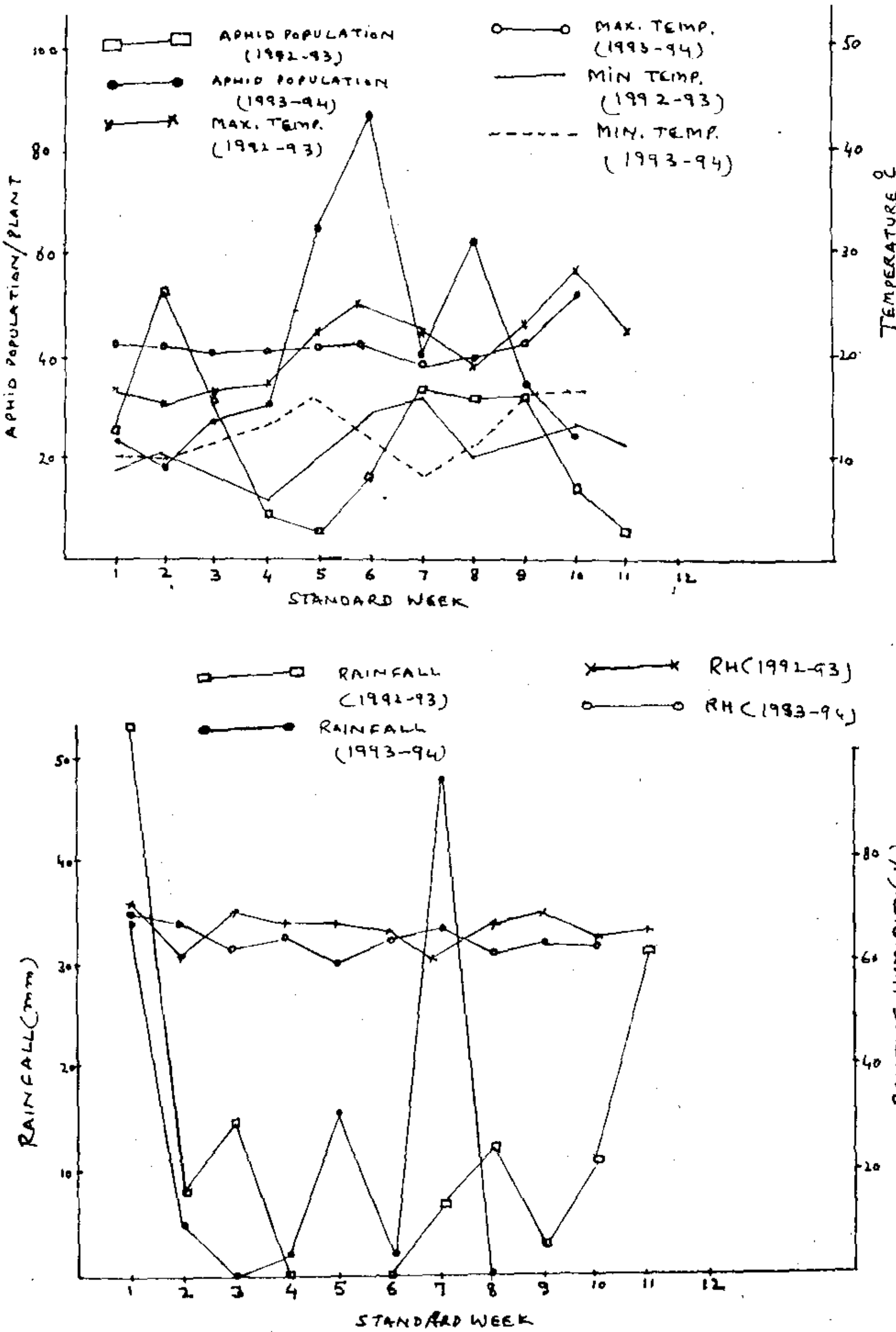
Periodical survey on the incidence of mustard aphid on mustard crop at the experimental farm revealed that the pest appeared in the 4th week of December when the host plants were at flowering stage as has been reported to be the most vulnerable stage of this crop (Kundu and Pant, 1968 and Brar *et al.*, 1976). Finding the most preferred plant (Floral) part, the aphid started establishing and building up its population. The pest population assumed its peak from a very few numbers to 53.4 (in the 2nd standard week) and 86.25 (in the 7th standard week) during 1992-93 and 1993-94, respectively and thereafter it continued to decline as the time advanced and crops attained maturity (Fig. 1). However, 2nd peak was also observed in 7th standard week (33.5 aphids/plant) during 1992-93 (Fig. 2).

The average aphid population during different periods of the months when examined in relation to ambient temperatures revealed that the average maximum and minimum temperatures ranged from 15.8 to 24.7^{0}C and 10.2 to 16.0^{0}C in 1992-93 and 20.1 to 21.0^{0}C and 11.4 to 12.2^{0}C in 1993-94, during the ascending phase of the population growth in January-February and were conducive for aphid multiplication. Rai (1961) reported similar observations from Uttar Pradesh.

The Peak activity period of the aphid remained confined to January and first fortnight of February. Similar observations were made by Prasad and Pradhan (1971), Srivastava and Srivastava (1972) and Sinha *et al.*, (1990) from Delhi, Uttar Pradesh and Bihar respectively.

Relative humidity ranging from 61 to 65% was conducive for the population build up of aphids during January-February. Dry conditions alongwith high ambient temperature in last week of February or during the March and the accompanying activity of parasite (*Diaeretiella sp.*), predators (Coccinellids and Syrphid) and maturity of host plants contributed much for the aphid population decline. Atwal *et al.* (1971) claimed that the aphid population was greatly influenced at temperature beyond 30^{0}C together with the enhanced activity of its parasite and predators. Later on Roy (1975) reported that the aphid population dwindled at the maturity of the crop on account of hardening of the foliage or low moisture content in the plants.

The variation in the aphid population of the four years appeared to have resulted due to differential pattern of rainfall (Fig. 2). The light rains in the 5th and 6th standard weeks helped in the increase of the aphid population, while the rains towards the maturity of crops right from 8th standard week to 12th declined the



1 Population dynamics of mustard aphid in relation to abiotic factors (1992-93 and 1993-94)

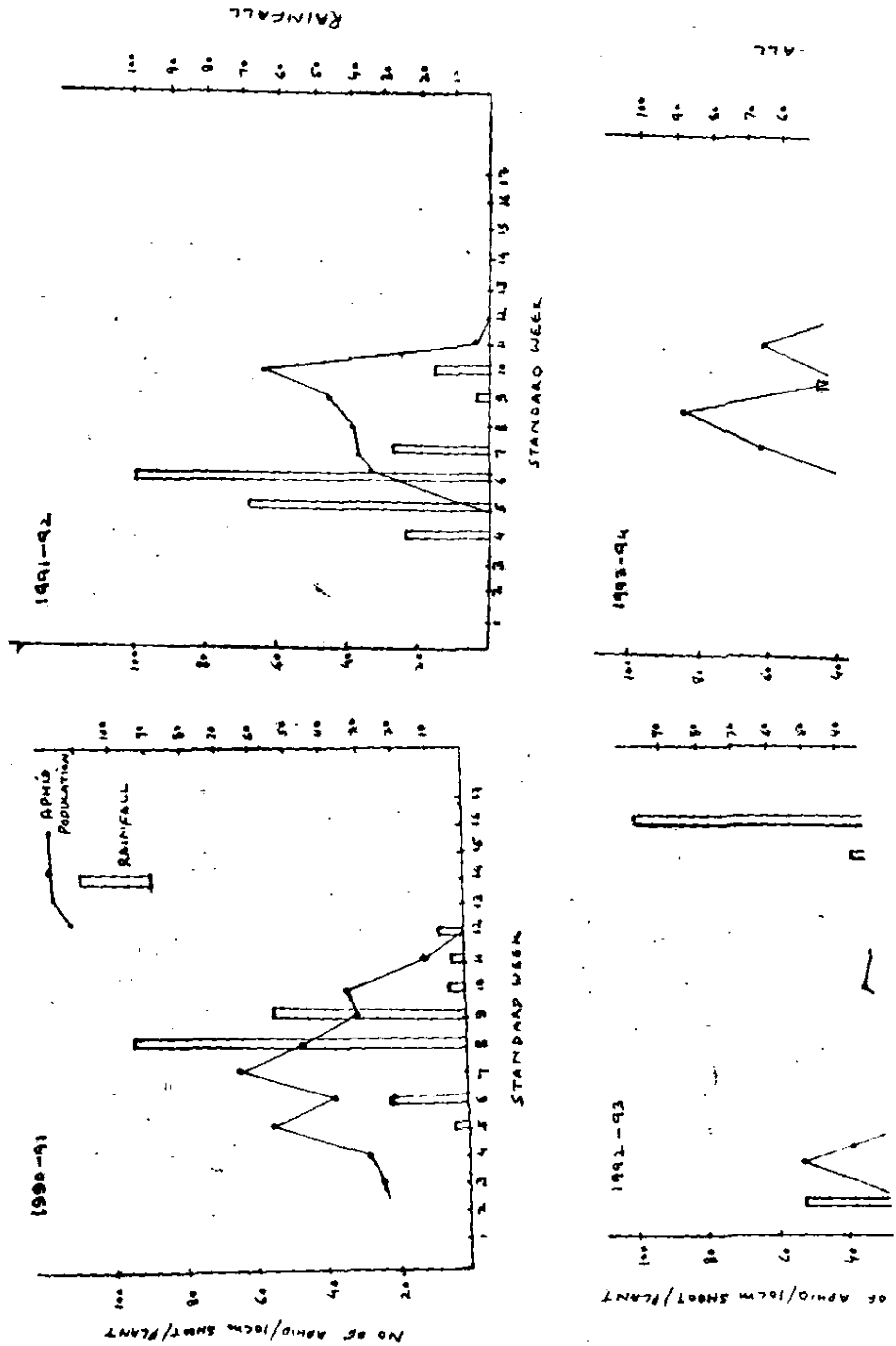

1990-91
1991-92
1992-93
1993-94
APHID POPULATION
RAINFALL
STANDARD WEEK
NO OF APHID/10CM SHOOT/PLANT

Table 1. Simple correlation cofficients between mustard aphid *Lipaphis erysimi* population and abiotic factors.

Abiotic factor	'r' with aphid population	
	1992-1993	1993-1994
Temperature °C (max.)	-0.4238	-0.3342
Temperature °C (min.)	0.1006	0.0933
Average R.H (%)	-0.5215	-0.4520
Rainfall	-0.0817	-0.6013*

* Significant at 5 per cent.

aphid population in the year 1990-91. Almost similar trend of rainfall was noticed in the year 1991-92. However, during the year 1992-93, the rainfall in the 1st to 3rd standard weeks increased the aphid population while during the 7th to 11th standard weeks resulted in the decline of aphid population. The Pattern of rainfall on aphid population during 1993-94 followed the same trend as in the previous years. So, it is evident from the foregoing discussion that rains of light intensity in the January and up to mid February resulted in the population build up of mustard aphid while the rains in the last week of February or on March had adverse effect on its population. The rains have been reported to exert profound effect on the aphid population (Roy, 1975 and Bishnoi *et al.,* 1992). The correlations between aphid population and abiotic factors showed non-significant associations except rainfall during 1993-94 which resulted in negative and significant correlation (Table 1). The studies are in confirmity with the finding of Roy, 1975 and Bishnoi *et al.* 1992.

LITERATURE CITED

Atwal, A.S., Chaudhary, J.P. and Ramzan, M. 1971. Mortality factors in the natural population of cabbage aphid, *Lipaphis erysimi* (Kalt.) (Aphididae : Homoptera), in relation to parasite, predator and weather conditions. *Indian J. Agric. Sci.* 41 : 507-510.

Bakhetia, D.R.C. and Sekhon, B.S. 1989. Insect-pests and their management in rapeseed and mustard. *J. Oilseeds Res.,* 6 : 269- 299.

Bishnoi, O.P., Singh, Harvir. and Singh, Roy. 1992. Incidence and multiplication of mustard aphid, *Lipaphis erysimi* in relation to meteorological variables. *Indian J. Agric. Sci.,* 62 (10) : 710- 712.

Brar, K.S., Ratual, H.S. and Labana, K.S. 1976. Differential reaction of mustard aphid, *Lipaphis erysimi* (Kalt.) to different rapeseed and mustard varieties under natural and artificial infestation. *J.Res. P.A.U.,* 13 : 14-18.

Kisimoto, R. and Dyck, V.K. 1976. Climate and rice insects. *In*: climate and rice. International Rice Research Institute, IOS Banos, Philippines, pp. 367-391.

Kundu, G.G. and Pant, N.C. 1968. Studies on *Lipaphis erysimi* (Kalt.) with special reference to insect plant relationship III. Effect of age of plants on susceptibility. *Indian J.Ent.*, 30(2) : 169-172.

Prasad, S.K. and Pradhan, S. 1971. Distribution and sampling mustard aphid, *Lipaphis pseudobrassicas* (Davis). *Indian J. Ent.*, 33 : 260 - 271.

Rai, B. 1961. Three enemies of rape and mustard, *Allahabad Farmer* 35 : 57-60.

Roy, P. 1975. Population dynamics of mustard aphid *Lipaphis erysimi* (Kalt.) (Aphididae : Hemiptera) in West Bengal. *Indian J. Ent.*, 37 : 318 - 321.

Singh, H. and Singh, Z. 1983. New records of insect-pests of rapeseed. *Indian J. Agric. Sci.*, 53 (9) : 970.

Singh, H. and Singh, Z. 1989. Population dynamics green peach aphid (*Myzus persicae* (Sulz.) on rapeseed cv. BSH - 1. *Crop Res.*, 2(2) : 194 - 199.

Singh, R.P., Yazdani, S.S. and Verma, G.D. 1990. Population dynamics of mustard aphid *Lipaphis erysimi* (Kalt.) (Homoptera : Aphididae) in relation to ecological parameters. *Indian J. Ent.*, 52 (3) : 387-392.

Srivastava, A.S. and Srivastava, J.L. 1972. Ecological studies on the aphid, Painted bugs and sawfly attacking mustard and rape in India. *Plant Prot. Bull. F.A.O.*, 20 : 136-140.

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WILT COMPLEX OF CASTOR (*Ricinus communis* L.): ROLE OF RENIFORM (*Rotylenchulus reniformis* Linford and Oliveira) NEMATODE

C. CHATTOPADHYAY and M.C.M. REDDY[1]
Directorate of Oilseeds Research, Rajendranagar, Hyderabad, 500 030

ABSTRACT

Reniform nematode (*Rotylenchulus reniformis* Linford and Oliveira) was found to be involved in the wilt complex of castor (*Ricinus communis* L.). Plants in carbofuran treated soil @ 3 kg a.i. ha^{-1} were unaffected while those without carbofuran were severely stunted and wilted. Nematode population was significantly higher in treatment without carbofuran. *Fusarium oxyporum* Schlecht., *Macrophomina phaseolina* (Tassi) Goid, and a *Pseudomonas* sp. were frequently intercepted through isolations from nematode affected plants, whereas, isolations from healthy plants revealed involvement of no microorganism. Shoot length and fresh weight of plants in treatments with and without carbofuran varied widely, the former had significantly greater length and weight at 12 weeks after sowing.

Keyworks : Reniform nematode; Castor; Carbofuran; Wilt

INTRODUCTION

Castor (*Ricinus communis* L.) is an important oilseed crop of India occupying about six lakh ha primarily in Andhra Pradesh and Gujarat with an annual production and productivity of 3.47 lakh MT and 591 kg ha^{-1} respectively (DOR, 1995). Wilt complex is one of the major biotic constraints in castor cultivation (AICORPO, 1983). Several organisms have been intercepted from wilt affected castor plants (Nanda and Prasad, 1974; AICORPO, 1983). Among them *Fusarium oxysporum* f. sp. *ricini* is known to cause wilt of castor (Sviriov, 1990). *Rotylenchulus reniformis* Linford and Oliveira, a reniform nematode is known to be associated with *Fusarium oxysporum* f. sp. *vasinfectum* in wilt syndrome of cotton (Varaprasad, 1986). Involvement of *R. reniformis* with the castor wilt complex has been reported (AICORPO, 1983; Varaprasad, 1986). A study was conducted to investigate the role of the reniform nematode and other associated organisms in the castor wilt complex.

MATERIAL AND METHODS

Pot culture experiment was laid out in a Completely Randomised Design at the Directorate of Oilseeds Research, Rajendranagar, Hyderabad during July-September, 1993. Soil (*Alfisol* having red sandy loam texture) from wilt sick plot ("sick" soil) and from plot not considered as sick ("non-sick" soil) from the farm were filled in pots (30 cm diameter; 10 kg soil pot^{-1}). There were four treatments having "sick" and "non-sick" soil with and without car-

1. Plant Quarantine Regional Station, National Bureau of Plant Genetic Resources, Rajendranagar, Hyderabad 500 030
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bofuran. Each treatment had nine pots, with three pots having two plants each for each variety. The three varieties were '48- 1', 'Aruna' and 'GAUC-1'. Population of nematodes including that of *R. reniformis* were assessed before adding carbofuran @ 3 kg a.i.ha^{-1} on the day before sowing and were again observed at 12 weeks after sowing (WAS) by sieving and decantation technique (Cobb, 1918) followed by modified Baermann funnel method (Schindler, 1961). The mean values over the varieties are presented.

Enumeration of *Fusarium* was done on modified *Fusarium* specific medium (Nash and Snyder, 1962) consisting of Difco Peptone: 15.0g; KH_2PO_4 : 1.0 g; MgSo4, $7H_2O$: 0.5 g; PCNB: 1.0 g; Dicrysticin (substituted for Streptomycin in original formula, added with PCNB after autoclaving) : 300 ppm; Agar : 20.0 g; Distilled water: 1L (pH:6.4). Rhizosphere soil samples from each treatment at the sowing date and at 6 and 12 WAS were diluted in sterile distilled water to 10^{-3}, one ml of it was placed in sterile Petri plate and 20 ml of medium cooled to nearly 45°C was poured over it. The plates were swriled to mix the inoculum with the medium. After solidification of the medium, plates were incubated at 27°C (soil dilution plate technique of Barron, 1971). Colony counts on each culture plate on the fourth day was made and expressed as the number of colony forming units (cfu) of *Fusarium* g^{-1} of soil.

Isolations were made from primary root portions of plant where ninety per cent more secondary roots have joined. A thorough surface sterilisation with 0.1 per cent sodium hypochlorite was followed by three rinsings in sterile water before placing on Potato Dextrose Agar (PDA). Shoot length and fresh weight of castor plants was recorded at 12 WAS. Appropriate statistical analysis of the data was done.

RESULTS AND DISCUSSION

Castor plants in untreated "sick" or "non-sick" soil recorded higher wilt incidence while carbofuran treatment showed less wilted plants (Table 1). The symptoms were uniform on all the three varieties in the treatment. A plant affected by nematode(s) and infected by the organisms intercepted frequently through isolations, viz., *F. oxysporum, Macrophomina phaseolina* and *Pseudomonas* sp., showed browning from the margins and not the deep black flecks as in case of infection by only *F. oxysporum*. Isolations from apparently healthy plants in treatments having received carbofuran revealed involvement of no fungus or bacterium.

The effect of the nematodes found to be involved in the wilt complex was uniform for all varieties. Population of *R. reniformis* as influenced by the treatments are presented in Table 2. Carbofuran treatment in "non-sick" soil helped in 13.7 per cent decline of the

Table 1. Incidence of wilt in castor involving *Rotylenchulus reniformis* with or without carbofuran application

Treatments	Wilted plants*	
	Number	Percentage
"Sick" soil + carbofuran	2	11.11
"Sick" soil	17	94.44
"Non-sick" soil + carbofuran	0	0
"Non-sick" soil	13	72.22

* Number of plants (seed sown and germinated) per treatment at the begining of the experiment : 18

Table 2. ***Rotylenchulus reniformis*** **population, shoot length and fresh weight of castor plants in "sick' and "non-sick" soil with or without carbofuran treatment at 12 weeks after sowing**

Treatments	Shoot lenght (cm)	Fresh weight* (g)	Rotylenchulus reniformis population per 1000 cc soil	
			Before carbofuran application and before sowing	12 weeks after sowing
"Sick" soil + carbofuran	75.00	93.00	148.00 (Ho : 32)	224.00 (Ho : 48)
"Sick" soil	25.50	10.17	148.00 (Ho : 32)	968.00 (Ho : 36)
"Non-sick" soil + carbofuran	71.00	78.33	136.00 (fl : 16) (He : 8)	117.33 (fl : 40) (He : 24)
"Non-sick" soil	14.33	4.17	136.00 (fl : 16) (He : 8)	756.00 (fl : 28) (He : 28)
SEm ±	2.132	3.820	NS	24.458
CD (P = 0.05)	4.18	7.49		47.93
(P = 0.01)	5.49	9.84		

* Mean of 3 replications and 3 varieties

Data in parentheses indicate population of other nematodes

H0 : *Hoplolaimus* spp.; He : *Helicotylenchus* spp.; fl : Free living

reniform nematode population at 12 WAS compared to the pre-treatment observation. Addition of carbofuran to "sick" soil resulted in checking the rise of *R. reniformis* population. Reniform nematode population in "sick" and "non-sick" soils without carbofuran treatment multiplied by about 6.5 and 5.6 times respectively. There are several reports of control of *R. reniformis* with carbofuran in different crops viz., french bean (Padhi and Misra, 1987). Thus, from this study it is evident that the reniform nematode is involved in the castor wilt complex and can be effectively controlled with carbofuran treatment as the plants having the chemical treatment had a better stand or less wilted plants (Table 1), better than those in "sick" and "non-sick" soil. Alongwith the *R. reniformis*, some other nematodes were also found to be present in different treatments (Table 2); the role of such nematodes were unknown in castor and need to be investigated. Data available from the present study on the non-reniform nematodes are inconclusive.

Fusarium population did not vary much in different treatments (Table 3). This was possibly because carbofuran has no effect on the fungal population. Only a slight rise in *Fusarium* population level is noted in the rhizosphere soil of 'Aruna' irrespective of the treatments. Similarly, marginal decline in *Fusarium* population is also observed in '48-1' only, in both "sick" and "non-sick" soils with or without carbofuran. This may be due to some effect of root exudates of the variety on the pathogen population in soil as also reported in chickpea (Shinde and Deshmukh, 1989).

The involvement of more than one kind of organism (viz., *F. oxysporum, M. phaseolina* and/or *Pseudomonas* sp.) is noted in the wilted plants. Occurrence of such complexes involving nematodes, fungal and/or bacterial or-

Table 3. *Fusarium* colony forming units (cfu) in rhizosphere soil of castor plants

Treatment	Variety	cfu (x 10^3) * g^{-1} soil	
		Before carbofuran application and before sowing	12 weeks after sowing
"Sick" soil + carbofuran	GAUC-1	27.33	30.33
	Aruna	27.67	35.33
	48-1	28.33	23.67
	Mean	27.78	29.78
"Sick" soil	GAUC-1	27.67	30.67
	Aruna	27.00	34.67
	48-1	26.67	24.33
	Mean	27.11	29.89
"Non-sick" soil + carbofuran	GAUC-1	2.33	2.67
	Aruna	1.33	3.33
	48-1	2.33	1.00
	Mean	2.00	2.33
"Non-sick" soil	GAUC-1	2.33	1.67
	Aruna	1.33	4.33
	48-1	1.67	0.33
	Mean	1.78	2.11
SEm ±		0.509	0.255
Cd (P = 0.01)		1.42	0.71

* Mean of 3 replications

ganisms are numerous *viz.*, the disease syndrome in jute involving *Meliodogyne incognita, M. arenaria, Macrophomina phaseolina, Fusarium solani* and *Pseudomonas solanacearum* causing wilts and rots (Chattopadhyay and Dev Sharma, 1978). However, in such complexes, the primary pathogen needs identification.

Shoot length and fresh weight of castor plants in "sick" and "non-sick" soil varied widely in treatments with and without carbofuran (Table 2). The investigation has also revealed that *R. reniformis* infestation results in reduction of shoot length and fresh weight, which is in agreement with previous reports (viz., Seshadri and Shivakumar, 1963). Addition of carbofuran resulted in overcoming the stunting caused by reniform nematode infestation as in "sick" and "non-sick" soil with carbofuran shoot length was about 2.9 times and 5.0 times more respectively than those without carbofuran. Similarly, fresh weight was also more in "sick" and "non-sick" soil when carbofuran was added than those without it. Data could be collected upto only 12 WAS as the plants died in untreated pots thereafter.

LITERATURE CITED

All India Coordinated Research Project on Oilseeds (AICORPO) 1983. Annual Progress Report, Castor 1982-83, Directorate of Oilseeds Research. pp. 125-140.

Barron, G.L. 1971. Soil Fungi. *In*: Booth, C. (Ed.) Methods in Microbiology, Vol. 4 Academic Press, London, pp.405.

Chattopadhyay, S.B. and Dev Sharma, B 1979. Investigation of wilt on jute *corchorus capsularis* L. and *corchorus olitorius* L. - I : Disease syndrome and incitants. *Indian J. Mycol. Res.* 17:55-64.

Cobb, N.A. 1918. Estimating the nematode population of soil. U.S. Department of Agriculture Technical Circular 1. U.S. Government Printing Office : Washington, D.C.

DOR. 1995. *Oilseeds situation in India : A Statistical* overview. Directorate of Oilseeds Research, Hyderabad.

Nanda, Sunila and Prasad, N .1974. Wilt of castor - a new record. *Indian J. Mycol. and Plant Path.* 5:103-105.

Nash, S.M. and Snyder, W.C. 1962. Quantitative estimation by plate counts of propagules of the bean root rot *Fusarium* in field soil. *Phytopathology* 52:567-572.

Padhi, N.N. and Misra R.P. 1987. Control of *Rotylenchulus reniformis* on french bean (*Phaseolus vulgaris* L.). *Indian J. Nemat.* 17:130-131.

Schindler, A.F. 1961. A simple substitute for a Baermann funnel. *Plant Dis. Reptr.* 45:747-748.

Seshadri, A.R. and Sivakumar, C.V. 1963. A preliminary note on the occurrence of the reniform nematode (*Rotylenchulus reniformis* Linford and Oliveira, 1940) on a number of cultivated crops in South India. *Madras Agriculture J.* 50:134-137.

Shinde, N.V. and Deshmukh, R.B. 1989. Effect of chickpea root exudates on *Fusarium oxysporum* f. sp. *ciceri*. *Indian J. Pulses Res.* 2:90-92.

Varaprasad, K.S. 1986. *Rotylenchulus reniformis* Linford and Oliveira, 1940 - a comprehensive account of systemics, biology and management. *In* : Swarup, G. and Dasgupta, D.R. (Eds.) Plant Parasitic Nematodes of India - Problems and Progress. IARI Publ., N. Delhi, 110 012. India, PP. 194-210.

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SCREENING FOR HIGH BIOMASS TYPES IN SUNFLOWER AN APPROACH TO IMPROVE CROP PRODUCTIVITY

Y.A. NANJA REDDY, R. UMA SHAANKER, M. UDAYA KUMAR and K. VIRUPAKSHAPPA*

Department of Crop Physiology, University of Agricultural Sciences, GKVK, Bangalore 560 065.

ABSTRACT

Four field experiments were conducted with 122 germplasm lines to identify genotypes with high dry matter production, harvest index and leaf area indices consequently to select for high yielding types. A significant positive relationship was obtained among the characters total dry matter (TDM), leaf area index (LAI), harvest index (HI) and seed yield. Considerable variation exists among the germplasm for these traits. Following a standard normal Z distribution, we have identified a few genotypes that exhibit consistently high biomass or leaf area index with high seed yield. A few of the genotypes with high biomass were also found to be drought tolerant. It is suggested that these lines be used in breeding programmes aimed at evolving genotypes or varieties for sustained productivity under rainfed conditions.

Keywords : Biomass; Productivity; Leaf area index; Harvest index; Total dry matter

INTRODUCTION

Sunflower is becoming an important oilseed crop due to its high level of polyunsaturated fatty acid content and thus contributing to low cholesterol diet. Though several high yielding varieties and hybrids are being cultivated in India, there is a need for further improvement in productivity to meet the growing edible oil demands of our country. As in other field crops, seed yield of sunflower is the product of the total biomass production (TDM) at maturity and harvest index (Sheshagiri Rao, 1989; Vronskih, 1988). Among these two factors, the contribution of the former is found to be important (Uma Shaanker *et al.*, 1991).

Improvement of seed yield by increasing TDM is relatively easy through various agronomic manipulations, such as increasing population density, fertilization etc. (Shivaram, 1986). Further enhanced accumulation of TDM can be accomplished by having higher leaf area index to enable greater light interception and photosynthetic capacity of the genotype (Rollier, 1982). Assimilation rates in sunflower is not a limitation for productivity (Connor and Sadrass, 1992). Therefore, it appears that, productivity of sunflower is predominantly constrained by poor LAI. Thus, selection for high LAI types in sunflower is imperative before any attempt is made to improve the productivity of the crop. In this context, an attempt is made to screen sunflower germplasm for high LAI and exploit the existing genetic variability to select for high TDM, HI, leaf area indices and seed yields. In this paper, the results of screening undertaken over the past four years and a list of accessions that

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* Project Co-ordinating Unit, UAS, GKVK Bangalore 560 065.

may be used in breeding programmes aimed at improving productivity through enhanced leaf area and dry matter production are presented.

MATERIAL AND METHODS

Four field experiments were conducted at the University of Agricultural Sciences, GKVK Campus, Bangalore on red loamy soils (pH 6.5) during 1990 through 1994 during summer seasons by providing protective irrigation. Experiments were laid out in simple Randomized Block Design with varying number of genotypes in each experiment replicated four times in plots of size 3 x 3 m^2. Crops were raised following the recommended package of practices.

In all the experiments, observations were made on leaf area at anthesis, total dry matter (TDM) and seed yield at crop maturity from an area of 1.0 m^2. Harvest index was computed. Correlation analysis was conducted on the data pooled over all experiments, among the various characters. For each experiment, the respective genotypes were grouped based on a two dimensional standardized normal distribution (Z - distribution) involving seed yield as one trait and one of the other characters such as TDM, LAI or HI. The genotypes in the first quadrant that are characterised by high values of seed yield and of either the TDM, LAI or HI were compared and those common in all the years were selected as those representing high biomass types (either with high LAI or TDM) coupled with high seed yield.

RESULTS AND DISCUSSION

Correlation studies using the pooled data of the experiments showed that the seed yield is positively related to TDM to a greater extent compared to HI (Fig. 1); this indicates the importance of TDM for sunflower crop improvement. However, the extent of dry matter accumulation depends upon the amount of light intercepted by the crop canopy and its assimilation capacity. Assimilation rate in sunflower is not a limitation and is well above of most of C_3 plants (Connor and Sadrass, 1992). The relationship of LAI towards TDM as well as seed yield was significant and positive (Fig. 1) suggesting the possibility of improving seed yields of sunflower through an increase in TDM and leaf area indices.

Data on range and mean for seed yield and other characters for all the experiments are presented in Table 1. Seed yield, TDM and LAI varied from 2 to 5 folds over the genotypes;

Table 1. Range, mean, and standard deviation for growth and yield attributes in various seasons in sunflower

	Range	Mean	±SD
Experiment - I (summer, 1994) (N=36)			
Seed yield	51-416	197	92
TDM at maturity	254-1601	734	304
HI	0.20-0.33	0.26	0.03
LAI at anthesis	1.00-6.89	3.19	1.22
Experiment - II (Summer, 1993) (N = 31)			
Seed yield	41-240	117	59
TDM at maturity	55-1036	450	225
HI	0.10-0.38	0.25	0.06
LAI at anthesis	0.76-2.83	1.60	0.54
Experiment - III (Summer, 1992) N = 31)			
Seed yield	59-106	147	67
TDM at maturity	184-1033	458	208
HI	0.19-0.43	0.32	0.06
LAI at anthesis	1.01-3.78	2.09	0.74
Experiment - IV (Summer, 1990) (N =24)			
Seed yield	85-275	192	50
TDM at maturity	308-817	573	131
HI	0.20-0.40	0.33	0.05
LAI at anthesis	1.15-3.00	1.76	0.46

Seed yield and TDM are g.m^{-2}

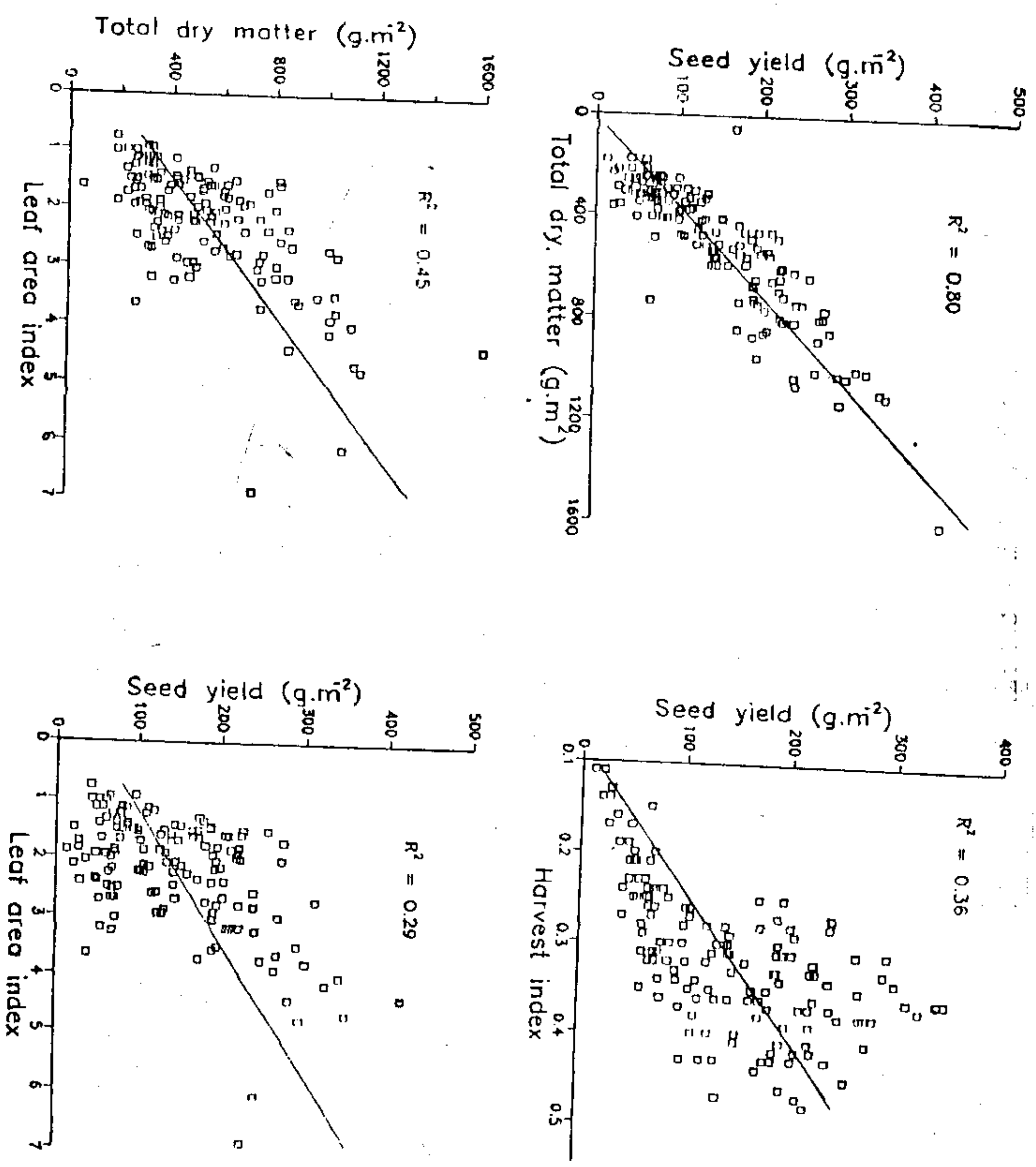

Fig. 1 Relationships among LAI, TDM, HI and seed yield in sunflower

variation in HI was rather low with only two-fold difference. Based on these variations, normal Z distribution analysis was performed for each experiment to select genotypes for higher TDM or LAI or HI along with higher seed yields. Selection was carried out separately, because each crop was grown under different environments. A few of such selected genotypes are listed in Table 2 along with their absolute performance values. Among the selected genotypes, a few such as Acc. 1603, 1606, 1620, 1648 performed best in two or more than two field experiments, suggesting their stability over seasons. Additionally, a few genotypes such as Acc. 438, 1260, 1648 and EC 68415 of the high biomass producing types were also found to be drought tolerant from a seperate study (Unpublished).

The results therefore suggest the availability of a few selected genotypes/accessions that can be readily used in enhancing the productivity of sunflower. Furthermore, these selected lines could also be used in breeding programmes to incorporate the genes imparting high biomass production into agronomic genotypes. As shown in the study, a few of these

Table 2. Selected sunflower genotypes for high biomass, TDM, HI and LAI and seed yields.

Genotypes	DFF	Seed yield ($g.m^{-2}$)	TDM ($g.m^{-2}$)	HI	LAI at flowering
Experiment - I					
Acc 423	(61)	264	1012	0.26	3.90
Acc 427	(62)	416	1601	0.26	4.37
Acc 456	(60)	267	889	0.30	3.64 (R)
Acc 1260	(60)	294	1136	0.26	4.78 (R)
Acc 1606	(67)	281	856	0.33	4.42 ***
Acc 1642	(63)	349	1108	0.31	4.68 (R)
Experiment - II					
Acc 1648	(67)	248	749	0.33	3.73 *** (R)
Acc 1651	(72)	192	654	0.29	2.11 **
Experiment - III					
Acc 1603	(61)	273	801	0.33	2.03 **
Acc 1611	(61)	193	531	0.36	2.05 **
Acc 1620	(61)	198	553	0.34	2.16 ***
EC 68415	(61)	181	566	0.32	2.75 ** (R)
Experiment - IV					
Acc 266	(63)	223	606	0.37	2.02
Acc 418	(67)	221	615	0.36	1.82
Acc 436	(71)	269	805	0.33	3.00 **
Acc 438	(71)	238	624	0.38	2.84 (R)

** and *** : Denote repeated consistent performance in two and three experiments respectively

R : Denote genotype tolerant to drought also

DFF : Values in parenthesis represents the days to 50 per cent flowering genotypes also exhibit drought tolerance. In the context that the cultivation of sunflower is rapidly expanding and grown predominantly as a rainfed crop in the *kharif* season where moisture stress is a major constraint, it is suggested the use of these genotypes to lend an overall stability to the sunflower productivity in the country.

LITERATURE CITED

Connor, D.J. and Sadras, V.O. 1992. Physiology of yield expression in sunflower. *Field Crop Res.* **30** : 333-389.

Ravishankar, K.V., Uma Shaanker, R., Ravishankar, H.M., Udaya Kumar, M. and Prasad, T.G. 1991. Development of drought tolerant sunflower for semi-arid tracts of India : Duration of genotypes influences their performance under imposed moisture stress. *Helia*.1 4 : 77-86.

Rollier, M. 1982. Pathways of yield elaboration in sunflower under various water stresses. *Proc. 10th Int. Sunflower Conference*. Toowoomba, Australia, pp. 11-14.

Sheshagiri Rao, P.R. 1989. Screening of germplasm for drought tolerance and formulation of selection indices for seed yield in sunflower. M.Sc. (Agric.) Thesis, Univ. Agric. Sci., Bangalore, India.

Shivaram, B. 1986. Physiological reasons for variations in productivity in sunflower genotypes under different plant populations. M.Sc. (Agric.) Thesis, Univ. Agric. Sci., Bangalore, India.

Uma Shaanker, R., Ravishankar, H.M., Virupakshappa, K., Prasad, T.G. and Udaya Kumar, M. 1991. A report on sunflower physiology, Department of Crop Physiology, Univ. Agric. Sci. Bangalore, India.

Vronskih, M.D. 1988. What are the properties of a hybrid ? *Seleckciya i Semenovodstvo*, 26-29 (in Russian).

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PHENOLOGY, ROOT AND SHOOT GROWTH OF SOYBEAN AND PEANUT AS INFLUENCED BY SOIL DRAINAGE

A.L. RATHORE and A.R. PAL
Department of Land and Water Management, Indira Gandhi Agricultural University, Raipur - 492 012

ABSTRACT

The experiment was conducted on a vertisol for two years to evaluate root and shoot growth and yield of soybean and peanut in relation to various root environments induced by different width of beds with intercepted furrows. Ground water table increased with width of bed and reached up to 2 cm below the soil surface in wide beds (4.8m). The recession rates of the water table varied from 2 to 10 cm/day during non-rainy period. Poor drainage in medium (2.4m) and wide beds delayed date of flowering, pod and seeds formation and finally, maturity of the crops. The crop yields were maximum with narrow bed (1.6 m) whereas, medium and wide beds proved on par in relation to seed yield of soybean and pod yield of peanut. Growth parameters such as plant height, number of leaves, nodes on main stem and dry biomass of leaves and stem were maximum at pod development stage and followed the pattern of yield. The yield component viz., number and weight of pods, seed weight, and shelling percentage of pods also followed the pattern of yield. Root density, number of nodules and their weight was highest at pod development stage in narrow bed. The soil moisture was high in wider beds as compared to narrow beds.

Keywords: Phenology; Water table; Root density; Soil drainage; Bed width

INTRODUCTION

In India 22.2 *per cent geographical area is* under vertisol and associated vertic soils, which have the problems of low infiltration rates (2.5cm/day) and poor drainage (Murthy, 1988). Mono-cropping of rice is a common practice in eastern India, which receives abundant rainfall (1200 to1600 mm), concentrated between June to October. Rice mainly suffers from erratic onset of monsoon distribution, withdrawal of rains and even in short dry spells due to shallow rooting system in spite of enough moisture in soil profile which can be exploited potentially by growing deep rooted upland crops. Soybean and peanut, if grown,suffer from abnormal root growth due to inadequate aeration which interferes with utilisation of available plant nutrients. Williamson and Carreker (1970) reported that, the plant limitation imposed by a restricted root surface with shallow water tables were evident in the lower yield of crops. Gupta *et al.* (1978) suggested for adoption of land configuration systems in rainy season for speedy disposal of excess water in stabilizing the production of upland crops under rainfed conditions. This necessitates to evaluate a suitable width of bed for safety disposal of excess rain and for an optimum growth of upland crops like soybean and peanut.

MATERIAL AND METHODS

The experiment was conducted at Indira Gandhi Agricultural University, Raipur during

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the rainy seasons of 1991 and 1992 on a vertisol rice field having about 0.1% slope in east-west direction. The soil has clay content ranging from 41 to 54% and bulk density 1.47 to 1.66 g/cc in 105 cm deep profile with 3.29 cm/day average saturated hydraulic conductivity. The soil was slightly alkaline in reaction (pH 7.6), rich in organic carbon (0.75%), low in available nitrogen (288 kg/ha) and phosphorus (8.8 kg/ha) and high in potassium (428 kg/ha). The lower bund of rice field was dismantled in order to drain excess rainwater.

The experiment consisted of three bed widths (1.6 m, 2.4 m and 4.8 m, each bed was 10 m long along the slope and connected with 0.30 m x 0.15m cross section intercepted furrows) and two upland crops (soybean and peanut) was laid out in Randomized Block Design with four replications. Gross plot size was 48 m^2 (4.8 m x 10 m). The seed of soybean cv. Gaurav and Peanut cv. J-11 were sown on 12th July during both the years at a row spacing of 40 cm using 80 kg seed/ha. Nitrogen (20 kg/ha) as urea and phosphorus (60 kg/ha) as single super phosphate were applied below the seed at sowing. All other recommended agronomic practices were followed as per the package. The plant growth parameters such as plant height and number of green leaves, nodes, pods and nodules and oven dry weight of green leaves, stem, pod, roots and nodules at different time intervals were taken as suggested by Fehr *et al.* (1971) and Boote (1982) for soybean and peanut respectively. Five plants were sampled for recording observations. The root at a depth interval of 10 cm to a depth of 30 cm were taken with a core sampler. Roots were washed with a foot sprayer and was held on a 2 mm iron wire woven sieve. Nodules count as well as the dry weight of nodules, root and shoot were recorded. Piezometers (PVC pipes having 50 mm inner diameter) were installed to a de[pth] of ground water table. Daily observation [with] battery operated water level indicator w[as] recorded at 8 am. The piezometers we[re] flushed weekly to avoid mud plugging at low[er] end. Rainfall data was taken from meteorolo[gi]cal observatory located less than one kilomet[er] away from experimental field.

RESULTS AND DISCUSSION

Ground water table

Root zone of the crops was flooded from later vegetative stage to initial seed development stage (Fig. 1.) During rainy days the perched water table in different size of beds were almost similar but had an increasing trend with the increase in width of beds, probably due to interconnection of furrows at less spacing in narrow beds than in wider beds, which drained both runoff and seepage water more efficiently. Das (1983) also reported higher water table during rainy days in flat beds as compared to raised beds. The water table reached up to 2-4 cm below the soil surface in different size of beds during rainy days. The ground water recession rate varied from 2 to 10 cm/day as also reported by Augustine and Garrity (1988) in rice lands under rainfed conditions.

Phenology

The phenology of soybean and peanut was altered due to water logging in the rootzone (Fig. 2). The date of flowering, pod and seed development was delayed in wide bed (4.8 m) as compared to medium (2.4 m) and narrow (1.6 m) beds, because of higher water table in wide beds which restricted the growth of the plants as also reported by Ogunrenri *et al.* (1981) in soybean plants. The extent to which phenology was modified by water table varied

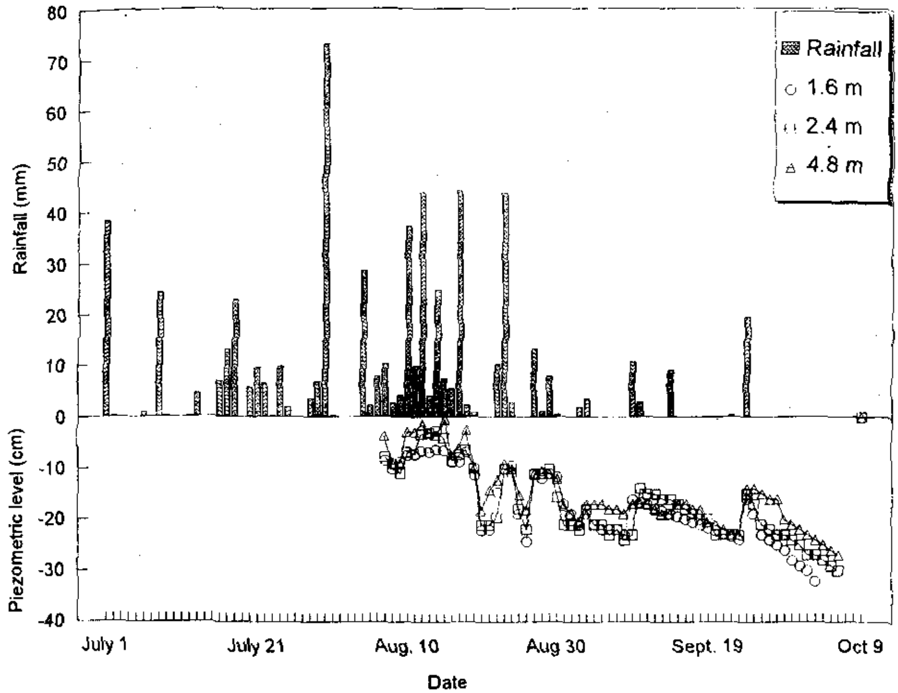

Fig. 1 Ground water table as influenced by width of beds and rainfall during 1991 growing season

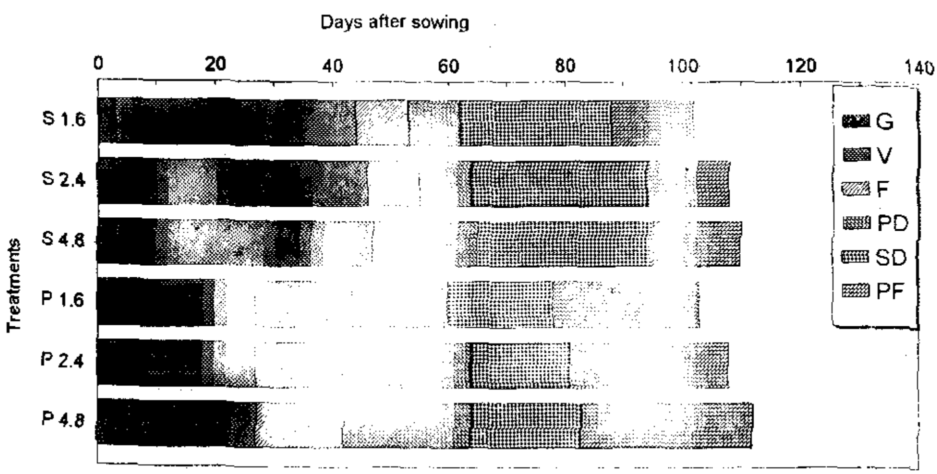

Fig. 2 Phenology of soybean and peanut in relation to soil drainage during 1991

(G - germination; V - vegetative; F - flowering; PD - pod development ; SD - seed development; PF - pod filling & end of PF- physiological maturity) with the crops. Soybean was found more tolerant to rootzone water logging than peanut. The observations showed that rootzone flooding not only reduced growth (Fig. 3 and 4) and yield (Table 1) but also delayed maturity of soybean and peanut.

Growth and dry matter production

The plant height and number of nodes on main stem increased with the advanced growth and reached maximum at seed development stage, thereafter, the height decreased slightly due to twisting and shriveling of growing tip of the plant (Fig. 3.) Number of leaves and their dry matter in soybean increased up to seed development stage and declined due to defoliation of plant caused senescence (Fig. 4). In peanut, number of leaves and their dry matter increased up to later part of pod filling (Fig. 4). Stem weight increased similar to height in both the crops, but in later part of growth, the weight was slightly reduced due to the translocation of food material from stem to sink.

Table 1. Seed yield of soybean and pod yield of peanut in relation to soil drainage

Treatment	Yield (kg/ha)		
	1991	1992	Mean
Soybean			
S1.6	2540	3090	2815
S2.6	2304	2870	2587
S4.8	2221	2680	2450
Peanut			
P1.6	970	820	895
P2.4	750	739	744
P4.8	650	635	642
CD (P = 0.05)			
Crop	97	134	-
Drainage	119	164	-

S1.6 = Soybean in 1.6 m wide bed
S2.4 = Soybean in 2.4 m wide bed
S4.8 = Soybean in 4.8 m wide bed
P1.6 = Peanut in 1.6 m wide bed
P2.4 = Peanut in 2.4 m wide bed
P4.8 = Peanut in 4.8 wide bed

The plant height, number of leaves, nodes and the dry weights of stem, leaves and pods were highest in 1.6 m wide bed at all the growth stages of the crops, except during early vegetative stage where a slight variation in the above parameters in different treatments was noted probably due to no water logging in early stage of growth.

Yield and its components

The seed yield of soybean and pod yield of peanut were significantly high in 1.6 m wide bed, whereas other two width of beds (2.4 m and 4.8 m) gave statistically similar yields (Table 1). The reduction in yield was associated with significant reduction in yield components viz., number of pods per plant, seed weight, pod weight and shelling percentage (Table 2). The water table was more shallow in wider beds than narrow beds, which may have adverse effect on the availability of nutrients and growth of the plant due to anaerobic condition in rootzone as also reported by Cannell, 1979. Ghowail and Shanery (1978) also reported that soybean seed yield, seed weight and straw yields decreased with increase in water table depth in rootzone. It was observed under peanut that, the length of gynophores was about 5-7 cm, therefore, the gynophores developed from upper nodes of the plant could not reach the soil surface to form pods, due to which, majority of gynophores remained podless and dried (Table 2). The earthing operation was less effective mainly due to shallow water table conditions and sticky clay soil. These facts were mainly responsbile for poor yield of peanut during both the years.

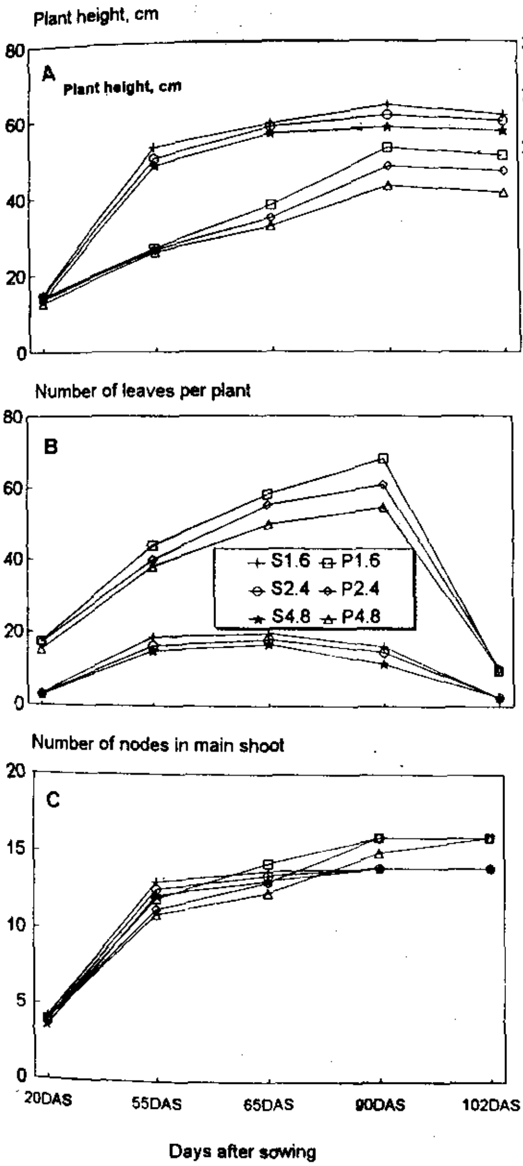

Fig. 3 (A,B,C) Plant height, number of nodes on main stem and green leaves at different growth stages of peanut and soybean in relation to bed width during 1991.

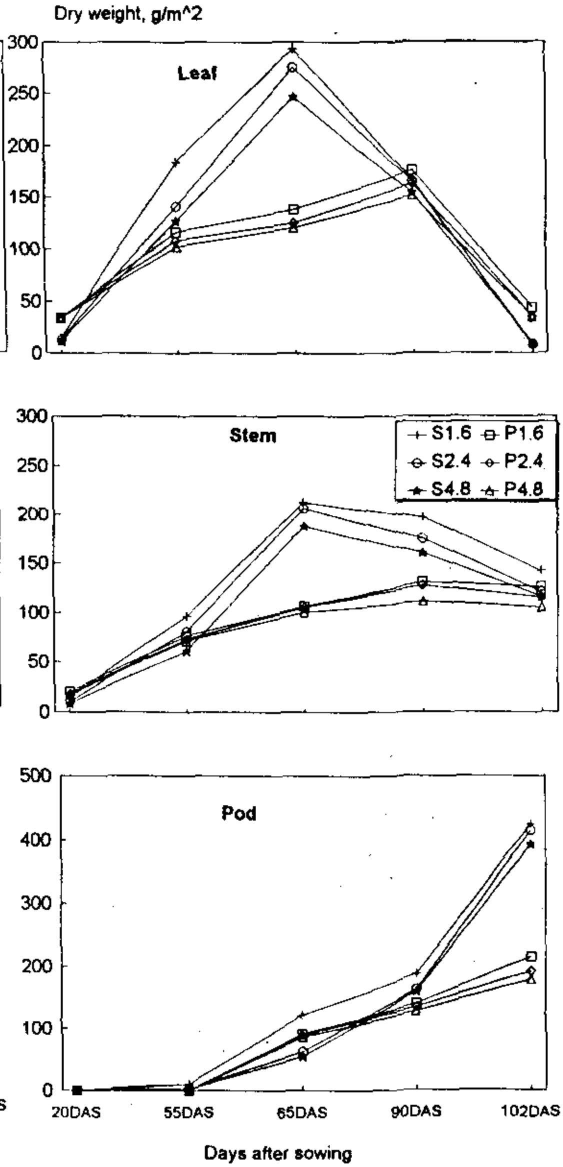

Fig.4 Dry matter production of leaves, stem and pods at different growth stages of soybean and peanut as affected by soil drainage during 1991.

Table 2. Yield components of soybean and peanut as influenced by soil drainage

Treatment	Plant height (cm)		Number of pods/Plant		Weight of pods/Plant		100, seed weight(g)		Shelling percentage		Gynophores without pod (%	
	1991	1992	1991	1992	1991	1992	1991	1992	1991	1992	1991	1992
Soybean												
S1.6	48.9	67.5	69	56	17.6	11.1	14.0	14.2	72.6	80.5	--	--
S2.4	46.9	63.9	65	53	15.3	10.6	13.8	14.0	71.2	78.4	--	--
S4.8	44.2	58.8	61	49	14.1	9.4	13.5	13.9	70.8	76.7	--	--
Peanut												
P1.6	45.9	55.1	16	15	6.6	4.1	31.0	31.9	68.9	70.3	67	75
P2.4	42.7	50.6	13	12	5.3	3.2	31.0	31.5	66.5	69.1	65	72
P4.8	40.9	46.5	9	8	4.3	2.8	30.6	30.7	65.8	68.1	63	65
CD (P=0.05)												
Crop	1.5	2.7	1.7	1.6	0.7	0.3	4.3	6.5	2.1	3.2	--	--
Drainage	1.9	3.4	2.1	2.1	0.9	0.3	NS	NS	NS	NS	--	--

NS - Not significant

Root growth and nodulation

The root growth during early vegetative stage was influenced a little with different sized beds (Fig. 5). The root growth was maximum at 65 days after sowing (DAS), Thereafter, the root weight density reduced due to decay of roots. Majority of roots were found in surface layer (10 cm) and very less in 20-30 cm depth of soil at all the growth stages. Drew and Trought (1977) reported that the adventitious roots developed on surface layer of soil due to flooding and restrict the growth of roots towards deeper layers.

Nodules in both soybean and peanut were maximum at 65 DAS (Table 3) thereafter, decay in roots and nodules were observed. Number of nodules in groundnut were more but due to its smaller size, the weight was less than soybean. It was observed that the maximum nodulation was occurred in surface soil (0-10cm) particularly in soybean and a few nodules in peanut were also found in lower depth. There was direct effect of water table on nodulation of both the crops and maximum number of nodules were recorded with narrow beds.

Soil moisture content

The wider beds had more soil moisture at harvest than narrow beds (Fig. 6). Das (1983) and Gupta *et al.* (1979) also reported that soil moisture content was always higher on flat beds than the raised beds. The differences in moisture content was more evident in upper 30 cm soil layer. Amongst the crops, soybean canopy conserved more moisture than peanut due to shad-

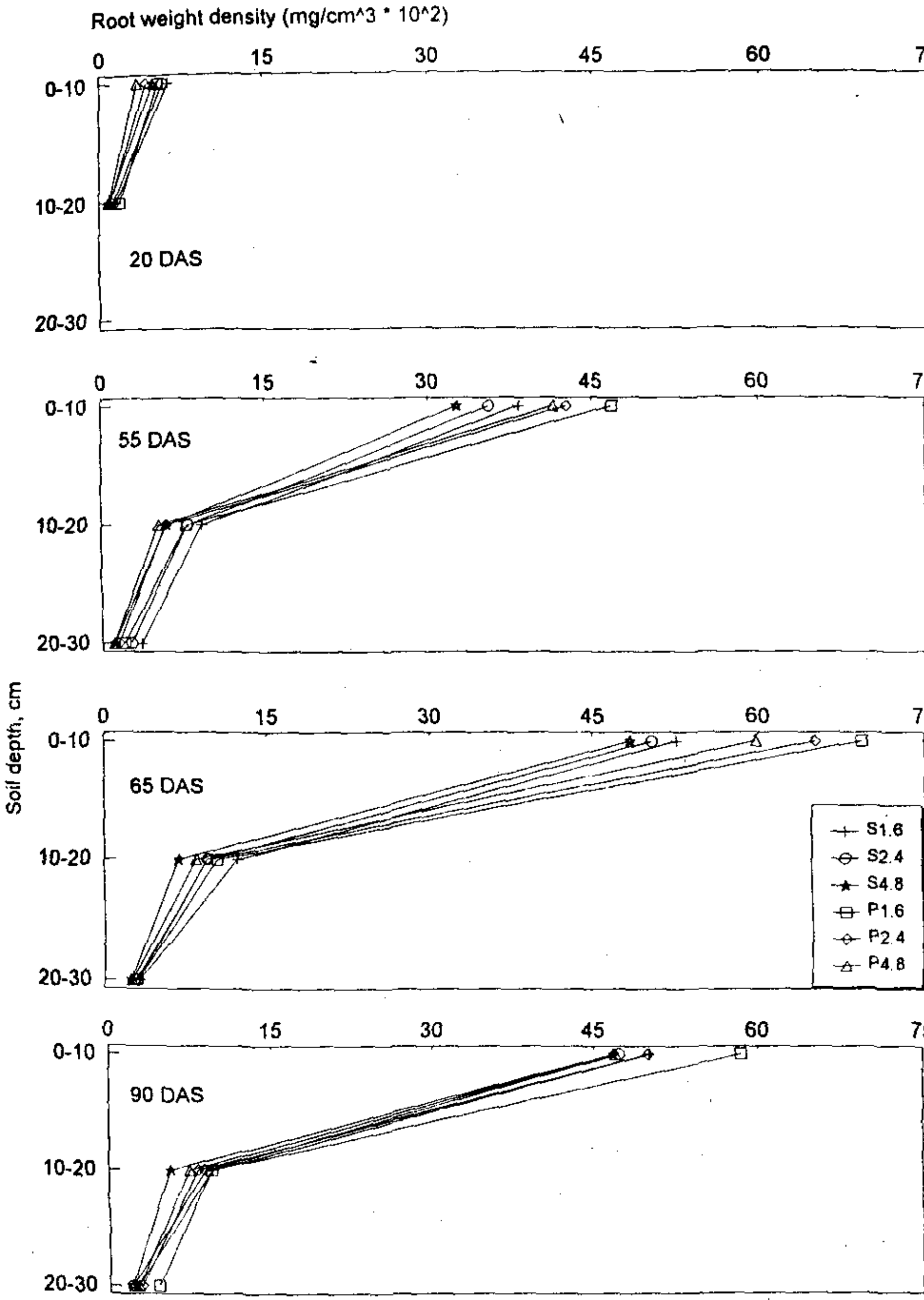

Fig. 5 Root weight desnsity of soybean and peanut at different time intervals of plant growth in relation to soil drainage.

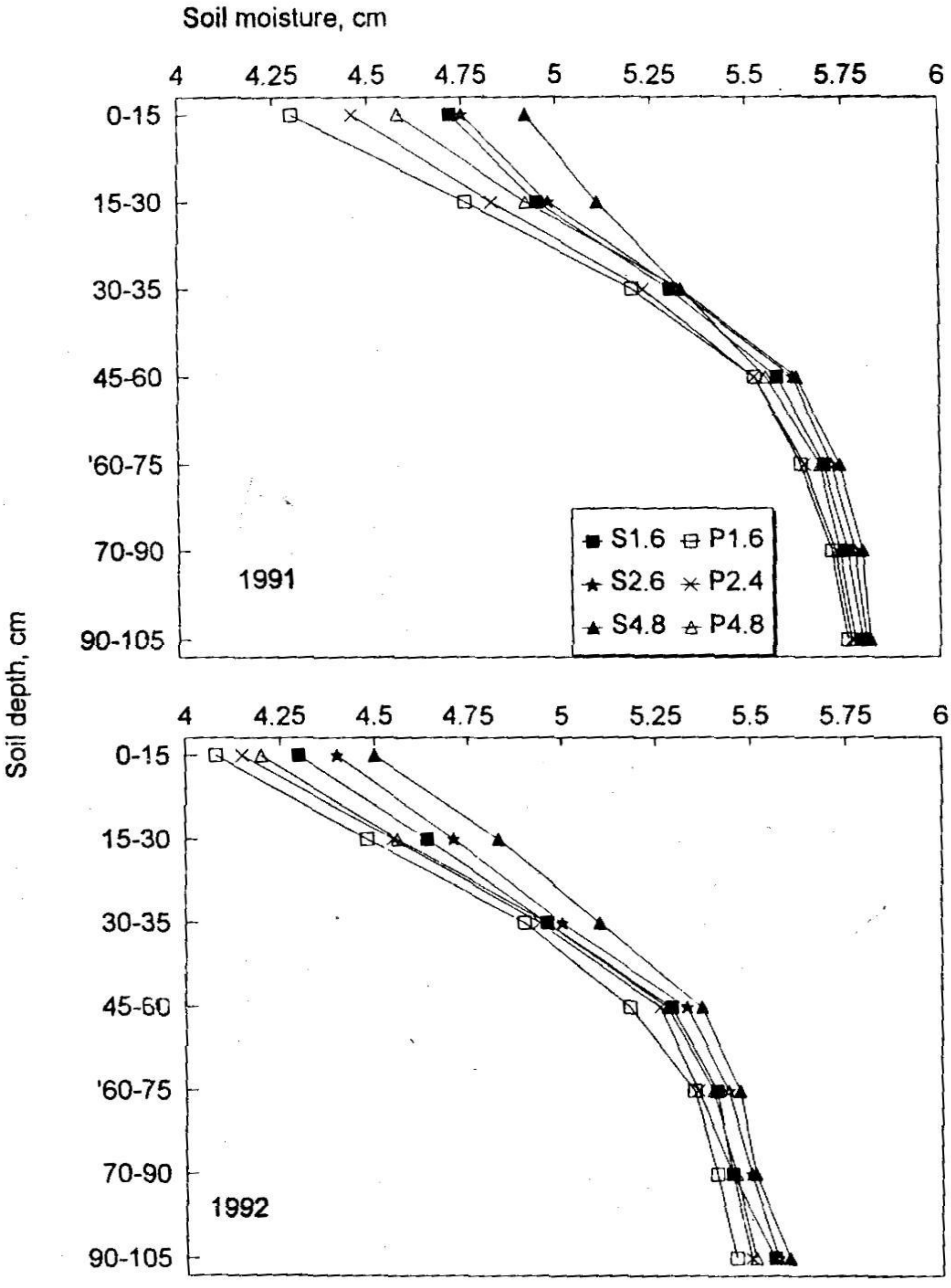

Fig .6 Soil moisture at harvest of soybean and peanut as influenced by bed width in vertisol.

Table 3. Influence of soil drainage on nodulation of soybean and peanut plants

Treatments	Number of nodules per plant			Dry weight of nodules (g/plant)		
	55DAS	65DAS	90DAS	55DAS	65DAS	90DAS
Soybean						
S1.6	20.10	54.20	30.20	2.37	4.66	3.47
S2.4	16.10	47.60	28.20	2.04	3.90	2.82
S4.8	12.60	35.70	26.20	1.73	3.01	2.25
Peanut						
P1.6	37.80	64.80	53.80	1.04	2.22	1.80
P2.4	25.50	51.65	51.80	0.85	2.09	1.67
P4.8	19.30	45.60	48.60	0.73	1.88	1.37

ing effects, which retarded the surface moisture loss through evaporation.

LITERATURE CITED

Agustin, P.C. and Garrity, D.P. 1988. Towards a site characterization methodology for on-farm cropping system Research in rainfed Ricelands. A paper presented at the 4th Scientific meeting of the federation of Crop Science Society of Philippines, held at the Apoview Hotel, Davao city, on April 27-30

Boote, K.J. 1982. Growth stages of peanut (*Arachis hypogaea* L.). *Peanut Sci.* 9:35-40.

Cannell, R.Q. 1979. Effects of soil drainage on root growth and crop production. *In*: Soil physical properties and crop production in the tropics edited by Lal, R. and Taylor, G.S. A Wiley Inter science publication.pp. 183-197.

Das. R.O. 1983. Effect of land configuration of a vertisol on soil moisture conditions, growth and yield of soybean and paddy crops. M.Sc.(Ag) Thesis, J.N. Agricultural University, Jabalpur (M.P.), India.

Drew, M.C. and Trought, M.C. T. 1977. Effects of water logging of soil on growth and nutrient uptake in wheat under controlled laboratory conditions. *Rep. Agric. Res. Coun. Letcombe.* pp.71-74.

Fehr, W.R., Caviness, C.E., Burmood, D.T. and Pennington, J.S. 1971. Stage of development descriptions for soybean, *Glycine max* (L.) Merrill. *Crop Sci.* 11:929-93

Ghowail, S.I. and Shanery, El.W.W. 1978. The effect of water table on field crops. III. Soybean *Agri. Res. Review.* 56,4:29- 34.

Gupta, R.K, Tomar, S.S. and Tomar, A.S. 1979. Improved soil management practices for maize and sorghum grown on vertisols in central India. *J. Agron. and Crop Sci.* 148:478-483.

Gupta, R.K., Sharma, S.G., Tambe, G.P. and Tomar, S.S. 1978. A new approach in farming system for problem soils of central Madhya Pradesh, *JNKVV Res. J.*, 12: 73-79.

Murthy, A.S.P. 1988. Distribution, properties and management of Vertisols in India. Adv. Soil Sci. 8:151-210.

Ogunrenri L.T., Lal, R. and Babalola, S. 1981. Effects of water table depth and calcium peroxide application on cowpea and soybean, *Plant and Soil*, 63,7: 275-281.

Williamson, R. E. and Carreker, John. R. 1970. Effect of water levels on evapo-transpiration and crop yield. Transaction of the ASAE 13, 168-170 and 176.

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PHYSIOLOGICAL ANALYSIS OF VARIETAL VARIATIONS IN YIELD OF INDIAN MUSTARD (*Brassica juncea*) GROWN IN NON-TRADITIONAL AREA

P. LAKSHMAMMA, C.V. RAGHAVAIAH and M.V.R. PRASAD
Directorate of Oilseeds Research, Rajendranagar, Hyderabad 500 030

ABSTRACT

A field experiment conducted during rabi 1993-94 to study the production potential of 9 mustard genotypes and to assess the physiological basis of yields revealed that the varieties TM4 (10.6 q/ha), Varuna (9.88 q/ha) and Pusabahar (10.19 q/ha) exhibited greater yield potential than the rest of the test genotypes. Their superior performance was due to greater number and weight of siliqua/plant besides higher seed number per siliqua resulting in higher harvest indices. These genotypes were found to be physiologically more efficient in terms of LAI, dry matter production, crop growth rate, relative growth rate, net assimilation rate and total dry matter/leaf area ratio in non- traditional area.

Keywords : Physiological analysis; Mustard; Yield; Non- traditional area

INTRODUCTION

Rapeseed and Mustard (*Brassica spp*.) occupy an important position in the oilseed economy of India next to groundnut. Currently India is witnessing crop shifts in favour of oilseeds, especially in non-traditional areas, owing to growing demand for oil, development of high yielding varieties suitable for an array of agro-ecological situations and favourable price structure in comparison with other traditional crops. Though mustard is sporadically raised as a mixed crop along with other rabi crops such as chickpea, coriander, jowar etc., in certain pockets to meet the domestic culinary requirements in Southern parts of the country, very few attempts were made to systematically evaluate the production potential and growth parameters in non-traditional areas of Deccan plateau. Hence, an attempt was made to assess the yield potential of mustard (*Brassica juncea* L.) varieties and analyse physiologically the varietal variations in seed yield of mustard under the agro-climatic situations of Hyderabad.

MATERIAL AND METHODS

A field experiment was conducted during rabi 1993-94 at the experimental farm of the Directorate of Oilseeds Research, Hyderabad to study the production potential of nine mustard varieties viz., Pusabold, Vardan, Vaibhav, Kranti, RLN 619, Pusa basant, TM 4, Varuna and Pusabahar and to analyse the Physiological basis of yield in terms of growth parameters. The soil of the experimental field was sandy loam with pH 6.8, low in nitrogen and phosphorus and medium in potassium status. The experiment was laid in Randomized Block Design with three replications on November 19,1993 after the harvest of groundnut crop with a spacing of 30 x 15 cm in plots of 3 x 3 m. size. the crop received 60 kg N, 40 kg P_2O_5 and 30 kg K_2O per hectare in the form of diam-

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monium phosphate, single superphosphate and muriate of potash, respectively. Half of the N and the entire dose of P and K were applied as basal dose, while the remaining N was top dressed twice in equal quantities at 30 and 50 days after sowing. Observations were made on growth parameters such as plant height, number of branches/plant, number of leaves/plant and dry matter at 15 day interval commencing from 55 DAS upto harvest. Various growth parameters such as leaf area index (LAI), crop growth rate (CGR), relative growth rate (RGR), net assimilation rate (NAR) were computed following the formula as described by Watson (1952). The seed yield and yield components such as number of siliqua/plant, siliqua weight/plant, 1000 seed weight and harvest index were recorded at the time of harvest. The oil content in the seed was estimated following NMR method.

RESULTS AND DISCUSSION

Growth and growth parameters

The crop growth, expressed in terms of plant height, number of branches/plant and number of leaves/plant (Table 1) revealed that, Varuna remaining comparable to RLN 619, Pusabasant and Pusabahar produced taller plants than the rest of the test varieties, with TM4 being the shortest one.

In branching, Pusabasant was comparable to Varadan, Kranti, RLN 619, Varuna and Pusabahar but superior to TM 4 and Vaibhav. The functional leaf number/plant in relation to time, showed that there was a gradual reduction in leaf number with advancement in crop age from 55 through 85 days after sowing. The cultivar Pusabasant remaining on par with Varuna and RLN 619 registered substantially higher number of leaves than the rest at 55 DAS and tended to maintain more leaves upto 85 DAS. The genotype TM 4 had the least number of leaves/plant all through the growth period indicating its earliness relative to the other test genotypes. Such varietal differences in respect of various morphological parameters were also reported by Mehrotra *et al.* (1976).

The total dry matter (TDM) increased with crop age upto harvest (Table 1). At 55 days, all the genotypes produced significantly higher dry matter than Pusabold, while at 70 DAS Pusabold, vaibhav, Kranti and TM 4 lagged behind the others. At harvest, Varuna and Pusabahar emerged as the producers of significantly higher dry matter than the others. Pusabold, Vardan and Vaibhav produced relatively lower dry matter. These varieties possessed higher stem dry weight. Although leaf dry weight in these genotypes was higher at 55 DAS, it declined later with age. This could be due to translocation of assimilates from source to sink.

The leaf area index (LAI) declined with crop age with maximum values at 55 DAS. Although the genotypes did not differ significantly at this stage, RLN 619 followed by Pusabahar had higher leaf area index. At 85 DAS, the genotypes TM 4, Kranti, varuna and Pusabasant had lower LAI than the other varieties (Table 2).

By and large the crop growth rate (CGR) and relative growth rate (RGR) of varieties declined from 55 DAS upto harvest stage barring in TM 4, Varuna and Kranti where it increased upto 85 DAS and then decreased at harvest. This was probably due to enhancement in siliqua number and siliqua weight on different branches. At 85 DAS, Varuna registered substantially greater CGR and RGR values followed by Kranti and TM 4.

Table 1. Morphological characters and total dry matter of mustard varieties grown in Hyderabad.

Variety	Plant height (m)	No. of Branches/Plant				No. of leaves/plant at (DAS)			Total dry matter (g/m^2) at (DAS)			
		Primary	Secondary	Tertiary	Total branches	55	70	85	55	70	85	At harvest
Pusabold	1.23	4.89	5.44	7.17	17.5	30.75	10.17	4.67	265.98	514.8	647.24	649.66
Vardan	1.21	4.55	10.19	3.83	18.57	44.71	11.50	6.83	429.88	580.8	638.88	660.22
Vaibhav	1.24	4.56	3.33	2.67	10.56	33.33	8.33	3.67	365.2	506.8	654.72	704.00
Kranti	1.09	5.89	6.56	5.57	18.01	41.72	9.83	5.50	407.44	510.18	688.38	734.14
RLN 619	1.38	5.00	9.56	3.50	18.06	47.54	13.50	6.30	477.84	634.92	770.0	825.66
Pusabasant	1.37	6.22	10.31	4.17	20.70	55.79	13.33	6.50	379.06	597.3	698.5	760.98
TM 4	0.92	4.22	4.44	3.50	12.17	20.19	5.33	3.00	357.5	436.48	611.6	770.44
Varuna	1.43	5.33	9.90	5.50	19.38	47.95	14.17	8.03	478.94	605.0	888.8	923.78
Pusabahar	1.30	4.44	6.22	8.33	19.00	45.36	12.33	6.33	469.92	641.3	820.6	892.76
SEm±	0.05	0.49	0.90	1.55	1.81	2.25	1.58	0.70	47.74	36.96	46.2	46.2
CD (0.05)	0.163	1.598	2.935	5.055	5.903	7.338	5.153	2.283	155.69	120.54	150.66	150.66

Variety	Leaf Area Index at (DAS)			CGR ($g/m^2/d$) at (DAS)			RGR (mg/g/d) at (DAS)			NAR ($mg/m^2/d$)		TDM\LA ratio (DAS)		
	55	70	85	70	85	At harvest	70	85	At harvest	70	85DAS	55	70	85
Pusabold	4.54	1.84	0.77	9.73	8.83	4.43	24	15	1	0.6	0.8	2.54	2.78	9.34
Vardan	2.59	1.61	1.09	10.06	3.86	1.21	20	9	2	0.5	0.3	1.66	3.66	6.15
Vaibhav	1.81	1.39	0.71	9.45	9.85	3.30	22	17	5	0.6	1.0	2.19	3.64	9.60
Kranti	2.33	1.80	0.46	6.85	11.88	3.96	15	20	6	0.3	1.1	2.02	2.84	11.24
RLN 619	3.22	1.97	0.67	10.49	9.00	3.37	18	14	5	0.5	0.8	1.60	3.24	11.64
Pusa basant	2.45	1.78	0.56	14.55	6.76	5.97	31	10	6	0.7	0.7	1.54	3.44	11.73
TM 4	2.55	1.02	0.46	14.55	6.76	5.97	31	10	6	0.4	1.5	2.54	3.44	11.73
Varuna	2.66	1.28	0.58	8.41	18.92	2.33	15	26	6	0.4	2.3	1.91	4.83	15.30
Pusabahar	2.69	1.38	0.62	11.42	7.28	4.81	21	16	6	0.7	1.3	2.11	4.72	13.31
SEm ±	0.52	0.14	0.09	1.62	1.98	0.71	08	6	5	0.1	0.2	0.43	0.35	1.30
CD (0.05)	NS	0.457	0.294	5.283	6.457	2.315	26	20	2	0.33	0.65	NS	1.141	4.24

Table 3. Seed yield and yield components in mustard varieties in Hyderabad

Variety	Siliqua no. /plant on			Total siliqua/ plant	Siliqua weight (g) on			Total siliqua Weight/plant (g)	Seed yield (q/ha)	1000 seed weight (g)	Harvest index (%)	Oil content (%)
	Primaries	Secondaries	Tertiaries		Primaries	Secondaries	Tertiaries					
Pusabold	134.0	71.0	44.3	249.3	11.38	4.68	1.75	17.81	3.98	6.19	15.10	29.66
Vardan	187.8	99.5	29.0	316.3	10.15	5.69	0.82	16.66	2.59	4.13	13.30	28.97
Vaibhav	136.9	125.3	30.3	292.5	10.60	7.08	0.67	18.32	9.00	4.08	19.52	30.00
Kranti	148.5	64.0	28.9	241.4	14.20	4.85	0.88	19.93	5.48	5.66	16.36	30.33
RLN 619	166.2	121.7	27.3	315.1	15.55	6.57	0.68	22.80	6.73	4.53	13.84	29.13
Pusabasant	164.0	143.0	20.4	327.4	12.45	8.10	0.55	21.10	6.46	7.19	17.37	29.70
TM 4	221.5	120.0	13.3	354.7	13.40	5.37	0.25	24.35	10.65	3.21	19.41	31.03
Varuna	242.3	136.7	32.3	411.3	18.13	8.67	0.38	27.18	9.88	6.67	16.09	30.10
Pusabahar	192.3	135.7	29.7	357.7	16.27	8.27	1.06	25.42	10.19	6.68	17.30	31.37
SEm ±	7.74	9.84	2.65	12.31	1.15	0.68	0.11	1.59	1.28	0.20	2.74	0.25
CD (0.05)	25.242	32.090	8.642	40.145	3.750	2.218	0.359	5.185	4.174	0.652	NS	NS

At harvest, TM 4 recorded significantly higher RGR than the rest of the genotypes (Table 2).

The net assimilation rate (NAR) also followed similar trend as that of CGR and RGR. The genotypes TM 4 and varuna exhibited significantly higher NAR compared with other varieties. Mehrotra *et al.* (1976) also reported considerable variability among varieties in respect of net photosynthetic rate, dry matter, leaf area index etc.

The photosynthetic efficiency, as represented by TDM, leaf area ratio exhibited a gradual enhancement with crop age due to leaf senescence and varietal variations were also observed (Table 2). Of the test genotypes, TM 4, Varuna and Pusabahar showed distinctly greater TDM/LA ratios. Correlation coefficients worked out between TDM/LA ratio and seed yield were found to be positively related ($r = 0.81$).

Yield and Yield Components

The genotypes differed significantly in seed yield where TM 4, Pusabahar, Varuna, Vaibhav and RLN 619 offered discernible increase in yield over the rest of the test genotypes (Table 3). Such genotypic variations in seed yield of mustard were also reported by Pathak and Pal (1990), Jain *et al.* (1989), Shastry and Kumar (1981) and Mehrotra *et al.* (1976).

The number and weight of siliqua on primary, secondary and tertiary branches at harvest (Table 3) revealed that the genotypes TM4 and varuna were bearing more number of siliqua on primaries, while those on secondary branches were higher in case of Pusabasant, TM 4 and Varuna. The total siliqua number/plant was substantially higher in Varuna than the rest, while in total weight of siliqua/plant, Varuna was comparable to Pusabahar, TM4 and RLN 619 (Table 3).

The test weight of seed was substantially higher in Varuna, Pusabahar and Pusabasant than other varieties. Though TM 4 produced seeds of lower test weight its higher yield potential could be due to greater number and weight of siliqua apart from higher seed number/siliqua (Table 3). The varieties studied did not differ in their oil content.

From the foregoing account it could be inferred that among the test genotypes TM 4, Varuna and Pusabahar exhibited greater yield potential in terms of various growth parametes and as a consequence of better physiological efficiency in dry matter production, leaf area index, CGR, RGR, NAR and TDM/LA when grown in non-traditional area like Hyderabad.

LITERATURE CITED

Jain, V.K., Chauhan, Y.S., Khandekar, M.P. and Jain, P.C. 1989. Effect of sowing dates and genotypes on yield and yield attributing traits in Indian mustard. *Madras agric Journal* 76: 241-246.

Mehrotra, O.N., Saxena, H.K. and Mohd. Moosa. 1976. Physiological analysis of varietal differences in seed yield of Indian mustard. *Indian J. of Pl. Physiolo.* 19: 139-146.

Pathak, S. and Pal, M.K. 1990. Performance of mustard in farmers fields in West Bengal. *Ann. of agric. Res.* 11: 263-267.

Shastry, A.B. and Arvind Kumar. 1981. Variations in yield, its attributes and quality of Indian mustard in relation to planting time and levels of plant population. Indian *J. of agric. Sci.* 51: 27-32.

Watson, D.J. 1952. The physiological basis of variation in yield. *Adv. Agron.* 4: 101-145.

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RESPONSE OF SOYBEAN GENOTYPES TO VARYING DEGREES OF PLANT DENSITY

H.B. BABALAD, B.S. LINGARAJU and G.D. RADDER
All India Co-ordinated Research Project on Soybean, Main Research Station, University of Agricultural Sciences, Dharwad - 580 005

ABSTRACT

The spatial distribution of plants in a crop community is an important determinant of yield. The varieties respond differently to changing plant density. Field experiments were conducted to evaluate the response of soybean varieties to plant density at Main Research Station, Dharwad. Population densities used in evaluation varied from 0.2 to 0.6 million plants ha^{-1}. Yield of semi determinate cultivars JS-335 and DS-86-75 increased significantly with successive increase in plant density. However, the varieties MACS-58, KHSb-2 and MACS-329 the increase in plant density resulted in increased interplant competition and there was no yield response. Among the varieties, during both the years of evaluation, JS-335 recorded significantly higher yield and was followed by JS-87-28. The varieites KHSb- 2 and MACS-329 noticed lower yield and not responded to higher population densities. The data suggested higher population densities for semi determinate varieties.

Keywords: Soybean; Genotypes; Population; Yield

INTRODUCTION

The spatial distribution of plants in a crop community is an important determinant of yield and many experiments have been conducted to determine the spacing between rows and between plants within row that maximizes yield. The cultivars responded differently, early maturity groups and determinate types produced higher yield at high population densities and they differed with late maturity and indeterminate types (Parvez *et al.,* 1989). This disparity in seed yield response is mainly due to inherent difference in their growth habit and canopy development.

Recently, soybean is becoming an important crop in northern parts of Karnataka and grown mainly during *kharif* season on medium deep black soils. With the introduction of the crop, several high yielding varieties suitable for the region have been identified. The cultivars have shown different growth habits and maturity, at different situations. Therefore, this study was conducted to assess the effects of population densities on vegetative and reproductive growth and development in soybean genotypes.

MATERIAL AND METHODS

The study was conducted at Main Research Station, Dharwad on a well drained medium black cotton soils during *kharif* season of 1992-93 and 1993-94. Six soybean cultivars, DS-86-75, KHSb-2, MACS-329, MACS-58, JS-335 and JS-87-28 as main plot treatments and three populations densities, 0. 2 (30 x 16 cm), 0.4 (30 x 8.3 cm) and 0.6 (30 x 5.5 cm) million plants ha^{-1} as sub-plots were used. The plots were 5

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m long and 3.6 m wide and laid out in a split plot design with three replications.

Fertilizers @20-80-40 (N-P_2O_5-K_2O) kg ha^{-1} were applied as basal. Seeds were treated with Capton @ 3 g/kg seed prior to seeding and inoculated with *Brady rhizobium japonicum* @ 375 g/ha. Rows were thinned to one plant per hill for the appropriate spacing between plants, as per treatments. Alachlor herbicide @ 2.0 kg a.i/ha was applied immediatley after sowing. The recommended plant protection measures were taken to control *spodoptera* and *cidia* during both the years of study. The climatic conditions were favourable with 690 and 642 mm rainfall during the crop growing period of 1992 and 1993, respectively.

RESULTS AND DISCUSSION

The general pattern of changes in yield of soybean with increasing plant population density (PPD) was similar in 1992 and 1993 (Table 1). Seed yield increased significantly with increasing PPD during both the years. The PPD of 0.6 mill. ha^{-1} recorded significantly higher yield (2535 and 3038 kg ha^{-1}) during 1992 and 1993 *kharif*, respectively, whereas 0.2 mill. ha^{-1} PPD noticed significantly lower yield during 1993 and on par yield with 0.4 million ha^{-1} PPD during 1992. The vegetative growth, plant height increased significantly with increase in PPD, whereas branches per plant differed significantly during 1992 and were on par during 1993. In general, yield components, pods $plant^{-1}$ and seed weight $plant^{-1}$ decreased significantly with increase in PPD. However, the decrease in yield components were compensated with increase in population at higher PPD and recorded higher yield.

Varieties differed significantly with respect to seed yield during both the years. The semi-determinate and early maturing vatiety JS-335 recorded significantly higher yield (2804 and 3336 kg ha^{-1}) over rest of the varieties during 1992 and 1993, respectively. The increase in yield was 37% over recommended semi-determinate variety KHSb-2 (1965 and 2697 kg ha^{-1})in both the years. JS-335 was fol-

Table 1. Soybean yield (kg/ha) as influenced by varieties and plant population

Varieties	Population (mill/ha)							
	1992-93				1993-94			
	0.2	0.4	0.6	Mean	0.2	0.4	0.6	Mean
DS-86-75	2042	2119	2711	2291	2336	2797	2956	2697
KHSb-2	1861	2034	1998	1965	2645	2790	2656	2697
MACS-329	1893	2097	2395	2128	2268	2384	2469	2374
MACS-58	2156	2247	2237	2213	3118	3268	3171	3161
JS-335	2445	2710	3255	2804	3067	3356	3578	3336
JS-87-28	2295	2460	2615	2457	3059	3245	3394	3233
Mean	2116	2278	2535		2749	2973	3038	
CD at 5%								
Varieties				205				62
Population				178				52
Interaction				324				120
CV%				11.34				7.80

lowed by JS-87-28, MACS-58, DS-86-75 and KHSb-2 in the order of seed yield during both years. The increase in yield was attributed to higher number of branches, pods plant^{-1} and seed weight plant^{-1}. JS-335 recorded significnatly higher seed weight (11.6 and 11.8 g/plant) over rest of the treatments during 1992 and 1993, respectively. Whereas number of branches were significant during 1992 and number of pods per plant during 1993. The genotypes JS-335, JS- 87-28 and DS-86-75 noticed significantly lower plant height as compared to KHSb-2, MACS-329 and MACS-58.

The interaction effect between varieties and PPD was significant. The seed yield increased with increasing PPD for JS-335 and DS-86-75 during both the years. The semi determinate cultivars JS-335 recorded higher yield at PPD of 0.6 mill. ha^{-1} indicating that interplant competition was less. At Sehore (MP) on medium black soils semi-determinate cultivar JS-81-335 noticed significantly higher yield with increase in PPD up to to 0.6 mill. ha^{-1} (Sharma and Sharma, 1993). The yield increase in PPD up to 0.6 mill. ha^{-1}in JS-335 was due to increase in seed weight per plant (Table 2). Similarly, Egli (1988) reported that, increase in yield was directly proportional to increase in seed weight and seed number per plant. The interaction of growth and yield components were non-significant indicating that there was no effect of PPD on soybean varieties tested. The individual plant performance was not affected and increase in population density has resulted in higher seed yield.

The increase in seed yield with increase in PPD was much less and non-significant in semi-determinate types, KHSb-2 and MACS-58. These varieties noticed higher yield at PPD of 0.4 mill. ha^{-1} and reduced with higher PPD

Table 2. Plant height (cm), branches per plant, pods per plant and seed yield (g/plant) as influenced by varieties and population.

Varieties	Plant ht (cm)		Branches/plant		Pods/plant		Seed weight (g/plant)	
	1992	1993	1992	1993	1992	1993	1992	1993
DS-86-75	47.6	51.3	2.93	3.13	36.5	46.3	8.4	9.3
KHSb-2	77.2	75.1	2.82	2.97	33.9	43.4	7.8	8.7
MACS-329	71.6	78.0	2.47	3.00	34.3	43.4	7.8	8.5
MACS-58	76.6	105.7	2.76	3.02	33.1	38.8	9.5	9.9
JS-335	46.9	46.4	4.76	3.87	39.5	49.8	11.6	11.8
JS-87-28	46.3	47.9	4.20	3.40	36.2	47.2	9.8	11.2
Plant density (mill./ha)								
0.2	59.2	63.8	4.02	3.40	46.7	49.4	12.2	12.8
0.4	60.6	67.6	2.87	3.08	34.5	44.3	9.0	9.4
0.6	63.2	70.8	2.40	2.84	25.6	40.8	6.4	7.1
CD (0.05)								
Varieties	7.81	3.15	1.18	NS	NS	3.58	1.68	0.30
Population	2.61	1.56	0.45	0.15	4.63	0.96	0.89	0.43
Interaction	NS	4.36	NS	NS	NS	NS	NS	0.91
CV %	6.21	13.4	17.0	7.05	17.0	13.12	13.9	6.42

(0.6 mill. ha^{-1}). which suggest that interplant competition was occurring due to mutual shading as density increases. Similarly Shanthaveerabhadraiah *et al.* (1986) noticed higher yield with 0.4 mill. plant population ha^{-1} for semi-determinate varieties KHSb-2 and indeterminate Hardee. It confirms that higher PPD are required for semi-determinate and short duration varieties to maximize yields.

LITERATURE CITED

Egli, D.B. 1988. Plant density and soybean yield. *Crop Sci. : 977-981*

Parvez, A.Q., Gardner, F.P. and Boote, K.J., 1989. Crop ecology, production and management. *Crop Sci.* 29 : 150-157

Shanthaveerabhadraiah, S.M., Patil. M.P. and Rajappa, M.G., 1986. Influence of sowing dates and plant population on soybean varieties. *Mysore J. Agric. Sci.* 20: 19-22

Sharma, J.P. and Sharma, S.P., 1973. Influence of genotypes and plant densities on physiological parameters, grain yield and quality of soybean. *Indian J. Agron.* 38 (2) : 311 - 313

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EFFECT OF INTERCROPPING OF VARIOUS OILSEEDS AND PULSES IN GROUNDNUT ON YIELD AND ECONOMICS IN WESTERN PLAIN ZONE OF MAHARASHTRA

D.K. KATHMALE, R.C. PATIL and B.B. MULIK
Agricultural Research Station, Mahatma Phule Krishi Vidyapeeth, K.Digraj
Sangli 416 305, Maharashtra.

ABSTRACT

A field experiment was conducted on medium deep black soils during rainy seasons of 1992 and 1993 on intercropping of various oilseeds and pulses in groundnut in 6:2 row proportions. The yield of groundnut declined due to introduction of various intercrops. However, groundnut + soybean, groundnut + sunflower and groundnut + greengram intercropping system showed the higher productivity as well as monetory returns as compared to sole crop of groundnut. The groundnut equivalent yield (2210 kg/ha) and net returns (Rs. 10727 per ha) as well as LER (1.28) and cost- benefit ratio (2.13) were the highest from the groundnut + soybean intercropping system, followed by the groundnut + sunflower and groundnut + greengram intercropping systems.

Keywords : Groundnut; Oilseeds; Intercropping; Economics; LER

INTRODUCTION

Groundnut is one of the important sources of vegetable oil in India. It is largely grown as rainfed crop in many cropping systems. The yields fluctuate every year. Intercropping is one of the important cropping systems recommended to mitigate the aberrant climatic conditions (Willey, 1979). In order to stabilize the yield and to obtain higher monetary returns an experiment was conducted to study the effect of intercropping of various oilseeds and pulses in groundnut.

MATERIAL AND METHODS

A field experiment was conducted at Agricultural Research Station, K. Digraj, Sangli in the rainy season (*kharif*) of 1992 and 1993. The soil of the experimental field was medium deep black clay loam in texture and slightly alkaline in reaction (pH 7.65). It has low available nitrogen (174 kg/ha) and low available phosphorus (12 kg/ha) and very high potash (425 kg/ha). The total annual precipitation received in 1992 was 313.5 mm in 27 days while in 1993 it was 418.8 mm in 38 days. However, the precipitation received during the crop growth period was 150 mm in 15 days in 1992 and 219.6 mm in 23 days in 1993. The treatment consisted of sole crops of groundnut, castor, sunflower, soybean, sesamum, greengram, blackgram and frenchbean and the intercropping of these in groundnut in 6:2 row proportion. The plant population of the main crop was adjusted by reducing the plant to plant distance (from 10 cm to 7.5 cm). The 15 treatment combinations were tested in a Randomized Block Design with three replications. The sowing of the crop was done on 22nd July in 1992 and 22nd June in 1993. All recommended crop management

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practices were followed as and when required. The values of land equivalent ratio were taken to compute yield advantages (Mead and Willey, 1980). The total productivity was given in terms of groundnut equivalent after converting intercrop yield into groundnut based on market prices.

RESULTS AND DISCUSSION

Maximum and significant higher groundnut equivalent yield was observed from groundnut + soybean intercropping system during both the years as well as in pooled mean. This was followed by the groundnut + sunflower and groundnut + greengram intercropping system. Maximum dry pod yield of sole crop of groundnut variety JL-24 (2065 hg/ha) was observed during the year 1993. The yield reduction of groundnut was less in groundnut + sunflower and groundnut + blackgram intercropping systems as reported by Biradar *et al.* (1986). Among the various oilseeds and pulses as an intercrop in 6:2 proportion, soybean gave highest yield (1380 kg/ha) followed by blackgram (593 kg/ha), greengram (565 kg/ha) and sunflower (514 kg/ha). Very low yield of sesamum was observed in sole crop as well as an intercrop during both the years. This is mainly because of low plant stand due to excess moisture immediately after sowing.

The biological advantages as measured in terms of LER was found to increase in various intercropping systems compared to sole crop treatments except with groundnut + frenchbean intercropping system. It ranged from 7 to 28 per cent in different treatments. The LER value recorded in groundnut + soybean intercropping system in 6:2 row proportion was the highest (1.28) indicating on an average 28 per cent biological advantage (Table 1).

Economic evaluation in terms of gross and net returns showed that the intercropping system of groundnut + soybean gave the highest gross returns as well as net returns (average being 19970 and 10727 Rs./ha respectively) during both the years which was closely followed by groundnut + sunflower (Rs. 17322 and 8491 per ha respectively) and groundnut + greengram (Rs. 16984 and Rs. 8134 per ha respectively).

The benefit-cost ratio was the highest in groundnut + soybean intercropping system (2.13). Thus growing of groundnut + soybean, groundnut + sunflower or groundnut + greengram intercropping systems in 6:2 row proportion with 100% population of groundnut is viable and recommended for higher monetary benefits.

LITERATURE CITED

Biradar, D.P., Patil, V.S., Hunshal, C.S. and Hiremath, S.M. 1986. Intercropping of spreading groundnut with sunflower, *J. of Maharashtra agric. Uinv.* 13 (2) : 238-9.

Mead, R. and Willey, R.W. 1980. The concept of land equivalent ratio and advantage in yields from intercropping. *Experimental Agriculture* 16: 217-28.

Willey, R.W. 1979. Intercropping, its importance and research needs. *Field Crop Abstr.* 31 (1) : 1-31.

Table 1. Evaluation of intercropping system as influenced by different treatments

Sl. No.	Treatment	Mean plant stand 000/ha (1992 and 1993)		Yield (kg/ha)						Groundnut equivalent yield kg/ha			Mean LER	Mean Net Returns Rs./ha	Mean B:C Ratio
				1992		1993		Mean							
		*M.C.	*I.C.	*M.C.	*I.C.	*M.C.	*I.C.	*M.C.	*I.C.	1992	1993	Mean			
1	Sole groundnut	265	-	758	-	2065	-	1412	-	758	2065	874	-	8077	1.88
2	Sole castor	45	-	752	-	1516	-	1134	-	376	1187	448	-	2311	1.28
3	Sole sunflower	46	-	720	-	1710	-	1215	-	450	1262	522	-	4050	1.55
4	Sole soybean	263	-	1895	-	2164	-	2030	-	1036	1411	1070	-	6728	1.96
5	Sole sesamum	192	-	168	-	304	-	236	-	262	396	274	-	-2752	0.59
6	Groundnut + castor	255	12	501	500	1258	584	880	542	751	1716	837	1.16	5800	1.62
7	Groundnut + sunflower	252	14	651	463	1545	564	1098	514	940	1965	1032	1.23	8491	1.93
8	Groundnut + soybean	258	71	516	1331	1285	1424	901	1380	1133	2210	1229	1.28	10727	2.13
9	Groundnut + sesamum	250	50	92	89	1467	78	980	84	632	1572	716	1.07	4336	1.4
10	Sole greengram	282	-	729	-	1824	-	1277	-	569	1743	674	-	6807	1.92
11	Sole blackgram	304	-	1143	-	2097	-	1620	-	522	1322	594	-	4154	1.57
12	Sole frenchbean	296	-	1372	-	964	-	1168	-	589	1005	626	-	2477	1.34
13	Groundnut + greengram	252	72	611	370	1124	760	918	565	899	1952	993	1.16	8134	1.89
14	Groundnut + blackgram	242	69	677	446	1346	740	1012	593	879	1812	963	1.15	7273	1.8
15	Groundnut + frenchbean	250	70	538	336	1424	249	981	293	683	1686	790	0.95	5176	1.54
	S.E. ±									25	80	126			
	C.D. at 5%									72	231	252			

* M.C. : Main crop
* I.C. : Inter crop

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RESPONSE OF LINSEED TO PHOSPHORUS AND POTASSIUM LEVELS UNDER RAINFED CONDITIONS

G.P. PALI, C. SARKAR, S.R. PATEL, and R.S. TRIPATHI
Department of Agronomy, Indira Gandhi Agricultural University, Raipur - 492 012

ABSTRACT

Field experiments were carried out in sandy loam soils of Raipur, Madhya Pradesh during *rabi* seasons of 1992-93 and 1993-94 to determine the proper P and K requirements of rainfed linseed. Results reveal that it responded to 40 kg P_2O_5 /ha and 20 kg K_2O/ha for good yields mainly due to improvement in plant height, branches/plant, capsules/plant, seeds/capsule and 1000-seed weight.

Keywords : Linseed; Rainfed; Phosphorus; Potassium; Monetary return.

INTRODUCTION

Linseed (*Linum usitatissimum* L.) is one of the important oilseed crop which is extensively grown in Chhattisgarh region of Madhya Pradesh under rainfed conditions. Its productivity in the state is very low (2.93 q/ha) as compared to its potential yield of about 6 and 12 q/ha under rainfed and irrigated conditions, respectively. The inadequate use of fertilizers is the reason for low yields. The crop has shown positive response to P and K fertilization even under rainfed conditions (Singh *et al.,* 1975). The present investigation was undertaken to determine the proper P and K requirements for rainfed linseed.

MATERIAL AND METHODS

Field experiments have been carried out on sandy loam soil at Indira Gandhi Agricultural University, Raipur, Madhya Pradesh during *rabi* seasons of 1992-93 and 1993-94. The soil of the experimental field was neutral in reaction (soil pH 7.2), it had low N (212 kg/ha), P (7.5 kg P_2O_5) and high K (352 kg K_2O/ha) contents. The rainfall during the crop season was 44.5 and 15.6 mm in the two consecutive years. The treatments consisting of four levels of phosphorus (0, 20, 40 and 60 kg P_2O_5/ha) and three levels of potassium (0, 20 and 40 kg K_2O/ha) were tested in Randomized Block Design with four replications. The carrier for phosphorus and potassium was single super phosphate and muriate of potash, respectively. A uniform dose of 30 kg N/ha through urea was applied to all plots along with p and K as per treatments as basal application. Sowing was done on October 15 and 20 during 1992 and 1993 respectively with seed rate of 30 kg/ha by drilling in the rows 25 cm apart. The test crop was linseed cv. Kiran Harvesting was done on February 22 and 24 during 1993 and 1994 respectively. Data on growth and yield parameters and finally on seed yield were recorded.

RESULTS AND DISCUSSION

Phosphorus levels

Every incremental dose of 20 kg P_2O_5/ ha in general, exhibited increasing trend in plant height, branches/plant, capsules/plant, seeds/capsule and 1000-seed weight from 0 to

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60 kg P2O5/ha in both the years (Table 1). But differences were significant beyond 40 kg P_2O_5/ha for capsules/plant and seeds/capsule and beyond 20 kg K_2O/ha for other characters. Consequently, the seed yields increased up to 40 kg P_2O_5/ha and further increase in P dose did not improve the yield parameters and even a little reduction in yield was observed (Table 2). The increase in yield between 20 and 40 kg P_2O_5/ha was also not significant during 1993-94. But monetory returns (based on two years mean yield data) significantly increased upto 40 kg P_2O_5/ha. The net profit and profitability (gross profit over every rupee of investment) also increased upto 40 kg P_2O_5/ha. Sharma and Rajput (1984) and Awasthi *et al.*, (1989) have also reported the response of rainfed linseed varieties from 20 to 30 kg P_2O_5/ha at differen locations.

Potassium levels

Different levels of K did not cause marked influence on plant height. However, application of 20 kg K_2O/ha significantly increased the growth and yield parameters viz. branches/plant, capsules/plant, seeds/capsule and 1000-seed weight as compared to control. Supplementation of additional 20 kg P_2O_5/ha over it though increased these parameters, the differences were not significant. Because of superiority in these yield attributes, seed yields increased up to 40 kg K_2O/ha with the remarkable rate of increase only up to 20 kg K_2O /ha (Table 2). The gross profit also increased up to 40 kg K_2O/ha with significant variation up to 20

Table 2. Effect of P and K levels on seed yield and economics of rainfed linseed (cv. Kiran)

Treatment	Seed yield (q/ha)			Monetary return (Rs./ha) (Mean basis)	Net return (Rs./ha)	B : C ratio
	1992-93	1993-94	Mean			
P_2O_5 kg/ha						
0	4.80	3.92	4.36	5232	2382	1.83
20	6.08	4.77	5.43	6516	3432	2.10
40	7.00	4.98	5.99	7188	3858	2.19
60	6.89	4.98	5.95	7128	3558	1.99
CD (0.05)	0.48	0.33	0.42	492	-	-
K_2O kg/ha						
0	5.62	4.35	4.99	5988	2838	1.90
20	6.34	4.68	5.54	6648	3398	2.04
40	6.60	4.96	5.76	6912	3622	2.06
CD at 5%	0.42	0.30	0.38	431	-	-
cv%	16.30	17.95	17.22	21.8	-	-

B : C ratio - Benefit : Cost ratio

Market price used for the calculation was Rs. 12 per kg of linseed and

Rs. 12 and 5 per kg phosphatic and potassic fertilizers respectively.

Table 1. ***Effect of P and K levels on growth and yield parameters of rainfed inseed (cv. Kiran.)***

Treatment	Plant height (cm)			Branches/plants (No.)			Capsules/plant (No.)			Seeds/capsule (g)			1000-Seed weight		
	1992-93	1993-94	Mean	1992-93	1993-94	Mean	1992-93	1993-94	Mean	1992-93	1993-94	Mean	1992-93	1993-94	Mean
P_2O_5 kg/ha															
0	42.8	43.6	43.2	4.2	4.1	4.2	32	30	31.0	7.0	6.3	6.6	6.1	6.2	6.3
20	48.5	48.4	48.5	5.5	5.2	5.4	39	35	37.0	8.1	8.1	8.1	7.1	6.8	6.9
40	51.8	50.7	51.4	5.6	5.4	5.5	43	40	41.5	8.9	8.8	8.8	7.2	6.9	7.2
60	53.3	52.9	53.1	5.5	5.5	5.5	42	41	41.5	9.0	8.7	8.9	7.1	7.0	7.1
CD (0.05)	5.1	4.6	4.8	0.5	0.3	0.4	3.5	4.1	3.8	0.4	0.6	0.5	0.5	0.6	0.5
K_2O kg/ha															
0	48.2	48.5	48.4	4.8	4.6	4.7	35	32	33.5	7.9	7.7	7.8	6.4	6.3	6.4
20	49.9	48.8	49.3	5.3	5.2	5.3	40	38	39.0	8 .1	8.1	8.2	7.1	7.0	7.0
40	49.4	49.1	49.3	5.5	5.3	5.4	42	39	40.5	8.3	8.2	8.3	7.1	7.3	7.2
CD at 5%	NS	NS	NS	0.4	0.2	0.3	3.1	3.4	3.4	0.2	0.4	0.4	0.3	0.5	0.3
CV %	20.9	17.6	19.5	20.7	19.4	20.1	15.3	12.4	14.5	17.3	15.4	16.4	10.6	13.1	12.0

kg/ha. The net profit also increased up to the highest level, but rate of increase in profit (B : C ratio Benefit : Cost) was not appreciable beyond 20 kg K_2O/ha. The interaction between phosphorus and potassium for seed yield and yield contributing characters showed non-significant differences.

The above findings clearly indicates that good yield and profitability of rainfed linseed could be obtained with the application of 40 kg P_2O_5/ha and 20 kg K_2O/ha.

LITERATURE CITED

Awasthi, U.S., Jha,G., Namdeo, N., Shukla, N.P. and Singh, R. 1989. Response of linseed to nitrogen and phosphorus levels. *Indian J.Agron.* 34 (4) : 432-433.

Sharma, R.S. and Rajput, V.S. 1984. Performance of seven linseed varieties with and without use of fertilizers. *JNKVV Res. J.* 18 (1-4) :95-96.

Singh, P.P., Kaushal, P.K. and Sharma, Y.K. 1975. Effect of N and P rates on seed yield and oil content of linseed. *Indian J.Agron.* 19(1):85-87.

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DEVELOPMENT OF HYBRID CULTIVARS IN OILSEED BRASSICAS: STATUS AND STRATEGIES*

B. RAI
Department of Genetics and Plant Breeding, Institute of Agricultural Sciences
B.H.U., Varanasi 221 005.

ABSTRACT

In the present paper, the existing status of the development of the experimental hybrids in mustard (*B. juncea* L. Czern& coss) and Gobhi-sarson (*B. napus*) in India has briefly been reviewed. In case of mustard hybrids, an average yield superiority of 6.5% over the check variety 'Kranti' has been obtained during 1993-94, but in case of Gobhi-sarson the experimental hybrid 'PGSH-51' has outyielded the check variety 'GSL-1' by a margin of 21.2 per cent in the experimental station trials and by 16.5% in the farmers field trials under Punjab conditions. Out of 4078 CMS crosses made during 1992-93 and 1993-94, to spot out fertility restoration, 54 showed complete fertility and 54 showed only partial fertility restoration. For hybrid seed production work while 2 Female : 1 Male row combination has given good performance under Ludhiana conditions, a combination of 6 Female : 2 Male row has been observed to be satisfactory under New Delhi conditions. Search for new and stable sources of fertility restoration and perfection of seed production techniques have been suggested in the coming years.

In case of oilseeds, usefulness of hybrid cultivars in raising the productivity has already been demonstrated in case of castor and sunflower in our country. It is now expected that the development and utilization of hybrid cultivars in oilseed Brassicas (i.e.Mustard, Sarson, Gobhi-sarson and Toria etc.) would be a worth-while approach in enhancing their per hectare production. The present paper, reviews the progress made in this area, suggests strategies, that would be worthwhile to follow to achieve this expectation.

Basic Requirements for Developing Hybrid Cultivars

The basic requirements for developing hybrid cultivars in seed producing crops like rapeseed and mustard are: the availability of 1) proven hybrids (preferably with more than 20 per cent standard yield heterosis); 2) stable performing cytoplasmic male sterile A, maintainer B and fertility restorer R lines; 3) good synchrony of flowering seed and pollen parents; 4) adequate seedsetting on male sterile seed-parent through natural cross-pollination; and 5) seed production system, which could ensure the availability of hybrid seeds to the farmers at reasonable cost.

Since 11 to 82 per cent standard yield heterosis has been reported in F_1 hybrids produced by artificial hybridization in mustard (*Brassica juncea*), 10 to 72 per cent in Gobhi-sarson (*B.napus*) 20 to 107 per cent in sarson and toria (*B. campestris*)and a level of 14 to 28 per cent natural outcrossing is usually observed

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in these crops, it is now possible and justifiable to develop A, B and R lines for producing hybrid cultivars. With the identification and availability of A and B lines, some headway has been made in developing hybrid cultivars in Gobhi-sarson. However, under the existing farming conditions of our country, mustard appears to be a better choice for hybrid cultivar development. It has comparatively much larger (i.e. around 75%) area under commercial production, higher biomas and seed yield production potential, and better responsiveness to fertilizer application and irrigation, than the other oilseed brassica crops now being grown. Further, it is tolerant to alternaria leaf blight and aphids.

Present Status

Performance of Mustard Experimental Hybrids

None of the 4 experimental hybrids (i.e. PHR-16, MEH 1-B, FMH-3 and FMH-11) evaluated during 1992-93 *rabi* season across all the mustard growing zones of the country could outyield the national check variety Kranti. Their mean yield levels were either at par or 10.7 to 15.6 per cent less than this superior performing check. However, in zone 2 , (which covers Delhi, Haryana, Rajasthan, and Punjab) hybrid, PHR-16 gave 14.4 per cent greater yield than the zonal check RL 1359. During the 1993-94 *rabi* season, however, hybrid PHR16 gave 6.5 per cent better performance than Kranti and FMH-3 also marginally (i.e. by 4- 5%) outyielded Kranti across all the zones (Table 1). This level of performance does not meet the basic requirement of their commercial production programmes, where a minimum of 20% yield advantage is usually required. However, the overall scenario is not as gloomy as one thinks it to be. If we take into account the performance of 4 selected centers in zone 2 and 3 i.e. Bhatinda (Punjab). IARI, New Delhi, Pantnagar (U.P) and Faizabad (U.P) where the two hybrids PHR-16 and FMH-3 have outyielded the national check Kranti by an average of 21.5 to 22.3 per cent. It indicates that possibilities do exist for searching location-specific hybrids, if we fail to get it at the national level. During the 1994-95 *rabi* season 5 new experimental hybrids (MH-5 and MH-7 from IARI, New Delhi, PHR-45 and PHR-47 from PAU, Ludhiana, and MRH-1 from Mahyco, Jalna) have been proposed to be evaluated in elaborate yield trials across the mustard growing zones of the country so that promising hybrids could be spotted and identified for their cultivation in the years to come.

Search for Usable Male Sterile & Fertility- Restorer lines

In oilseed Brassicas, a number of CMS sources (i.e *Brassica carinata* CMS, *B. juncea* CMS, *B.oxyrrhina* CMS, *B.tournefortii* CMS, *Ogura* CMS, *Polima* CMS, *Settiana* CMS, *Siifolia* CMS etc.) are now well known and some of them are being worked with rather intensively. Out of these CMS sources, fertility restoration has been identified in *B carinata* CMS, *B. tournefortii* CMS, *Polima* CMS, *Siifolia* CMS in our country. During 1992-93 and 1993-94 *rabi* seasons a total of 784 and 3292 CMS F_1 crosses were made. Of these 54 showed complete fertility and other 54 showed partial fertility (Table 2). The fertility restoration in *B. tournefortii* CMS has been observed to be female genotype specific and photoperiod dependent. Complete fertility under Ludhiana conditions is retained till mid-February in short-day length conditions but sterility reversal starts after that.

Table 1. Performance of experimental hybrids (Rabi 1992-94)

Entries	Mean seed yield (q/ha) across the zones		Mean seed yield (q/ha) (1993-94) at 4 selected centres*			
			Zone 2		Zone 3	
	1992-93	1993-94	Bhatinda (Punjab)	New Delhi	Pantnagar (UP)	Faizabad (UP)
Checks						
Kranti (NC)**	18.5	19.9	20.1	16.8	23.4	14.8
Varuna (C)	17.3	17.3	16.2	16.9	22.8	11.9
RL 1359 (ZC)	*16.6*	*18.9*	*24.4*	*19.8*	*18.2*	*16.0*
Hybrids						
PHR-16	16.8	21.2	22.4	20.8	31.1	17.5
PHR-33	-	17.9	22.4	13.4	20.5	17.8
FMH-3	16.0	20.8	25.7	22.3	25.0	18.1
FMH-11	17.0	18.5	22.2	16.8	20.4	12.0
Per cent increase/ decrease in yield of PHR-16 over Kranti	- 10.7	6.5	11.1	23.8	32.9	18.2
Per cent increase/ decrease in yield of FMH-3 over Kranti	- 15.6	4.5	27.8	32.7	6.8	22.2

* The centres where hybrids have outyielded National check Kranti

** NC = National check; C = Longtime check; ZC = Zonal check

Table 2. Detection of fertility restoration in CMS based F_1 crosses (Rabi 1992-94)

Centres	year	Number of CMS crosses made	Fertility restoring crosses detected		CMS*** sources used
			Complete	Partial	
1. Ludhiana* (Punjab)	1992-93	250	15	-	*B. tournefortii* CMS
			2	-	*Siifolia* CMS
	1993-94	54	35**	-	*B. tournefortii* CMS
		40	2	-	*Polima* CMS
		325	-	-	6 CMS sources
2. Hisar (HAU) (Haryana)	1992-93	225	-	15	8 CMS lines
	1993-94	989	-	some	6 CMS lines
3. Hisar (PCU) (Haryana)	1992-93	300	-	-	*B. tournefortii* CMS
		60	-	-	*B. oxyrrhina* CMS
	1993-94	432	-	-	*B. tournefortii* CMS
4. Navgaon (Rajasthan)	1992-93	593	-	35	-
	1993-94	1272	-	-	-
5. Pantnagar (UP)	1992-93	219	-	2	*B. tournefortii* CMS
	1993-94	184	-	some	*B. tournefortii* CMS
6. Faizabad (UP)	1992-93	136	-	-	-
	1993-94	90	-	2**	-
Total	1992-93	786	17	52	-
	1993-94	3292	37	2	

* Affected by photoperiod, male fertility reversal observed under long day after mid-February

** Subject to confirmation

*** CMS = Cytoplasmic Male Sterility

To spot out possible fertility restorer lines during 1994-95 *rabi* season a total 3382 CMS based F_1 crosses have been made at 4 centers (Hissar (1800) (HAU + PCU), Navgaon (459), Pantnagar (805) and Faizabad (318)).

The available CMS has been transferred in the agronomic background of a number of popular varieties of mustard (like Varuna, Pusa-bold, RLM198, Prakash etc.) and their male sterile A lines would possibly be used in developing superior performing hybrid cultivars in the coming years.

In case of Gobhi-sarson, Polima CMS, has been observed to be the most promising type of cytoplasmic male sterility and provides stable expression of sterility for hybrid seed production under different environments. Restorer genes are now available and restoration of male sterility in this crop species seems to be satisfactory. Under north-Indian conditions, more than 90 per cent pollen fertility has been observed in 2 Gobhi-sarson CMS hybrids, i.e Hybrid 10 (Bna) x F 60698) and Hybrid 2 (CMS (Bna) X SU 74578). Under Canadian conditions in elaborate field trials, the first commercial hybrids based on *Polima* CMS appeared in 1986. The hybrid cultivars in Gobhi-sarson (*B.napus*) held promise for significant yield increase in Canada and in this country, the hybrid cultivars of mustard (*B. juncea*) may follow soon.

PGSH-51. The Gobhi-sarson Hybrid recommended for release in Punjab

Punjab Agricultural University, Ludhiana has recently recommended the release of its first CMS based Gobhi-sarson hybrid PGSH-51 for cultivation in Punjab (Table 3). This hybrid has given 21.2 per cent better yield than the check variety GSL-1 in station trials, the actual yield being 20.9 and 17.2 q/ha, respectively. Under farmers field conditions in adaptive trials, its average yield was 19.1 q/ha as compared to 16.4 q/ha for GSL-1. The seed rate needed for growing PGSH-51 and GSL-1 is the same 3.75 kg/ha. Their normal seed cost in Punjab is Rs.50/- and Rs.23.50 per kg, respectively.

A farmer has to invest an additional seed cost of Rs.99 per hectare for hybrid seed but he/she gains Rs.2303 per hectare extra by growing the hybrid over that of growing the recommended variety GSL-1 at a support price of Rs.760/- per quintal of the produce. But for realizing high yield from the hybrid, planting the crop at proper sowing time, provision of two irrigations and the fertilizer application of 100 kg N, 40 Kg P_2O_5, and 40 kg, K per hectare should normally be practiced.

Some Seed Production Aspects

Fortunately, oilseed Brassicas have a higher (1:100) seed to seed multiplication ratio than many other oilseeds. Two generations of multiplication from the breeder seed stage is adequate to obtain the needed commercial seed quantities. The seeds of the parental A, B, and R lines of the hybrids must be maintained in the field isolation distances of 400 m for the breeder and foundation seed stocks and 200 m for the certified grade seeds. Both insects and wind could dessiminate the pollen of oilseed brassicas over long distances. Under Canadian field conditions, a safe isolation distance of 366 m has been suggested to maintain the purity of genetic stocks. For certified seed production of the hybrids, planting in a row to row proportion of 2 Female :1 Male row at a row to row distance of 30 cm has been suggested as adequate under Ludhiana conditions, while at Navgaon (Rajasthan) a row to row proportion of 4 Female :2 Male rows and at IARI, New Delhi

Table 3. Performance of Gobhi-sarson hybrid PGSH-51 under Punjab conditions*

Trials conducted	Seed yield (q/ha)			Per cent increase over GSL-1	Cost : Benefit ratio (CBR)**
	PGSH-51 A	GSL-1 B	Difference (A-B)		
Onstation					
Reseach trials (15)	20.9	17.2	3.7	21.2	-
On-Farm					
Adaptive trials (29)	19.1	16.4	2.7	16.5	1.21
Overall (44)	19.7	16.7	3.0	13.1	1.23
Best performance observed	28.0	23.2	4.8	20.6	1.36

* Data source provided by Dr. S.S. Banga of PAU, Ludhiana.

** *Support price of Rs. 750 per quintal of produce* and hybrid seed cost of Rs. 50/- per kg. as compared to Rs. 23.50 per kg. for variety GSL-1 seed. (Seed rate needed is 3.75 kg/ha for both variety and the hybrid)

of 6 Female : 2 Male rows have given good results. Under experimental conditions at Ludhiana, the seed setting on the CMS lines of *Siifolia* is better than that observed on the *B. carinata* CMS or *B. tournefortii* CMS. Honey bees could possibly be utilized in ensuring a high level of hybrid seeds set and a low incidence of stray pollen contamination in the seed production plots.

Possible yield loss upon Growing Advanced Generation seeds of Hybrids

It is a basic requirement with the hybrids that the farmers should purchase and use the fresh hybrid seeds each year to take full advantage of their high yield potential. But, since old habits die hard, more often than not, quite a number of them use the advance generation seeds of the hybrid seed planted crop for cultivation and in this process, they loose a valuable part of the seed yield of their crop. In an experiment conducted with 25 experimental mustard hybrids and 28 rapeseed hybrids at BHU there was an average yield depression of 12 per cent with a range of 5.2 to 24.6 per cent in the case of the mustard hybrids. The average loss of oil content in these hybrids, however, was 0.9 per cent with a oil depression range of 0.1 to 3.2 per cent. In case of rapeseed hybrids, the average loss in the seed yield was to the tune of 14.7 per cent and the range varied from 3.4 to 25.6 per cent. The loss of oil content in case of these hybrids was to the extent of 2.8 per cent with a range of 0.4 to 5.3 per cent. In case of mustard, the 3 top performing hybrids (EMH 7, 12 and 18) showed the inbreeding-depression values of 9.6, 9.6 and 12.6 per cent respectively while that of the 3 top rapeseed experimental hybrids (ERH-15 4 and 19) showed the yield loss values of 22.9 18.3 and 7.8 per cent in that order.

Strategies to be Followed

Though, we have very much succeeded in developing and releasing the first commercial hybrid cultivar in Gobhi-sarson, the one in mustard, which has very large acreage and could make much of a dent on oilseeds production in the country is not yet in sight. So, the work on this area of research has to be accelerated. More basic work is needed on the stability of sterility in CMS lines developed, understanding of the mechanics of fertility restoration mechanism, genetics of the expression of heterosis in CMS based F_1 hybrids, extent of cytoplasmic penalty that could be expected on using CMS sources from very remote wild types, and hybrid seed production techniques. Some of the disease tolerant or Canola quality (00) lines may not be high yielders *per se* under our field conditions but they could possibly make good parental lines for production of the hybrids. That possibility exists and it should be explored.

The production of double haploids derived lines either by microspore or anther culture is now possible to rapidly produce homozygous inbred lines from the promising *B. juncea* and *B. campestris* genotypes as well. Such inbreds could be produced to develop more productive hybrid cultivars. The inputs available from biotechnology may be utilised in solving the problems of quality and male-sterility and fertility restoration system in developing hybrids of these crops.

Genetic male sterility, self-incompatibility and Hybrid seed production

In our country, exploitable levels of yield heterosis have been observed in the hybrids of the *B. campestris* var. sarson and *toria* types and presence of genetic male sterility has also been reported in this species. Possibilities have also to be explored in producing the hybrids based on genetic male sterility and assess the feasibility of their commercial production. In China, where adequate labour is available, Gobhi-sarson hybrids have been produced utilizing genetic male sterility by removing the male fertile segregants from the seed parents in the field before flowering. In our country, this system is now being tried in safflower in case of oilseeds and in pigeonpea in pulses. In case of rapeseed, whether this system could work in our country only the time could tell but it is well worth a trial.

Very often, utilization of self incompatibility mechanism present in *toria* and *lotni* brown *sarson* types has been suggested to produce hybrids in these crops. But the difficulties in production of commercial quantities of selfed seeds on the self incompatible lines and detection of the breakdown of self-incompatibility in production plots during crop duration, make it rather economically unprofitable to put it in the production gears. Self-incompatibility is a good outbreeding mechanism in nature but unfortunately, due to high inbreeding depression, it frustrates the efforts to produce and maintain the homozygous lines which could produce the hybrid cultivars.

Fortunately, since the hybrid variety development work is now underway separately under an ambitious special project on Promotion of Research and Developmental efforts on hybrids in selected crops by Indian Council of Agricultural Research it is hoped that the pressing problems of the hybrids developmental work will be looked into seriously and systematically and they will be sorted out and solved. At least, now there is a good reason to be hopeful.

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PRODUCTIVITY POTENTIALS OF OIL PALM *VIS-A-VIS* OTHER TRADITIONAL ANNUAL OIL YIELDING SPECIES IN INDIA: MISCONCEPTIONS AND GROUND REALITIES

V. RANGA RAO
ITC Limited - Agri Businesses Division, 31, Sarojini Devi Road, Secunderabad - 500 003

ABSTRACT

According to a host of published reports on oil palm in the country both from private and public sector, the annual oil yielding species which contribute 80-85% of the current indigenous vegetable oils output seldom produce more than 10-14% of the oil yields realisable from oil palm. The paper in question examines the scientific basis and validity of the above claims, their reliability vis-a-vis underlying assumptions and performance under comparable crop growing situations using data from front line demonstrations of All India Co-ordinated Research Project on Oilseeds Research.

The studies revealed that such comparisons between oil palm, a perennial normally preferred under exceptionally favourable moisture, input and management levels, and other annual oleagenous species whose cultivation is predominantly confined to marginal and sub-marginal situations is not only grossly misleading but highly unfair. Contrary to the prevailing wide spread misconceptions based on comparisons of absolute yields/ per hectare/ per year, of oil palm under conditions of optimal environment (moisture, inputs and management) with sûperior agronomic background, some of the most potential and high oil bearing annual oilseed crops such as sunflower, produced on per hectare per day basis 70% to nearly 90% of corresponding yields from oil palm. The superiority of oil palm over other annual oilseed crops become less striking if one considers either the declining productivity phase of the former and or the aggregate monetary returns realisable from most promising and remunerative double and triple crop sequences involving oilseeds under high input - high management situations. In view of this, the specific strengths and opportunities each of them offer and more importantly the mutually complementary role both are expected to play in transforming the country from one of chronically deficient to a net sustainable and exportable surplus in vegetable oils, the author calls for a re-orientation of the currently followed developmental stratagies in oil palm to make the latter more focussed to specific target areas, situations, potential competitors and accomplish the over all growth objectives speedily and without accompanying confusion or conflict.

INTRODUCTION

The phenomenal success of red or African oil palm (*Elaeis Guineensis* Jacq) in some countries more particularly Malaysia, Indonesia and the highly optimistic reports from pilot plantations in Andhra Pradesh, Karnataka, Kerala, have prompted the Government of India embark on massive developmental programmes for harnessing its huge potentials in several parts of the country (Chaddha, 1986). The exceptionally favourable climate prevailing in the country in recent years for oil palm development thanks for the conducive governmental policies, support systems and attractive incentives, a number of commercial

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entities from private and public sector (AP and Karnataka =7 each; All India=20) have already ventured into this virgin but greenfield area.

With the above developments and the launching of aggressive programmes by private and public sector agencies for the large scale plantation of oil palm, the vegetable oil and oilseed profile of the country is no doubt, set to undergo in not too distant a future rapid metamorphosis thereby imparting the latter the much needed cushion/resilience against any set back to the production of more dominant but vulnerable segment i.e., the nine annual oil crops (% contribution to vegetable oil pool is 80%) on account of vagaries of weather (currently 80% of the area under Oilseeds is rainfed). In its enthusiasm to achieve repaid commercialisation of the new introduction, the oil palm lobby has also been propagating an impression that all other annual oil crops traditionally grown in the country are far inferior in terms of oil yield per hectare and hence by implication less attractive than oil palm. How far such comparisons and conclusions between a perennial oil bearing species and the country's principal sources of vegetable oil namely *the nine annual* oilseeds which are purely seasonal in nature often differing widely in their agro-ecological and crop growing conditions/ situations are factually correct and scientifically valid? The paper is an attempt to examine the above conclusions/reports dispassionately and objectively under the Indian context and unravel the truth.

ANALYSIS OF PAST CLAIMS : SOME KEY ISSUES

According to a host of published reports from India (Abraham, 1992; Lubis and Amin, 1992; Chaddha and Rethinam, 1991; and Iyer, 1991) oil palm yields 9-32 times more oil per hectare per year than various other oil yielding species traditionally grown in the country (Table 1).

The implicit assumptions underlying the above comparisons are:-

1. All other annual oil crops also occupy land year round as in case of oil palm.
2. Cropping intensity for annual oilseed crops is either equivalent to 100% (i.e. only one crop is taken per year in any specific field) or other crops in the sequence ignored wherever crop intensity is more than 100%.
3. Sub optimal or less than optimal environment for other crops (as reflected by average/ above average yield levels assumed from either India or world) in contrast to near optimal growing conditions for oil palm (irrigation, high inputs and management levels).

None of the above assumptions infact, hold true for the crops and specific agro ecological and crop growing situations in India. Unlike oil palm which is a perennial (Projected economic *life span is* 25-30 years) and hence locks the land resources year round, the traditional annual oilseed crops (exception: castor) vacate the land in less than 4-5 months. More over, under assured moisture conditions so characteristic of the potential oil palm growing situations, farmers rarely keep their land fallow after or before harvest of oilseed crops; the latter invariably forms an integral part of some established cereal/legume/non-legume based relay/sequential/intercropping systems *viz.,* Paddy groundnut, paddy-sesame, paddy-sunflower in coastal Andhra and Cotton - groundnut (Maharashtra, Gujarat), paddy-toria/potato-sunflower, cotton-sunflower (Northern region) etc., in other parts of the country.

Equally questionable are the yield levels assumed for different annual crops. Even at current levels of technology and the genetic materials available, the above estimates grossly underestimate the true realisable potentials of oilseeds more particularly rapeseed mustard, groundnut, sunflower, castor under high input and management levels generally representative of oil palm (Ranga Rao, 1991; Prasad and Kiresur, 1994; DOR, 1994). The results of large scale demonstrations now available from AICORPO network under real farm situations as for instance groundnut (2 to 3 tonnes/ha and above), rapeseed-mustard (2 to 3 tonnes/ha), sunflower (2.5 to 3 tonnes/ha), safflower (2 to 2.5 tonnes/ha), castor (3 to 5 tonnes/ha)amply corroborates the above point (Table 2). On the other hand, estimates in respect of oil palm (20 tonnes FFB equivalent to 4.2 tonnes of oil/ha) are more or less close to the maximum potentials possible under Indian conditions if one takes into account the performance of earlier plantations established in the later part of 80's, their future outlook and estimated yield levels during its peak (9-15 years) and declining phases of growth.

The above anomalies obviously render any such comparisons between two unequal biological systems and growing situations not only unjust and scientifically incorrect but leads to very unrealistic, grossly misleading and biased conclusions. Under intensive cropping situations where two or three crops (i.e., 200-

Table 1. Comparative yield potentials of oil palm and other oil bearing species+

Crop and Product	Average yield Kg. ha		% Oil content/ Extraction rate		Potential Oil yield (Kg/ha)	
	1	2	1	2	1	2
Oil plam* (Fruit)	13,000	--	21	--	2,730	--
Oil plam** (Fruit)	25,000	--	21	--	5,250	3,700
Coconut (Copra)	1,490	--	65	62	968	340
Groundnut (Kernel)	830	800	45	40	373	320
Soyabean (Seed)	1,887	1,830	18	18	340	330
Cottonseed (Seed)	992	980	18	15	178	150
Sesame (Seed)	358	--	45	--	161	--
Linseed (Seed)	561	--	37	--	208	--
Olive (Fruit)	2,245	--	30	--	673	--
Castor (Seed)	505	670	46	42	232	280
Tung (Seed)	2,245	--	39	--	875	--
Sunflower (Seed)	1,362	1,320	40	40	545	540
Safflower (Seed)	493	----	32	--	157	--
Rapeseed (Seed)	1,404	--	40	--	561	--

*Rainfed crop as in Kerala and Africa

** Crop under Malaysian Conditions

+Source: 1)Abraham, (1992)

2) Lubis and Amin (1992)

300% intensity) are the rule rather than an exception mere comparison of absolute yields (oil in this case) of one of the components in the system with oil palm fails to capture their relative income generating potentials unless the total cropping system is taken into consideration and the output from different crops translated into either aggregate income or oil or energy equivalent per unit area and time.

A RE-APPRAISAL OF THE RELATIVE POTENTIALS OF OIL PALM AND OTHER ANNUAL OIL CROPS

I) Seasonal cropping i.e. 100% cropping intensity:

For a realistic and unbiased comparison, the estimates of per hectare yields (high and low) of various oil bearing species which are based on experiences from real farm situations under conditions of high inputs and management levels are transformed into oil yield per ha/ day using the number of days different species occupy the land in a specific year as a denominator. Contrary to the claims of oil palm proponents which are infact highly exaggerated, use of the above criteria resulted in a significant narrowing down of the differences between oil palm and various other crops. Interestingly, on per day basis crops like sunflower and rapeseed mustard, which are *rich sources of oil (40% oil content in the seed)* and are known to display good response to improvements in moisture and input regime produce as much as 58-90% of the oil yield *otherwise possible from oil palm under similar* situations. If the results of large scale demonstrations available from major oilseed growing areas of the country are any indication even soyabean which is inherently low in oil content (18%) has the potentials to give 30-36% of the oil yields realisable from oil palm per hectare per day. Evidently, even extreme situations of one crop per year (100% cropping

Table 2. Relative day productivity potentials (oil) of plam and oil palm and some select annual oil yielding species under comparable real farm situation (high input and high management) in India

Crop and Product	Yield in t/ha. realisable with Improved Technology		Oil%	Oil yield in kg/ha		Duration in Days	Oil yield in kg/ha/Day	
	High	Low		High	Low		High	Low
Peanut (pods)	2.5-3.0	2.0-2.5	30	750-900	600-750	110-115	6.5-8.2	5.2-6.8
Sunflower(Seed)	2.5-3.0	2.0-2.5	40	1000-1200	800-1000	95-100	10.0-12.6	8.0-10.5
Rapseed-Mustard (seed)	2.5-3.0	2.0-2.5	40	1000-1200	800-1000	120	8.3-10.0	6.7-8.3
Soybean(Seed)	3.0	2.0-2.5	18	540	360-450	105-110	4.9-5.14	3.3-4.1
Castor(Seed)	4-5	3.0-3.5	48	1440-1680	1440-1680	240	8.0-10.0	6.0-7.0
Oil Plam (FFB)	25	20	21	5250	4200	365	14.48	11.5

Source: 1) Ranga Rao (1991&1994); 2) DOR, 1994; 3) Abraham. 1992.

intensity) which is seldom the case in irrigated areas, the gap between oil palm and other annual oil crops is not as wide as reported in various oil palm reports/publications.

ii) Sequence cropping systems: (i.e., 200% cropping intensity)

In the agro-climatic regions which are otherwise identified as most potential for commercial introduction of oil palm, cropping essentially revolves around paddy, sugarcane and a host of other upland crops including oilseeds as catch/relay sequential components as for example paddy-paddy, paddy-groundnut/ sesame/sunflower/grain legumes, sugarcane-sugarcane (ratoon) etc. Since such combinations also involved crops whose economic end product is not necessarily oil, the aggregate net returns accruing from the entire cropping systems are computed at the prevailing market rates for the purpose of comparison.

A study of economics of oil palm vis-a vis other competing crops carried out by the author in collaboration with ITC's Palm Tech India Limited (Ranga Rao, 1994) in one of the most potential oil palm zones in the country namely Coastal Andhra Pradesh (East Godavari) the aggregate monetary net returns from some of the established cereal based cropping sequences cover at prevailing costs of input and out put as much as 58-68% of the estimated returns from oil palm at its peak bearing phase (43306/ha/yr). The differences between it and the major competing crops\cropping systems which are not only most productive but remunerative, however, become much less pronounced (the latter gives as much as 84-96% of return from oil palm) is one takes into accounts the average yields of oil palm over its entire life cycle of 25-30 years (Rs.30284/ha/yr). Infact, in irrigated area outside the zones identified as most potential in the country, oil palm when averaged over its economic life cycle of 25-30 years hardly offers any striking monetary advantages over other most established 2 or 3 crop sequences involving commercial crops as components viz. cotton-wheat, cotton-sunflower, paddy-toria/potato-sunflower in North, Cotton-groundnut in Gujarat, Maharashtra and paddy-groundnut/sunflower, maize/groundnut - sunflower, onion - groundnut - sunflower, turmeric- sunflower etc., in south. This is much more conspicuous if one takes into consideration the best yields rather than general averages realised by most progressive farmers in the area.

CONCLUSIONS

Oil palm and various other annual oilseed crops possess little or no similarities in their agro-climatic requirements and cultural conditions. Hence the latter seldom compete with oil palm for land except occasionally as relay/ sequence crops in cereal based cropping systems in certain restricted areas/situations. The aggregate contributions from all such areas to the country's total oilseed output is however very negligible. Such adhoc comparisons between oil palm - a perennial (likely economic life span: 25-30 years) and various oil yeilding species which are other wise purely seasonal in nature in terms of their absolute yields/ha/year are neither scientifically valid nor do they serve the interests of Developmental agencies achieve sizeable shifts from major competing crops under irrigation.

More over, each of them have their own positive points and specific areas of adaptability. Unlike oil palm which requires assured moisture supplies associated with good management throughout the year for reasonable returns, the annual oil bearing plant species are successfully grown under a truly wide range of agro-ecological and crop growing situations (soils, climate, altitude, moisture and nutrient regime, biotic stresses, cultural conditions etc.) extending right from most fertile areas with assured rainfall, adequate levels of inputs and high management to marginal and sub marginal areas that receive far from optimal environment.

Similarly, in some situations as for instance coastal areas of Andhra Pradesh, Karnataka, Kaveri Basin of Tamilnadu, which are otherwise endowed with assured water supplies and ideal agro-climate, oil palm confers distinct advantages over other competing crops and cropping systems on account of its (i) higher returns per unit investment, area and time, (ii) sustainability of yields and incomes over a comparatively longer cycle than otherwise possible with cereal-legume/non legume based mono or sequence cropping systems and (iii) higher water use efficiency than other more water intensive crops like paddy, sugarcane under similar situations.

There is therefore, neither any need nor justification for either over playing or under playing the potentials and specific merits of oil palm over various other annual oil bearing species as both of them possess inherent strengths and advantages in their respective niches and are expected to play significant and mutually complementary role in transforming the country from a chronically deficit one to net exporter in the domain of vegetable oil.

LITERATURE CITED

Abraham, V.K. 1992. Palm Oil Statistics. *Indian Oil Palm J.*. V. : (5) 23.

Adlin U. Lubis. and Kabul Amin. 1992. Oil Palm Industry in Indonesia. *Indian Oil Palm J.*. V. 1(5) : pp. 11-17.

DOR 1994. Transfer of Technologies of Oilseed crops through front line demonstrations: Significant features and achievements. Annual Report of Front Line demonstrations in Oilseeds for the year 1993-94. Directorate of Oilseeds Research Rajendranagar, Hyderabad

Chaddha, K.L. and Rethinam, P. 1991. Future of Oil Palm Cultivation in india Reservations and potentialities. *Indian Oil Palm J.*. V. 1 (1) 1-10.

Iyer, N.S. 1991. Edible oil scene in India with specific reference to oil palm. *Indian Oil Palm J.*. V. 1 (3) : pp. 1- 8.

Prasad, M.V.R. and Kiresur, V. 1994. Potentials of improvved oilseed crop production technologies in India : assessment through front line demonstrations: *J. Oilseeds Res.* 11 (2) 1994: pp. 245-258.

Ranga Rao, V. 1991. *IN* : "Improved technologies in Oilseeds: Performance and promise under real farm situations ": Directorate of Oilseeds Research (ICAR) Hyderabad pp. 1-139.

Ranga Rao., V. 1994. ITC's Oil Palm Project - An appraisal ITC Agri Businesses Division, Secunderabad. pp. 1-29

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SHORT COMMUNICATIONS

GENETICS OF PLANT NITROGEN DISTRIBUTION IN RAPESEED

Nitrogen is essential for plant growth and production of all plant proteins. There are circumstantial evidences that the capacity of total nitrogen uptake by the plant is under genetic control (Halloran and Lee, 1979). A lot of variation has already been observed for this character (Gupta and Labana, 1989). The existing variability in nitrogen uptake may be utilised for the development of high yielding cultivars with enhanced protein content. The present investigation was under taken to know the genetics of plant nitrogen distribution for formulating a proper breeding methodology in rapeseed.

An experiment was conducted at Punjab Agricultural University, Ludhiana during *rabi* 1985-86. Eight *Brassica napus* cultivars from different agroclimatic conditions were used and crossed in all possible combinations excluding reciprocals. Twenty eight F_1's and eight parents were grown in a Randomised Block Design with three replications. Nitrogen in seed, straw (including chaff) and chaff was estimated by kjeldhal method. The percentage of seed straw and chaff nitrogen was multiplied by 5.7 in order to obtain seed protein (SP), straw protein (StP) and chaff protein (CP). Nitrogen harvest index (NHI) and protein harvest index (PHI) were estimated following Austin and Jones, (1975), and Gupta and Labana, (1989) respectively. The seed protein yield (SPY) is estimated by multiplying seed yield with seed protein %.

The analysis of variance indicated that the mean squares due to *g c a* were significant, for SP, CP, StP, SPY and PHI and *s c a* for SP, CP, SPY, NHI and PHI (Table 1). The general combiner for SP was Topa which also showed significant *gca* estimates for Stp and SPY. Bronowski and Lores were good combiners for SP and average combiners for CP, Stp, SPY, NHI and PHI. The remaining parental lines exhibited significant *gca* for other traits. These inbred lines offer possibilities for exploitation in the development of improved *B. napus* quality lines. The hybrid viz. christa x ISN -129,

Table 1. Analysis of variance for combining ability for different characters

Source	d.f.	Mean squares					
		SP	CP	StP	SPY	NHI	PHI
gca	7	14.07**	0.61*	7.46*	0.97*	11.86	58.31*
sca	28	11.21*	1.32**	4.88	2.06**	47.06**	136.73**
Error	70	0.79	0.15	1.56	0.25	16.60	9.67
$1/7\, g_i^2$		1.17	0.02	0.26	0.02		0.85
$1/28\, S_{ij}^2$		8.82	0.87	-	1.30	37.39	86.92

*,** *Significant at 5 and 1 per cent levels respectively*

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Table 2. Estimates of general and specific combining ability effcts for different characters

Parents/Crosses	SP	CP	StP	SPY	AHI	PHI
Ashai	-0.49	0.16	0.93**	-0.22	-1.58**	-1.98
Christa	-2.32**	0.18	0.28	-0.41**	-0.16	-2.75**
GSL-1	-0.33	-0.31**	-0.17	-0.11	0.001	-0.61
Bronowski	0.85**	-0.20	-0.38	0.11	0.66	1.71
Lores	1.34**	-0.09	-0.24	0.06	-1.19	1.47
ISN-129	-0.15	-0.28**	-0.90	-0.19	1.61	1.55
Topa	0.96**	0.18	1.50**	0.69**	0.35	-1.69
g_i	0.26	0.11	0.37	0.15	0.92	1.20
Ashai x Christa	-1.15	0.42	-1.23	-1.39**	0.76	1.91
Ashai x GSL-1	0.59	1.30**	-4.99**	-0.70	-0.69	8.81**
Ashai x Bronowski	-5.39**	-0.39	0.23	-0.09	1.94	-5.43
Ashai x Lores	1.30	0.89**	1.27	1.64**	-3.92	-1.73
Ashai x ISN-129	3.53**	1.06**	6.31**	1.27**	10.63**	-7.07**
Ashai x Topa	-0.70	0.45	0.12	0.31	4.14	2.89
Ashai x Pol-6	-4.43**	-1.30**	-1.65	-2.67**	-5.11**	-3.36
Christa x GSL-1	-3.96**	-0.30	2.79**	-2.40**	14.39**	-10.95**
Christa x Bronowski	-3.29**	0.79**	-0.18	-1.10**	1.55	-4.32
Christa x Lores	-4.31**	0.87**	-3.51**	-0.66	-7.69	-5.08
Christa x ISN-129	5.69**	2.32**	0.01	2.21**	-10.47**	4.38
Christa x Topa	-2.86*	0.03	0.46	-0.44	1.08	-3.57
Christa x Pol-6	3.57**	0.16	-0.99	1.38**	-4.01	1.91
GSL-1 x Bronowski	1.63**	1.89**	1.34	0.55	-1.34	-4.34
GSL-1 x Lores	0.81	1.31**	-0.67	-0.28	9.94**	3.85
GSL-1 x ISN-129	-2.41**	0.33	-0.01	0.45	0.93	-5.17
GSL-1 x Topa	2.34**	0.31	0.11	2.64**	-1.93	4.15
GSL-1 x Pol-6	2.60**	1.64**	1.32	0.49	-0.80	3.08
Bronowski x Lores	2.89**	-0.39	0.34	-0.38	-6.63**	3.36
Bronowski x ISN-129	0.85	0.05	-1.66	0.62	6.73**	7.76**
Bronowski x Topa	1.95**	-0.05	-1.79	1.66**	1.42	8.56**
Bronowski x Pol-6	-0.26	-2.01**	-1.39	1.48**	9.74**	-8.44
Lores x ISN-129	3.90**	-1.12**	0.86	1.33**	7.27**	-3.28
Lores x Topa	-0.72	0.05	0.72	-0.62	10.44**	-2.59
Lores x Pol-6	4.91**	0.23	-2.07**	1.68**	2.84	3.87
ISN-129 x Topa	5.09**	-1.04**	0.31	-0.05	-2.41	0.05
ISN-129 x Pol-6	-5.30**	1.52**	-1.39	-1.19**	2.30	-5.90
Topa x Pol-6	-2.41**	1.15**	-0.76	-1.78**	-0.63	-4.85
S_{ij}	0.70	0.30	0.98	0.39	2.45	3.21

*,** Significant at 5 and 1 per cent levels

christa x Pol-6, Lores x Pol-6, Lores x ISN-129, ISN-129 x Pol-6, GSL-1 x Bronowski, GSL-1 x Pol-6 and GSL-1 x Topa had high significant positive *s c a* effects (Table 2). All these hybrids could be expected to produce better segregants in advance generations which can be exploited for the development of pure breeding lines.

The heterosis over mid and better parent was estimated for those characters which showed significant parent vs hybrid variances. In the present study only NHI showed significant parents vs hybrid variance. The significant heterosis over the mid parent was exhibited by ten crosses. The cross GSL-1 x Lores had 62.83 per cent heterosis followed by christa x Lores, Ashai x ISN-129, Lores x Topa, Lores x ISN-129 and Bronowski x Pol-6. However, the cross GSL-1 x Lores had the maximum heterosis (52.52%) over the better parent followed by Ashai x ISN-129.

All the traits except NHI and Stp showed significant *g c a* and *s c a* variances which indicated the importance of both additive and non-additive gene effects. Under these circumstances, biparental mating coupled with progeny evaluation could help in breaking gene constellation and release of variability for fixing pure breeding lines.

Department of Plant Breeding, Punjab Agricultural University, Ludhiana.
* SKUAST, Dryland Research sub-station
Dhiansar Bari-Brahamna, Jammu 181 133

S.K. GUPTA*
K.S. LABANA

Austin, R.B. and Singh.B. 1975. The Physiology of Wheat. Annual Report Plant Breeding Institute, Cambridge, England. 327-355.

Griffing, B. 1956. Concept of general and specific combining ability in relation to diallel crossing system. *Aust. J. Biol. Sci.* 9:463-465.

Gupta, S.K. and Labana, K.S. 1989. Nitrogen harvest index in rapeseed, *Indian J. Genet.* 49(3):337-340.

Gupta, S.K. and Labana K.S. 1989. Protein harvest index in rapeseed. *Cruciferae Newsletter* 14:

Hallran, G.M. and Lee, 1979. Plant nitrogen distribution in wheat cultivars. *Aust. J. Agric. Res.* 30:779-89.

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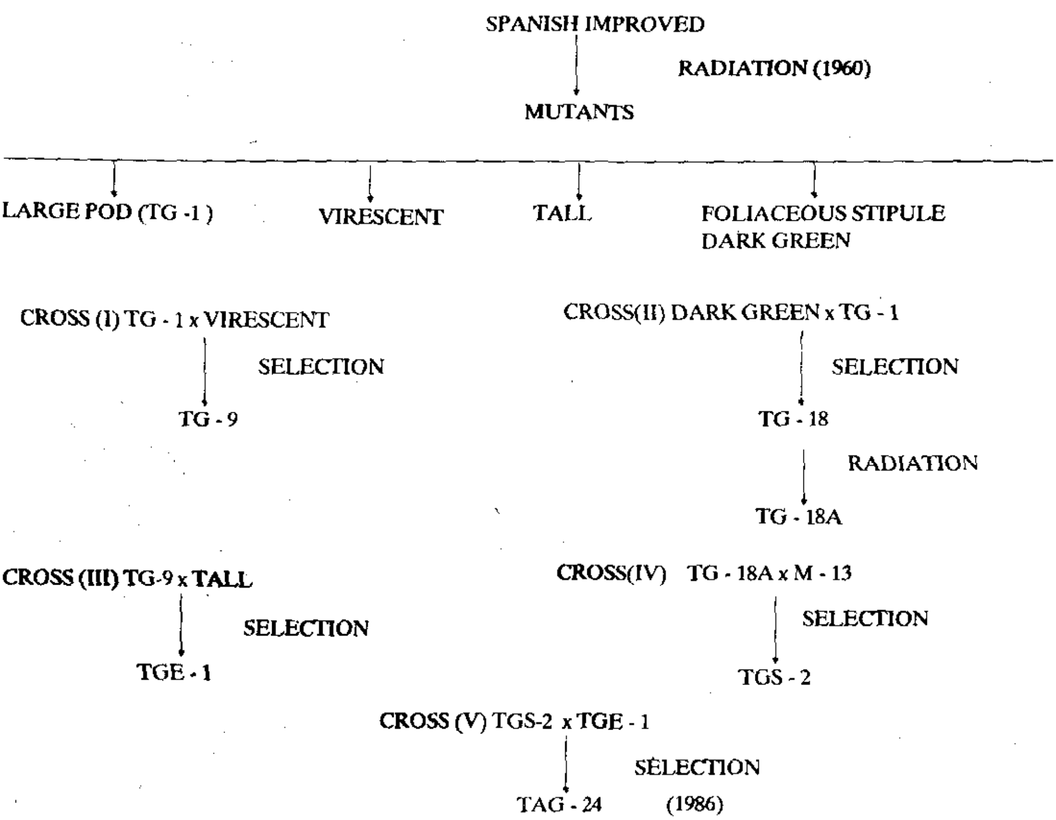
SEMI DWARF, EARLY MATURING AND HIGH YIELDING NEW GROUNDNUT VARIETY, TAG - 24

A high yielding groundnut (*Arachis hypogaea* L.), Trombay-Akola- Groundnut-24 (TAG-24) was developed by using induced mutants (Patil S.H., 1966) in cross breeding. It is a Spanish bunch type with semi-dwarf growth habit, early maturity, high harvest index (HI) and field tolerance to bud necrosis disease (BND). In Maharashtra, three groundnut varieties viz., SB-XI, JL-24 and UF- 70103 are under cultivation which contribute about 0.9 million tonnes annually (Oilseeds Production, 1989). TAG-24 developed by Bhabha Atomic Research Centre (BARC), Trombay in collaboration with Punjabrao Krishi Vidyapeeth (PKV), Akola exhibited superiority in yield and other major attributes over the check varieties. Hence, it was released for general cultivation in Vidarbha region of Maharashtra. The development of this variety and its superior attributes are presented here.

TAG-24 is a derivative of multi-parental cross (Fig.1). After testing a number of pure

Fig. 1 Pedigree of the groundnut variety TAG - 24



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line derivatives from the cross TGS-2 x TGE-1 (Patil S.H. *et al.*, 1982), one line with high yield and tolerance to BND was selected in F_7 in 1984.

Morphological characters of TAG-24: The distinguishing character of TAG-24 is the semi-dwarf habit resulting from shorter length of main stem and branches (Table 1). It is spanish bunch type with small and dark green foliage. Majority of the leaves have accessory leaflets during vegetative growth period. Two seeded pods are common in TAG-24 with occasional 3 seeded pods.

Agronomical characters: The number of days to maturity of TAG-24 is similar to SB XI and JL 24 in *kharif* and summer whereas it matures 13 and 18 days earlier than ICGS 11 and UF 70103 respectively in summer (Table 1). Shelling percentage, hundred kernel weight (HKW) and oil content are similar to the check varieties.

TAG-24 has relatively high HI (57.5%) as compared to 44% or less in the checks (Table 1). The observed high HI in TAG-24 resulted from selection for better partitioning of photosynthates to economic yield.

Yield evaluation of TAG-24: Yield potential of TAG-24 was confirmed in *kharif* and summer seasons during 1985 and 1986 at Trombay. Further evaluation was carried out by PKV in Vidarbha region by conducting multilocation yield trials during *kharif* and summer seasons between 1987 and 1989 at different research stations. TAG-24 produced average pod yields of 1311 kg/ha which was 44.1 and 23.9% more than the yield of SB XI and JL-24 respectively in *kharif* (Table 2). Superior yield ability of TAG-24 was more pronounced in summer with a mean pod yield of 2493 kg/ha and the increase over the three checks ranged from 20.7 to 50.5% (Table 2). In the *rabi*, trials conducted at Akola during 1988-89 and 1989-90, TAG-24 out yielded all the checks.

Table 1. Comparative Morphological and agronomical traits of TAG -24 and the check varieties

	Kharif			Summer			
	TAG-24	SB-XI	JL-24	TAG-24	SB-XI	UF-70103	ICGS-11
Length (Cm) Main axis/brs.	13/17	31/37	33/40	12/15	23/28	15/24	17/28
No. of branches Pri. + Sec.	4+0	5+1	4+0	5+1	5+7	10+9	9+4
Leaflet Green Colour Size lxb (Cm)	Dark ---	Pale ---	Dark ---	Dark 4.8 x 2.4	Pale 6.1 x 3.6	Dark 4.9 x 2.3	Dark 5.9 x 2.5
Flowering Days to flower	26	28	27	38	41	43	41
Pod Shelling%	66.0	67.0	69.8	68.9	69.6	66.0	67.8
Kernel 100 Kernel wt. (g) Oil content (%)	28.7 52.4	21.6 51.4	31.3 51.0	35.8 53.0	27.2 52.4	41.1 51.9	32.7 49.6
Days to maturity	100	102	102	112	115	130	125
Harvest Index	56.5	25.7	26.6	57.5	30.0	33.0	44.0s

Table 2. Yield performance of TAG-24

Institute	Year	No. of trials	Mean yield (kg/ha)					% increase over			
			TAG-24	JL-24	SB-XI	UF-70103	ICGS-11	JL-24	SB-XI	UF-70103	ICGS-11
KHARIF											
PKV (MLT)	1987-89	12	1311	1058	910	--	--	29.4	41.7	--	--
PKV(ADAPT).	1988-89	13	1485	1160	--	--	--	28.0	--	--	--
BARC	1987-89	3	3850	2656	2475	--	3275	45.0	55.6	--	17.6
AICORPO (IET)	1988	23	1684	1563	--	--	--	7.8	-	--	--
SUMMER											
PKV (MLT)	1987-89	9	2493	--	1659	1657	2098	--	50.3	50.5	20.7
PKV (ADAPT.)	1989	9	1769	--	--	1362	--	--	--	29.9	--
AICORPO (IET)	1988	14	2614	--	2218	--	--	--	17.9	--	--
AICORPO (CVT)	1989	15	2675	--	2382	--	--	--	20.9	--	--
RABI											
PKV	1988-90	2	1937	--	1320	425	842	--	45.9	355.8	130.0

MLT = Multilocation trial; ADPT. = Adaptive trial; IET = Initial evaluation trial; CVT = Coordinated varietal trial

At BARC, Trombay also similar results were observed in *kharif* and summer (Table 2). Further, yielding ability of TAG-24 is demonstrated by the AICORPO trials conducted by the ICAR in different zones in the country (Table 2).

In adaptive trials conducted in Vidarbha during *kharif* and summer 1988 and 1989, TAG-24 produced more than 28% higher yields compared to respective checks (Table 2) indicating its adaptability to both the seasons.

Spacing trials conducted by doubling the plant density from 2.22 to 4.44 lakhs/ha at Akola and 3.33 to 6.66 lakhs at BARC, Gauribidanur revealed increased pod yields from 3024 to 3876 and 3540 to 4430 kg/ha respectively. At Akola, varying spacings, 22.5 x 20, 30 x 15 and 45 x 10 cm without changing plant density, produced similar yields. These results demonstrated that in a given population density the spacing did not affect the yield in TAG-24.

Pest and Disease reaction: Differences in pest infections among the varieties were not noticed. Disease viz., Tikka, Rust and BND were scored in the fields under natural infestation conditions. Disease infection of both 'Tikka" and 'Rust' during *kharif* were lesser in TAG-24 than SB-XI and JL-24. At Trombay, under "hot spot" conditions for BND in summer of 1986-87 and 1987-88 TAG-24 had 31% infected plants compared to more than 80% in SB-XI and JL- 24 at harvest. The kernel development and discolouration in the infected plants of TAG-24 was very less compared to SB- XI and JL- 24 resulting in lesser yield reduction. In the laboratory tests at ICRISAT, Hyderabad (personal communication, 1988), TAG-24 showed only 10% damage as compared to 70% due to BND in JL- 24 and 35% in UF-70103.

TAG-24 has the desirable traits like semi-dwarf habit, higher yield, early maturity, high HI, tolerance to BND and wider adaptability. Hence, it was released for general cultivation in Vidarbha region for both *kharif* and summer by the Maharashtra State Varietal Release Committee in 1991 and notified by the Ministry of Agriculture, Government of India in 1992.

Nuclear Agriculture Division
Bhabha Atomic Research Centre
Bombay 400 085
*Crop Research Unit (Oilseeds)
Punjabrao Krishi Vidyapeeth , Akola 444 104

S.H. PATIL
D.M. KALE
S.N. DESHMUKH*
G.R. FULZELE*
B.G. WEGINWAR*

Oilseeds Production 1989, Maharashtra Department of Agriculture, M.S., Pune-1 publication.

Patil S.H. 1966, Mutation induced in groundnut by X-rays. *Indian J Genet. and Plant Breed.* 26A: 334-348.

Patil S.H., Chandra Mouli and Kale D.M. 1981 Varietal improvement in groundnut at BARC. Proc. "Induced mutants for improvement of grain legume production. II" IAEA-TECDOC-260: 47-57 (1982).

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COMBINING ABILITY ANALYSIS OF SEED YIELD, PER CENT OIL AND OTHER YIELD ATTRIBUTES IN SAFFLOWER.

Safflower (*Carthamus tinctorius* L.) is an important rabi oil seed crop of Deccan Plateau. The limited literature on the combining ability (Ramachandram and Goud, 1981; Parameshwarappa *et al.*, 1984) suggest that the simultaneous improvement for seed yield and oil content is difficult in safflower due to absence of genotypes with high *GCA* for both yield and oil characters. Therefore, an attempt has been made in this study to identify parents with good *GCA* for seed yield and oil content besides other important yield contributing traits.

Six genotypes viz., A-1, S-144 (both released varieties), Co-1 (tall and spineless), APRR-3 (striped hull with high oil) 83 and B-263-2A (high yielding types) were selected as females and crossed to seven males *viz.*, KAS-1, 18-66-18, 19-185 and G-2225 (high oil types), KAS-2, EC-32012 (bold capitula) and G-54 (basal and profuse branching type) to obtain 42 F_1 crosses. The F_1's along with their parents were sown under rainfed conditions in a Randomized Block Design with two replications at Agricultural Research Station, Annigeri during *rabi* 1988-89. Each entry was sown in a single row of 5m length and spaced 45 and 20 cm between rows and plants, respectively. Observations on important characters such as capitula/plant, size of capitulum (diameter in cm), seeds/capitulum, capitula weight/plant (g), number of seeds/capitulum, seed weight (g), yield/plant (g) and oil per cent were recorded on five random plants.

Analysis of variance for different characters is presented in Table 1. The mean squares due to parents were significant for all the traits indicating that the parents involved in the study were diverse. The variance due to *GCA* and *SCA* (Table 2) were significant for most of the characters suggesting the role of additive and dominant gene action in expression of these characters. However, *GCA/SCA* ratio indicates the predominance of non-additive gene action for majority of the characters (Ramachandram and Goud, 1981; Rao, 1983).

None of the parents studied showed positive significant *GCA* effects for both seed yield as well as oil content (Table 3). However, parents with significant and positive *GCA* for yield and oil were reported by Ramachandram (1981), Deshmukh and Gorphade (1991), Gupta and Singh (1990). The variety A-1 exhibited good *GCA* for seed yield, weight of capitula and 100 seed weight but low *GCA* for oil content (Rao, 1983). The lines S-144 and APRR-3 exhibited good *GCA* for oil content, capitula number but a poor combiner for other traits. The line Co-1 was a good combiner for seed number. The testers KAS-1, KAS-2 and 18-66-18 were good combiners for oil content but had low *GCA* for other yield traits except 18-66-18 for number of capitula/and KAS-2 for number of seeds per capitula. In general the study indicated the lack of parents exhibiting good *GCA* for both seed yield and oil content and hence makes simultaneous improvement for these two economical traits difficult.

However, strategies have to be worked out keeping in view the nature of inheritance of seed yield and its components for formulating

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Table 1. Mean sum of squares for seed yield, oil per cent and yield components in safflower

Source	D.F.	No. of capitula/ plant	Size of capitulum (cm)	No. of seeds/ capitulum	Weight of capitula/ plant (g)	100-seed weight (g)	Seed yield/ plant (g)	Oil per cent
Replication	1	61.43	0.00	14.85	76.28	0.00	204.27**	0.02
Treatment	54	198.20**	0.15**	193.26**	549.81**	1.36**	128.47**	11.58**
Parents	12	152.15**	0.16**	270.63**	657.62**	2.00**	76.41**	19.33**
Parents Vs. Crosses	1	714.01**	0.49**	142.20**	6953.41**	1.38**	1964.96**	3.52
Crosses	41	199.08**	0.14**	171.86**	362.07**	1.18**	98.91**	9.51**
Lines	5	159.66**	0.18**	283.44**	523.06**	4.30**	304.68**	33.30**
Testers	6	942.74**	0.72**	838.30**	52.01	2.44**	13.83	24.25**
Line x Testers	30	56.92**	0.02**	19.98	397.26**	0.40**	81.63**	2.60**
Error	54	8.78	0.01	14.31	42.44	0.16	18.20	0.93

* - *Significant at 5 per cent level*

** - Significant at 1 per cent level

Table 2. Mean sum of squares for combining ability for seed yield, oil per cent and yield components in safflower

Source	D.F.	No. of capitula/ plant	Perimeter of capitulum (cm)	No. of seeds/ capitulum	Weight of *capitula* (g)	100-seed *weight (g)*	Seed yield/ *plant (g)*	Oil per cent
GCA (Lines)	5	0.62	0.001	1.02*	3.03**	0.01	1.30**	0.06*
GCA (Testers)	6	0.73	0.001	1.19*	3.53**	0.01	1.51**	0.07*
SCA	41	4.39**	0.004	7.15**	21.21**	0.08	9.09**	0.46
GCA/SCA (L)	-	0.14	0.250	0.14	0.14	0.14	0.14	0.14
GCA/SCA (T)	-	0.17	0.250	0.17	0.17	0.17	0.17	0.17
S.E. (L)		0.79	0.023	0.01	1.74	0.11	1.14	0.25
S.E. (T)		0.85	0.025	1.09	1.88	0.11	1.23	0.27
S.C.A		2.09	0.061	2.67	4.60	0.28	3.03	0.68
C.D. (L)		1.58	0.046	2.02	3.49	0.21	2.28	0.51
C.D. (T)		1.71	0.050	2.18	3.77	0.23	2.46	0.55
C.D. (SCA)		4.20	0.12	5.36	9.23	0.56	6.04	1.36

* - Significant at 5 per cent level

** - Significant at 1 per cent level

Table 3. General combining ability effects of parents for seed yield, oil per cent and yield components in safflower

Parents		No. of capitula/ plant	Size of capitulum (cm)	No. of seeds/ capitula	Weight of capitula/ plant (g)	100-seed weight	Seed yield/ plant (g)	Oil per cent
Lines	A-1	1.94	0.00*	-1.83	6.30**	0.52**	6.31**	-1.55**
	S 144	3.66**	0.01	0.21	0.43	-0.42**	0.42	1.33**
	83	0.97	-0.01	1.98	2.33	0.74**	1.32	-1.94**
	B-263-2A	1.83	-0.14**	4.22**	2.57	-0.04	-0.19	0.03
	APRR-3	-4.03**	-0.06*	-0.85	-11.61*	-0.56**	-8.17**	1.97**
	Co-1	-4.38**	0.20**	8.67**	-0.03	-0.04	0.31	0.15
Testers	18-16-18	4.40**	-0.01	-0.84	3.48	0.02	1.14	1.38**
	KAS-2	-3.67**	0.53**	18.21**	-0.80	-0.72**	-1.01	1.04**
	19-185	2.22	-0.08	-6.23**	2.33	0.21	0.81	-0.05
	G-54	14.86**	-0.22	-5.18**	-0.30	0.34**	0.97	-1.15**
	KAS-1	-0.59	-0.12**	0.12	-1.30	0.05	0.33	0.96**
	6-2225	-1.06	0.08*	-1.92	-2.00	-0.46**	-0.74	0.41
	EC-32012	-6.14**	0.00	-4.14**	-1.41	0.56**	-1.92	-2.59**
S.E. gi-gj (L)		1.12	0.03	1.43	2.46	0.15	1.61	0.36
S.E. gi-gj (T)		1.21	0.03	1.54	2.65	0.16	1.74	0.39
C.D. at 5% (L)		2.24	0.06	2.86	4.93	0.29	3.23	0.73
C.D. at 1% (T)		2.42	0.07	3.09	5.37	0.32	3.49	0.78

* Significant at 5 per cent level

** Significant at 1 per cent level.

the breeding programme to overcome the present impasse. Resorting to biparental mating in the early segragating generations would accumulate the favourable genes for seed yield and oil content besides breaking negative relationship among important yield traits in order to derive superior progenies. Further many of the yield and oil components are controlled by non-additive gene actions. Hence development of hybrids and exploitation of heterosis for both seed yield and oil content may help to break the stagnation and achieve higher seed yield and oil yield/ha in safflower.

Agricultural Research Station, Annigeri 582 201, Karnataka

K.G. PARAMESHWARAPPA
B.T. NINGANUR
V. RUDRANAIK
G.G. GULAGANJI
U.K. HULIHALLI
N.K.B. PATIL

Deshmukh, M.P., Patil, B.R. and Gorphade, P.B. 1991. General evaluation of some selected lines of safflower (*Carthamus tinctorius* L.). *Indian J. Agric. Research* 25 (4) 181-188.

Gupta, R.K. and Singh, S.P. 1990. Combining ability in relation to breeding systems in safflower (*Carthamus tinctorius* L.). *Genetika* (Beograd) 22 (3) 173-182.

Parameswharappa, K.G., Aradhya, K.M. and Prakash, K.S. 1984. Inheritance of seed yield, hull and oil content in safflower, *Sabro J.* 16 (2) 129-134.

Ramachandram, M. and Goud, J.V. 1981. Genetic analysis of seed yield, oil content and their components in safflower (*Carthamus tinctorius* L.) *Theor. Appl. Genet.* 60, 191-195.

Rao, V.R. 1983. Combining ability for yield, per cent oil and related components in safflower. *Indian J. Genet.* 43 (1) 68-75.

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MANAGEMENT OF SESAMUM ROOT ROT WITH BIOCONTROL AGENTS

Macrophomina Phaseolina is the important pathogen affecting sesamum, which causes root rot disease at all stages of crop growth resulting in considerable yield loss. Chemical seed treatment can protect the crop only at the early stage of its growth. Antagonists applied to seeds were found to colonize the rhizosphere and offered protection against soil-borne pathogens (Muthamilan, 1989; Selvarajan, 1990; Turner and Backman, 1991).

In the present investigation, isolates of antagonists collected all over Tamil Nadu were tested for their efficacy against root rot pathogen. The study was undertaken under pot culture condition in a Completely Randomized Block Design with 10 treatments and three replications using sterilized soil. The pathogen inoculum multiplied in sand-maize medium, was incorporated to the soil at 5% level (w/w). Different isolates of *Trichoderma* and *Gliocladium* presented in Table 1 were multiplied in molasses-yeast medium for 10 days and they were mixed with talc powder @ 50 ml/100g. This formulation was treated @ 4 g/kg of seed. Peat based inoculum of *Bacillus subtilis* was also prepared and treated with the seeds @ 12 g/100 g seeds. Carbendazim treatment (2 g/kg of seed) was also included in the experiment and the treated seeds were sown @ 5 seeds/ pot. A total of 40 plants were maintained for each treatment. The incidence of root rot was recorded periodically and the final observation was made at 70 DAS. A field trial was also conducted during summer 1993 in Randomized Block Design with a plot size of 4 x 3 m^2 to test the efficacy of antagonists on the management of root rot disease. Seeds were treated with the antagonists as followed in pot culture experiment and sown. Each treatment was replicated three times. Periodical observation on root rot incidence and yield data were recorded and analysed statistically. The results are presented in Table 1.

The results revealed that seed treatment with antagonists significantly reduced the root rot of sesamum caused by *M. phaseolina*. Among the different antagonists, *T. viride* recorded the minimum root rot incidence

Table 1. Efficacy of antagonists on the control of sesamum root rot

Treatment	Sterilzed soil	Natural field condition	
	Mean root rot incidence (%)	Root rot (%)	Yield (kg/ha0
Trichoderma viride	21.9(27.87)	11.3 (19.60)	543
T. harzianum	27.6(31.67)	14.5 (22.32)	505
T. hamatum	37.9(38.00)	25.6 (30.37)	402
T. koningii	25.3(30.20)	23.6 (29.03)	460
T. pseudokoningii	46.1(42.77)	27.1 (31.36)	444
T. longibrachiatum	47.7(43.70)	24.1 (29.40)	461
Gliocladium virens	41.5(40.13)	16.1 (23.66)	477
Bacillus subtilis	24.7(29.77)	14.4 (22.32)	517
Carbendazim	29.0(32.53)	21.2 (27.40)	497
control	78.2(62.20)	42.7 (40.78)	371
SEm ±	0.92	3.71	8.4
CD at 5%	2.73	11.03	25

Figures in parentheses are transformed Arc sine values

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(21.9%) followed by *B. subtilis* (24.7%) and *T. harzianum* (25.3%), which are on par with *T. viride*. The efficacy of *T. viride* in reducing the root rot disease (11.3%0 significantly over other treatments. The same was also observed under natural field condition. The same antagonist increased the yield to 543 from 371 kg/ha in control.

Reduction in the incidence of blackgram root rot due to *T. viride* (Jeyarajan and Ramakrishnan, 1991), and *B. subtilis* (Sridhar *et al.*, 1991) and groundnut root rot by *B. subtilis* (Sridhar *et al.*, 1992) were reported. Jeyarajan *et al.* 1991 found that *T. viride* registered 28.3% root rot against control (58.7%) in blackgram. The present results are also indicated the efficacy of *T. viride* as seed treatment to manage the root rot disease in sesamum.

Department of Plant Pathology,
Tamil Nadu Agricultural University
Coimbatore - 3. Tamil Nadu

D. DINAKARAN
G. RAMAKRISHNAN
R. SRIDHAR
R. JEYARAJAN

Jeyarajan, R. and Ramakrishnan, G. 1991. Efficacy of *Trichoderma* formulation against root rot disease of grain legumes. *Petria* 1: 137-138.

Jeyarajan, R., Ramakrishnan, G., Rajamanickam, B. and Sangeetha 1991. Field demonstration of efficacy of *Trichoderma* as biocontrol agent for root rot disease of grain legumes and oilseeds. *Petria* 1: 143.

Muthamilan, M. 1989. Biological control of root rot of groundnut (*Arachis hypogaea* L.) caused by *Sclerotium rolfsili* sacc. M.Sc.(Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore pp. 97.

Selvarajan, R. 1990. Biological control of chickpea root rot caused by *Fusarium solani* (Mart.) sacc. and *Macrophomina phaseolina* (Tassi.) Goid. M.Sc. (Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore pp. 158.

Sridar, R., Ramakrishnan, G. and Jeyarajan, R. 1991. *Studies on the efficiency of Bacillus subtilis* isolates against the root rot fungus, *Macrophomina phaseolina* on urd bean. *J.Biol. Control* 5: 59-60.

Sridar R., Ramakrishnan, G. and Jeyarajan, R. 1992. Seed bacterisation with *Bacillus subtilis* for the management of *Macrophomina* root rot in groundnut. Paper presented at IX Southern Regional Conference on microbial inoculants, UAS, Dharwad, Nov. 2-3, 1992. pp. 64.

Turner, J.T. and Backman, P.A. 1991. Factors relating to peanut yield increases after seed treatment with *Bacillus subtilis*. *Plant Dis.* 75 : 347 - 353.

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CONTROL OF CUTWORMS, *AGROTIS* SPP. IN SUNFLOWER CROP IN PUNJAB

Among the 40 insect species infesting sunflower from germination to maturity, the cutworms, *Agrotis ipsilon* (Hufn.) and *A. flammatra* Schiffer Mueller cause very serious damage to the germinating sunflower crop during the spring season in Punjab and Haryana (Sandhu *et al.*, 1973; Rohilla *et al.*, 1980; Yadav *et al.*, 1983). The recommended insecticides namely aldrin and heptachlor, have been banned for oilseed crops including sunflower by the Government of India. Hence the field experiments were conducted to test the efficacy of some insecticides and a cultivation technique of ridge sowing to control cutworms.

During spring 1992, an experiment was laid out in Randomized Block Design with three replications, 10 rows and x 3 m plot size and 30 cm x 15 cm spacing between rows and plants respectively. Three to four seeds per hill of sunflower hybrid MSFH 8 were flat sown in each treatment. The treatments comprised chlorpyriphos 20 EC and aldrin 30 EC each at 6.25, 5.00 and 3.75 l/ha and imidacloprid 25 WP at 0.375, 0.250 and 0.150 kg/ha. The insecticides after diluting with a small quantity of water (50 ml) were mixed with the soil (about 25 kg/ha) and broadcasted in the plots before sowing. One cultural method of sowing the sunflower on ridges was also included in the experiment. Fifteen days after germination (DAG), percentage seedling damage by cutworms was recorded.

During spring 1993, two dosages each of chlorpyriphos and quinalphos (3.75 and 5 l/ha) and imidacloprid (0.300 and 0.50 kg) and two more insecticides, cypermethrin (0.250 and 0.500 l) and fenitrothion (3.75 and 5.00 l) applied to flat sown sunflower as described above were compared with ridge slowing. The number of replications and the spacing was similar like that in 1992 and seedling mortality was observed at 21 DAG. It is evident from the data (Table 1) that during 1992 the damage to the seedling by cutworms in the insecticidal treatments and ridge sowing range from 0-4 per cent and were significantly lower than that recorded in unprotected plots (20.3 per cent).

During 1993, ridge sowing with 3.04 per cent damage to seedlings was the most effective treatment. All other treatments except the lower dosage of imidacloprid 25 WP were also equally effective and on par with ridge sowing. Both the dosages of imidacloprid and lower dose of chlorpyriphos (3.75 1/ha) and cypermethrin (0.250 1/ha) proved non-significant with control.

The investigations clearly indicated that ridge sowing minimized the cutworm damage in sunflower crop. However, its effectiveness on community basis in large areas needs further investigations. Among the insecticides, chlorpyriphos 20 EC at 5 l, fenitrothion 50 EC and /or quinalphos 25 EC at 3.75 l and cypermethrin 20 EC at 500 ml/ha were found quite effective. Recently it has been demonstrated (Yadav *et al.*,1993) that in sunflower lower doses of fenvalerate 20 EC at 150 ml or cypermethrin 20 EC at 150 ml, or cypermethrin 20 EC at 125 ml or decamethrin 2.8 EC at 375 ml per ha were very effective for the control of cutworms. However, further studies on dosage-mortality relationship may help in ascertaining the efficacy of lower dosages of these insecticides. Aldrin 30 EC, although found to be very effective for the control of cutworm, but its usage is banned in India. The method of mixing the insecticides with small

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Table 1. Efficacy of soil application of different insecticides compared with ridge sowing against cutworms of sunflower

Treatments	Dosage		Seedling damage	
	1992	1993	1992	1993
	(1 or kg/ha)	(1/kg)	15 DAG	** 21 DAG
Aldrin (30 EC)	6.25		2.7 (10.53)	-
-do-	5.00		1.0 (7.67)	-
-do-	3.75		0.0 (5.74)	-
Chlorpyriphos (20 EC)	6.25	3.75	4.0 (11.90)	9.43 (17.70)
-do	5.00	5.00	1.0 (7.67)	3.44 (11.86)
-do-	3.75		0.0 (5.74)	
Imidacloprid (25 WP)	0.375	0.300	2.7 (10.92)	17.14 (24.12)
-do-	0.250	0.500	1.3 (8.13)	7.83 (16.76)
-do-	0.150		1.0 (7.67)	
Cypermethrin (20 EC)	-	0.250	-	8.38(17.27)
-do-	-	0.500	-	6.26(15.15)
Fenitrothion (50 EC)	-	3.75	-	4.23 (13.14)
-do-	-	5.00	-	4.10 (12.91)
Quinalphos (25 EC)		3.75	-	4.53 (13.01)
-do-		5.00	-	4.73 (13.72)
Aldrin (30 EC)(post sowing treatment with irrigation work)	6.25	-	0.0(5.74)	-
Ridge sowing	-	-	3.7 (11.08)	3.04 (11.01)
Untreated Control	-	-	20.3(27.5)	16.10 (24.40)
L.S.D (p=0.05)			(7.47)	(8.67)

* Imidaclopird was applied at 0.500 and 0.300 1/ha during 1993.

Figures in parentheses are arcsin $\sqrt{percentage+values}$.

DAG = Days after germination.

quantity of soil and applying in the field proved very promising as it neither hampered the germination nor adversely affected the efficacy of the insecticides tested in these experiments.

Department of Entomology, Punjab Agricultural University, Ludhiana-141004

D.R.C. BAKHETIA
RAMESH ARORA

Rohilla, H.R., Singh, H.V., Gupta, D.S. and Krishan Singh, 1980. Pest complex other than diseases of sunflower, *Helianthus annuus* in Haryana. *Indian J. Pl. Prot.* 8(2): 177-182.

Sandhu, G.S., Brar, K.S. and Bhalla, J.S. 1973. Pests of sunflower and other insects associated with sunflower crop. *Oilseeds J.* 3(2): 19-26.

Yadava, P.R., Arya, D.R. and Singh, H. 1993. Major pests of sunflower and their management. *Haryana Fmg.* 22 (2): 8-9.

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RESPONSE OF MUSTARD STRAINS TO SOIL ALKALINITY

Degraded (salt affected) lands can not be put to agricultural use unless reclaimed. After reclamation, relatively tolerant and resistant crop varieties can be grown successfully. Mustard is one of the crops recommended for such lands(Gupta and Gupta, 1987). The salt tolerant behaviour in mustard also varies from variety to variety (Kumar and Malik, 1983 and Chopra, 1992). Present study is an effort to screen and select varieties/strains which are more tolerant to alkalinity.

Four levels of gypsum, equivalent to no gypsum, 33, 66 and 100 per cent requirement (8.0 tonnes per hectare) of the alkali soil was broadcasted uniformly in the month of July and mixed in 10 cm soil so as to create 4 levels of alkalinity in soil. The soil of the experimental plot was sandy loam having pH_2 9.2 to 10.2 and EC_2 1.0 to 1.5 ds/m. The soil was low in nitrogen and organic matter. A pre-sowing irrigation was given and the 10 varieties of mustard viz., CS-12, CS-15, CS-42, CS-50, CS-52, CS- 52AS, CS-416, Kranti, Varuna (T 59) and local check, were sown in each treatment on October 25, 1989. Three irrigations (as and when required) were given, with water of pH 9.1 and EC 3.65 ds/m during the entire growth period. The crop was fertilized with 60 kg N and 40 kg P_2O_5/ha. The experiment was conducted in a strip-plot design with levels of gypsum in main plots and varieties in strip plots with four replications.

The results presented in Table 1 showed that among the varieties tested CS-15 gave significantly the highest yield (15.75 q/ha) which was at par with CS-42 (14.6 q/ha). The yields of both the entries were, however, superior to remaining entries tested. Entries CS-12, CS-50, CS-52, CS-416 and varuna did not differ significantly with regards to yields. Varieties kranti and local check yielded the lowest. Seed yield increased, with every increase in gypsum dose, from 9.15 to 14.91 q/ha at full dose of gypsum. The increase was the highest when the gypsum dose was increased from 33 to 66 per cent of its requirement.

At no gypsum application varieties CS-15, CS-42 and CS-50 were at par and yielded significantly higher yield than the others. The varieties CS-15 and CS-42 continued their superiority over others even at higher gypsum doses. This showed that at all levels of alkalinity the varieties CS-15 and CS-42 were superior to others. The variety CS-50 though gave slightly higher yield at no gypsum level, it could not show superiority at higher gypsum levels. This showed that the strain CS-50 had low yield potential as compared to others but at the same time it was more resistant to alkalinity than the remaining strains.

AICRP on Salt Affected Soils and Saline Water in Agriculture
SKN College of Agriculture- Jobner(Rajasthan).
1.KVK, Kotputly
2. Soil Salinity Project, RAU, Bikaner
3. RAU, College of Agriculture, Udaipur.

D.S. BHATI[1]
R.A. SINGHANIA[2]
L.L. SOMANI[3]

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Table 1.Sseed yield (q/ha) of different mustard strains at different levels of sodicity

Strains	Gypsum treatment				
	No gypsum	33% of GR	66% of GR	100% of GR	Mean
CS-12	7.75	8.79	13.83	14.63	11.25
CS-15	11.54	14.21	18.38	18.88	15.75
CS-42	10.75	13.08	16.21	18.38	14.60
CS-50	10.67	11.25	12.63	13.68	12.05
CS-52	9.00	10.71	10.83	14.08	11.16
CS-52AS	8.83	10.38	14.46	16.38	12.51
CS-416	8.38	9.25	12.42	14.00	11.01
Kranti	7.04	8.04	11.48	13.08	9.91
Varuna	9.17	10.96	12.25	15.13	11.88
Local check	8.33	10.13	10.33	10.92	9.93
Mean	9.15	10.68	13.28	14.91	
	sodicity (S)	Strain (V)	SxV		
C.D. 5%	0.08	1.00	1.20		
C.V. %	11.70				

GR- Gypsum Requirement

Chopra, N. and Chopra, N.K. 1992. Salt tolerance of raya (*Brassica napus* var.glauca) varieties. *Indian J.Agron.* 37 (1):93-96.

Gupta, S.K. and Gupta, I.C. 1987. Management of saline soils and waters. Oxford and IBH publishing New Delhi, pp284.

Kumar, D. and Malik, R.S.1983. Salt tolerance of six Indian mustard cultivars. *Indian J.Agron.*28(4):325-331.

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HEAT UNIT EFFICIENCY IN TORIA (*Brassica campestris*)

Crop production mainly depends upon the climatic requirements of a particular crop. Temperature affects the growth of plants in numerous ways, from germination of seed to maturity of the crop by influencing various physiological processes including photosynthesis and respiration. Crop productivity was reported to be inhibited at temperature higher than optimum (Gilmore and Rogers, 1958). The efficiency of temperature utilisation or heat use varies depending upon the variety and also location. The present study was aimed at to find out the heat unit efficiency of toria cultivars under different environments.

The experiments were conducted at the experimental farm of Chaudhary Charan Singh Haryana Agricultural University, Hisar (29° 10' N, 46° E, 215.2 m above MSL) during *kharif* season 1989-90, 1991-92 and 1992-93 to study the heat unit use efficiency of *toria (Brassica campestris)* cultivars. Two toria cultivars one (V_1) long duration (Sangam) and another (V_2) short duration (TH- 68) were selected for the study. The trial was conducted in three different sowing dates viz., 2-9-89, 15-9-89 and 2-10-89 in 1989-90, 13.9.91, 27.9.91 and 10.10.91 in 1991-92 and 21.9.92, 1.10.92 and 10.10.92 in 1992-93 in a Randomized Block Design with three replications in a plot size of 10 x 7.2 m^2. All agronomic practices were followed as per recommended package of practices for toria crop. The total dry matter accumulation (DMA) was recorded at budding, podding and harvest stages. Growing degree days (GDD) or effective heat unit was calculated as per the method suggested by Iwata (1984). The temperature 5° C (Ram Niwas *et al.,* 1990 for *Brassica* sp.) was considered as base temperature for toria for calculating the degree days. The maximum and minimum daily temperature were observed in the meteorological observatory 100 meters away from the experimental field. The heat unit efficiency (HUE) was calculated as suggested by Rajput, 1980.

Simple regression analysis was carried out on seed yield with heat unit efficiency. The GDD increased steadily from budding to harvest (Table 1.) The long duration cultivars (Sangam) exhibited higher GDD in all the stages. Similar trend was also noticed in the case of DMA. The high amount of DMA in the long duration cultivar was due to its longer cropping period (105 to 120 days) in all the dates of sowing and in all the three years studied. GDD and DMA were decreased progressively from 1st week of September sowing to Ist week of October sowing in all the three years studied. This might be due to the high mean temperature (21.5° C) prevailed during that period as compared to 1st week of October (17.5° C).

In the present study, the high DMA, GDD and HUE could be related to the comparatively higher mean temperature (21.5° C) in D_1, than D_2 (19.9° C) *and* D_3 (17.5° C). Similar results were observed by Balakrishnan and Natarajaratnam (1986) in pigeonpea crop. At all the stages of crop growth, HUE was higher during the 1989-90 season than in 1991-92 and 1992-93 (Table 1). This is attributable to the fact that the crop was sown 10 days late in 1991-92 and 15 days in 1992-93 as compared to 1989-90. When mean air temperature was higher in 1989-90 (21.1° C) than in 1991-92 (19.2° C) and 1992-93 (18.5° C). Of the two

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Table 1. **Severity and disease progression of Alternaria leaf spot and yield parameters as influenced by sunflower stalk mulching**

Sl. No.	Treatments	Alternaria leaf spot severity (%) at									Plant stand at 50% flowe-ring	Plant height (cm)	Head diam. (cm)	Stalk yield (kg/plot)	Grain yield (kg/plot)	100 grain weight (g)
			15 DAS	22 DAS	29 DAS	36 DAS	43 DAS	50 DAS	57 DAS	50% grain filling stage						
1.	Sunflower stalk mulch (10t/ha)	74.3*	1.9	67.3	46.3	63.3	35.8	9.0	8.0	9.0	20.3	66.9	5.1	0.16	0.11	2.37
2.	Sunflower stalk mulch (5t/ha)	66.7*	3.5	60.7	39.7	54.3	29.0	8.0	8.0	8.0	32.0	100.5	7.9	0.30	0.43	2.85
3.	Control (no mulch)	0.2*	0.0	2.1	3.8	4.0	3.4	5.0	5.0	5.0	50.0	135.6	14.6	1.45	1.17	3.67
CD AT 5%		12.02*	NS	18.0	7.8	8.32	11.64	2.77	2.77	NS	7.40	11.58	0.38	0.11	0.53	0.41
SEm		3.06*	1.09	4.58	1.99	2.12	2.97	0.33	0.33	0.78	1.89	2.95	0.10	0.03	0.13	0.10
CV %		11.26*	10.50	18.12	11.47	9.05	22.59	7.87	8.24	16.25	9.60	5.06	1.80	8.82	36.48	6.09

DAS = Days after sowing
* = On cotyledonary leaves

varieties of toria cultivar, sangam gave the highest HUE for biomass production at all the stages, showing its better adaptability in the region (Table 1).

Correlation of HUE with seed yield was positive and significant (at 5% level) at all the stages of crop growth except at budding (r = 0.07). The highest significant value (r = 0.88) was noticed at harvest stage followed by podding stage (r = 0.77). A similar correlation in pigeonpea also obtained earlier by Chi-Chu Wang (1979).

Department of Meteorology
CCS Haryana Agricultural University
Hisar - 125 004

RAJ SINGH
D.S. NEHRA
RAM SINGH
O.P BISHNOI

Balakrishnan, K. and Natarajaratnam, N. 1986. Heat Unit efficiency in pigeonpea. *Madras Agric. J.* 73(2): 101-104.

Chi-Chu Wang. 1979. Effects of accumulative temperature in the growth and time of flowering of pigeonpea. 1 Effect of accumulative temperature on the altitude adaptation and yield potential of pigeonpea. *Sci. Agric.*: 109-115.

Gilmore, E.C. and Rogers J.S. 1958. Heat unit of measuring maturity in corn. *Agron.J.* 50: 611-615.

Iwata, F. 1984. Heat unit concept of crop maturity. pp. 351-370. *In*: physiological aspects of dry land farming. Ed. (Gupta, V.S.) Oxford and IBH.

Rajput, R.P. 1980. Response of soybean crop to climate and soil environments. Ph.D. Thesis, IARI, New Delhi.

Ram Niwas, Rao, V.U.M. and Bishnoi, O.P. 1990. Heat units requirements of raya. *Mausam.* 41(4): 637-638.

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PROGRESSION OF ALTERNARIA LEAF SPOT SEVERITY AND ITS EFFECT ON GROWTH AND YIELD PARAMETERS OF SUNFLOWER AS INFLUENCED BY SUNFLOWER STALK MULCHING.

Sunflower (*Helianthus annuus* L.) is known to suffer from several foliar diseases (Kolte, 1985). Alternaria leaf spot caused by *Alternaria helianthi* is most serious and widespread disease on this crop, reported from wherever it is grown. It produces symptoms on all parts of plant, causing severe losses when favourable environmental conditions prevailed during the crop season (Anonymous, 1987) and yield losses may go up to 80 per cent (Agrawath *et al.*, 1979). The pathogen could readily be isolated from sunflower crop debris from a diseased crop that had harvested one year earlier (Allen *et al.*, 1983) and may serve as excellent source of *Alternaria helianthi* for the succeeding crop.

There has been no previous attempt made to describe accurately the effect of crop debris on the initial inoculum build up and further severity of the disease on sunflower. Hence, an experiment was conducted to know the effect of mulching of sunflower stalk on the appearance and further development and severity of the disease on sunflower crop under field conditions and the results obtained are presented in this paper.

Sunflower hybrid, BSH 1 which is moderately resistant to Alternaria leaf spot was used for this study. Two levels of sunflower stalk mulching i.e., 10 t/ha and 5 t/ha was adopted. Sunflower stalk after harvest of the crop during summer grown at UAS, GKVK was procured and made them to pieces of 2-5 cm size. Sowing of the crop was done during July 1992 in 3 x 2 m plots following a spacing of 60 x 20 cm. One week after sowing, the pieces of sunflower stalks were spread on the ground in between rows at two doses at the rate of 10 and 5 t/ha along with a control plot, replicated three times. Regular cultural practices were followed except plant protection measures. Observations were recorded soon after emergence of the seedlings i.e., 15 DAS and later on every week. Number of lesions on cotyledonary leaves and their size, percentage leaf spot severity on cotyledonary leaves and on true leaves at 15 DAS in each treatment were recorded. At 22 DAS, percentage leaf spot severity on true leaves and the fate of cotyledonary leaves in all the treatments were recorded. Percentage leaf spot severity was arrived at by taking average of 10 observations in each plot through visual observations in each treatment (Nagaraju *et al.*, 1992). Similar recording of observations were carried upto 57 DAS and final observation was recorded at 50 % grain filling stage. Using the available plants in the respective treatments, plant stand at 50% flowering, plant height, head diameter, grain and stalk yield and 100 grain weight after threshing and drying were also recorded.

The disease started appearing a week after mulching was done on cotyledonary leaves. The lesion size (0-9 scale) (Anonymous, 1991), number of lesions and percentage severity of Alternaria leaf spot on cotyledonary leaves at 15 DAS and percentage leaf spot severity on true leaves at 15, 22, 29, 36, 43, 50, 57, DAS, and 50% filling stage, and plant stand

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at 50% flowering stage, plant height, head diameter, stalk and grain yield and 100 grain weight on all the treatments are presented in Table 1. There was no difference in lesion size *in any of the treatments and varied from 0 to 3* scale on the cotyledonary leaves. At 15 DAS, on cotyledonary leaves, the number of lesions were more (17.3 and 16.4) compared with negligible number of lesions in control plots. The severity was very high in mulched plots on cotyledonary leaves (74.3 and 66.7%) and was negligible in control plot (Table 1), whereas it was least on true leaves in all the treatments.

The situation was suddenly changed at 22 DAS. The percentage severity on true leaves was very high (67.3 and 60.7) and was minimum in control plot (2.1). At this stage, all the cotyledonary leaves in mulched plots were dead, but were quite healthy in control plot. Outward curling of leaves due to severe leaf spot and strained expansion of young sprouting leaves were observed in the mulched plots and most of the plants in the mulched plots started dying due to high severity of this disease. Whereas, the plants in control plot, though nearby were quite healthy and the severity did *not increase beyond 5% even after 22 DAS.*

At or after 22 DAS, many plants started dying and few plants in the mulched plots survived and the observations were continued on such plants. Similar was the trend even at 29, 36, 43 DAS and so on. But the severity of the disease decreased on the remaining plants in *the plot, while in control plot, it never in*creased beyond 5% even at 57 DAS. There was no difference between treated and control plots on remaining plants, which indicates that the release of inoculum might have reduced by that time from the stalk mulch, due to exhaustion.

At 50 per cent flowering stage, only 20.3 and 32 plants/plot survived in mulched plots as against 50 in control plot. There was drastic reduction in plant height (66.9 and 100.5 cm) as against 135.6 cm in control plots, head diameter (5.1 and 7.9 cm) compared to control plots (14.6 cm). Proportionately, sunflower stalk yield and grain yield (Tabel 1) were also affected. However, 100 grain weight was not affected much though little variation exist between treatments. This study also revealed that the sunflower stalk mulching is deleterious to succeeding sunflower crop. By considering these results, the sunflower stalk may be effectively used for effective screening of sunflower germplasm lines after manipulating the suitable dose of mulching material.

1 Project Co-ordinating Unit (Sunflower)
2 Department of Agronomy, UAS, GKVK,
Bangalore - 560 065, India.

NAGARAJU[1]
R. POONGUZHALAN[2]
H.V. NANJAPPA[2]

Agrawath, J.M., Chhipa, H.P. and Mathur, S.J. 1979. Screening of sunflower germplasm against *Alternaria helianthi. Indian J. Mycol. Pl. Pathol.*, 9 : 85-86.

Allen, S.J., Brown, J.F. and Kochman, J.K. 1983. The infection process, sporulation and survival of *Alternaria helianthi* on sunflower. *Ann. Appl. Biol.*, 102 : 413-419.

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Sl. No.	Treatments		Alternaria leaf spot severity (%) at								Plant stand at 50% flowe-ring	Plant height (cm)	Head diam. (cm)	Stalk yield (kg/plot)	Grain yield (kg/plot)	100 grain weight (g)
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2.	Sunflower stalk mulch (5t/ha)	66.7*	3.5	60.7	39.7	54.3	29.0	8.0	8.0	8.0	32.0	100.5	7.9	0.30	0.43	2.85
3.	Control (no mulch)	0.2*	0.0	2.1	3.8	4.0	3.4	5.0	5.0	5.0	50.0	135.6	14.6	1.45	1.17	3.67
CD AT 5%		12.02*	NS	18.0	7.8	8.32	11.64	2.77	2.77	NS	7.40	11.58	0.38	0.11	0.53	0.41
SEm		3.06*	1.09	4.58	1.99	2.12	2.97	0.33	0.33	0.78	1.89	2.95	0.10	0.03	0.13	0.10
CV %		11.26*	10.50	18.12	11.47	9.05	22.59	7.87	8.24	16.25	9.60	5.06	1.80	8.82	36.48	6.09

DAS = Days after sowing
* = On cotyledonary leaves

Anonymous, 1987. Annual Progress Report of AICRP on oilseeds (Sunflower), for the year 1987-1988, DOR, ICAR, Hyderabad, 137 pp.

Anonymous, 1991. Annual Progress Report of AICRP on oilseeds (Sunflower), for the year 1991-1992, DOR, ICAR, Hyderabad, 232 pp.

Kolte, S.J. 1985. Sunflower diseases. *In* : Diseases of Annual edible oilseed crops. V. III 9-96. CRC Press, Florida, 154 pp.

Nagaraju, Ravikumar, R.L., Gangappa, E. and Jayarame Gowda, 1993. Sources of field resistance to Alternaria leaf spot in sunflower. *J. Oilseeds Res.*, 10 : 148-150.

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EFFECT OF MOISTURE STRESS AND APPLIED POTASSIUM ON YIELD AND BIOCHEMICAL PARAMETERS OF SOYBEAN IN VERTISOLS

Soybean has acquired an important position in oilseed crops of India. It is a protein rich (40%), edible oil containing (20%) crop with vitamins like A, B, C and D in its composition. The acreage under soybean crop is increasing recently in Andhra Pradesh as its cultivation is being extended to rice fallows and vertisols. Potassium is known to offer resistance to water stress and inadequate potassium supply is likely to retard reproductive development and filling of storage tissue with photosynthates. Since, no report is available on the effect of moisture stress and potassium in vertisols, the present study was conducted to assess the influence of applied potassium under moisture stress conditions on leaf chlorophyll, NRA, yield, oil and protein content of soybean.

Two field experiments were conducted during the post-rainy season of 1991-92 and 1992-93 on deep vertisols, having 175, 18.6 and 348 kg ha^{-1} of available N, P and K during 1991-92 and 178, 17.8 and 346 kg ha^{-1} during 1992-93, respectively with pH 8.1. The treatments constituted four levels of moisture stress viz., no moisture stress (M_0), moisture stress before flowering (M_1), moisture stress during flowering (M_2) and moisture stress during pod filling (M_3) in main-plots, and four levels of potassium viz., 0 (K_0), 25 (K_1), 50 (K_2) and 75 (K_3) kg ha^{-1} in sub-plots. The plots were irrigated to field capacity in the respective stages of crop growth, while the water stress was imposed by withholding irrigation in the specific physiological stages as per the above treatments. Seeds were treated with *Bradyrhizobium japonicum* culture @ 5 g/kg seed. N @ 10 kg ha^{-1} as urea, 60 kg P_2O_5 ha^{-1} as single super phosphate and K as per treatments in the form of muriate of potash were applied as basal. The second dose of N @ 10 kg/ha as urea was applied on 30 days after emergence (DAE). The experiment was conducted in split-plot design with four replications. Soybean variety Hardee was sown in rows, spaced at 30 cm apart with an intra-row spacing of 10 cm during the first week of November in both the years. Leaf chlorophyll was estimated using the method developed by Witham *et al.* 1971. Total N was determined by Kjeltec system. Protein content was calculated by multiplying N percentage of seed with the constant factor 6.25. Oil content of seed was estimated by Nuclear Magnetic Resonance (NMR) Spectrometer (Tiwari *et al.* 1974). Nitrate reductase activity (NRA) was estimated by the method developed by Klepper *et al.* 1971. Total chlorophyll and NRA were estimated at 20, 40, 60, 80 and 100 DAE with leaf material but the values at the peak stage are presented in Table 1.

The data in Table 1 revealed that moisture stress in general, reduced the total chlorophyll content irrespective of growth stage as compared to plants supplied with irrigation throughout the crop growth (control). Potassium application improved the leaf chlorophyll content. Cations especially K are moved out into the stroma of the chloroplast in

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Table 1 Effect of moisture stress and applied potassium on yield and biochemical parameters of soybean in vertisols.

Treatment	Total chlorophyll on 60 DAE (mg g^{-1} fresh wt.)		Nitrate reductase activity on 40 DAE (μ moles NO_2 g^{-1} h^{-1})		Yiled (kg ha^{-1})		Protein (%)		Oil (%)	
	1991-1992	1992-1993	1991-1992	1992-1993	1991-1992	1992-1993	1991-1992	1992-1993	1991-1992	1992-1993
MOISTURE STRESS LEVELS										
No moisture stress	1.96	1.99	1.40	1.49	2630	2824	40.9	41.4	21.0	21.0
Moisture stress before flowering	1.90	1.92	1.31	1.33	2402	2614	38.6	39.2	20.3	20.2
Moisture stress during flowering	1.83	1.84	1.27	1.27	2057	2176	37.3	37.8	19.2	19.2
Moisture stress during pod filling	1.98	1.98	1.24	1.25	1698	1848	35.4	36.7	17.9	18.5
C.D. (P = 0.05)	0.02	0.02	0.05	0.07	222	201	0.6	0.5	0.27	0.19
Potassium levels (kg\ha)										
0	1.79	1.82	1.25	1.26	1851	2022	35.4	36.1	18.9	18.8
25	1.90	1.91	1.29	1.36	2112	2285	37.5	38.2	19.4	19.5
50	1.98	1.98	1.39	1.46	2338	2506	39.6	40.3	19.1	20.2
75	2.00	2.02	1.42	1.50	2487	2649	39.8	40.5	20.1	20.3
CD (P = 0.05)	0.06	0.04	0.05	0.04	167	182	0.87	0.45	0.31	0.15

DAE = Days after emergence

exchange for inward movement of protons and K deficiency causes reduced chlorophyll content in leaves, which contribute to impairment of photosynthetic machinery.

Soybean seed yield was more sensitive to moisture stress during pod-filling period. There was least effect on seed yield when moisture stress was imposed before flowering. These results corroborate the findings of Eck *et al.* 1987. Seed yield was increased with applied potassium at 50 and 75 kg ha^{-1} which were on par. Sale and Campbell (1987) also reported similar results.

In the present study, NRA was at its peak on 40 DAE. Its activity was reduced with moisture stress at various growth stages. In higher plants, the inhibitory effect of moisture stress on NRA was due to reduced enzyme synthesis (Hsiao, 1973). Similar response was observed in respect of protein content which decreased with moisture stress, with lowest values obtained in the treatment with moisture stress during pod filling stage. This was due to low N recovery in seeds as a consequence of improper filling of seeds caused by limited partitioning of assimilates to the reproductive structures as also observed by Futukoku and Yamada (1981). Application of potassium increased the NRA and also protein content which was in agreement with the findings of Minotti *et al.* 1968.

As to the oil content, no moisture stress throughout crop growth recorded higher values while lowest values were recorded in the treatment when moisture stress was imposed during pod-filling stage because of improper filling of seeds for want of moisture (Sionit and Kramer, 1977). In the present study, potassium at higher levels improved the oil content since it promotes the formation of fats by its favourable influence on the carbohydrate metabolism and the photosynthates migrate as sugars into the storage tissue of seeds and are then transformed into fats as reported by Sale and Campbell (1987).

Moisture stress reduced the biochemical parameters studied in soybean besides yield with potassium application improved the seed yield, protein and oil content in vertisols.

Department of Plant Physiology
College of Agriculture
A.P. Agricultural University
Rajendranagar, Hyderabad - 500 030.

K. ANURADHA
P.S. SARMA

Eck, H.V., Matuers, A.C. and Musick, J.T. 1987. Plant water stress at various growth stages and growth and yield of soybeans *Field crops Res.* 10 : 6-16.

Fukutoku, Y. and Yamada, Y. 1981. Sources of proline-nitrogen in water stressed soybean *Glycine max* (L.) I.Protein metabolism and proline accumulation. *Plant and cell physiol.* 22(8) : 1397-1404.

Hsiao, T.C. 1973. Plant responses to water stress. *Ann. rev. of Pl. Physiol.* 24 : 519 - 570.

Klepper, L., Flesher, D. and Hageman, R.H. 1971. Generation of reduced nicotinamide adenine dinucleatide for nitrate reduction in green leaves. *Pl. Physiol.* 48 : 580-590.

Minotti, P.L., Williams, D.C. and Jackson, W.A. 1968. Nitrate uptake and reduction as affected by calcium and potassium. *Soil Sci. Soc. of Amer. Proc.* 32 : 692 - 698.

Sale, P.W.G. and Campbell, L.C. 1987. Differential responses to K deficiency among soybean cultivars. *Plant and Soil* 104 : 183- 190.

Sinoit, N. and Krammer, P.V. 1977. Effect of water stress during different growth stages of soybean. *Agron. J.* 69 : 274-278.

Tiwari, P.N., Gambhir, P.N. and Rajan, T.S. 1974. Rapid and non distructive determination of seed oil by pulsed nuclear magnetic resonance technique. *J. Amer. Oil. Chem. Soc.* 51 : 104-109.

Witham, F.M., Blaydes, D.F. and Dexlin, R.M. 1971. Chlorophyll absorption spectrum and quantitative demonstration pp. 55-56. *In* Experiments in plant physiology. Van Noster and Reinhold company, New York.

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RESPONSE OF MUSTARD (*Brassica Juncea* L.) TO VARYING LEVELS OF IRRIGATIONS, NITROGEN AND SULPHUR.

A field experiment was conducted at the college farm, Gujarat Agricultural University, Navsari during *rabi* season of 1988-89 on mustard. The treatments consisting of four levels of irrigation viz., at vegetative + pre-flowering stage = I_1, at vegetative + pre-flowering + siliqua formation stage = I_2, at vegetative + flowering + grain filing stage = I_3 and at vegetative + pre-flowering + flowering + siliquae formation + grain filling stage = I_4 as main plot treatments and three levels of nitrogen viz., 25, 50 and 75 kg N/ha and two levels of sulphur 0 and 50 kg S/ha as sub plot treatments. The treatments were replicated four times in a split plot design. The soil was clayey in texture with 0.51% organic carbon content with pH 7.9. The available N, P_2O_5, K_2O and S were 228, 31, 352 kg/ha and 21.99 .ppm respectively. The depth of each irrigation applied was 60 mm. The value of field capacity, permanent wilting point and bulk density of the experimental plot were 32.5% 18% and 1.36 g/cc, respectively. Half of nitrogen and full dose of sulphur was applied at the time of sowing as per treatments and remaining half dose of nitrogen was applied at 30 days after sowing and at the time of first irrigation. The mustard variety "Varuna" was sown on 14th November, 1988 and harvested on 23rd February, 1989.

In general due to heavy infestation of mustard saw fly at the time of siliqua develop-

Table 1. Effect of irrigation, nirtogen and sulphur on seed yield (kg/ha) and yield attributes of mustard

Treatment	Seed yield (kg/ha)	Stalk yield (kg/ha)	Oil yield (kg/ha)	No. of siliquae/ plant	No. of seeds/ siliqua	Seed weight/ plant (g)	Test weight (g)
Irrigation (I)							
I_1	786	2661	289	113.2	12.1	5.77	4.21
I_2	923	2882	326	129.8	12.1	6.86	4.33
I_3	943	2973	339	133.5	12.2	6.95	4.39
I_4	1110	3207	406	145.2	12.4	7.66	4.60
S. Em±	12.1	29.3	4.5	1.74	0.29	0.08	0.03
C.D. at 5%	39.0	96.0	14.0	5.56	NS	0.24	0.10
Nitrogen (kg/ ha)							
N_1 = 25	824	2832	301	108.2	11.6	6.30	4.20
N_2 = 50	945	2933	343	128.9	12.3	6.82	4.40
N_3 = 75	1054	3027	384	154.3	12.8	7.31	4.54
S. Em±	8.1	18.5	2.89	1.79	0.21	0.05	0.02
C.D. at 5%	23.0	49.0	8.0	5.06	0.58	0.14	0.07
Sulphur (kg/ha)							
S_1 = 0	940	2923	342	130.1	12.2	6.80	4.37
S_2 = 50	941	2938	343	130.8	12.2	6.82	4.39
S. Em±	6.6	14.7	2.36	1.46	0.17	0.04	0.02
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS

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ment, mustard yield levels were low. The results presented in Table 1 indicated that scheduling of irrigation at vegetative + pre-flowering + flowering + siliqua formation and grain filling growth stages (I_4) significantly increased seed as well as stalk yields of mustard. It also significantly improved oil yield (406 kg/ha) over rest of the irrigation treatments. Malty *et al.* (1980) reported that the reproductive stages were the most critical stages for water needs to mustard. The significant improvement in the mustard seed yield might be the cumulative effect of significant improvement in the value of yield attributes viz., number of siliquae per plant (142.5), number of seeds per siliqua (12.4), seed weight per plant (7.66 g) and test weight (4.60 g).

Table 2. Moisture use and nutrient uptake as influenced by different levels of irrigation, nitrogen and sulphur.

Treatment	Consumption water use (mm)	Water use efficiency (kg/ha^{-mm})	Total nutrient uptake (kg/ha)	
			N	S
Irrigation (I)				
I_1	223	3.52	40.27	10.38
I_2	264	3.49	48.58	11.90
I_3	293	3.22	50.61	12.39
I_4	354	3.13	60.30	14.74
S.Em. ±	-	-	0.78	0.36
C.D. at 5%	-	-	2.49	1.15
Nitrogen (kg/ha)				
N_1 = 25	275	3.06	43.00	11.28
N_2 = 50	283	3.37	50.01	12.22
N_3 = 75	294	3.60	56.81	13.67
S.Em. ±	-	-	0.32	0.22
C.D. at 5%	-		0.90	0.61
Sulphur (kg/ha)				
S_1 = 0	282	3.35	49.57	12.25
S_2 = 50	285	3.32	50.31	12.47
S.Em. ±	-	-	0.26	0.18
C.D. at 5%	-	-	0.73	NS

Linear response to each successive increase of nitrogen level on mustard seed yield, stalk yield, oil yield as well as growth and yield attributes were observed. These findings are in confirmity with those reported by Vasvelia (1988). However, no response of elemental sulphur to mustard crop was observed. This could be ascribed to sufficient status of soil with regard to sulphur.

The mean consumptive wateruse recorded in the treatment I_1, I_2, I_3 and I_4 was 223, 264, 293 and 354 mm, respectively. This indicates that the consumptive wateruse increased with the increase in levels of irrigation as expected (Samui *et al.*, 1986). In contrast to this the water use efficiency decreased with increasing the number of irrigations (Table 2) The soil moisture extraction decreased progressively with the depth of soil almost in all treatments. This indicates that when sufficient moisture is available in upper root zone, plant absorb more amount of water from it and more amount of moisture was extracted from lower zone only when upper layer observed moisture stress conditions.

The data on total uptake of N and S indicated that the treatment I_4 in which maximum number of irrigations were given, recorded significantly the highest total uptake of N and S (60.30 and 14.74 kg/ha). This might be due to high frequency of irrigation in which the absorption and translocation of food including the elements N and S accelerated. This increase in nitrogen level had increased the total N and S uptake by plant.

N.M. College of Agriculture,
Gujarat Agricultural University, Navsari
*Main Pulses Research Station, GAU,
S.K. Nagar 385 506, Gujarat

A.I.PATEL*
D.M. PATEL
K.R. PATEL

Malty, P.K., Sengupta, A.K. and Jana, P.K. 1980. Response of mustard variety Varuna to levels of irrigation and nitrogen. *Indian Agriculturist* 24 (1) : 43-47.

Samui, R.C., Das, S., Bhattacharya, P., Singh, R.K. and Das, P. 1986. Effect of irrigation, nitrogen and iron on growth, yield and consumptive use of Indian mustard. *Indian J. Agron.* 31 (1) 58-62.

Vasvelia, S.P. 1988. Response of mustard (*Brassica Juncea* L.) to varying irrigation schedules, row spacing and levels of nitrogen in low land conditions of south Gujarat. M.Sc. (Agric.) Thesis submitted to GAU, S.K.Nagar.

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INTEGRATED WEED MANAGEMENT SYSTEM IN SOYBEAN (*Glycine max.* L.)

Soybean (*Glycine max*. L.) is an important grain legume cum oilseed crop grown on a large scale in India. In Andhra Pradesh, it is now getting popular with a cultivated area of about 400 ha with average productivity of 900 kg/ha. Because of slow growth of this crop at initial stages it is highly infested by weeds causing considerable yield losses ranging between 27 to 71% (Muniyappa, *et al.*, 1986; Jha *et al.*, 1993) and the most critical period of weed competition was considered to be first 30-45 days after sowing (DAS). The prohibitive cost of labour and occurrence of intermittent rains during crop growing season makes manual weeding less effective and uneconomical, thus the use of herbicides has greater scope in soybean. However, continued use of high rates of herbicide may control one type of weeds resulting in resurgence of other weeds and may affect the crops succeeding soybean besides causing pollution problems. Hence, "Integrated Weed Management" approach is gaining importance. The information available on integrated weed management (IWM) in soybean is very scarce in India in general and Andhra Pradesh in particular. Hence, the present investigation was undertaken to develop an effective and economical weed management strategy consisting of some individual or combination of herbicides and cultural practices.

The present experiment was conducted during *kharif*, 1993 at Students Farm, College of Agriculture, Andhra Pradesh Agricultural University, Hyderabad in a sandy loam soil with pH 7.5, 0.69% organic carbon and low in available nitrogen, medium in available phosphorus and potassium. The experiment with 11 treatments (Table 1) was laid out in a Randomised Block Design with three replications. Soybean variety "Hardee" (100-120 days duration) was sown on 18th July, 1993 with a spacing of 30 x 10 cm by dibbling.

The crop was irrigated immediately after sowing and subsequent irrigations were given as and when required. The total rainfall received during the crop growth period was 431.5 mm in 33 rainy days. However, the crop received a total of five supplemental irrigations during the crop season at dry spells. The crop was fertilized with 60 kgN, 60 kg P_2O_5 and 40 kg K_2O / ha in the form of urea, single super phosphate and muriate of potash. Pre-plant incrporation of fluchloralin was done at the time of final levelling before sowing. Pre-emergence herbicides, oxyflourfen and pendimethalin were applied 48 hours after sowing and post-emergence application of glyphosate was done at 30 DAS using water @ 600 litres/ha. Observations on crop growth, yield and weed population were recorded at harvest from 0.25 m^2 quadrate from enmarked area. The Integrated Weed Management Index which is a measure to indicate an increase in yield in percentage over control and was calculated for all treatments involving the integrated weed management practices using the following formulae:

$$Y = \frac{I - H}{I} \times 100 \quad \text{where,}$$

Y = Integrated Weed Management Index
I = Yield due to integrated weed management

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Table 1. Effect of different weed management practices on total weed population and dry matter in soybean

Sr. No.	Treatments	Dose	Total weed Population (m^{-2})	Total weed dry matter (g/m^2)	WCE (%)	IWMI (%)	WI (%)
1.	Fluchloralin	1.0 kg/ha (ppi)	351	135.4	30.1	--	41.7
2.	Oxyflourfen	0.2 kg/ha (pre. em)	304	114.3	41.7	--	45.7
3.	Pendimethalin	1.0 kg/ha (pre. em)	358	141.0	28.1	--	48.2
4.	Fluchloralin + Hand weeding (30 DAS)	0.75 kg/ha (pre.em)	200	85.7	56.3	50.9	15.0
5.	Oxyflourfen + Hand weeding 30 DAS	0.15 kg/ha (pre.em)	208	92.6	52.8	39.0	31.6
6.	Pendimethalin + Hand weeding 30 DAS	0.75 kg/ha (pre.em)	287	101.5	48.2	22.8	45.2
7.	Fluchloralin + Glyphosate	0.75 kg/ha (pre.em) 1.0 kg/ha (post.em at 30 DAS)	285	124.3	30.6	37.1	33.7
8.	Oxyflourfen + Glyphosate	0.15 kg/ha(pre.em) 1.0 kg/ha(post em. at 30 DAS)	282	95.1	51.5	38.7	31.9
9.	Pendimethalin + Glyphosate	0.75 kg/ha(pre.em) 1.0 kg/ha(post em. at 30 DAS)	355	126.5	35.5	23.4	45.6
10.	Hand weeding	Twice at 20 and 40 DAS	138	49.4	74.8	58.3	0
11.	Unweeded check		515	196.1	0	--	58.3
CD (0.05%)			35	10.1	-	--	--

WCE = Weed control efficiency; IWMI = Integrated weed management index;
WI = Weed index; ppi = Preplant incorporation

practices with recommended package of practices
H = Yield due to no weeding

Weed Index was calculated by using the following formulae:

$$W.I(\%) = \frac{\text{Yield in twice hand weeding} - \text{Yield in treated plot}}{\text{Yield in twice hand weeding}} \times 100$$

The weather prevailed during the crop season was congenial for crop growth and did not interfere with the herbicidal sprays. The predominant weed species observed during the crop growth period were *Cyperus rotundus*, *Cynodon dactylon*, *Digitaria sanguinalis*, *Dactyloctenium aegyptium*, *Parthenium hysterophorus*, *Commelina benghalensis*, *Amaranthus viridis*, *Digeria arvensis*, *Euphorbia geniculata*, *Trichodesma indicum*, *Cleome viscosa* and *Celosisa argentia*. Monocot and Dicot weeds accounted for 40 and 60% of total weed flora, respectively. Higher weed population and dry mater was observed in unweeded check, while the lowest was in treatment of hand weeding twice (Table 1). Among the her-

Table 2. Effect of different weed management practices on yield and its attributes of soybean

Sr. No.	Treatments	Dose	No. of pods/ plant	No. of seeds/ plant	100 seed wt(g)	Seed yield (kg/ha)	Halum yield (kg/ha)	Net returns (Rs./ha)	Benefit cost ratio
1.	Fluchloralin	1.0 kg/ha (ppi)	32.0	2.4	12.02	1113	1792	4015	0.82
2.	Oxyflourfen	0.2 kg/ha (pre. em)	32.6	2.2	11.09	1037	1695	3361	0.68
3.	Pendimethalin	1.0 kg/ha (pre. em)	30.3	2.1	11.97	990	1652	2843	0.56
4.	*Fluchloralin* + Hand weeding (30 DAS)	*0.75 kg/ha (pre.em)*	38.3	2.4	12.15	1623	2122	8610	1.69
5.	Oxyflourfen + Hand weeding 30 DAS	0.15 kg/ha (pre.em)	38.0	2.4	12.07	1306	1989	5592	1.15
6.	Pendimethalin + Hand weeding 30 DAS	0.75 kg/ha (pre.em)	34.0	2.2	11.89	1046	1702	3404	0.69
7.	Fluchloralin + Glyphosate	0.75 kg/ha (pre.em) 1.0 kg/ha (post.em at 30 DAS)	36.0	2.3	11.93	1267	1769	4261	0.73
8.	Oxyflourfen + Glyphosate	0.15 kg/ha(pre.em) 1.0 kg/ha(post em. at 30 DAS)	38.0	2.3	12.03	1300	1824	4496	0.76
9.	Pendimethalin + Glyphosate	0.75 kg/ha(pre.em) 1.0 kg/ha(post em at 30 DAS)	36.1	2.2	11.56	1040	1704	2299	0.38
10.	Hand weeding	Twice at 20 and 40 DAS	43.4	2.5	12.27	1910	2390	9533	1.66
11.	Unweeded check		19.5	1.9	11.17	797	1425	2546	0.67
CD (0.05%)			2.5	0.4	NS	212	241	--	--

Cost of herbicides : Fluchloralin - Rs. 446/lit; Pendimethalin - Rs. 360/lit; Oxyfluorfen - Rs. 1240/lit; Glyphosate - Rs. 486/lit bicidal treatments pre-emergence application of Fluchloralin @ 0.75 kg/ha and Oxyflourfen @ 0.15 kg/ha in combination with one hand weeding at 30 DAS was most effective in reducing weed population and dry matter with higher weed control effeciency and lower weed index. The weed control efficiency was highest under hand weeding (twice) treatment. Integrated weed management index and weed index were superior for fluchloralin @ 0.75 kg/ha + hand weeding (30 DAS) treatment next only to hand weeding twice treatment.

The combination of fluchloralin @ 0.75 kg/ha and one hand weeding at 30 DAS resulted in significantly higher seed yield than other treatments. The higher seed yield was due to higher number of pods/plant, number of seeds/pod and test weight of soybean (Table 2). However, none of the treatments were superior to hand weeding (twice) treatment which resulted in the highest yield and its components. As regards economics, the net returns were higher due to hand weeding twice and next best treatment in terms of net returns was fluchloralin + one hand weeding (30 DAS). But the benefit cost ratio was highest in favour of fluchloralin @ 0.75 kg/ha + hand weeding at 30 DAS (1.69) as compared to hand weeding (1.66). The lower benefit, cost ratio was due to more expenditure incurred on labour for hand weedings. Hence, it can be inferred that the integrated approach involving fluchloralin @ 0.75 kg/ha in combination with one hand weeding at 30 DAS was more economical for soybean crop in areas with labour scarcity. The system of integrated weed management by reducing the quantity of herbicide application combined with cultivation could be effective in providing acceptable weed control with least cost.

Department of Agronomy,
College of Agriculture,
Rajendranagar, Hyderabad - 500 030,
Andhra Pradesh.

P. PADMAVATHI
V. SATYANARAYANA
P. CHANDRASEKHARA RAO
A. LATCHANNA
P.V. VARAPRASAD

Jha, V., Tripathi, S.C., Mithyantha, M.S. and Sivasankaran, K. 1993. Efficacy of Sethoxydin for the control of grossy weeds in soybean (*Glycine max* (L.) Merril). Proceedings of International Symposium, Indian Society of Weed Science, Hissar, November 18-20, 1993 Vol.II : 161-162.

Muniyappa, T.V., Ramachandra Prasad, T.V. and Krishnamurthy, K. 1986. Critical stages of crop weed competition and chemical weed control in soybean. *Indian J. Weed Sci.* 18 : 34-38.

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RELATIVE SUSCEPTIBILITY OF THE DIPLOID AND AUTOTETRAPLOID OF OILSEED *BRASSICA* VARIETIES AND THEIR HYBRIDS TO MUSTARD APHID

The precise informations on the relative sen-susceptibility of different oilseed *Brassica* varieties to mustard aphid (*Lipaphis erysimi* Kalt) is being sought after by the breeders for developing usable defence mechanism against this pest. Incorporation of genetic resistance against this insect in cultivated varieties is now considered necessary. Preliminary studies on the varietal reactions to this devastating pest in cruciferous oilseed crops have been reported (Singh *et al.*, 1965; Rai and Sehgal, 1975, Teotia & Lal, 1970; Bakhetia and Singh 1993 and Malik, 1991). In the present study, an effort was made to evaluate the relative susceptibility of the diploid and the colchicine induced autotetraploid forms of representative rapeseed and mustard varieties and their F_1 hybrids.

The experimental material for the study comprised, one *toria* variety 'PT 30', two promising sarson selections (DYS 18 and DYS 26) and one mustard variety 'Varuna' as well as three F_1 hybrids obtained between 'PT 30', 'DYS 18' and 'DYS 26' both with the diploid as well as their colchicine induced autotetraploid forms. The F_1 hybrids and autotetraploids were made during *rabi* 1989-90 and the experimental materials were grown during *rabi* 1990-91 at the Crop Research Centre, BHU, Varanasi in a Ramdomized Block Design with three replications. Four rows of 4 m length of each entry were planted and spaced at 45 cm apart. The plant to plant space within a row was kept at 15cm. The crop was planted rather late, which favoured heavy natural infestations of aphids under field conditions. Observations on aphid infestation was recorded on 10 competitive plants in each replication at full flowering stage when aphid infestation was at its peak on the basis of 0 to 5 scale, where 0 is free from aphid and 5 represents the most heavily infested plants (Bakhetia and Sandhu, 1973; Bakhetia and Bindra, 1977). These ratings were based on the quantification of number of aphids in grade 0, 1 to 20 in grade 1, 21 to 100 in 2, 101 to 250 in 3, 251 to 500 in 4 and more than 501 in 5. Later on these values averaged out, which represented the aphid rating of the variety/hybrid concerned and the relative comparisons made were based on this value.

The comparative average aphid infestation ratings of different parental populations and their F_1 hybrids and the level of resistance observed at both the ploidy levels are summarised in Table 1. The *toria* variety 'PT 30', which has an aphid infestation rating of 3.7, supported comparatively less aphid population than that of the sarson selections 'DYS 18' and 'DYS 26', which had the average scores of 4.5 and 5.0, respectively. Toria beeing basically an early maturing crop than sarson, it might have escaped the aphid infestation, even though, it might have the same level of susceptibility. While the sarson selections could provide comparatively longer and more favourable growth period to aphids. So far the genetic resistance between toria, sarson varieties and their F_1 hybrids is concerned, there is little to choose between them. Rather, mustard (*Brassica juncea*) varieties show comparatively better tolerance behaviour than those of the *Brassica*

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Table 1. Comparative aphid infestation scores of different parental populations of rapeseed mustard and their F_1 hybrid

Oilseed *Brassica* types (Rapessed Mustard)	Parents/crosses	Average aphid infestation scores (0 to 5 scale)		Level of Resistance*	
		Diploid	Autotetraploid	Diploid	Autotetraploid
Rapeseed					
Toria	PT 30	3.7	4.0	S	S
Sarson	DYS 18	4.5	3.5	S	MR
Sarson	DYS 26	5.0	4.0	S	S
Average		4.4	3.8	S	S
Mustard	Varuna	3.5	3.0	MR	MR
Rapeseed F_1 Hybrid					
Toria x Sarson	PT 30 x DYS 18	3.0	2.5	MR	R
Sarson x Sarson	DYS 18 x DYS 26	4.0	4.0	S	S
Toria x Sarson	PT 30 x DYS 26	3.5	3.5	MR	MR
Average		3.5	3.3	MR	MR

* S = Susceptible, MR = Moderately resistant and R = Resistant

campestris selections (Rai and Sehgal, 1975; Rai *et al.*, 1987).

In general, (except PT 30 and the hybrids PT 30 x DYS 26 and DYS 18 x DYS 26) the autotetraploids supported quantitatively lower populations of aphids as compared to their diploid counterparts. This observation is in conformity with the report of Rajan (1961). In this study, the two hybrids mentioned above did not show any difference in the aphid scores at the two ploidy levels. But in the case of PT 30 x DYS 18, the situation was quite different. The autotetraploid forms of this hybrid could be considered to be less susceptible even though both parents PT 30 and DYS 18 were susceptible. Some heterozygote advantage for better aphid tolerance could however, be possible and expected. There are also reports of negative heterosis for flowering behaviour in toria x sarson and sarson x sarson crosses (Agrawal, 1976 and Deloi, 1977). A better genic balance for providing tolerance or antibiosis may be accomplished in the hybrids by complementation from the parental populations. But it is also likely that because of early maturity of the hybrids than its parents, it might as well have developed a possible escape mechanism.

Department of Genetics and Plant Breeding
Institute of Agricultural Sciences,
B.H.U. Varanasi - 221 005. (U.P.)
* Rubber Research Institute of India
Kottayam 9, Kerala.

G.PRABHAKARA RAO*
H. KUMAR
B.RAI

Agrawal, B.L. 1976. Studies on genetic diversity and heterosis in rapeseed (*B. campestris* L.). Unpublished Ph.D. Thesis, GBPUAT Library, Pantnagar, (Nainital), U.P.

Bakhetia, D.R.C. and Sandhu, R.S. 1973. Differential response of Brassica species/varieties to aphid (*Lipaphis erysimi* Kalt) infestation. *J. Res. PAU, Ludhiana* 10: 272-279.

Bakhetia, D.R.C. and Bindra, D.S. 1977. Screening technique for aphid resistance in Brassica crops. *SABRAO J.* 9 : 91-107.

Bakhetia, D.R.C. and Singh P. 1993. Host plant resistant to insect pests in oilseed crops, pp. 207-248. *In :* Advances in Host plant resistance to insects (eds.) G.S. Dhaliwal and V.K. Dilawari, Kalyani Publishers, New Delhi.

Deloi, P.C. 1977. studies on the level of self-incompatibility, inbreeding depression and the expression of heterosis in rapeseed. Unpublished Ph.D. Thesis, GBPUAT Library, Pantnagar, Nainital (U.P.).

Peter, K.V. and Rai, B. 1976. A note on the heterozygote advantage for frost resistance in autogamous tomato cultures. *Indian J. Agric. Sci.* 46 : 235-236.

Rai, B. and Sehgal, V.K. 1975. Field resistance of Brassica germplasm to mustard aphid (*Lipaphis erysimi* Kalt) *Sci. and Cult.* 41 : 444-445.

Rajan, S.S. 1961. Aphid resistance of autotetraploid toria. *Indian oilseeds J.* 5 : 251-255.

Testia, T.P.S. and Lal, D.P. 1970 Differential response of different varieties and strains of oleiferous Brassicae to aphid (*Lipaphis erysimi* Kalt) Labdev. *J. Sci. & Tech* 8 B: 219-226.

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MUTATION FREQUENCY AND SPECTRUM INDUCED BY DIETHYLSULPHATE IN LINSEED (*Linum usitatissimum* L.)

Mutations have been induced in linseed by both, physical and chemical mutagens for the improvement of various characters (Srinivasachar *et al.*, 1972; Rai and Das, 1976; Nayar, 1978; Galkin, 1982). One of the methods of increasing the mutation frequency is the application of chemical mutagens in water presoaked seeds. However, such work is lacking in this crop. The present experiment was conducted to study the effect of different durations of water pre-soaking on mutation frequency and spectrum induced by diethylsulphate (dES) in linseed.

Dry seeds of linseed cultivar T 397 were soaked in distilled water for 0, 4, 8, 12, 16, 20 and 20 h periods and were then treated with 0.3% solution of dES. Duration of treatment was 2 h at 22°C and the dES solution was replaced by freshly prepared solution after every 30 minutes. Seedling growth and fertility of pollen and ovules were studied in M_1 generation. At maturity, 300 M_1 plants from each treatment were harvested and threshed separately. Seeds from every M_1 plant were grown in separate lines in M_2. Chlorophyll deficient seedling mutations were scored on cotyledonary leaves in M_2 generation in field conditions.

Seedling growth and fertility of pollen and ovules in M_1 generation were reduced due to dES treatment and the effect was greater in water presoaked than non-presoaked seed treatment. On M_2 seedling basis, mutation frequency was 1.003% in dES treatment of non-presoaked seeds. A rise in mutation frequency occurred at 12 h of water presoaking (1.772%) and it increased up to the maximum of 2.094% at 20 h of water presoaking (Table 1.). Mutation frequency decreased and became 0.821% in 24 h water presoaked seeds.

The mutation spectrum consisted of 12 types of chlorophyll mutant and it was wider in water pre-soaked than non-presoaked treatments (Table 1.). All the 12 types of mutant were induced by dES in 16 and 20 h of water pre-soaked seeds. *Albina* was more frequent mutant in water pre-soaked than non-presoaked treatment. At 20 h of water pre-soaking (inducing the highest mutation frequency), the frequencies of *albina, viridis, xantha* and red tip mutants were 13.6, 29.6, 11.4 and 14.2% respectively (Table 1).

After soaking the seed in water, embryo is activated for germination and metabolic processes start. DNA replication begins after certain period of soaking in water and this period differs in different plant species. So the mutation frequency can be increased by applying the mutagen at DNA replication phase (S-phase). In the present study, higher mutation frequency and wider spectrum observed at 12-20 h of water presoaking indicated that DNA replication in linseed begin after 12 h of soaking the seeds in water and continues up to 20 h of soaking.

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Table 1. Spectrum and frequencies of chlorophyll mutants induced by dES *in* water pre-soaked linseed

Water pre-soak (h)	Mutant seedlings		Mutant types * and frequencies (%)											
	No.	%	A	V	X	AV	VA	XV	YT	RT	WT	WS	RS	YS
0	132	1.003	0.8	43.9	7.5	36.4	-	0.8	9.1	1.5	-	-	-	-
4	125	1.051	15.2	24.0	31.2	8.0	13.6	7.2	0.8	-	-	-	-	-
8	136	1.087	-	22.0	12.5	9.6	7.3	-	21.3	12.5	-	9.6	5.2	-
12	194	1.772	10.3	32.0	4.1	18.6	6.2	8.8	8.2	-	-	7.2	3.1	1.5
16	145	1.988	7.6	12.4	4.1	11.7	12.4	3.5	7.6	11.0	10.4	6.9	11.0	1.4
20	176	2.094	13.6	29.6	11.4	4.5	2.3	4.5	2.3	14.2	7.4	6.8	1.1	2.3
24	94	0.821	12.8	26.6	12.8	22.3	-	13.8	4.3	7.4	-	-	-	-

* A = Albina; V = Viridis; X = Xantha; AV = Albo-viridis; VA = Virido-albina; XV = Xantho-viridis; YT = Yellow tip; RT = Red tip; WT = White tip; WS = White spots; RS = Red spots; YS = Yellow spots

Department of Agricultural Botany,
S.D.J. Post Graduate College, Chandesar,
Azamgarh 276 128, U.P.

GANESH PRASAD
R.M. PANDEY

Galkin, F.M. 1982. Use of chemical mutagens in breeding linseed. *Refrat. Zh.* 3. 65. 342.

Nayar, G.G. 1978. Induced early flowering, dwarf mutations in linseed (Linum usitatissimum). *Mutation Breeding Newsletter* 11: 9.

Rai, M. and Das, K. 1976. Potentiality and genetic variability in irradiated population of linseed. *Indian J. Genet. Pl. Breed.* 36: 20-25.

Srinivasachar, D., Seetharam, A. and Malik, R.S. 1972. Combination of three characters (high oil content, high iodine value and high yield) in a single variety of linseed, *Linum usitatissimum* L. obtained by mutation breeding. *Curr. Sci.* 41: 169-171.

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STUDIES ON THE SUNFLOWER GENOTYPES UNDER MOISTURE STRESS CONDITIONS

Sunflower *(Helianthus annuus* L.), an important oilseed crop of India is mainly cultivated as a rainfed crop during the monsoon season. During this season, the crop experiences moisture stress intermittently leading to a substantial drop in the productivity (Ravishankar *et al.*, 1991). In particular, moisture stress during the mid vegetative phase i.e., around 15 days prior to flowering affects the crop growth and productivity resulting in more than 70 per cent decrease in biomass and seed yield (Uma Shaanker *et al.* 1991). Improvement of sunflower productivity under rainfed environment thus necessitates the identification of genotypes exhibiting intrinsic tolerance to moisture stress as well as those that show least per cent reduction in their growth and yield attributes under stress. Earlier studies have indicated that productivity of sunflower critically depends upon the ability of the genotype to accumulate total dry matter (TDM) by maintaining a high leaf area index (LAI).

In this context, a study was taken for exploring the possibility of selection of sunflower genotypes exhibiting less per cent reduction in leaf area under stress. These lines would be expected to maintain a high TDM and consequently result in less reduction of seed yield under moisture stress. Such selected genotypes/accessions can be readily used in breeding programmes to improve the crop productivity under rainfed conditions. In this paper, the results of the attempts made to screen a large number of genotypes or accessions for their intrinsic drought tolerance in terms of both the absolute leaf area, TDM and seed yields as well as the per cent reduction in these traits under moisture stress imposed in the field are presented.

Three field experiments in factorial Randomized Block Design were conducted at the University of Agricultural Sciences, Bangalore on red loamy soils during summer seasons of 1990, 1993, and 1994. Each experiment included a stress and a control (irrigated) treatment with varying number of genotypes in four replicates with a plot size of 3 x 3m^2 Moisture stress was imposed by withholding irrigation during mid-vegetative phase i.e., from 35 days after sowing (DAS). Observations on leaf area per plant at the initiation and at the end of stress period, TDM and seed yield at harvest, were recorded. Using this basic data, the per cent reduction in these characters under stress over that under control were compared. From each experiment, the genotypes were grouped based on a two dimensional standardized normal distribution (Z-distribution) involving one of the trait such as leaf area, TDM or seed reductions due to stress. The genotypes possessing intrinsic drought tolerance (least per cent reduction) characterised by high or low values on absolute scale basis for leaf area, TDM and seed yield are termed as drought tolerant coupled with superior argonomic performance or otherwise.

Genotypic variations existed for a given leaf area at the end of moisture stress, TDM and seed yield at crop harvest and their respective per cent reductions due to moisture stress (Ravi Shankar, 1990; Ganesh Kumar, 1993; Uma Shaankar and Nanja Reddy, 1994; Fereres *et al.*, 1986 and Ravi Shanker *et al.*,

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1991.). This indicates that, there exists a strong possibility for selection to be imposed to identify the drought tolerant genotypes.

Based on the normal Z distribution, in each experiment, two to three genotypes are identified for least per cent reduction in seed yield under stress compared to that under control coupled with high or low absolute yields under control (Table1). Similar analyses were followed for leaf area and TDM also. In general, low absolute yielders showed less per cent reduction under stress compared to high yielders. Among the former category of genotypes, EC 68414 is one of the widely cultivated genotype. It is suggested that such genetic stock be made use of in developing population/varieties for intrinsic drought tolerance. The maintainer line CMS 353 B, which also exhibited a low per cent reduction could be directly used in the generation of hybrids for selection for tolerance to moisture stress.

Among the genotypes that are high yielders under control conditions, few of the promising ones are EC 68414 and accessions 1628 and 1730. These material could be used

Table 1. Promising sunflower genotypes exhibiting drought tolerance

Genotype	Seed yield		TDM		Leaf area	
	Seed yield	% reduction	TDM	% reduction	Leaf area	% reduction
Genotype with high absolute values						
Experiment -I (summer, 1994)						
Acc 456 (1,2)	53.4	23.2	177.8	30.5	6611	46.4
Acc1616 (1,2)	48.0	30.8	213.4	13.6	--	--
Experiment - II (Summer, 1993)						
Acc 1628 (1,2,3)	34.3	11.0	169.9	8.6	4241	41.0
Acc 1630 (1,2,3)	47.9	5.0	207.1	29.4	5102	28.0
EC 68415 (1)	28.9	7.0	113.2	29.4	3725	31.0
Experiment -III (Summer, 1990)						
Acc 430 (1,2)	47.7	26.9	163.5	14.8	4649	35.2
Acc 438 (1,2)	47.3	26.2	124.8	9.6	5115	44.4
Genotypes with low absolute values						
Experiment - I (Summer, 1994)						
353 B (1,2)	19.8	18.2	84.4	23.2	2056	42.8
Acc 931 (1,2	23.0	24.4	74.8	20.3	3388	55.3
Experiment - II (Summer, 1993)						
Acc 1610 (1,2)	20.4	9.0	76.2	17.0	3078	66.0
Acc 1634 (1,2,3)	25.2	5.0	84.6	10.0	2890	26.0
Experiment - III (Summer, 1990)						
Acc 275 (1,2)	28.9	1.1	103.3	25.1	3065	24.1
EC 68414 (1,2,3)	30.1	11.9	82.9	12.8	2798	6.8

Seed yield and TDM (g plant^{-1}) at maturity and leaf area (cm^2) per plant at anthesis are the absolute values under control treatment

% reduction: per cent reduction over control in respective parameters

(1), (1,2) and (1,2,3) are least per cent reduction shown in (Seed yield), (Seed yield and TDM) and (Seed yield , TDM and leaf area) respectively directly or further incorporated into breeding programmes since evidence exists to show that there is moderate to high heritability for yield and yield attributes in sunflower (Shinde *et al.*, 1983).

Department of Crop Physiology and
* Project Co-ordinating Unit (Sunflower)
University of Agricultural Sciences
GKVK, Bangalore 560 065.

Y.A. NANJA REDDY
R. UMA SHAANKER
K. VIRUPAKSHAPPA*

Fereres, E., Gimenez., C. and Fernandez, J.M. 1986. Genetic variability in sunflower cultivars under drought. I. Yield relationships. *Aust. J. Agric. Res.* 37: 573-582

Ganesh Kumar, 1993. Evaluation of sunflower genotypes for relative drought resistance and understanding the physiological basis of drought resistance. M.Sc. (Agric.) Thesis, Univ. Agril. Sci., Bangalore.

Ravishankar, K.V. 1990. Drought tolerance studies in sun flower: Field evaluation of sunflower germplasm for relative drought resistance at two crop growth stages. M.Sc. (Agric.) Theses, University Agricultural Science, Bangalore.

Ravishankar, K.V., Uma Shaanker, R., Ravishankar, H.M., Udaya Kumar, M. and Prasad, T.G. 1991. Development of drought tolerant sunflower for semi-arid tracts of India: Duration of genotypes influenced their performances under imposed moisture stress. *Helia.* 14 77-86

Shinde, Y.M., Wattamwar, M.J. and Patil, S.D. 1983. Variability and correlation studies in sunflower. J. *Maharastra Agric. Univ.,* 8:122-123

Uma Shaanker, R. and Nanja Reddy, Y.A. 1994. Annual Report, 1994., Sunflower Physiology, AICRP (Sunflower), University Agriculture Science, Bangalore

Uma Shaanker, R., Ravishankar, H.M., Virupakshappa, K. Prasad, T.G. and Udaya Kumar, M. 1991. A report on Sunflower Physiology, Department of Crop Physiology, University Agriculture Sciences, Bangalore.

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RESPONSE OF GROUNDNUT GENOTYPES TO PLANT DENSITY AND PHOSPHORUS NUTRITION IN ALFISOLS

In India, groundnut is predominantly raised under rainfed situations in *kharif*. Due to vagaries of monsoon, biotic stresses, crop shifts in favour of more remunerative crops etc. the productivity of this crop is decreasing. Crop improvement programmes resulted in the development of spanish bunch type varieties characterized by innate ability to withstand drought, field tolerance to biotic stresses like leafspot, budnecrosis etc. apart from high partitioning efficiency of photosynthates and synchronous pod development. Being a legume, the crop responds favourably to phosphorus applications which depends on the soil type and its phosphorus-dynamics. This calls for a need to generate information on the response of these new genotypes to plant density and nutrients, especially phosphorus, for realising their full yield potential in a given agro-climatic situation.

A field experiment was therefore conducted during late *kharif* 1993-1994 at the research farm of the Directorate of Oilseeds Research, Rajendranagar, Hyderabad on a sandy loam soil having 6.5 pH, low in available nitrogen (87.5 kg/ha), medium in available phosphorus (17.5 kg P_2O_5/ha) and potassium status (140.5 kg K_2O/ha) with a view to assess the performance of groundnut genotypes under various plant densities and phosphorus levels. Two spanish bunch groundnut varieties viz., DRG 17 and Kadiri 3 were sown on 8th August, 1993 at three Plant densities of 30 x 10 cm, 30 x 15 cm and 30 x 20 cm under three levels of phosphorus viz., 0, 30 and 60 kg P_2O_5 per hectare in plots of size 4 x 3m. These treatments were tested in a Factorial Randomized Block Design with 3 replications. The crop received 20 kg N/ha as basal dose along with the entire dose of phosphorus as per treatment in the form of single super phosphate apart from 10 kg N and 500 kg gypsum/ha at flowering stage. The crop received three irrigations at critical stages. Observations were made on pod yield and yield components such as pod number, pod weight, kernel weight per plant and 100 seed weight besides dry matter/plant. The oil content in kernel was estimated by NMR Method.

Yield and yield components

It was observed that the genotype DRG 17 produced significantly higher pod yield (4.29 t/ha) than Kadiri-3 check (3.38 t/ha). Though the varieties did not differ significantly in respect of pod number, pod weight per plant and 100 seed weight, DRG 17 excelled Kadiri-3 in respect of kernel weight/plant and dry matter production consequently contributing to greater pod yield (Table 1).

High density sowing adopting 30 x 10 cm spacing resulted in significant pod yield enhancement (4.05 t/ha) over low density sowing at 30 x 15 cm (3.88 t/ha) and 30 x 20cm (3.58 t/ha) highlighting the importance of maintaining adequate plant stands for realising higher yield (Table 1).

The variety DRG 17 yielded more at 30 x 10 cm spacing while Kadiri 3 performed equally both at 30 x 15 cm and 30 x 10 cm spacing as evident from the interaction (Table 2). However, significant interaction between spacing and genotype on kernel weight/plant

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Table 1. Yield and yield components of groundnut genotypes in relation to plant density and phosphorus nutrition

Treatment	Pod No./ plant	Pod wt/ plant (g)	Kernel wt/pl(g)	Dry wt/ plant (g)l	100 seed Wt. (g)	Pod yield (kg/ha)	Oil Content (%)
Variety							
DRG 17	23.25	31.51	23.05	52.99	53.22	4298.82	46.14
Kadiri 3	21.09	28.74	17.59	46.31	52.71	3386.30	47.16
SEm±	1.043	1.452	0.341	2.052	0.546	30.56	0.27
CD (0.05)	NS	NS	0.980	5.898	NS	87.84	0.79
Plant density (cm)							
30 x 15	23.00	31.08	19.75	50.66	53.72	3885.39	46.87
30 x 20	24.34	33.34	24.28	54.70	51.94	3589.33	46.69
30 x 10	19.17	25.94	16.92	43.60	53.28	4052.94	46.38
SEm±	1.278	1.778	0.418	2.514	0.668	37.43	0.34
CD (0.05)	3.672	5.111	1.201	7.224	NS	107.58	NS
Phosphorus levels (p2o5)							
0 kg/ha	19.72	29.75	19.54	48.03	53.89	3569.78	46.76
30 kg/ha	21.86	28.33	19.22	48.25	52.67	3877.78	46.63
60 kg/ha	24.92	32.29	22.19	52.67	52.39	4080.11	46.55
SEm±	1.278	1.778	0.418	2.514	0.668	37.43	0.34
CD (0.05)	3.672	NS	1.201	NS	NS	107.58	NS

Table 2. Interaction effect of groundnut genotypes and plant density on pod yield (kg/ha) and kernel weight/plant.

Genotype	Spacing (cm) 30 x 15	30 x 20	30 x 10	Mean
Pod yield (kg/ha)				
DRG 17	4309.7	3871.2	4715.6	4298.8
Kadiri-3	3461.1	3307.4	3390.3	3386.3
Mean	3885.4	3589.3	4053.0	
SEm±	52.93			
CD (0.05)	147.37			
Kernel weight/plant (g)				
DRG 17	21.4	29.0	18.8	23.05
Kadiri-3	18.2	19.6	14.8	17.60
Mean	19.8	24.3	16.9	
SEm±	0.59			
CD (0.05)	1.69			

showed that providing 30 x 20 cm for DRG 17 and Kadiri 3 resulted in higher kernel weight/plant than (Table 2) high density sowing, which is due to less inter-plant competition for various growth factors.

Sowing the crop at 30 x 10 cm spacing along with application of 60 kg P_2O_5/ha remaining comparable with 30 kg P_2O_5/ha offered substantially higher pod yield than the rest (Table 3). The genotypes differed in their phosphorus response in terms of pod number/plant and kernel weight/plant, where DRG 17 responded up to 60 kg P_2O_5/ha, while Kadiri-3 showed marginal response (Table 3). Sowing the crop at a wider spacing of 30 x 20 cm in conjunction with 60 kg P_2O_5/ha resulted in discernible increase in weight of kernels/plant than (Table 3) high density sowing regardless of the genotypes which could be attributed to lower inter-plant competition for various growth factors like light moisture and nutrients.

An increase in the level of phosphorus from 0 through 60 kg/ha resulted in significant

Table 3. Interaction effects of phosphorus with plant density and genotype on yield and yield components.

Spacing(cm)/ Genotype	P_2O_5 (kg/ha)			
	0	30	60	Mean
Pod yield (kg/ha)				
30 x 15	3605.5	3996.2	4054.5	3885.4
30 x 20	3531.3	3386.8	3849.8	3589.3
30 x 10	3572.5	4250.3	4336.0	4052.9
Mean	3569.8	3877.8	4080.1	
SEm±	64.83			
CD (0.05)	186.33			
Kernel weight/plant (g)				
30 x 15	19.0	18.8	21.5	19.76
30 x 20	22.3	22.5	28.0	24.28
30 x 10	17.3	16.4	17.1	16.90
Mean	19.5	19.2	22.2	
SEm±	0.72			
CD (0.05)	2.08			
Pod number/plant				
DRG 17	19.0	21.9	28.8	23.2
Kadiri-3	20.0	21.8	21.0	21.0
Mean	19.7	21.9	24.9	
SEm±	1.81			
CD (0.05)	5.19			
Kernel weight/plant (g)				
DRG 17	20.5	21.2	27.5	23.0
Kadiri-3	18.6	17.3	16.9	17.6
Mean	19.5	19.2	22.2	
SEm±	0.59			
CD (0.05)	1.69			

and linear enhancement in the pod yield of groundut (Table 1). This was due to concomitant increase in pod number and kernel weight per plant; though the graded levels of phosphorus could not cause discernible variations in the pod weight and dry matter per plant and test weight. Similar observations were also made by Pushpendra Singh *et al.* (1994) and Ved Singh *et al.* (1994).

Oil content

The oil content of Kadiri-3 variety was more than that of DRG 17. The different densities of sowing and phosphorus levels could not bring about discernible variations in the oil content of groundnut kernels. This indicates that oil content is more a genetically controlled factor and is less influenced by density of plants and phosphorus nutrition (Table 1)

From the present study it could be inferred that DRG 17 out yielded Kadiri-3 by 0.91 t/ha when grown in late *kharif* due to higher kernel weight and dry matter production per plant. Genotypic variations exist in the requirements of spacing and phosphorus, where DRG 17 yielded more at 30 x 10 cm spacing, while Kadiri 3 needed 30 x 15 cm spacing. DRG 17 showed better response to phosphorus from 30-60 kg P_2O_5/ha than Kadiri-3.

Directorate of Oilseeds Research,
Rajendranagar, Hyderabad - 500 030.

C.V . RAGHAVAIAH
P. PADMAVATHI
M.V. PRASAD

Pushpendra Singh, Verma, B.S. and Sahu, M.P. 1994. Effect of levels and source of phosphorus and bioregulators on groundnut (Arachis hypogea). *Indian J. Agronomy* 39 (1): 66-70.

Ved Singh, Sharma, S.K. Verma B.L. and Siag, R.K.1994. Effect of irrigation schedule and phosphorus fertilization on yield, water use and phosphorus uptake by groundnut (*Arachis hypogea*). *Indian J. Agronomy* 39 (1): 58-61.

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UTILITY AND ACCEPTABILITY OF SAFFLOWER PETAL POWDER AS FOOD INGREDIENT

The safflower is a herb with yellow to red petals and belongs to compositae family. Chinese use safflower plant both for food or medicinal use. A number of medicinal products based on safflower petal powder were developed and are being used for treating coronary heart diseases, hypertension, renal throbosis etc. The colouring pigment in safflower petals is called carthamin. (Wada 1952). Originally safflower contains yellow colour petals and in course of time gets changed to red due to change in components. The safflower red is soluble in alcohol while yellow pigment is soluble in water. Apart from yellow and red pigments, safflower contains safflower factors like safflower glycoside and safflower benzyl glucoside. These components taste bitter, warm and are non-poisonous. But the extracted red pigment is tasteless and odourless. The petal powder taste slightly astringent.

Table Acceptability of products using safflower petal powder (%)*

Products	Highly acceptable	Moderabtely acceptable
Beverage:-		
a. Flavoured milk	100	-
b. Herbal tea/decoction	-	80
Sweet dishes:		
a. Kesari	-	80
b. Coconut burfi	-	80
c. *Basundi*	*100*	-
Meal items:		
a. Lime rice	100	-
b. Kichidi	100	-
c. Cabbage curry	100	-
d. Potato curry	100	-

* No of taste panel members = 12

Safflower petals after pollination, were collected from Directorate of Oilseeds Research (DOR) fields at Rajendranagar. They were sun dried and finely powdered. This powder was utilised in the preparation of some edible items at the department of Foods and Nutrition, Andhra Pradesh Agricultural University, Rajendranagar which are indicated in the Table. These items include beverages (flavoured milk, and herbal tea); Sweet dishes (*Kesari*, Coconut *burfi* and *Basundi*) and a variety of main meal items (lime rice, *kichidi*, cabbage curry and potato curry). The above items were subjected to sensory evaluation by a panel of 12 members.

Under beverage products herbal tea was moderately accepted since our tastes are directed towards dicoction, made out of tea leaves or tea dust. *Kesari* and Coconut *burfi* were moderatly accepted by 80 percent of the subjects because of slight perception after taste. Of the three dishes, *basundi* was highly accepted by 100 per cent of the subjects. All the meal items were well accepted by all the panel members. Therefore, this study proves that safflower petal powder can be used as natural colouring pigment in a number of food items. However, slight refinement is needed to eliminate the astringent in the powder and further studies are needed in this direction.

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AICRP - Foods and Nutrition, Post Graduate and Research Centre, Andhra Pradesh Agricultural University, Rajendranagar, Hyderabad-30

G. SAROJINI
G. NIRMALA
G. NAGARAJ

Wada M (1952) Proc. Japan Acad 29: 218, 351.

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GENETICS OF AERIAL PODDING ATTRIBUTE IN GROUNDNUT (*Arachis hypogaea* L.)

The aerial podding of groundnut was first reported by Prasad (1985). The aerial podding genotypes TAP 1 and TAP 5 occurred as spontaneous mutations in a population of Brazilian groundnut variety 'Tatu' exhibiting a large proportion of well developed aerial pods. The aerial pegs which otherwise go waste without developing into pods in traditional varieties, develop into pods with good seed filling in the reported material, perhaps due to a different mechanism of 'Ca' translocation (Prasad and Muralidharudu, 1991). Wynne and Gregory (1981) suggested structural alterations of groundnut plant involving the enhancement of fruiting sites as one of the possible ways of breeding groundnut genotypes possessing perceptibly higher levels of productivity. Considering the possible role of aerial podding genotypes in enhancing groundnut productivity, the information on the inheritance of this attribute could be of interest in groundnut breeding.

The twelve groundnut genotypes belonging to different botanical groups viz., M 13, ICG 2271, MK 374, Gujarat Narrow Leaf Mutant, TMV 2 Narrow Leaf Mutant, G 201 and Kadiri 3 (*Virginia* group), PGN 1, TMV 2, JL 24 and J 11 (*Spanish* group) and PI 350680 (*Valencia* group) were crossed to TAP 5 (an aerial podding *Valencia* genotype) at Agricultural College Farm, Rajendranagar. The latter was used as a pollen parent.

Each F_1 plant was harvested separately. Individual plant progenies were grown in F_2 generation by adopting a spacing of 60 cm x 20 cm in a Randomized Block Design with two replications. The F_2 populations ranged from 300 to 500 plants in different crosses. The plants exhibiting aerial podding attribute were counted in each progeny. Chi-sqare test was done to test the goodness of fit of the phenotypic frequencies observed (Gomez and Gomez, 1984).

It was observed that the pattern of inheritance varied with the female parent employed in the cross, the male parent TAP 5 (an aerial podding genotype) being common in all crosses. The F_1's of all crosses involving sequential branching female parents (*Spanish* and *Valencia*) and of Kadiri 3 (*Virginia*) exhibited aerial podding character, thereby indicating the dominant nature of this attribute in these crosses (Table 1.) The F_2 generation of crosses with sequentially branched female parents exhibited a monogenic Mendelian inheritance pattern of 3 aerial podding : 1 non-aerial podding (normal). With the exception of Kadiri 3, all crosses involving alternate branching *Virginia* types as female parent did not show any aerial podding in F_1 while F_2 these crosses segregated in the ratio of 1 aerial podding : 3 non-aerial podding (normal). The above segregation pattern was also observed in the case of Kadiri 3 x TAP 5 (Table 1). This odd behaviour of Kadiri 3 could be the result of its origin. Kadiri 3 (also known as Robut 33-1) originates from Robut 33 (a corruption of Rehovat 33), a *Spanish* cultivar, introduced into India from Isreal in 1964 as EC 27 988.

From the foregoing discussion, it is clear that the expression of the aerial podding attribute is very much conditioned by the genetic

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Table 1. Inheritance of aerial podding in groundnut.

Cross	Phenotype of F_1	Phenotypic classes in F_2	Observed Frequency in F_2	Chi-square value	Probability level
M 13 x TAP 5	Normal	Aerial Podding	49	1.0897[a]	0.25
		Normal	174		
ICG 2271 x TAP 5	Normal	Aerial Podding	77	1.1905[a]	0.25
		Normal	266		
MK 374 x TAP 5	Normal	Aerial Podding	80	0.3549[a]	0.50
		Normal	259		
GNLM x TAP 5	Normal	Aerial Podding	65	1.3107[a]	0.25
		Normal	229		
TMV 2 NLM x TAP 5	Normal	Aerial Podding	50	1.0705[a]	0.25
		Normal	177		
G 201 x TAP 5	Normal	Aerial Podding	84	0.8728[a]	0.25
		Normal	283		
Kadiri 3 x TAP 5	Aerial Podding	Aerial Podding	64	0.9012[a]	0.25
		Normal	167		
PGN 1 x TAP 5	Aerial Podding	Aerial Podding	303	0.0664[b]	0.75
		Normal	104		
TMV 2 x TAP 5	Aerial Podding	Aerial Podding	157	0.4480[b]	0.25
		Normal	58		
JL 24 x TAP 5	Aerial Podding	Aerial Podding	328	0.9045[b]	0.25
		Normal	98		
J 11 x TAP 5	Aerial Podding	Aerial Podding	293	0.5899[b]	0.25
		Normal	89		
PI 350680 x TAP 5	Aerial Podding	Aerial Podding	238	0.8485[b]	0.25
		Normal	70		

a = χ^2- values for an expected ratio of 1 aerial podding vs. 3 normal podding

b = χ^2- values for an expected ratio of 3 aerial podding vs. 1 normal podding

background. While the genetic background of sequential branching type is conducive for better expression of this trait, the genetic background of alternate branching genotypes tends to modify the expression of aerial podding attribute. A similar observation was made by Prasad (1988).

Considering the suggestion that the aerial podding attribute could be the result of a different mechanism of 'Ca' translocation of developing gynophores (Prasad and Muralidharudu, 1991), it would be worthwhile to investigate the inheritance pattern of aerial podding attribute with detailed studies on the 'Ca' translocation pattern in all the segregants.

Directorate of Oilseeds Research,
Rajendranagar, Hyderabad - 500 030, A.P.

G. VANISREE
M.V.R. PRASAD

Gomez, K.A. and Gomez, A.A. 1984. Statistical procedures for agricultural research. A wiley Interscience Publication, John Wiley New York.

Prasad, M.V.R. 1985. Aerial podding in groundnut (*Arachis hypogaea* L.). *Indian J.Genet.* 45 : 89-91.

Prasad M.V.R. 1988. Genetic restructuring of groundnut plant (*Arachis hypogaea* L.). *Proc. Conf. on Cyto. and Genet.* 1 : 247-254

Prasad, M.V.R. and Muralidharudu, Y. 1991. Calcium uptake in relation to pod development in aerial podding genotype of groundnut. pp. 464: *In* Groundnut - a global perspective: proceedings of an international workshop, 25-29 Nov. 1991, ICRISAT Center, India: Ed. (Nigam, S.N.) International Crops Research Institute for the Semi- Arid Tropics, Patancheru, Hyderabad

Wynne, J.C. and Gregory, W.C. 1981. **Peanut Breeding.** *Adv. Agron.* 34 : 39-72.

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EFFECT OF IRRIGATION AND NITROGEN ON DRY MATTER, YIELD AND WATER REQUIREMENT OF SUMMER SOYBEAN (*Glycine max*)

Efficient use of water is most important in the irrigated areas of south-eastern Madhya Pradesh during summer season. Summer Soybean (*Glycine Max* (L.)) Merr.) irrigated frequently on the basis of evaporation demand (irrigation water applied (IW):cumulative pan evaporation (CPE) ratio) gives a maximum yield (Tuteja and Tripathi 1993). However, maintenance of a particular ratio throughout the crop growth-period may not be appropriate because evapo-transpiration (ET) remains lower at vegetative and maturity stages than at flowering to pod development stage. The nitrogen requirement in soybean is high during pod development stage (Pahalwan and Tripathi 1984).The declined N-fixation activity at pod development stage may become a barrier to high seed and protein yields under reduced supply of nitrogen. Hence, an experiment was conducted to determine an alternative method of irrigation schedule and nitrogen requirement in summer soybean.

The experiment was conducted during summer season of 1991 at Raipur. The soil was low in available N (207 kg/ha), medium in available P (35 kg/ha) and high in exchangeable K (337 kg/ha), with pH 6.8. The moisture content at field capacity and wilting point was 27.5 and 18.3%, respectively. Out of different possible combinations of 3 IW/CPE ratios (0.3, 0.5 and 0.7) and 3 growth stages (germination to flowering (vegetative stage)up to 38 days after sowing, flowering to pod-initiation stage (flowering stage), 39 to 58 days after sowing and pod initiation to maturity stage (podding stage), 59 to 93 days after sowing; 6 combinations of irrigation schedules (main plot) were studied along with 3 nitrogen levels (sub plot) in a split-plot design with 3 replications. The treatments are as given in the Table. A medium-duration variety "Gaurav" was sown on 6 February and harvested on 10 May in 1991. At each irrigation 6 cm water was applied

The irrigation scheduled at 0.7 IW/CPE ratio throughout the crop period (IW/CPE 0.777) gave the maximum dry matter and seed yield (Table). Similar was the effect of I_5 treatment (IW/CPE 0.575) which could save 10 cm water without reducing the seed yield compared with that under IW/CPE 0.777. The I_5 gave higher water use efficiency (WUE) than I_1. It significantly reduced the N concentration in leaf and stem and N-accumulation in all the plant parts except seeds compared with the latter, but N concentration in pod wall and seed was maintained properly, resulting in similar N accumulation in seed and seed yield. The result confirms the finding of Pahalwan and Tripathi (1984). Treatment I_6 reduced the growth, yield and N concentration and accumulation in all the plant parts. Thus flowering stage of soybean appears most susceptible to water deficit and needs frequent irrigation at IW/CPE 0.7. It also confirmed from treatment of I_3, where irrigation was withheld at flowering stage, reduce seed yield more than I_1.

The treatment N_2 significantly increased the dry matter and N concentration and accumulation in different plant parts ie. leaves, stem, pod wall and seed, and seed yield as compared with N_1. N @ 40kg/ha supple-

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Table. Effect of irrigation and nitrogen on seed *yield, water requirement* (WR) and dry matter and nitrogen accumulation in different plant parts at maturity of summer soybean

Treatment	Dry matter (g/plant)				N concentration (%)				N accumulation kg/ha					Seed yield q/ha	WR cm	MUE kg/ha/cm
	Stem	Leaf	Pod wall	Seed	Stem	Leaf	Pod wall	Seed	Stem	Leaf	Pod wall	Seed	Total			
Irrigation																
I_1	2.24	2.33	3.97	6.11	1.62	1.82	1.87	7.56	15.3	14.1	24.8	154.0	208.2	15.24	50.4	30.3
I_2	1.90	1.91	3.44	5.07	1.50	1.52	1.41	7.05	10.0	9.7	16.2	119.0	154.9	12.14	38.4	31.7
I_3	1.84	1.84	3.16	4.96	1.45	1.49	1.38	7.09	9.6	9.1	14.5	117.2	150.4	12.68	44.4	28.6
I_4	2.15	1.96	3.33	5.00	1.12	1.63	1.63	7.19	7.8	10.7	18.1	119.8	156.4	11.75	32.4	36.3
I_5	1.97	2.27	3.75	6.00	1.26	1.54	1.54	7.33	10.8	11.7	19.3	146.6	188.4	14.44	40.4	35.7
I_6	1.63	1.62	2.75	4.87	1.26	1.40	1.32	7.00	8.7	7.6	12.0	113.6	141.9	11.46	32.4	35.4
CD P = 05	0.23	0.26	0.24	0.68	0.31	0.22	0.35	0.29	2.5	2.8	4.4	7.9	-	1.29	--	--
Nitrogen																
N_1	1.78	1.80	2.98	5.19	1.18	1.39	1.39	7.02	8.3	8.3	13.8	121.4	151.8	10.98	39.4	51.0
N_2	2.01	2.00	3.35	5.37	1.38	1.61	1.58	7.19	10.6	10.7	17.6	128.7	167.6	13.55	39.8	60.7
N_3	2.08	2.17	3.86	5.45	1.54	1.70	1.61	7.40	12.1	12.3	20.7	134.4	179.5	14.32	40.0	63.2
CD P = 05	0.12	0.08	0.14	0.12	0.13	0.08	0.16	0.18	1.7	1.2	3.2	5.8	-	1.28	-	-

• I_1 - IW/CPE 0.7 at all stages; I_2 - IW/CPE 0.3 at vegetative and 0.7 at flowering and podding; I_3 - IW/CPE 0.7 at vegetative and podding;
I_4 - IW/CPE 0.7 at vegetative and flowering and 0.3 at podding; I_5 - IW/CPE 0.5 at vegetative and podding and 0.7 at flowering;
I_6 - IW/CPE 0.5 at all stages;
N_1 - 20 kg/ha basal; N_2 - 20 kg/ha basal + 20 kg/ha at pod initiation; N_3 - 20 kg/ha as basal + 40 kg/ha at pod initiation

mented at pod-initiation stage increased the N concentration and accumulation in leaf and stem of soybean.

The result indicates that scheduling of irrigation at IW/CPE ratio 0.5 at vegetative and podding stages and 0.7 at flowering stage of soybean increased seed yield and reduced the water requirement during summer season. N application @ 20 kg/ha basal and also at pod initiation stage was beneficial for seed yield and N accumulation.

Indira Gandhi Krishi Vishwavidhyalaya, Raipur,
Madhya Pradesh 492 012

R. DHURANDHER
N . PANDEY
R.S. TRIPATHI

Pahalwan D.K. and Tripathi R.S. 1984. Nodulation, accumulation and redistribution of nitrogen in soybean as influenced by seed inoculation and scheduling of irrigation. *Plant and Soil* 81: 235-46

Tuteja S.S. and Tripathi R.S. 1993. Effect of water stress and irrigation schedule on performance of summer soybean. *J. Oilseeds Res.* 10(1) : 16-19.

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EFFECT OF IRRIGATION SCHEDULES AND ROW SPACING ON THE YIELD OF SAFFLOWER (*Carthamus tinctorious* L.)*

Safflower (*Carthamus tinctorious* L.) is an important *rabi* oilseed crop of the rainfed agriculture in our country. Productivity of this crop can be substantially increased by adopting appropriate soil and water management practices. Even on certain irrigable lands only one or two irrigations can be provided due to limited water resources. Hence, this resource should be efficiently utilised to achieve maximum benefit.

The present study was undertaken to determine the most suitable irrigation schedule under limited irrigation conditions and optimum row spacing to obtain high yield. The experiment was conducted in the *rabi* season of 1990-1991 at Allahabad Agricultural Institute, Allahabad; on deep alluvial soil with a pH of 7.8. Soil nutrient analysis showed organic carbon -0.28%, available phosphorus - 20.3 kg P_2O_5 /ha and available potassium - 112.10 kg K_2O/ha.

The experiment was laid out in a Split Plot Design by assigning 5 irrigation schedules in the main plot and three row spacing (30,45,60 cm) in sub plots replicated thrice.

The main plot treatments were T_1: no irrigation, T_2: one irrigation at flowering, T_3: two irrigation at branching and post flowering, T_4: three irrigations at rosette, branching and post flowering. T_5: three irrigations at branching flowering and post flowering. Plant to plant distance of 7 cm was maintained and a depth of 7-8 cm of water in the field was maintained in each irrigation given as per treatment.

Soil mositure contents in each treatment were determined at weekly intervals.

Results indicate that the drought resistant safflower crop responded quite well to irrigation and row spacing. Highest yield (1.68 t/ha) was obtained from the treatment combination where the crop was row spaced 30 cm apart and one irrigation scheduled at flowering stage of the crop. When three irrigations were scheduled at various growth stages, there was no substantial increase in yield (Table 1).

It was also noticed that plants grown in the narrow row spacing (30 cm) yielded more than the widely spaced rows (45 cm and 60 cm).

Gravimetric soil moisture contents at weekly intervals for each irrigation treatments showed a consistent pattern on the growth. Integration results show that amount of moisture present in the soil throughout the crop growth increased with increasing irrigation schedules (Table 2).

Allahabad Agricultural Institute, Allahabad.
[1]National Research Centre for Groundnut, Junagadh Gujarat

T.T. SAMARTHIA [1]
D.K. MULDOON

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Table 1. Yield and yield attributes as affected by irrigation and row spacing on safflower

Yeild attributes	Trearments					
	I_1	I_2	I_3	I_4	I_5	Mean
Seed yield (kg/ha)						
S_{30}	1300.0	2053.3	1593.3	1440.0	1686.6	1614.6
S_{45}	1373.3	1566.6	1170.0	1180.0	1526.6	1363.3
S_{60}	983.3	1430.0	930.0	596.6	1593.3	1106.6
Mean	1218.0	1683.3	1231.1	1072.2	1602.0	
1000 Seed weight (gm)						
S_{30}	42.3	40.0	41.0	41.0	41.3	41.1
S_{45}	42.0	41.0	42.3	41.3	41.3	41.6
S_{60}	43.0	41.3	41.6	41.3	44.0	42.2
Mean	42.4	40.7	41.6	41.2	42.2	

Least significant difference

	Main plot	*Sub plot*
Yield	604.54	405.08

Table 2. Integrated results for soil moisture during crop growth

Treatments	Number of irrigations	Stage of crop growth	Integrated results for soil moisture
I_1	0	-	9417
I_2	1	Flowering	10880
I_3	2	Branching and Post flowering	10120
I_4	3	Rosette, Branching and Post flowering	11311
I_5	3	Branching, flowering and Post flowering	11227

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CHARACTER ASSOCIATION AND PATH ANALYSIS IN LINSEED

Linseed has been one of the principal agro-industrial oilseed crops of India. The success of a good breeding programme usually depends upon the quantum of variability present in breeding material. The knowledge of association among yield and its component traits and their further partitioning into direct and indirect effects is of immense value in determining correlated response of different characters to selection. With this objective, the present investigation was carried out.

The experimental material comprising 26 linseed genotypes was raised in Randomized Block Design with three replications at R.S. Pura. The plot size was $10m^2$ with inter and intra-row spacing of 25 cm and 10 cm, respectively. At maturity, data were recorded on five competitive randomly selected plants from each genotype in every replication for six quantitative traits viz., plant height (cm), days to maturity, number of seeds per capsule, number of capsules per plant, 1000-seed weight (g) and seed yield per m^2 (g).

The results of estimated mean, range, genotypic coefficient of variation (GCV), heritability and genetic advance as per cent of mean are presented in Table 1. The genotypic coefficient (GCV) ranged from 2.31 to 19.00 and was highest for seed yield followed by number of capsules per plant, plant height and 1000-seed weight. Other characters like days to maturity and number of seed per capsule showed low genotypic coefficient of variation High heritability in broad sense, and genetic advance for seed yield, 1000-seed weight and plant height suggested that additive gene effects play an important role in the expression of these characters. Similar findings were reported in same crop by choudhary *et al.* 1972. High heritability estimates and moderate gentic advance was recorded in case of number of seeds per capsule whereas low heritability and moderate to low genetic advance estimates were observed for number of capsules per plant and days to maturity, respectively.

Table 1. The estimates of genetic parameters for different characters in linseed

Characters	Mean	Range		GCV	h^2 (BS)	GA as % mean
		Min.	Max.			
Plant height (cm)	76.45	50.30	102.68	12.62	0.51	14.13
Days to maturity	166.06	146.00	181.00	2.31	0.26	2.40
Number of seeds per capsule	8.86	7.20	10.00	7.05	0.51	10.40
Number of capsules per plant	51.80	24.00	92.80	13.75	0.26	14.11
1000-seed weight (g)	7.64	4.25	11.31	11.61	0.98	23.71
Seed yield per m^2 (g)	52.39	23.33	88.33	19.70	0.53	46.71

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The genotypic coefficient of variation revealed that days to maturity and number of capsules per plant exhibited highly significant and positive association whereas 1000-seed weight showed significant and positive association with seed yield. The number of seeds per capsule had a positive but non-significant association with yield indicating that seed yield and these characters have the same physiological basis for their expression. Similar results were also reported earlier by Badwal *et al*. 1970 and Patil *et al*., 1980 in linseed for some of the characters. The seed yield and the number of capsules per plant have significant and highly significant association with plant height, respectively while significant positive association of number of capsules was found with days of maturity. This suggests that reduced plant height and late maturity in linseed may produce more photo-synthetic material for formation of capsule in the plant.

Path coefficient analysis was carried out for all the six characters to workout the direct and indirect contribution on seed yield (Table2). Direct effect of plant height, days to maturity and 1000-seed weight were of higher magnitude indicating their importance in seed yield. In most of the characters, high magnitude of indirect effect *via* these characters was also observed. The number of capsules per plant had no direct effect on seed yield but indirect effect *via* plant height and days to maturity. These results are in partial agreement with earlier findings of Badwal *et al*., 1970 and Singh and Mahto, 1994. Thus, reduced plant height and 1000 seed weight are the major yield contributing characters and selection for these characters in most of the breeding programmes would be effective for yield improvement

Table 2. Direct and Indirect effect of different characters on yield in linseed.

Characters	Plant height (cm)	Days of maturity	No of seeds per capsule	No of capsules per plant	1000-seed weight (g)	Genotypic correlation coefficient with yield
Plant height (cm)	-0.402	-0.102	0.008	-0.007	0.021	-0.482*
Days to maturity	0.055	0.744	-0.001	0.005	0.002	0.805**
Number of seeds per capsule	0.102	0.030	-0.029	0.001	0.033	0.137
Number of capsule per plant	0.207	0.313	-0.002	0.013	-0.022	0.510**
1000-seed weight (g)	-0.017	0.002	-0.002	-0.001	0.505	489*

Residual effect = 0.201

* and ** indicate significance at 5 and 1 per cent levels, respectively.

Regional Agricultural Research Station, S.K.University of Agricultural Sciences and Technology, R.S.Pura Jammu 181 102

M.N.KHAN
S.C.GUPTA

Badwal, S.S., Gill, K.S. and Singh, H. 1970. Path coefficient analysis of seed yield in linseed. *Indian J.Genet.Pl.Breed.* 30:551-56.

Chaudhary, R.K., Bhatt, R.N., Choudhary, J.B. and Pathak, R.S. 1972. Analysis of yield components in Linum cross. *Indian J. Genet. Pl. Breed.* 32: 7-11.

Patil, V.D., Makne, V.G. and Chaudhari, V.P. 1980. Association analysis in linseed. *Indian J. Genet. Pl. Breed.* 40:235-37.

Singh, S.N. and Mahto, Jay Lal, 1994. Path coefficient analysis in linseed. *J. Oilseeds Res.* 11(1): 115-117.

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BOOK REVIEW

SUSTAINABILITY IN OILSEEDS, 1994. By Prasad, M.V.R. *et al.,* (Ed.), ***Proceedings of the National Seminar on Oilseeds Research and Development in India: Status and Strategies,*** August 2-5, 1994. Hyderabad. pp ix - 602 Published by the Indian Society of Oilseeds Research, DOR, Rajendranagar, Hyderabad-500 030 (A.P.). Price: Rs.500/-(postage Rs.40/- extra).

Of all the institutional innovations introduced by the Indian Council of Agricultural Research for the planning, execution and management of agricultural research in India, none has been so rewarding in its fulfilment as the All India Coordinated Research Projects. Forging a national grid of research appartus, free exchange of material, multi-location testing, inter-disciplinary approach to problems, prompt analysis and review of research results, have been cardinal to the success to the AICRPs. The pivotal role played by the All India Coordinated Research Projects on Wheat, Rice, Maize, Sorghum and Bajra in ushering what has come to be known as 'Green Revolution' is well documented. Outside the food grains the AICRP on Oilseeds has been the most outstanding in its contributions towards the amelioration of production problems in oilseed crops. Jointly with the Technology Mission on Oilseeds (T.M.O.), launched in 1986, it catalysed a spectacular improvement in the vegetable fat economy of the country. Imports of vegetable oils (peaking at 1634000 tonnes valued at Rs.1318 crores in 1983-84) could be reduced to 108000 tonnes valued at Rs 79 crores due to increased domestic production. It is, therefore, only timely that the completion of 25 years of operation by AICORPO should be celebrated in a befitting manner: That the Indian Society of Oilseeds Research, along with the Directorate of Oilseeds Research (I.C.A.R.) thought of organising a National Seminar on the status of oilseeds research in the country and the strategies to be followed, is most appropriate. To have decided on 'Sustainability in Oilseeds' as the burden theme of the seminar is also very relevant.

The volume under review is a record of the proceedings of this seminar. Besides the inaugural session, there were five sessions *viz.,* (i) Genetic enhancement of oilseed crops (46 papers), (ii) Sustainability of oilseed production systems (56), (iii) Post- harvest processing technology (4), (iv) Vegetable fat in human diet (24) and (v) Development scenario and strategies (12). In addition there was a panel discussion on 'Market Intervention and Policy Support'. This reviewer is not competent to review material spanning such wide discipline range and hence will confine himself only to a few of them.

None of the papers presented carry a summary which would have been most useful. Perhaps the summaries were printed in advance in a companion volume and distributed at the meeting itself. Even so, inclusion of summary at the end of each paper would certainly have been very helpful to the reader.

The production values of the proceedings are good, with double column presentation. The proof reading has also been good except for the presentation of tabular material. Some of the lapses in the proof reading of tables could be cited as those on pages, 71, 110, 281, 285, 295, 296, 354, 379, 381, 404, 426, 437, 439, 440, 562, 564 etc. Variation in type size points and line spacings of text matter is rather jarring and gives the impression of hasty compositing.

The techniqal quality of the papers included in the proceedings also varies over a wide range. Thus, we have a masterly overview of the groundnut production, its potential and problems, by P.S. Reddy and T.G.K. Murthy (page 1), who also highlighted the fact that "although 114 varieties have so far been developed and released in India, the increase in productivity over the years is not promising". Nigam (28) quantifies this as 1.3 to 3.2% genetic gain per year for pod yield. He also sees the future of groundnut breeding only through hybridization. It is interesting to note that he feels the future of groundnut "lies not in oil but in food use". G.M. Reddy (78) evaluates biotechnological methods in the improvement of some oilseeds. At the other quality extreme are "papers" that deal with a single year and single location data, e.g., use of weedicides in *Sesamum* (294) concluding that two hand weedings were the best, or the effect of "combined mutagenesis" in groundnut (163) reporting only on germination pollen sterility and survival. These would have rated inclusion only in the "Letters to Editor" section of conventional scientific periodicals. Probably a more stringent technical screening of the papers submitted, to be in tune with the seminar theme, would have vastly improved the quality of the articles presented, as well as reducing the size of the volume.

On the issue of "sustainability" itself, which was the main theme of the national seminar, one does get the impression that the papers had treated the issue of sustainability in a perfunctory way. One wishes that the presidential address of Dr R.S. Paroda emphasising that oilseeds are "very efficient users of limited moisture as well as nutrients", and the key note address of Dr M.S. Swaminathan drawing attention to the pillars of sustainable agriculture, i.e., ecological sustainability, economic efficiency, equity and job generation, had been circulated in advance to the contributors of the papers so that they could have reoriented their contributions well attuned to the main theme. It is realised that this would not have been possible. At least the organisers could have issued some guidelines in this regard.

The 46 papers in the genetic enhancement session straight away assume a one-to-one relationship between "productivity" and "sustainability". This could be true only to certain extent. Beyond certain limits, considerations of "economic efficiency" come into play. The phenomenon of diminishing returns discerned in cereal crops with input-intensive production system, should forewarn the oilseed research worker against "productivity-at-any-cost" approach. Significantly, Somasekara *et al.* (287) analysing 92 groundnut frontline demonstrations, spread over 5 years, found that overall sustainability was marginally "higher" with the farmers' method. Several genetical aspects relevant to "sustainability" seem to have been ignored in the case of oilseed crops. Some of these are : genetic control of wide adaptability *per se*; compatibility of genotypes of crop species involved in mixed cropping; cooperation or competetion between genotypes of the same species in varietal blends, composites or synthetics; photo-sensitivity or insensitivity for drought evasion; root and shoot characteristics involved in resistance to drought etc.

In the Session-II, on sustainability, are presented papers dealing with agronomic and crop management areas and have a more direct reference to sustainability than the papers in the genetic enhancement section. Gill (216) not only defines sustainability but also refers to some profitable cropping sequences, like paddy-toria-sunflower with a gross return of Rs.41,334 per hectare compared to the traditional paddy-wheat sequence yielding only Rs.25,715 per ha. He also emphasises the nutrient potential of cattle dung mannure, crop residues, forest litter, rural compost, city refuse etc. R.P. Singh (228) points out that under limited water supply oilseed gave higher income than wheat or lentil; oilseeds require lesser fertilization than cereals, in addition they yield oil cake with 4 to 8% nitrogen, 1.5 to 3% P_2O_5 and 1.5 to 2% K_2O. Oilseeds gave the highest sustainable yield through conjunctive use of part organic and part chemical nutrient while in cereals sustainability was highest when the recommended dose of fertilizers was applied through chemical source. The eco-friendly nature of response in oilseeds is very apparent. Rajan (252) challenges the very notion of sustainability of a single commodity and calls it a "contradiction in terms". He examines the potential of oilseeds in a sustainable agricultural production system as a whole. Suggesting an evaluation protocol with eleven parameters he assesses oilseeds for their impact on sustainability, for a given oil yield in quintals per hectare in 80-120 days. He accords positive unity (+1), for beneficial impact, negative unity (-1) for detracting impact and naught (0) for no direct impact, for each of the 11 parameters. While the evaluation method appear to be useful, the method could perhaps be further refined by allocating different weights to the different parameters. Curiously, this analysis brings out the groundnut as the crop having the maximum positive impact on sustainability. Curious because, this author has often averred groundnut crop, because of its dominance, as the bane of Indian vegetable fat economy and identifies the dilution of this dominance as a major component of the strategy for improvement.

There are three important papers presented only as extended summaries. These are (i) "Biopesticides and IPM system for sustainable oilseed production: By S. Jayaraj (327): (ii) Sustaining groundnut yields: an agro-climatic analytic approach for evaluating production constraints" by S.M. Virmani and Piara Singh (263) and (iii) 'Sustainability in production of groundnut' by M.S. Basu (271). The volume would have been much richer had the full papers been included, even if not presented at the seminar.

In the panel discussion on market intervention and policy support several important issues were discussed by the panel participants. Did the market intervention succeed? Is the Indian Oilseed farmer internationally competetive? Is the area shift consequent on support pricing policies beneficial to the nation? Is self-sufficiency in oilseeds is a real goal to be chased or is it prudent to import cheap edible oils from abroad? These and other interesting issues were discussed in considerable depth. One only wishes that there could have been a more verbatim reproduction of points raised by the panel members as well as the discussants from the floor.

It is rather surprising that while we repeatedly emphasize on the need for reducing cost of cultivation of oilseeds, one aspect that could have substantially contributed to this issue viz., development of farm implements for the oilseed farmer with small holdings, has been totally neglected in this seminar.

For the planner, administrator, researcher and oilseed cultivator, this volume will serve as a invaluable reference source.

[S. S. Rajan]

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GUIDELINES FOR AUTHORS

General

Membership in the Indian Society of Oilseeds Research is a pre-requisite for publication of articles in the Journal of Oilseeds Research. The Journal considers for publication 1. Original research papers concerning significant developments of wide interest in any field of oilseeds. 2. Critical review articles indicating gaps in research with suggestions for future lines of work. 3. Short communications on research results not warranting comprehensive treatment and 4. Book reviews. The responsibility for the contents of articles rests with the author (s). Papers must not contain political statements or unsubstantiated assertions.

Submission of Manuscript

Submission of an article implies that it is original and unpublished and not submitted elsewhere for publication.

Papers for consideration should be forwarded to

The Editor,
Journal of Oilseeds Research, Directorate **of Oilseeds Research,**
Rajendranagar, Hyderabad 500 030, India

Preparation of Manuscript

1. The official language of the Journal is English.

2. Submit the manuscript **in triplicate.** Enclose the original **illustrations and two sets** of photo copies (three prints of any photograph).

3. Manuscript should be typewritten in double space, on one side of the bond paper, with two inches margin throughout including abstracts and literature cited. The full papers and reviews should not exceed 15 typed pages and short communications should not exceed 5 typed pages (Two or less than two tables). Every page of the manuscript should be numbered in the upper right hand corner, including title page, literature cited, tables etc. However, in the text no reference should be made to page numbers, if necessary one may refer to sections. Underline words that should be in italics.

4. When corrections are necessary, never follow the same rules as for proof correction.

5. Manuscript should in general be organised in the following order:

   Title (avoid long titles); Author(s) name(s); Affiliations(s); Abstract; Keywords; Introduction; Material and Methods; Results and Discussion (Combine together to avoid repetition), Acknowledgement; Literature Cited.

6. Editor reserves the privilege of rejecting the manuscripts and illustrations which do not confirm to the guidelines.

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An abstract of not more than 400 words should be included in the manuscript. The abstract should be very brief covering the summary of the significant contents of the article.

Keywords: 4-6 keywords should be provided for information search indicating the key areas discussed in the article.

Tables

Each table should be typed on a separate sheet of paper at the end of manuscript. An indication of where the tables are to appear may be made in the text margin. Tables should be numbered according to their sequence in the text. The text should include all tables. Each table should have a brief and self explanatory title. Any explanation essential for understanding the table should be given as a foot note.

Illustrations

1. All illustrations should be given separately, unmounted and unfolded and neatly drawn with Indian ink on butter paper or the original printed with laser printer .
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3. Legends should be in Indian ink or in print. Make sure that the size of the lettering is big enough to allow a reduction of 50% without becoming illegible.
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b. For edited symposia, special issue etc.

Biswell, H.H. 1974. Effects of fire on chaparral. pp 321-365, *In*: fire and ecosystems Eds. T.T. Kozlowski and D. B. Ahlgrer. Academic press, New York.

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Nomenclature

Authors and editors are by general agreement, obliged to accept the rules governing biological nomenclature as laid down in the International code of Nomenclature of Botanical and the International code of Zoological Nomenclature.

For chemical nomenclature, the conventions of the International Union of Pure and Applied Chemistry and the official recommendations of the IUPAL-IUB combined Commission on Biochemical Nomenclature should be followed.

Membership

All the authors should be members of Indian Society of Oilseeds Research at the time of submitting the article for publication. The membership is for one calendar year (January to December). The membership fees : Ordinary member Rs. 50/-; Student member Rs. 30/-(With addition of Rs.10/- for registration); Life member Rs. 600/- (Payable in 3 equal installments in one year period only). The payment should be made in favour of General Secretary/Treasurer, Indian Society of Oilseeds Research, payable at State Bank of Hyderabad, Rajendranagar Branch, through Bank Draft only.

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INDIAN SOCIETY OF OILSEEDS RESEARCH

DIRECTORATE OF OILSEEDS RESEARCH

Rajendranagar, Hyderabad - 500 030

HARDF AWARDS FOR OUTSTANDING OILSEEDS RESEARCH FOR 1995

Background of awards

Indian Society of Oilseeds Research founded in 1983 is a registered society of individuals and organisations/institutions engaged in oilseeds research and development and vegetable oil technology in India. The foremost amongst its objectives is the promotion of research in various aspects of oilseeds production. The society firmly believes that the initiative and dedication on the part of the scientific community is the prime driving force to accelerate the pace of oilseeds research in the country. In our endeavour to recognise outstanding research and to provide some incentive to the scientists it has been decided to institute fifteen awards, through the kind courtesy of Hexamar Agricultural Research and Development Foundation. The awards are named **HARDF AWARDS FOR OUTSTANDING OILSEEDS RESEARCH.**

Nature of awards

Cash awards of Rs. 3000/- each and a citation in the following disciplines of oilseeds research

i) Four awards for varietal improvement of groundnut, rapeseed-mustard, sesame, safflower, sunflower, soybean, castor, linseed and niger.

ii) Five awards for insect pest management. Of these one each is earmarked for groundnut and rapeseed-mustard and the rest for sesame, safflower, sunflower, soybean, castor, linseed and niger.

iii) Four awards for disease management. Of these one each is earmarked for groundnut and rapeseed-mustard and the rest for sesame, safflower, soybean, castor, linseed and niger.

iv) Two awards for chemical weed control one each in groundnut and soybean.

Eligibility for awards

i) All scientists essentially members of Indian society of Oilseeds Research (for atleast three consecutive years preceding the year of awards) and working in research centres or departments or laboratories of universities, research institutes, directorates and national research centres under ICAR, CSIR, BARC etc., in India.

ii) Original research work carried out during 5 years preceding the year of award which has bearing on finding solution to any important problem in the disciplines and crops specified.

iii) Outstanding basic research leading to inventions or discoveries in the disciplines concerned duly supported by publications in journals of repute.

iv) Results of routine experiments and the research work already submitted or to be submitted for award of any degree or diploma are not considered.

Presentation of awards

i) Awards will be presented at Annual General Body Meeting of Indian Society of Oilseeds Research.

ii) Hexamar Agricultural Research and Development Foundation will pay TA and DA for recipients of awards as per their entitlement.

iii) Indian society of Oilseeds Research reserves the right to publish the results of research works selected for the awards and/or submitted for the awards in Journal of Oilseeds Research.

Guidelines for submitting proposals for the awards

i) Nominations for the award may be made by the Directors of Research Institutes, Vice-chancellor of Agricultural Universities and President of recognised scientific societies. The nominations should invariably be accompanied by eight type written copies of proposals containing:

a) Bio-data giving full name, designation, office address, date of birth, academic qualification starting from Bachelor's degree and experience.

b) An abstract of research contribution not exceeding 500 words.

c) Certificate stating the research work submitted for HARDF award is the original contribution of the investigator (s) duly authenticated by the Head of the Institution where it was carried out, and

d) Detailed technical report as per proforma given below.

ii) Nominations should reach the General Secretary, Indian Society of Oilseeds Research, Directorate of Oilseeds Research, Rajendranagar, Hyderabad - 500 030 by June 30, 1996.

Judging Committee

i) Consists of (a) President of Indian Society of Oilseeds Research or his representative from Executive Committee, (b) Director of HARDF or his representative and (c) three experts in each disciplines nominated by the President or Executive Committee of ISOR.

ii) In all matters relating to the awards, the decision of the Judging Committee is final and no correspondence on this account shall be entertained.

PROFORMA FOR TECHNICAL REPORT OF THE WORK TO BE SUBMITTED FOR HARDF AWARDS

1. Title of the Project/Research Programme
2. Address of Institute/Research centre/Laboratory where research was carried out
3. Investigator(s) with proportion of contribution of each
4. Year of initiation
5. Year of completion
6. Brief background of the project indicating the importance of the research project/programmes.
7. Objectives
8. Description of the work done.
9. Pooled results
10. Implications of the research work
11. Publications in journal of repute based on results of research work
12. Signature of the investigator(s)
13. Signature of the Head of the Institute.

INDIAN SOCIETY OF OILSEEDS RESEARCH - Publications

1. **"SUSTAINABILITY IN OILSEEDS"** Oilseeds Research and Development in India : Status and Strategies

The Indian Society of Oilseeds Research has published " Oilseeds Research and Development in India : Status and Strategies" edited by M.V.R. Prasad, R. Kalpana Sastry, C.V. Raghavaiah and T. Damodaram. This publication is featured with the presentations by eminent personalities in oilseeds research, development and allied areas. Also included around 50 invited papers, apart from 117 full papers and session-wise discussions and recommendations. The publication is available in an attractive paper back form.

The material provides the most current thinking about the status and strategies in oilseeds research and development in India. This publication is a treasure of information for personal collection of the scientists, development personnel, processing and nutrition experts concerned with oilseeds, libraries and institutions since it covers the following varied topics.

- Genetic Enhancement of Oilseed Crops
- Sustainability of Oilseed Production Systems
- Post-harvest Processing Technology
- Vegetable Fat in Human Diet
- Development Scenario and Strategies
- Panel Discussion on Market Intervention & Policy support

The price fixed for the publication is:

Registered participants in the seminar	:	Rs. 100/-
Others (in India)	:	Rs. 500/-
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Postage extra (in India)	:	Rs. 40/-

2. PROCEEDINGS OF THE NATIONAL SEMINAR - " **Strategies for making India Self-reliant in Vegetable Oils**" by Ranga Rao *et al.*, (Ed.), pp.-720 Concessional price Rs. 250/- (Rs. 40/- extra for postage).

3. **PROCEEDINGS OF INTERNATIONAL SAFFLOWER CONFERENCE**- by Ranga Rao *et al.* (Ed.) pp - 419. Price Rs. 500/- (Rs. 40/- extra for postage)

Orders may be placed with :

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