ISSN 0970 - 2776

VOLUME 12 NUMBER 1 JUNE 1995

DOR - 345

JOURNAL OF OILSEEDS RESEARCH

INDIAN SOCIETY OF OILSEEDS RESEARCH
DIRECTORATE OF OILSEEDS RESEARCH
RAJENDRANAGAR HYDERABAD - 500 030 INDIA

Journal of Oilseeds Research is the official organ of the Indian Society of Oilseeds Research published half yearly.

JOURNAL OF OILSEEDS RESEARCH

Volume 12 | June 1995 | Number 1

DOR-345

SHORT COMMUNICATIONS

J. Oilseeds Res. 12(1) 1995 :1-4
ISSN 0970-2776

GENETIC VARIABILITY, CORRELATION AND PATH ANALYSIS IN LINSEED

B.P.S. MALIK* and S. SINGH
Department of Plant Breeding, CCS Haryana Agricultural University, Hisar - 125 004

ABSTRACT

Seventy six diverse genotypes of linseed were raised to measure genetic variability, correlations and direct and indirect effects for days to flowering and maturity, plant height (cm), branches, capsules and grain yield per plant (g), seeds per capsule, biological yield (q/ha), grain yield per plot (g), 1000 grain weight (g), and harvest index. High genotypic coefficient of variation for capsules per plant, grain yield per plant and grain yield per plot indicated good scope of improvement in these traits. The environment did not play an important role in the control of most of the traits as the heritability estimates were high for all the traits except for branches per plant. The traits grain yield, capsules per plant, and 1000 grain weight could be improved easily as they had high values of both genetic advance and heritability. Grain yield per plot and biological yield showed highest positive correlation between them. Biological yield emerged as the single most important trait to influence grain yield per plot directly as well as indirectly.

Keywords : Linseed; Genetic variability, Path analysis; Correlation; Grain yeild; Biological yield.

INTRODUCTION

Breeding high yielding varieties of crops requires information on the nature and magnitude of variation in the available materials, association of characters with yield and among themselves. Path coefficient analysis measures the direct effect of variable upon another and permits the separation of the correlation coefficient into components of direct and indirect effects. Since information on these aspects in linseed (*Linum usitatissimum* L.) is scanty, the present investigation was undertaken to determine various genetic parameters for grain yield and its components in 76 linseed genotypes.

MATERIAL AND METHODS

The material of the present study consisted of 76 genotypes received from different centres of oilseeds all over India. These genotypes were grown in a Randomized Block Design with three replications during *rabi* 1989-90 at Regional Research Station, Kaul (Haryana). Each genotype was planted in 4 rows of 4 m length with a row to row spacing of 25 cm. The data were recorded on ten random plants from each plot for 11 characters viz. days to flowering, days to maturity, plant height (cm), branches per plant, capsules per plant, seeds per capsule, biological yield (q/ha), grain yield per plant (g), grain yield per plot (g), 1000 grain weight (g) and harvest index.

The plot means were subjected to standard statistical procedures. Heritability (broad sense) and expected genetic gain (as percentage of mean) were calculated according to Burton (1952). Calculations for correlations and path analysis were carried out as per methods suggested by Miller *et al.* (1958) and Dewey and Lu (1959).

* CCS, HAU, Regional Research Station, Kaul, Haryana.
Received for publication on September 12, 1991.

RESULTS AND DISCUSSION

The genotypes differed significantly among themselves for all the characters. The estimates of phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) exhibited almost similar magnitude for most of the characters (Table 1). The maximum GCV was recorded for capsules per plant. Next in order were grain yield per plant and grain yield per plot indicating better scope for the genetic improvement in these characters.

The heritability estimates were high for all the characters except for branches per plant and seeds per capsule for which these estimates were low and moderate, respectively. This indicates that the environment did not play an important role in controlling most of the characters in the varieties. High heritability coupled with high values of genetic advance and genotypic as well as phenotypic coefficient of variation for grain yield per plant, capsules per plant, grain yield per plot and 1000 grain weight indicates that considerable improvement can be achieved in respect of these characters by using simple selection procedures. These results are in agreement with those of Rao and Singh (1985) and Satpathi *et al.* (1987). On the contrary, high heritability estimates for days to maturity and days to flower were associated with very low values of genetic advance and those of genotypic and phenotypic coefficients of variation. Improvement for such characters is not easy and efforts should be made for increasing genetic variability in such cases.

Phenotypic and genotypic correlation coefficients for 11 metric traits in linseed are presented in Table 2. The values of genotypic correlations were in almost all cases higher than those of the phenotypic correlations. Such a situation could arise due to genotype x environment interaction. The grain yield per plant showed significant positive correlation only with capsules per plant and harvest index. On the other hand, biological yield and grain yield per plot both had significant positive cor-

Table 1. Mean, range, coefficient of variation, heritability and genetic advance for eleven characters in linseed

Character	General mean	Range	GCV	PCV	Heritability (BS)	Genetic advance (% of mean)
Days to flowering	84.3 ± 1.2	78.3 - 91.0	3.4	3.8	80.5	6.4
Days to maturity	148.3 ± 1.1	139.7 - 154.7	2.9	3.0	91.6	5.7
Plant height (cm)	83.7 ± 4.5	60.0 -110.0	12.7	14.3	78.9	23.2
Branches per plant	3.5 ± 0.5	2.3 - 6.0	13.2	23.0	32.8	15.6
Capsules per plant	48.5 ± 6.5	31.3 - 99.0	29.0	33.4	75.5	51.9
Seeds per capsule	6.2 ± 0.5	4.2 - 8.2	13.4	17.0	62.4	21.9
Biological yield (q/ha)	3.4 ± 0.3	1.1 - 4.7	18.2	20.7	77.2	33.0
Grain yield per plant (g)	2.5 ± 0.2	1.3 - 4.5	28.6	30.9	85.5	54.4
Grain yield per plot (g)	662.5 ± 46.0	266.7 - 950.0	22.9	24.5	87.9	44.3
1000 grain weight (g)	9.3 ± 0.6	5.2 - 14.4	20.9	22.2	88.9	40.5
Harvest index	19.4 ± 1.5	12.2 - 27.3	14.3	17.5	70.8	24.9

Tabel 2. Correlation coefficients (phenotypic above diagonal and genotypic below diagonal) for eleven characters in linseed

Characters	Days to flowering	Days to maturity	Plant height	Branches/ plant	Capsules/ plant	Seeds/ capsule	Biological yield	Grain yield per plant	Grain yield per plot	1000 grain weight	Harvest index
Days to flowering		0.536**	0.482**	0.167	0.181	0.073	0.396**	-0.127	0.300**	0.043	-0.023
Days to maturity	0.646		0.537**	0.133	0.256*	0.107	0.544**	0.014	0.494**	0.225*	0.022
Plant height	0.587	0.624		0.015	0.832**	0.141	0.596**	-0.082	0.355**	0.096	-0.158
Branches per plant	0.293	0.259	0.065		0.233*	-0.101	-0.008	0.122	0.058	0.066	0.084
Capsules per plant	0.214	0.297	0.994	0.232		-0.840**	0.435**	0.540**	0.247*	-0.238*	0.257*
Seeds per capsule	0.085	0.133	0.188	-0.302	-0.995		0.278*	0.024	0.405**	-0.201	0.141
Biological yield	0.531	0.625	0.776	0.039	0.586	0.418		-0.145	0.670**	0.072	-0.208
Grain yield per plant	-0.129	0.017	-0.111	0.151	0.594	-0.043	-0.208		0.201	0.039	0.512**
Grain yield per plot	0.366	0.530	0.440	0.119	0.309	0.523	0.767	0.231		0.144	0.474**
1000 grain weight	0.032	0.233	0.118	0.093	-0.277	-0.275	0.093	0.059	0.139		0.102
Harvest index	-0.035	0.033	-0.230	0.097	0.334	0.199	-0.090	0.695	0.542	0.096	

* P = 0.05 ** P = 0.01

Table 3. Direct (diagonal) and indirect effects of different characters on grain yield per plant in linseed.

Characters	Days to flowering	Days to maturity	Plant height	Branches per plant	Capsules per plant	Seeds per capsule	Biological yield	Grain Yield per plant	Genotypic correlation with grain yield per plot
Days to flowering	0.033	0.048	-0.244	0.024	0.008	0.017	0.534	-0.054	0.366
Days to maturity	0.0222	0.075	-0.260	0.022	0.011	0.026	0.628	0.007	0.530
Plant height	0.019	0.047	-0.426	0.005	0.036	0.037	0.780	-0.057	0.440
Branches per plant	0.010	0.019	-0.027	0.083	0.008	-0.059	0.036	0.053	0.119
Capsules per plant	0.007	0.022	-0.424	0.019	0.039	-0.196	0.590	0.249	0.309
Seeds per capsule	0.003	0.020	-0.068	-0.025	-0.022	0.197	0.430	-0.008	0.523
Biological yield	0.017	0.047	-0.323	0.003	0.022	0.082	1.006	-0.086	0.767
Grain yield per plant	-0.009	0.001	0.046	0.013	0.021	-0.009	-0.229	0.404	0.231

$R^2 = 0.140$ $R = 0.374$

relations with days to flowering and maturity, plant height, capsules per plant and seeds per capsule. However, the strongest positive correlation was observed between these two characters themselves, i.e., between biological yield and grain yield per plot. In addition, grain yield per plot had positive correlation with harvest index. Also, a positive significant correlation of days to flowering was found with days to maturity and plant height. Similarly, days to maturity was positively correlated with plant height, capsules per plant and 1000 grain weight. Significant positive correlations were also observed between plant height and capsules per plant, capsules per plant and branches per plant and between capsules per plant and harvest index. As expected, significant negative correlations were found between capsules per plant and seeds per capsule and between capsules per plant and 1000 grain weight, indicating that simultaneous improvement cannot be achieved for these traits unless the undesirable linkages are broken by using some breeding techniques like biparental matings. These results, however, indicate that improvement in grain yield per plot can be achieved by improving the characters like days to flowering and maturity, plant height, capsules per plant, seeds per capsule, biological yield and harvest index. Similar results regarding correlations between different traits of linseed were obtained by Rao and Singh (1985) and Satpathi *et al.* (1987).

However, simple correlations many times do not give a clear picture of the association between different traits of a crop species. For this, one should go for path coefficient analysis which is based on cause-effect relationship. The direct and indirect effects of various characters on grain yield per plot are given in Table 3. This table reveals that biological yield had highest direct effect on grain yield per plot and the positive significant correlation between these two traits was only due tothis direct effect of biological yield. On the contrary, the positive correlation of days to flowering, days to maturity, plant height, capsules per plant and seeds per capsule with grain yield per plot were not because of the direct effect of these traits but all these traits influenced the character grain yield per plot through the indirect effect of biological yield. Similarly, there was no apparent significant correlation between grain yield per plant and grain yield per plot but the former trait had a moderately high direct effect on the latter character. These results, therefore, indicate that biological yield had highest direct and indirect effect on grain yield per plot.

LITERATURE CITED

Burton, G.W. 1952. Quantitative inheritance in grasses.: Proceedings 6th International Grassland Congress 1: 227-233.

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

Miller, P.A., Williams, J.C., Robinson, H.F. and Comstock, R.E. 1958. Estimation of genotypic and environmental variance and covariances in upland cotton and their implications in selection. *Agronomy Journal.* 50 : 126-131.

Rao, S.K. and Singh, S.P. 1985. Relationship of maturity with seed characteristics and their *implications* in selection of linseed. *Journal of Oilseeds Research* 2(1) : 86-92.

Satpathi, D., Misra, R.C. and Panda, B.S. 1987. Variability correlations and path coefficient analysis in linseed *Journal of Oilseeds Research* 4(1) : 28-34.

J. Oilseeds Res. 12(1) 1995 : 5-9
ISSN 0970-2776

GENETIC BEHAVIOUR OF YIELD AND ITS COMPONENTS IN LINSEED

BEENA PILLAI, P.W. KHORGADE *and* M.N. NARKHEDE
Department of Agricultural Botany, Punjabrao Krishi Vidyapeeth, Akola 444 104, M.S.

ABSTRACT

Combining ability analysis of eight diverse cultivars of linseed (*Linum usitatissimum* L.) revealed that the mean squares due to *gca* and *sca* were highly significant for all the characters, except for number of tillers per plant due to *sca* . However, the general predictability ratio indicated predominance of additive components for days to maturity, number of tillers per plant, number of capsules per plant, seed yield per plant, 100 seed weight and plant height. Among parents LMH 354 *and* T 397 *were found good* combiners for yield and most of its attributes. The crosses RLC 4 x LMH 354 followed by LMH 354 x T 397 were found to be promising for seed yield and its components and LMH 354 x C 429 followed by RLC 4 x Kiran for oil content.

Keywords: Diallel analysis; Combining ability; Predictability ratio; Linseed

INTRODUCTION

The development of varieties for high seed and oil yield than the existing varieties is the main aim of linseed breeding. This necessitates to undertake a sound and appropriate breeding programme. Since, the combining ability analysis is useful in the selection of good general and specific combiners (parents) used in crossing plan to have desired end products. The present investigation was undertaken to assess the combining ability for seed yield, oil content and some yield attributes through a diallel crossing programme.

MATERIAL AND METHODS

Eight genetically diverse genotypes of linseed (*Linum usitatissimum* L.) were used to develop a diallel set, excluding reciprocals. All these 36 progenies (28 F_1's and 8 parents) were grown in a Randomized Block Design with three replications during *rabi*, 1990-91 at Punjabrao Krishi Vidyapeeth, Akola adopting all recommended package of practices. Each progeny consisted of a single row of 3.0 m length spaced at 30 cm apart maintaining 15 cm plant to plant distance. The observations were recorded on five randomly selected plants per progeny in each replication for nine characters, viz., days to maturity, plant height (cm), number of tillers per plant, number of capsules per plant, number of seeds per capsule, 100 seed weight (g), oil content (%), harvest index (%) and seed yield per plant (g).

The data were analysed with the mean values of five plants using standard statistical methods. Combining ability analysis was carried out using Griffings' model I, method 2 (1956).

RESULTS AND DISCUSSION

Analysis of variance exhibited high significant differences among genotypes (parents and crosses) for all the characters studied. The variances due to *parents vs hybrids* were also

Received for publication on April 15, 1992

highly significant for all the characters, except days to maturity and plant height.

The mean squares due to general (*gca*) and specific combining ability (*sca*) were highly significant for all the characters (Table 1), except for *sca* for number of tillers per plant. This indicated the importance of both additive and non-additive gene actions in expression of these characters. However, the general predictability ratio (Baker, 1978) calculated on the basis of equivalent components of genetic variances (σ^2_g and σ^2_s) revealed the predominance of additive components of genetic variance for days to maturity, number of tillers per plant, number of capsules per plant, seed yield per plant, 100 seed weight and plant height. This ratio being close to 0.5 indicated both additive and non-additive components equally responsive for expression of harvest index, number of seeds per capsule and oil content. The predominance of additive gene action in linseed was also reported by Kumar and Chauhan (1980), Patil and Chopde (1982), Singh *et al.* (1983) and Khorgade *et al.* (1990) for plant height, number of tillers per plant, number of capsules per plant, 100 seed weight and seed yield per plant and Thakur *et al.* (1987) for days to maturity. On the other hand the importance of both additive as well as non-additive gene actions was noticed by Badwal *et al.* (1974) for number of seeds per capsule and Bhatnagar and Mehrotra (1980) for oil content.

The estimates of *gca* effects (Table 2) revealed that the short statured early maturing parent LMH 354, besides being the best general combiner for seed yield, also showed highest *gca* effects for yield components like days to maturity, plant height, number of capsules per plant, number of seeds per capsule and harvest index. The parent T 397, being the best general combiner for oil content appeared next good combiner for yield and most of its attributes. For 100 seed weight, AKL 14 was the best combiner while AKL 33 was the best com-

Table 1. *Analysis of variance for combining ability in linseed*

Source	d.f.	Mean Squares								
		Days to maturity	Plant height (cm)	No. of tillers/ plant	No. of capsules /plant	No. of seeds/ capsule	100 seed weight (g)	Oil content (%)	Harvest index (%)	Seed yield/ plant (g)
gca	7	35.28**	36.17**	2.60**	240.05**	1.54**	0.013**	4.30**	20.94**	1.03**
sca	28	1.05**	3.37**	0.39	23.95**	0.25**	0.001**	0.82**	2.32**	0.08**
Error	70	0.53	1.12	0.27	11.35	0.08	0.0002	0.07	0.06	0.02
Equivalent components of mean squares										
σ^2_g		3.48	3.50	0.23	22.87	0.15	0.0013	0.42	2.09	0.10
σ^2_s		0.53	2.25	0.13	12.60	0.17	0.0008	0.75	2.26	0.06
Predictability ratio										
$\frac{2\sigma^2_g}{(2\sigma^2_g + \sigma^2_s)}$		0.93	0.76	0.78	0.78	0.64	0.76	0.53	0.65	0.77

** Significant at 1% level

Table 2. ***Estimates of general combining ability effects and mean values (in parentheses) of parents***

Parents	Days to maturity	Plant height (cm)	No. of tillers/plant	No. of capsules/plant	No. of seeds/capsule	100 seed weight (g)	Oil content(%)	Harvest index (%)	Seed yield/plant (g)
RLC 4	-0.60** (105.3)	1.75** (41.9)	-0.15 (7.1)	2.49* (49.9)	0.21* (7.7)	0.010* (0.74)	0.44** (39.7)	0.85* (30.4)	0.17** (2.6)
Kiran	0.80** (108.0)	-0.81* (37.9)	-0.14 (6.9)	-2.60* (43.3)	-0.09 (7.9)	-0.030** (0.69)	0.06 (38.4)	-0.09 (30.1)	-0.10* (2.4)
AKL 14	0.97** (109.0)	0.58 (36.8)	0.46** (8.0)	1.44 (49.1)	-0.14 (7.4)	0.034** (0.76)	-0.61** (37.9)	-0.65** (29.0)	0.08 (2.5)
AKL 33	1.30** (109.7)	0.25 (39.5)	0.48** (7.7)	-0.99 (46.4)	-0.10 (7.0)	-0.025** (0.71)	-0.61** (38.5)	-0.97** (27.8)	-0.10* (2.2)
LMH 354	-3.60** (101.0)	-4.24** (32.5)	-0.59** (5.5)	3.88** (47.2)	0.39** (8.0)	0.030** (0.73)	0.74** (39.4)	2.12** (31.1)	0.29** (2.6)
T 397	-1.80** (104.7)	-0.05 (40.7)	0.43** (7.2)	3.49** (49.4)	0.37** (7.6)	0.029** (0.75)	0.76** (40.0)	1.18** (30.1)	0.25** (2.7)
Jawahar-23	2.00** (109.0)	1.19** (41.2)	-0.83** (6.2)	-10.75** (33.2)	-0.82** (6.8)	-0.065** (0.65)	-0.95** (38.5)	-2.58** (27.0)	-0.71** (1.6)
C 429	0.93** (108.7)	1.33** (41.6)	0.34** (7.4)	3.03** (48.5)	0.18* (7.5)	0.019** (0.74)	0.18** (39.1)	0.14 (28.8)	0.12* (2.3)
SE (gi) ±	0.21	0.31	0.15	1.00	0.08	0.004	0.08	0.07	0.05
SE (gi-gj) ±	0.32	0.47	0.23	1.51	0.12	0.006	0.12	0.11	0.07

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

biner for number of tillers per plant. Among the parents, Jawahar-23 proved to be the poor general combiner for all the characters associated with the yield. The parents with high magnitude of desirable general combining ability may possess the favourable genes for seed yield and its components and can give useful segregants in early generations.

Further, high *gca* effects coupled with high *per se* performance of the parents LMH 354 and T 397 (Table 2) for early maturity, number of capsules per plant, number of seeds per capsule, oil content, harvest index and seed yield per plant suggested that *per se* performance of parents would provide an indication of their gêneral combining ability for their meaningful utilization in hybridization programme.

The performance of some selected crosses in related parameters are presented in Table 3. The crosses RLC 4 x LMH 354 followed by RLC 4 x C 429 were found to be the best combinations involving high x high general combiner parents and also exhibited high mean performance and high heterotic potential for number of capsules and seed yield per plant. The cross LMH 354 x C 429 was observed to be the best combination for oil content, followed by RLC 4 x Kiran and LMH 354 x T 397. The cross LMH 354 x C429 was also found to be promising for seed yield and number of capsules per plant. The extensive intermating between these crosses may be useful in fixing maximum favourable genes, which are desirable for creating superior recombinant lines for increasing seed and oil yields as well

Table 3. Promising crosses and their performance in some related parameters

Character/crosses	Mean	Heterosis (%)	Useful heterosis (%)	*gca* effect		*sca* effect
				P_1	P_2	
Number of capsules/plant						+
RLC 4 x LMH 354	65.07	34.05**	34.08**	H	H	9.31**
RLC 4 x C 429	63.00	28.05**	29.82**	H	H	8.09**
LMH 354 x T 397	62.20	28.78**	28.17**	H	H	5.44
LMH 354 x C 429	60.27	25.90**	24.19**	H	H	3.97
Oil content (%)						
LMH 354 x C429	41.63	6.06**	6.47**	H	H	1.96**
RLC 4 x Kiran	41.07	5.20**	5.04**	H	A	1.82**
LMH 354 x T 397	40.90	3.02**	4.60**	H	H	0.66**
Kiran x T 397	40.30	2.81**	3.07**	A	H	0.74**
Seed yield/plant (g)						+
RLC 4 x LMH 354	3.36	30.23**	45.45**	H	H	0.38**
LMH 354 x T 397	3.29	26.54**	42.42**	H	H	0.22
LMH 354 x C 429	3.17	30.45**	37.23**	H	H	0.24
RLC 4 x T 397	3.09	17.49**	33.77**	H	H	0.15

** Significant at 1% level

H and A indicate high and average general combiners, respectively as some other important yield components in linseed.

LITERATURE CITED

Badwal, S.S., Gupta, V.P. and Singh, H. 1974. Genetic analysis of seed yield and its components in linseed. *Indian J. Agric. Sci.* 44 (7) : 472-477.

Baker, R.J. 1978. Issues in diallel analysis. *Crop Sci.* 18 (4): 533-536.

Bhatnagar, S.K. and Mehrotra, H.N. 1980. Combining ability and gene action for oil content in linseed. *Indian J. Genet.* 40(1) : 99-101.

Griffing, B. 1956. Concept of general and specific combining ability in relation to diallel crossing system. *Australian J. Biol. Sci.*. 9 463-493.

Khorgade, P.W., Narkhede, M.N., Ingle, W.S., Raut, S.K. and Dakhore, S.R. 1990. Combining ability for yield, oil content and related components in linseed. *J. Maharashtra Agric. Univ.* 15(3): 281-283.

Kumar, S. and Chauhan, B.P.S. 1980. Combining ability in linseed. *Indian J. Genet.* 40(1): 216-221.

Patil, V.D. and Chopde, P.R. 1982. Genetics of yield and associated characters in linseed (*Linum usitatissimum* L.) in peninsular region of India. *J. Maharashtra Agric. Univ.* 7(1):61-63.

Singh, R.R., Singh, S.P. and Singh, R.V. 1983. Combining ability of yield components in linseed. *Oilseeds J.* XIII: 24-26.

Thakur, H.L. Rana, N.D. and Sood, O.P. 1987. Combining ability for some quantitative characters in linseed. *Indian J. Genet.* 47(1): 6-10.

J. Oilseeds Res. 12(1)1995 : 10-16
ISSN 0970-2776

INFLUENCE OF CROP AGE AND WEATHER FACTORS ON THE INCIDENCE OF APHID ON SAFFLOWER*

A.K. AWASTHI and R.K. AGRAWAL
Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) 482 004.

ABSTRACT

Effects of crop age and meteorological factors on the incidence of aphid (*Uroleucon compositae* Theobald) on safflower (*Carthamus tinctorius* L.) variety 'Jawahar safflower-1' were studied during *rabi* seasons of 1988-89 and 1989-90. Simple correlation studies to evaluate the instantaneous effects of the meteorological variables revealed that, of the several weather factors considered, the temperature and relative humidity were negatively and positively correlated with aphid incidence, respectively. However, less rainfall (1.30 - 21.90mm.) with moderate temperature (13.61- 19.59°C.), relative humidity (55.78-75.49%), low wind speed (1.35-3.91 km/hr) and sunshine (1.81-9.67 hr/day) appeared to be conducive for the rapid multiplication of the pest. Polynomial regression studies showed that besides meteorological, the other ecological factor i.e. crop age has shown significant relationship with the aphid incidence. Vegetative growth stage of the crop with maximum succulancy in the emerging shoots and leaves found to be most preferred by aphid. The studies inferred that the crop age followed by weather factors in the preceding periods had a stronger influence on pest incidence.

Keywords: Carthamus tinctorius; Crop age; Aphid; Weather factors

INTRODUCTION

Aphid (*Uroleucon compositae* Theobald) is a serious pest of safflower (*Carthamus tinctorius* L.) throughout India and causing yield loss up to 72 per cent (Basavana Goud, 1979). The nymphs and adults suck the cell sap from all green parts of the plant, due to which there is drastic reduction in the crop yield. Attempts have been therefore made to examine effects of crop age and weather factors on occurrence and the intensity of pest.

MATERIAL AND METHODS

Safflower variety 'Jawahar Safflower-1' was sown on October 23, 1988 and November 2, 1989 in a plot of 20 x 20 m^2 area at the Agricultural University Research Farm, Jabalpur. The population of nymphs, apterous and alate adults of aphid was counted at weekly intervals from the start of the pest appearence till the harvest of the crop. The pest population was recorded on four twigs including central shoot of 10 cm length per plant on 20 random plants of central rows. Weekly meteorological data on temperature, relative humidity, rainfall, sunshine hours and wind velocity were recorded for all the weeks for two crop seasons and are depicted in figures 1 and 2, respectively.

To study the influence of crop age and abiotic (meteorological) factors on pest incidence two approaches were followed. In one case graphical super-imposition technique was employed while in the other simple correlations were worked out between pest incidence and meteorological factors for the same period. The polynomial regression between the

* Part of the Ph.D thesis submitted to JNKVV, Jabalpur, M.P.

Received for publication on May 11, 1992.

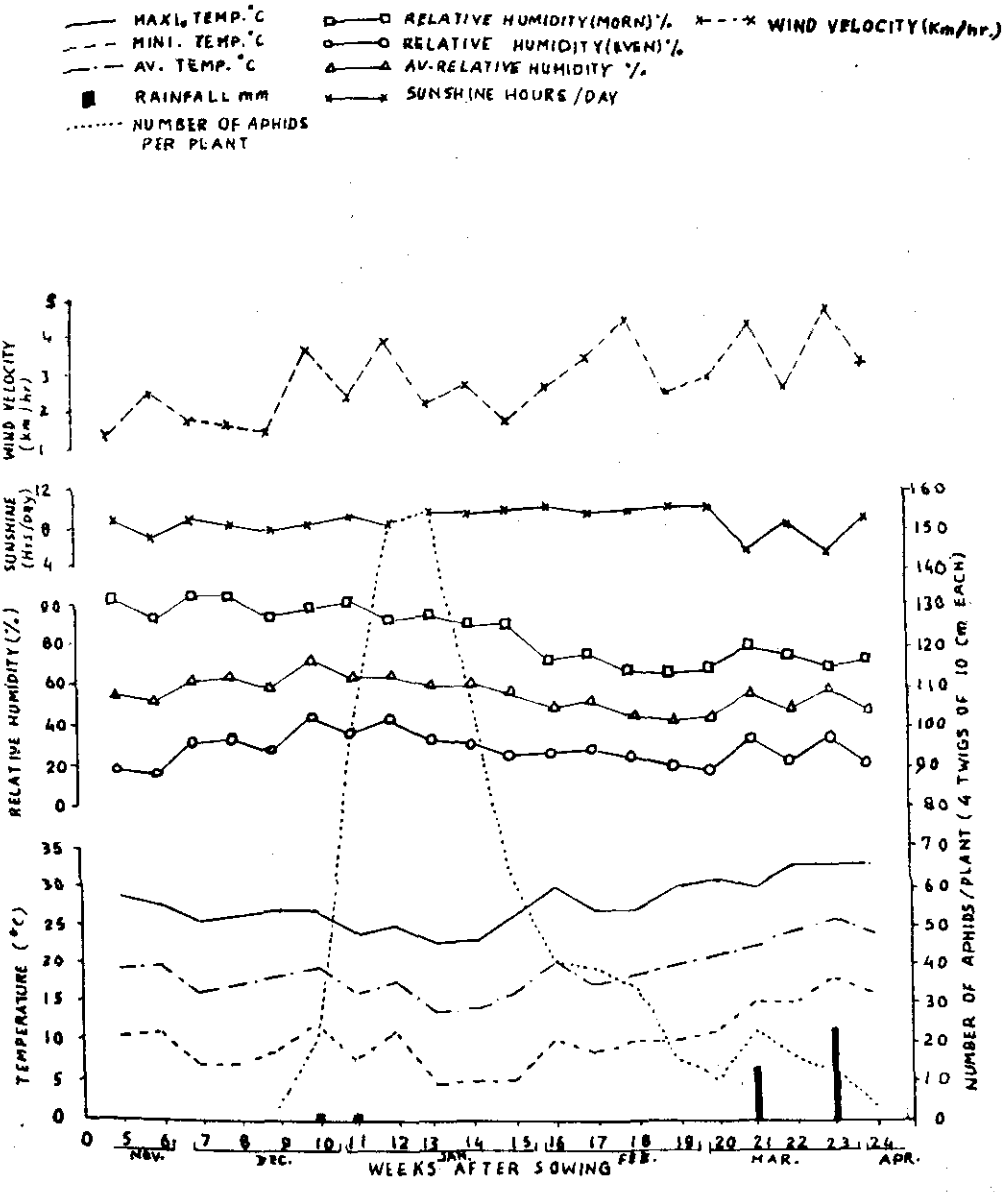


Fig. 1. Average meteorological data and population of *Uroleucon compositae* during 1988-89

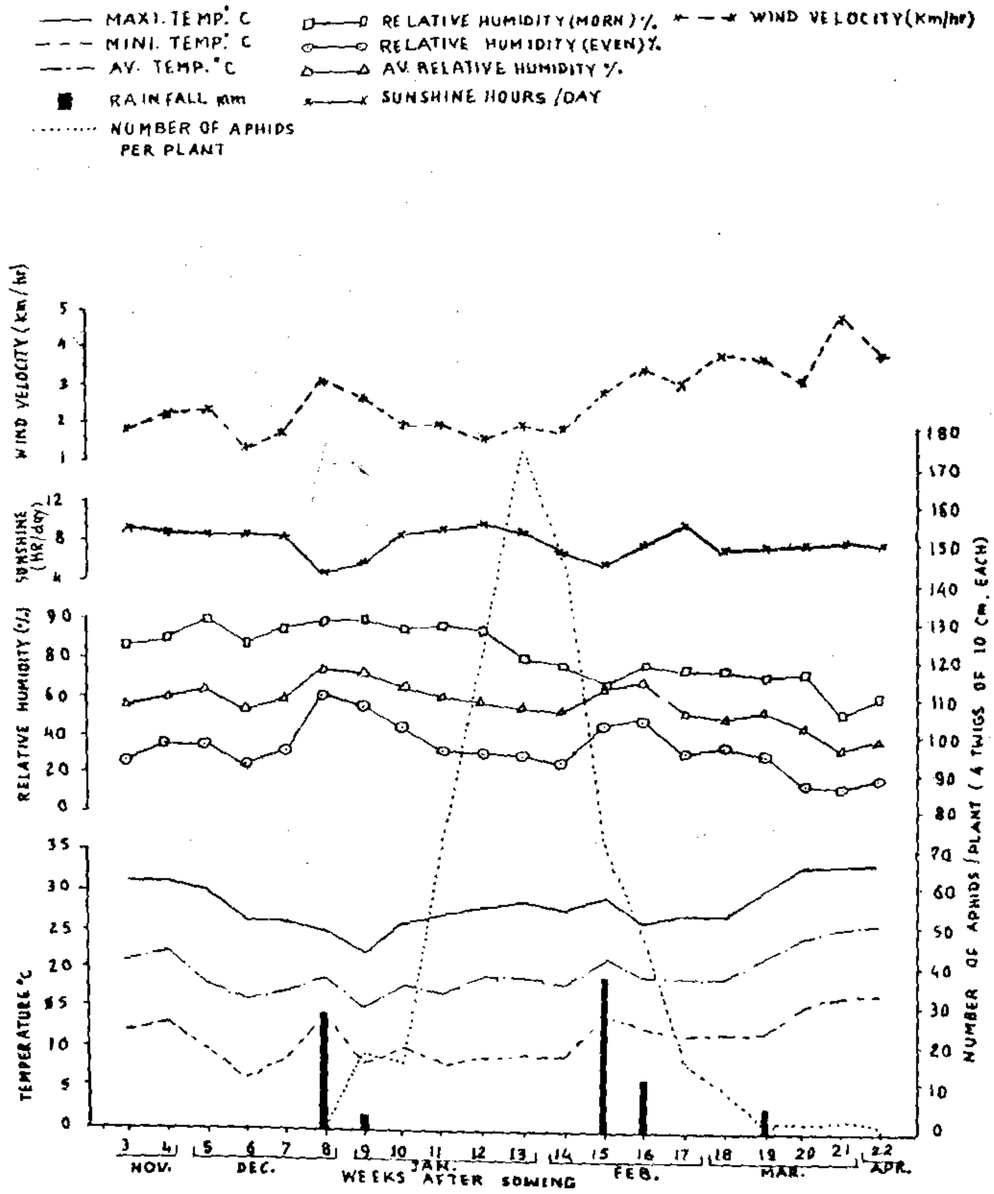


Fig. 2. Average meteorological data and population of *Uroleucon compositae* during 1989-90

weeks after sowing i.e. crop age and the aphid population was also calculated as per procedure laid down by Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

The relationship between crop age, meteorological parameters viz. temperature, relative humidity, rainfall, sunshine hours, wind velocity and incidence of aphid on safflower during 1988-90 are presented as detailed below.

The initial aphid incidence was observed in 3rd week of December which coincided with the 8-9 weeks after sowing at the initial stage of crop growth. The meteorological conditions viz. the average temperature (14.86-19.32°C), under the influence of moderate level of humidity (56.85-75.49%), sunshine (4.81-8.28 hr/day) and low wind speed (1.35-3.18 km/hr) proved conducive for the appearence of the pest. The population continued to build up and attained peak (163.07 *aphids/plant) during 3rd to 4th week of January* when the crop was 13 weeks old. The weather conditions prevailed during this period were 21.65- 29.28°C, maximum; 4.60-12.05°C, minimum and 13.61-19.59°C average temperature under the influence of 81.42-91.57% morning, 26.85-61.42% evening and 55.78-75.49% average relative humidity; 1.35-3.81 km/hr of wind speed and 4.81-9.67 hr/day of sun shine and less rainfall of 1.30-21.90 mm were appeared to be conducive for the rapid multiplication of the pest. The population started declining 14th week after sowing onwards, gradually during 1988- 89, due to constant decrease in humidity, but sharply during 1989-90 due to sudden fall in relative humidity, rise in temperature and increase in wind velocity with increase in crop age. Present findings showed that rainfall has positive impact on aphid incidence in the begining of the incidence as less rainfall (4.30 mm) during 10-11 weeks in 1988-89 and again (23.20 mm) during 8-9 weeks after sowing in 1989-90 provided congenial environment for aphid multiplication, and higher incidence. While it showed a negative impact on aphid population during the later part of pest incidence as rainfall (37.90 mm) during 15th week in 1989-90 helped to decline the already low population from 144.65 to 72.55 aphids/plant. The population ultimately disappeared during 25th and 23rd week after sowing i.e. at the maturity stage of the crop during 1988-89 and 1989-90, respectively.

The correlation studies between the aphid incidence and meteorological variables (Table 1) however failed to show a consistantly significant picture of the several weather factors considered, the temperature and relative humidity appeared to be the most critical. The incidence of aphid was negatively associated with temperature. Out of the two humidity variables considered, the morning relative humidity had a positive association with population of aphid. The evening relative humidity had a non-significant correlation with aphid population. The effect of sunshine on aphid incidence was not found to be not associated, while the wind velocity was negatively correlated with aphid incidence during 1989-90.

These results show that there were indications of some instantaneous effect of weather variables on the incidence of aphid. The significant correlation coefficients have values ranged from 31.40% to 58.40% (percentage r^2), hence it cannot be said firmly that there exists any relationship between aphid population and meteorological variables.

Table 1. Simple correlation coefficient (r) and Linear regression equation (Y = a ± bX) between meteorological parameters (X) and population of *U. compositae* (Y) on safflower crop

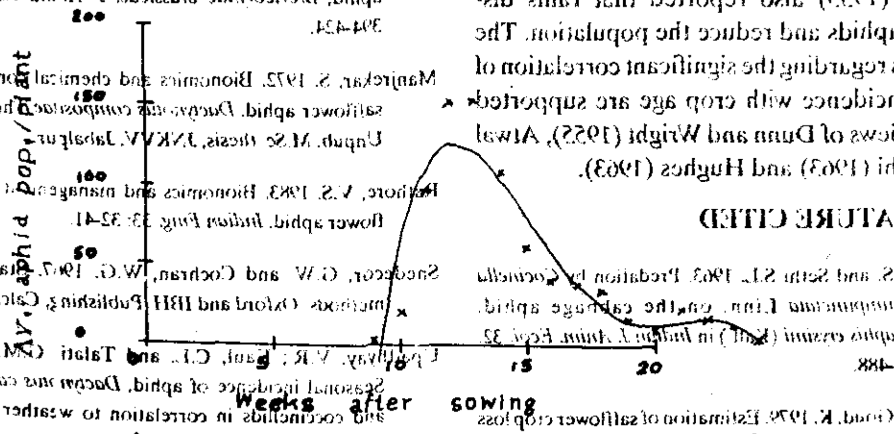
	Temperature (°C)			Relative humidity (%)			Sunshine (hr/day)	Wind Velocity (km/hr)
	Maximum	Minimum	Average	Morning	Evening	Average		
1988-89								
r =	-0.561*	-0.613*	-0.781*	0.567*	0.484	0.582*	0.370	0.154
Y =	254.55 - 67.512 X	128.14 - 7.642 X	243.785 - 10.158 X	201.862 + 3.208 X		161.787 + 3.932 X		
1989-90								
r =	-0.058	-0.603*	-0.344	0.342	0.075	0.139	0.219	-0.704*
Y =	-	188.393 - 12.173 X						168.279 - 40.929 X

*Significant at 5 per cent Level of significance

On the basis of these studies, the pest incidence found to be related with the age of crop. The polynomial regression analysis revealed that there was significant curvilinear relationship between the crop age i.e. weeks after sowing and aphid incidence. The aphid incidence initiated from 8-9 weeks onwards after sowing (branching stage) started rapid multiplication during 11th week (bud initiation stage) and reached its peak on 13 weeks after sowing which coincided with the late bud initiation stage of the crop. The pest population started declining 14th week crop stage onwards (flowering) due to advancement in crop age which caused reduction in succulancy of various plant parts and ultimately disappeared during first week of April at maturity stage of crop.

Thus the polynomial regression between the crop age and aphid incidence in different years showed that the fourth degree polynomial is best fitted to the data of average aphid population/plant at different crop age during 1988-89 (Fig. 3) which will be able to provide good estimates of aphid population for any particular value of weeks after sowing in the prevailing weather conditions on safflower crop.

From the present studies, it could be inferred that the aphid first appeared on safflower crop during 8-9 weeks after sowing i.e. between 3rd and 4th week of December. The pest population continued to build up with profuse branching of the plants and reached the peak on 13 week old crop during 3rd to last week of January at vegetative stage of the crop. Manjrekar (1972) also observed first appearence of the aphid on the safflower crop during third week of December, while Upadhyay *et. al.* (1981) recorded its appearence.



$$Y=-3165.6712+1296.0249X-114.7002X^2+4.3382X^3-0.0597X^4$$

R^2 0.8648

Fig. 3. Polynomial of 4th degree fitted to average aphid population per plant at different weeks after sowing during 1988-89

during first week of December. The findings regarding peak period of activity of the pest agree with those of Bindra *et al.* (1964), but not with Rathore (1983), who reported peak density during mid-march.

The meteorological conditions which were found conducive for aphid multiplication under Jabalpur condition in the present studies are in agreement with those of Manjrekar (1972); Hodek *et al.* (1972) and Behura (1979). The negative correlation of temperature and positive correlation of humidity with pest incidence are also in close agreement with the findings of Upadhyay *et al.* (1981). However, Rathore (1983) found slightly higher temperature, maximum 33.80°C; minimum 15.30°C and lower level of humidity 44.20%, favourable for aphid multiplication. The present findings revealed that rainfall has positive impact on aphid incidence in the begining while negative impact during the later part of aphid incidence. Although, Broadbent (1953) and Dunn and Wright (1955) also reported that rains dislodges aphids and reduce the population. The findings regarding the significant correlation of aphid incidence with crop age are supported by the views of Dunn and Wright (1955), Atwal and Sethi (1963) and Hughes (1963).

LITERATURE CITED

Atwal, A.S. and Sethi S.L. 1963. Predation by *Cocinella septempunctata* Linn. on the cabbage aphid, *Lipaphis erysimi* (Kalt.) in *Indian J. Anim. Ecol.* 32: 481-488.

Basavana Goud, K. 1979. Estimation of safflower crop loss due to the aphid, *Dactynotus compositae* Theobald and reaction of varieties and insecticides to it. Unpub. M.Sc. thesis, Univ. of Agril. Sciences, Banglore.

Behura, B.K. 1979. The green bugs. Symp. on *Recent Trends in Aphidological studies, held at Bhubaneshwar* India.

Bindra, O.S., Vaishampayan, S.N. and Despande, R.R. 1964. Further studies on the chemical control of safflower aphid, In '3rd All India Oil-seeds Research Workers Conference' held at Bhopal, M.P., India.

Broadbent, L. 1953. Aphids and virus diseases in potato crop. *Biol. Rev.* 28: 350-380.

Dunn, J.A. and Wright, D.W. 1955. Population studies of the pea aphid in East Anglia. *Bull. Ent. Res.* 46: 369-387.

Hodek, I.; Hagen, K.S. and Van Emden, H.F. 1972. Methods for studying effectiveness of natural enemies. *In* : Aphid Technology. Academic Press, London and New York.

Hughes, H.D. 1963. Population dynamics of cabbage aphid, *Brevicoryne brassicae. J. Anim. Ecol.* 32: 394-424.

Manjrekar, S. 1972. Bionomics and chemical control of safflower aphid, *Dactynotus compositae* Theobald. Unpub. M.Sc. thesis, JNKVV, Jabalpur.

Rathore, V.S. 1983. Bionomics and management of safflower aphid. *Indian Frmg.* 33: 32-41.

Snedecor, G.W. and Cochran, W.G. 1967. Statistical methods. Oxford and IBH. Publishing, Calcutta.

Upadhyay, V.R.; Kaul, C.L. and Talati, G.M. 1981. Seasonal incidence of aphid, *Dactynotus carthami* and coccinellids in correlation to weather conditions. *Indian J. Plant Prot.* 8: 117- 121.

J. Oilseeds Res. 12(1) 1995 :17-19
ISSN 0970-2776

VARIABILITY AND CORRELATION IN LINSEED

S.K.VARSHNEY[1], J.N.SAH and O.N.SINGH
Department of Plant Breeding, Tirhut College of Agriculture, Dholi (Muzaffarpur) Bihar.

ABSTRACT

Thirty six varieties of linseed were evaluated for variability and relative association among yield and its attributes. Wide range with high genetic variability was observed for tillers, number of capsules and branches plant^{-1}. Seed yield was positively associated with these characters. Improvement in seed yield could be made through selection for these traits.

Keywords: Linseed; Variability; Correlation.

INTRODUCTION

Linseed (*Linum usitatissimum* L.) is an important *rabi* oilseed crop for Bihar State. For augmenting the production of linseed, there is a need to develop high yielding genotypes. Selection of desirable genotypes from the population depends upon the extent of variability for various characters. The phenotypic variation in quantitative characters includes the genotypic, environmental and their interaction. But it is only the genotypic variability in which a breeder is primarily interested for selection. The yield is very important and a complex character for which direct selection is not much effective. A knowledge of direction and magnitude of association of different characters is of great value in identifying the high yielding genotypes.

MATERIAL AND METHODS

A collection of thirty six varieties/lines of linseed from different agroclimatic zones of the country were evaluated in Randomized Block Design with two replications in 3-rowed plots of 5 meter length with 25 cm spacing during *Rabi* 1984-85. Observations were recorded on plant height (cm), number of tillers plant^{-1}, number of branches plant^{-1}, capsules plant^{-1}, number of seeds capsule^{-1} and seed yield per plant (g) using 5 randomly chosen plants from each plot. Days to 75% maturity was recorded on plot basis. Coefficients of variability at phenotypic, genotypic and environmental levels were calculated following Panse and Sukhatme (1978). Correlation coefficients were worked out according to Al Jibouri *et al*. (1958)

RESULTS AND DISCUSSION

The analysis of variance indicated significant differences among varieties for characters viz. number of tillers plant^{-1}, number of capsules plant^{-1} and yield plant^{-1}. The estimates of mean, range, critical difference and coefficients of variabilities are presented in Table 1. A wide range was observed for all characters under study, the highest being in tillers plant^{-1} (2.7-7.3) followed by capsules plant^{-1} (30.95-76.00), branches plant^{-1} (15.30-30.10) and yield plant^{-1} (2.80-4.50). Considerable amount of exploitable genetic variability was observed for tillers plant^{-1} (17.49), capsules plant^{-1} (17.49) and branches plant^{-1} (10.79). Comparatively high genotypic and phenotypic variability with

1. Department of Seed Technology, Tirhut College of Agriculture, Dholi, Bihar.
Received for publication on March 16, 1992.

wide range for these characters suggested a greater scope of improvement in these traits. In general, the magnitude of coefficient of phenotypic variability was higher than that of genotypic variability because former includes the variation due to environment as well as variation due to interaction.

Comparatively, the capsules plant^{-1} and tillers plant^{-1} were less influenced by the environmental factors as evidenced from the magnitude of genotypic and phenotypic coefficients of variability (Table 1). However, other characters are by and large influenced by environmental factors. Therefore, simple selection based on phenotypic variation may not give worth while improvement in those traits.

The genotypic, phenotypic and environmental correlation coefficients are presented in Table 2. The seed yield Plant^{-1} was positively associated with number of tillers plant^{-1}, number of branches plant^{-1} and number of capsules plant^{-1}. The genotypic correlation of seed yield with branches plant^{-1}, number of tillers plant^{-1} and number of seeds capsules^{-1} was also observed to be high and positive. Genotypic correlation between days to maturity and yield plant^{-1}, was negative. However, the magnitude of this negative correlation at phenotypic level was very low. Further, a high negative genotypic correlation for days to maturity was also observed with number of tillers plant^{-1}, number of branches plant^{-1} and seeds per capsule which are the important yield contributing characters. Rao & Singh (1985) also reported negative association for days to maturity with seed length, seed width and 1000-seed weight. This indicates that it is possible to develop early maturing varieties with high seed yield in linseed. Further, it is indicated that the lines included in this study have been developed for high yield with early maturity. Based on one year testing the number of tillers plant^{-1} were observed to be positively associated with number of branches plant^{-1} and number of capsules plant^{-1}.

A positive correlation was recorded between number of branches plant^{-1} and number of capsules plant^{-1} and number of seeds capsule^{-1}. These associations are obvious because the increase in number of tillers is supposed to have comparable increase in number of branches plant^{-1} and number of capsules per plant. Number of capsules plant^{-1} were observed to be positively associated with number of seeds capsule^{-1}.

Table 1. Range, variability and general mean of different characters in linseed.

Characters	Range	Coefficient of Variability GCV	PCV	ECV	Critical difference (5%)	General mean	S.Em ±
Days to maturity	[illegible]	2.85	3.94	3.25	8.38	127.18	2.92
Plant height (cm)	[illegible]	[illegible]	[illegible]	9.79	11.11	55.88	3.87
Tillers plant^{-1}	2.7-7.3	17.54	29.98	24.32	1.86	3.76	0.65
Branches plant^{-1}	15.30-30.10	16.79	24.77	[illegible]	[illegible]	[illegible]	[illegible]
Capsules plant^{-1}	30.95-76.00	17.49	26.45	[illegible]	[illegible]	[illegible]	[illegible]
Seeds capsule^{-1}	7.75-9.45	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Yield plant^{-1} (g)	2.80-4.50	8.60	17.68	[illegible]	1.04	3.32	0.36

Table 2. Genotypic, phenotypic and environmental correlations between yield and yield contributing characters

Characters		Plant height	Tillers plant^{-1}	Branches plant^{-1}	Capsules plant^{-1}	Seeds Capsule^{-1}	Yield plant^{-1}
Days to maturity	G	0.498	-0.766	-2.222	0.880	-2.824	-2.928
	P	-0.013	0.049	0.168	0.007	0.024	-0.099
	E	-0.063	0.207	0.475**	0.213	0.184	0.310
Plant height	G		0.388	[illegible]	-0.205	0.792	0.013
	P		0.027	0.086	0.088	0.063	0.145
	E		0.069	0.075	0.192	0.006	0.174
Tillers plant^{-1}	G			0.583	0.268	0.061	0.466
	P			0.360*	0.164**	0.099	0.359**
	E			0.563**	0.421**	0.115	0.320
Branches plant^{-1}	G				[illegible]	0.892	1.079
	P				0.571**	0.260*	0.410**
	E				0.562**	0.203	0.231
Capsules plant^{-1}	G					1.600	0.132
	P					0.281*	0.404**
	E					0.080	0.552
Seed Capsule^{-1}	G						0.448
	P						0.178
	E						0.155

In general, the genotypic cerrelations were higher than the phenotypic correlations. This could occur when the genes governing two traits are similar and environmental factors play negligible role in the expression of these traits. However, in certain associations the phenotypic correlations were higher in magnitude than the genotypic correlations. This may indicate the influence of the environmental factors in such associations. Further, the significance of the environmental association revealed that a common environment influenced the expression of such traits in a similar direction. Moreover, when the environment is altered these associations may not exist. Therefore, in a selection programme emphasis need not be given to the environmental associations.

The phenotypic correlation of number of tillers plant^{-1}, number of branches plant^{-1} and number of capsules plant^{-1} with seed yield in conjuction with exploitable genotypic variability and wide range for these characters clearly revealed that these are the most important components of seed yield in linseed and substantial improvement in seed yield could be brought about by selection for these characters.

LITERATURE CITED

Rao, S.K. and Singh S.P. 1985. Relationship of maturity with Seed characterstics and their implications in Selection of Linseed. *J. Oilseeds Res.* 2(1): 86-92.

Aljibouri, H.A. Miller P.A. and Robinson H.E. 1968. Genotypic and environmental Variances and Covariances in an upland Cotton cross of interspecific origin. *Agron. J.* 50: 633-637.

Panse, V.G. and Sukhatme, P.V. 1978. Statistical methods for Agricultural workers, ICAR, New Delhi.

J.Oilseeds Res. 12(1) 1995 : 20-23
ISSN 0970-2776

EFFECT OF CROPPING SYSTEM, IRRIGATION SCHEDULE AND NITROGEN LEVELS ON MUSTARD (*Brassica juncea* L.)*

N.S.YADAV, R.L.RAJPUT, S.S.TOMAR, O.P.VERMA and D.SINGH
JNKVV, Zonal Agricultural Research Station, PB No. 14, AB Road, Morena 476 001 (M.P.)

ABSTRACT

The experiment was conducted during *rabi* seasons of 1985-86 and 1986-87 on sandy loam soil at JNKVV, Zonal Agricultural Research Station, Morena (M.P.) to study the effect of different cropping systems, irrigation schedules and nitrogen levels on yield and yield attributes of mustard (Var. Pusa bold). Results showed that the maximum seed yield, growth and yield attributing characters were recorded in fallow-mustard system, one irrigation at pre-flowering stage (PF) and at 100 kg N/ha.

Keywords : Mustard; Cropping system; Irrigation; Nitrogen levels; Yield.

INTRODUCTION

Mustard (*Brassica juncea* L.) crop is grown under monocropping system in the Chambal command area. Nearly 2 lakh hectares of land is kept fallow in *kharif* followed by mustard in *rabi*, resulting in low cropping intensity and productivity. Therefore, to replace this traditional practice and to increase the cropping intensity as well as profit per unit area, experiments were conducted to study the effect of cropping system, irrigation schedules and nitrogen levels on yield and yield attributes of mustard in Chambal command area of Madhya Pradesh.

MATERIAL AND METHODS

A field experiment was conducted at JNKVV, Zonal Agricultural Research Station, Morena during *rabi* seasons of 1985-86 and 1986-87. The experiment was laid out in a split-split plot design with four replications. The three cropping systems (fallow-mustard, urid- mustard and bajra-mustard) were kept as main plots; four irrigation schedules (no irrigation; irrigation at pre-flowering, irrigation at siliqua development, and irrigation at pre-flowering + siliqua development stage) as sub plots and three nitrogen levels (0, 50 and 100 kg/ha) as sub-sub plots. The soil was sandy loam having 188 kg/ha available N, 17 kg/ha available P_2O_5 and 312 kg/ha available K_2O. The fertilizers were applied at sowing (35 kg P_2O_5/ha as single super phosphate, 20 kg K_2O /ha as muriate of potash and nitrogen as ammonium sulphate as per treatments). The crop was sown on 27th October and 9th November during 1985-86 and 1986-87 respectively. In the first year, 67.2 mm rainfall was received with 12.2 mm rainfall around 60 DAS and 36.0 mm rainfall around 95 DAS, whereas in the second year, 38.2 mm rainfall was received with 34.9 mm rainfall around 62 DAS.

RESULTS AND DISCUSSION

Effect of cropping system

Significantly higher seed yield of mustard was obtained in fallow-mustard as compared to urid-mustard and bajra-mustard (Table 2). On

* Part of the Ph.D. thesis submitted by the senior author to the Jiwaji University, Gwalior (MP).
Received for publication on November 1, 1992.

an average, fallow-mustard produced 21.1 and 67.2 per cent more seed yield of mustard over *urid*-mustard and bajra- mustard respectively. Similarly urid-mustard produced 38.1 per cent more seed yield of mustard over bajra-mustard. Similar trend was observed in respect of all the growth and yield attributing characters except 1000 seed weight in 1985-86 where fallow-mustard was at par with urid-mustard.

Effect of irrigation schedules

Mustard yield under one irrigation at pre-flowering stage (PF) was at par with two irrigations at pre-flowering and siliqua development (PF + SD) but significantly superior over no irrigation and irrigation at siliqua development (SD) during 1985-86. In 1986-87 irrigation at pre-flowering produced significantly higher seed yield of mustard over rest of the irrigation schedules except no irrigation which was due to the fact that substantial rainfall was received during flowering and pod initiation stage. The data further revealed that irrigation at PF was significantly superior over no irrigation, irrigation at SD and PF +SD in respect of all the yield attributes except number of siliqua/plant which was at par with irrigation at PF + SD in 1985-86 (Table 2). The biomass per plant, plant height and number of branches/plant was significantly superior when two irrigations were applied at PF + SD over all the other irrigation treatments during both the years. The probable reason, for higher yield with irrigation at PF as compared to irrigation at PF + SD may be due to the fact that the vegetative growth is retarted by moderate stress but sugar is still available in good quantity for siliqua and seed development resulting in better yield and attributes, while in case of irrigation at PF + SD abundant moisture at siliqua development promote vegetative growth resulting in poor siliqua and seed development. Singh (1968) and Rana *et al.* (1991), reported similar results.

A perusal of data (Table 1 & 2) indicates that the seed yield of mustard significantly increased with the increasing levels of nitrogen from 0 to 50 and 50 to 100 kg/ha during both the years. On an average, the increase in seed yield over control was 71.4 % with 100 kg N and 44.7 % with 50 kg N. The yield increase was 18.4% over 50 kg N with 100 kg N. Similar trend was recorded in respect of growth and yield attributes viz., plant height, branches/plant, biomass/plant, siliqua/plant, seeds/siliqua and test weight during both the years. The probable reason may be that increasing levels of N resulted in greater accumulation of carbohydrate, proteins and their translocation to the productive organs which, in turn, improved all the growth and yield attributing characters and yield. These findings are in agreement with the findings of Singh (1988) and Rana *et al.* (1991).

LITERATURE CITED

Rana, D.S. Singh, H.P. and Ahlawat, I.P.S. 1991. Effect of irrigation, plant density and nitrogen application on water use yield and yield attributes of mustard. *Indian J. of Agron.* 36 (Suppl.) : 138-142.

Singh, G.B. 1968. Studies on the effect of irrigation and fertilizer levels on the nutrient uptake, water use and quality of raya, Ph.D.Thesis submitted to the PAU Ludhiana.

Singh, K.K. 1988. Comparative performance of mustard varieties under varying levels of nitrogen. M.Sc. (Ag.) thesis submitted to Agra University Agra (UP).

Table 1. Growth and yield attributing characters as affected by cropping systems, irrigation schedule and nitrogen levels on mustard

Treatments	Plant height (cm)		No. of branches/plant		Biomass/plant		Seed weight/plant	
	1985-86	1986-87	1985-86	1986-87	1985-86	1986-87	1985-86	1986-87
Cropping system								
Fallow-mustard	163.9	179.8	5.8	6.7	24.3	26.8	6.7	8.7
Urid-mustard	146.6	163.7	5.4	6.2	18.4	21.8	6.6	7.1
Bajra-mustard	112.0	133.5	5.1	5.6	14.4	12.9	6.3	4.8
CD at 5%	2.94	0.61	0.14	0.21	0.38	2.80	0.63	0.63
Irrigation schedule								
No. Irrigation	128.9	149.4	4.6	5.3	14.2	19.1	5.6	7.3
Irrig. at Pre-flowering (PF)	148.8	165.9	5.8	6.5	21.3	19.2	7.6	8.1
Irrig. at Siliquae development (SD)	132.9	153.6	5.1	6.0	18.0	19.2	6.2	6.7
Irrig. at (PF + SD)	152.8	167.2	6.1	7.6	24.8	23.9	6.8	8.9
CD at 5%	2.46	0.54	0.12	0.34	1.91	1.93	0.68	0.66
Nitrogen levels kg/ha								
0	128.2	151.3	4.1	5.2	15.8	14.7	4.5	4.9
50	143.5	160.6	5.8	6.4	19.6	21.5	6.8	7.4
100	150.8	165.9	6.3	7.0	22.6	24.9	8.3	8.8
CD at 5%	0.97	1.38	0.19	0.16	0.61	1.25	0.47	0.42

Table 2. *Yield and yield attributing characters as affected by cropping systems, irrigation schedule and nitrogen levels on mustard*

Treatments	Seed yield (kg/ha)		No. of siliqua/plant		No. of seeds/siliqua		1000 seed weight (g)	
	1985-86	1986-87	1985-86	1986-87	1985-86	1986-87	1985-86	1986-87
Cropping system								
Fallow-mustard	16.11	18.23	130.3	139.4	12.1	12.7	6.19	5.91
Urid-mustard	12.89	15.48	104.6	128.6	11.5	12.1	5.93	5.46
Bajra-mustard	9.82	10.93	85.2	93.5	11.0	11.1	5.58	5.22
CD at 5%	0.99	1.40	11.69	7.96	0.24	0.14	0.28	0.14
Irrigation schedule								
No. Irrigation	11.25	14.93	85.8	116.6	10.9	12.1	5.42	5.88
Irrig. at Pre-flowering (PF)	14.31	15.79	127.0	137.9	12.2	12.3	5.70	6.41
Irrig. at Siliquae development (SD)	12.14	14.55	87.3	145.9	11.2	11.9	5.45	5.69
Irrig. at (PF + SD)	13.28	14.42	125.1	124.9	11.9	11.6	5.56	5.59
CD at 5%	1.100	1.04	9.86	9.59	0.17	0.16	0.14	0.21
Nitrogen levels kg/ha								
0	8.58	11.43	78.9	90.5	11.0	11.5	5.56	5.13
50	13.67	15.27	109.1	125.7	11.6	12.1	5.95	5.60
100	16.35	17.90	139.9	155.4	11.9	12.4	6.19	5.87
CD at 5%	0.63	0.48	10.07	6.99	0.19	0.20	0.15	0.20

J. Oilseeds Res. 12(1) 1995 :24-29
ISSN 0970-2776

EFFECT OF CROPPING SYSTEM, IRRIGATION SCHEDULE AND NITROGEN LEVELS ON NUTRIENT UPTAKE BY MUSTARD (*Brassica juncea* L.)

N.S.YADAV, R.L.RAJPUT, S.S.TOMAR and O.P.VERMA
JNKVV, Zonal Agricultural Research Station, 14AB Road, Morena 476 001, (MP)

ABSTRACT

A field experiment was conducted during *rabi* seasons of 1985-86 and 1986-87 on sandy loam soil at JNKVV, Zonal Agricultural Research Station, Morena (MP). Seed yield, uptake of N, P and K contents in mustard were significantly higher in fallow-mustard system as compared to urid-mustard and bajra-mustard systems. Significantly higher seed yield, uptake of NPK and N, P contents were also recorded when one irrigation was applied at pre-flowering stage (PF). Uptake of NPK and seed yield significantly increased with the increasing levels of nitrogen during both the seasons.

Keywords : Mustard; Cropping system; Irrigation; Nitrogen; Nutrient uptake.

INTRODUCTION

Cereal crops are known to deplete the soil fertility to a relatively greater extent whereas legumes are restorative. There are reports that growing of preceding crop of legume favourably effects the growth and development of mustard (*Brassica juncea* L.) crop (Sen Gupta, 1965). Inclusion of a legume in the cropping system adds soil nitrogen through atmospheric fixation which in turn, may bring about some changes in the pattern of N concentration and uptake by mustard crop. But adequate information is not available for agroclimatic zone and soil conditions of Chambal command area of Madhya Pradesh. In view of this, field experiments were conducted for two seasons to study the effect of cropping system, irrigation schedule and nitrogen levels on yield, N P concentration and uptake by mustard crop.

MATERIAL AND METHODS

A field experiment was conducted on sandy loam soil during *rabi* seasons of 1985-86 and 1986-87 at JNKVV, Zonal Agricultural Research Station, Morena (MP). The experiment was laid out in a split-split plot design with four replications. The main plots consisted of three cropping systems (Fallow-mustard; Urid- mustard; and Bajra-mustard). The four irrigation schedules (No irrigation, irrigation at Preflowering (PF), irrigation at Siliqua development (SD) and irrigation at Preflowering and Siliqua development (PF + SD) were taken as sub plots. whereas three nitrogen levels (0, 50 and 100 kg/ha) were taken as sub-sub plots. Plant samples were collected periodically and mustard seeds were collected after the harvest of the crop from each treatment and were analysed by standard methods as reported by Jackson (1973).

---

*Part of the Ph.D. thesis submitted by the senior author to the Jiwaji University, Gwalior, M.P.
Received for publication on November 1, 1992

RESULTS AND DISCUSSION

In general, the maximum concentration of N and P in mustard plant was recorded at early stage (25 DAS). Thereafter, a progressive decrease in contents with increase in plant growth up to 100 DAS were recorded due to cropping systems, irrigation schedules and nitrogen levels during both the years.

Effect of cropping systems

The N and P content differed significantly among different cropping systems and higher contents were found in fallow-mustard at each growth stage as compared to urid-mustard and bajra-mustard systems in both the seasons (Tables 1 & 2). It is evident from the Table 3 that in both the years the uptake of NPK kg/ha and seed yield were, significantly higher in fallow-mustard system as compared to urid-mustard and bajra-mustard. The higher value of N P content, seed yield and uptake of NPK in fallow-mustard may be attributed to a highly favourable soil environment created due to frequent cultivation of fallow plots during *kharif*, resulting in better root growth and uptake (Wolfe and Kipps, 1959). Further the exhaustive preceding crop of pearlmillet in the system depletes the soil fertility to a great extent resulting in lower N P contents, seed yield and uptake of NPK kg/ha in mustard crop (Sen Gupta, 1965).

Effect of irrigation schedules

It is clear from the Tables 1 & 2 that at early stage (25 DAS) N and P contents in mustard plants were not affected and were found more or less similar under all the irrigation schedules in both the years as the treatments commenced after 25 DAS. But at later stages N and P contents in plant under pre-flowering and PF + SD were higher as compared tc and irrigation at SD. It is becau: that irrigation improves the solubility of nutrients to the plants and decreases the soil strength, increasing root ramification which ultimately resulted in higher absorption of nutrients. Similar findings were also reported by Khan (1980) and Rana *et al.* (1991).

Data in Table 3 indicate that the uptake of N by seed and total crop was higher under irrigation at pre-flowering stage as compared to other treatments in both the years except first year in case of total uptake by crop where irrigation at PF + SD was marginally superior to irrigation at PF. In case of N uptake by stover, although irrigation at PF was inferior to irrigation at PF + SD in first year, it was statistically at par with irrigation at PF + SD in second year while PF was significantly superior to no irrigation and irrigation at SD in both the years. Data further reveals that irrigation at PF, in respect of P uptake by seed, and by the crop and K uptake by seed was significantly superior to all the irrigation treatments in both the years except that in the first year where it was at par with irrigation at PF + SD. Similarly irrigation at PF was also superior to rest of the irrigation treatments, as regards with P uptake by stover in both the years except that in second year it was at par with irrigation at PF + SD. Thus from the above discription, irrigation at PF may be concluded as a very good treatment under which supply and availability of water to the crop results into better root proliferation and thus greater uptake of NPK kg/ha. Further maximum NPK uptake in irrigation at PF was in accordance with the seed production capacity of the irrigation treatment. Similar results have been reported by Singh (1968) and Tomer *et al.* (1992).

Table 1. N content (%) in mustard plant at successive growth stages as affected by cropping system, irrigation schedule and nitrogen levels.

Treatment	N content (%)							
	25 DAS		50 DAS		75 DAS		100 DAS	
	1985-86	1986-87	1985-86	1986-87	1985-86	1986-87	1985-86	1986-87
Cropping systems								
Fallow-mustard	5.5	5.7	3.6	3.6	2.3	2.4	1.3	1.5
Urid-mustard	5.5	5.6	3.4	3.4	2.1	2.3	1.2	1.5
Bajra-mustard	5.3	5.4	3.0	2.9	2.0	2.1	1.2	1.2
CD at 5%	0.05	0.02	0.01	0.02	0.07	0.09	0.04	0.04
Irrigation schedules								
No irrigation	5.4	5.5	3.1	3.2	1.8	2.0	1.1	1.1
Irrig. at pre-flowering (PF)	5.4	5.5	3.4	3.4	2.4	2.7	1.3	1.3
Irrig. at siliqua development (SD)	5.5	5.5	3.3	3.2	1.8	2.0	1.2	1.2
Irrig. at PF + SD	5.4	5.5	3.4	3.4	2.5	2.6	1.4	1.4
CD at 5%	NS	NS	0.09	0.09	0.12	0.12	0.06	0.07
Nitrogen levels kg/ha								
0	5.2	5.2	2.9	2.9	1.9	2.0	1.1	1.1
50	5.6	5.5	3.3	3.3	2.2	2.2	1.2	1.2
100	5.5	5.8	3.6	3.7	2.3	2.5	1.4	1.4
CD at 5%	NS	0.08	0.08	0.09	0.05	0.04	0.02	0.02

Table 2. P content (%) in mustard at successive plant growth stages as affected by cropping systems, irrigation schedules and nitrogen levels

Treatment	P content (%)							
	25 DAS		50 DAS		75 DAS		100 DAS	
	1985-86	1986-87	1985-86	1986-87	1985-86	1986-87	1985-86	1986-87
Cropping systems								
Fallow-mustard	0.58	0.59	0.41	0.44	0.24	0.26	0.12	0.13
Urid-mustard	0.56	0.57	0.39	0.43	0.22	0.23	0.11	0.12
Bajra-mustard	0.52	0.53	0.36	0.41	0.19	0.20	0.10	0.10
CD at 5%	0.005	0.006	0.006	0.001	0.006	0.007	0.003	0.003
Irrigation schedule								
No irrigation	0.55	0.56	0.37	0.42	0.20	0.22	0.10	0.11
Irrig. at pre-flowering (PF)	0.55	0.56	0.40	0.44	0.23	0.24	0.11	0.12
Irrig. at silique development (SD)	0.55	0.56	0.38	0.42	0.20	0.22	0.10	0.11
Irrig. at PF + SD	0.55	0.56	0.007	0.44	0.23	0.25	0.12	0.12
CD at 5%	NS	NS	0.35	0.001	0.007	0.008	0.004	0.004
Nitrogne levels kg/ha								
0	0.53	0.54	0.35	0.41	0.10	0.19	0.10	0.10
50	0.56	0.57	0.39	0.43	0.22	0.24	0.11	0.12
100	0.7	0.58	0.42	0.45	0.24	0.216	0.12	0.13
CD at 5%	0.008	0.008	0.001	0.006	0.01	0.01	0.005	0.006

Table 3. Nutrient uptake by seed and stover as affected by cropping systems, irrigation schedules and nitrogen levels on mustard

Treatment	N uptake kg/ha				P uptake kg/ha				K uptake kg/ha		Seed yield kg/ha	
	Seed		Stover		Seed		Stover					
	1985-86	1986-87	1985-86	1986-87	1985-86	1986-87	1985-86	1986-87	1985-86	1986-87	1985-86	1986-87
Cropping Systems												
Fallow-mustard	53.0	64.7	35.1 (88.2)	62.3 (127.0)	10.8	12.6	7.5 (18.3)	10.2 (22.8)	18.2	22.1	16.11	18.23
Urid-mustard	40.9	53.3	23.7 (64.5)	49.2 (102.5)	8.1	10.0	5.6 (13.6)	7.7 (17.8)	14.3	18.6	12.89	15.48
Bajra-mustard	29.8	36.7	19.7 (49.5)	33.7 (70.4)	5.6	6.7	4.3 (9.9)	5.0 (11.7)	10.8	13.2	9.62	10.93
CD at 5%	3.29	5.47	2.35 (2.52)	3.52 (8.34)	0.62	0.95	0.32 (0.62)	0.68 (1.61)	1.50	1.60	0.99	1.40
Irrigation Schedules												
No irrigation	35.9	50.0	15.4 (51.2)	36.2 (86.2)	7.2	9.7	4.7 (12.0)	6.9 (16.6)	12.7	17.5	11.75	14.93
Irrig.. at pre flowering (PF)	46.5	55.2	30.2 (76.8)	55.4 (110.6)	9.1	10.5	6.7 (15.8)	8.5 (18.9)	16.3	19.4	14.31	15.79
Irrig. at siliqua development (SD)	38.0	50.1	21.4 (59.4)	44.3 (94.4)	7.6	9.6	5.2 (12.8)	7.2 (16.8)	13.4	17.3	12.14	14.55
Irrig,. at PF + SD	44.6	50.9	37.5 (32.2)	57.6 (108.6)	8.7	9.5	6.4 (15.1)	8.1 (17.6)	15.4	17.7	13.28	14.42
CD at 5%	3.90	3.43	2.63 (526)	4.96 (7.42)	0.72	0.71	0.30 (0.69)	0.53 (1.11)	1.30	1.30	1.10	1.09
Nitrogen levels kg/ha												
0	24.8	36.5	13.6 (38.4)	30.0 (66.5)	5.1	7.2	3.6 (8.7)	4.9 (12.1)	9.3	13.2	8.58	11.43
50	43.9	52.3	28.0 (71.9)	47.9 (100.2)	8.7	10.1	6.0 (14.7)	7.9 (18.0)	15.3	18.4	13.67	15.27
100	55.2	65.9	36.9 (91.9)	67.2 (133.2)	10.7	12.2	7.7 (18.4)	0.40 (22.3)	0.7	0.7	0.63	0.48
CD at 5%	2.03	1.84	1.14 (2.17)	2.00 (3.39)	0.42	0.38	0.31 (0.46)	0.40 (0.58)	0.7	0.7	0.63	0.48

* Figure in parentheses indicate total uptake by crop.

Effect of nitrogen levels

Tables 1 and 2 indicate that N and P contents in plant was increased significantly with the increasing levels of nitrogen at all the stages of crop growth in both the years. It may be due to the fact that the application of N increases the root growth as well as root cat ion exchange capacity which enhances nutrient absorption and plant growth. Further the data in Table 3 clearly indicate that seed yield, uptake of NPK by seed, stover and total uptake by crop were also increased significantly with the increasing levels of nitrogen during both the seasons. Singh and Singh (1984) and Rana *et al.* (1991) have also observed similar results.

LITERATURE CITED

Jackson, M.L. 1973. Soil chemical analysis Prentice Hall of India, New Delhi.

Khan, G.M., 1980. Water use efficiency, yield and quality of raya in relation to water stress, sowing method and N levels. Ph. D. thesis submitted to HAU, Hissar.

Rana, D.S., Singh, H.P. and Ahlawat, I.P.S., 1991. Oil yield and nitrogen uptake in mustard as affected by irrigation, plant density and nitrogen application. *Indian J. Agron.* 36 (Suppl.) : 143-146.

Sen Gupta, M.B., 1965. Influence of treatment and crops on the nutrient status in calcarious soil. *J. Indian Soc. Soil Sci.* 13 (3) : 199-203.

Singh, G.B., 1968. Studies on the effect of irrigation and fertilizer levels on the nutrient uptake, water use and quality of raya. Ph.D. Thesis submitted to P.A.U.Ludhyana.

Singh, T.P. and Singh, H.P., 1984. Dry matter accumulation and nutrient uptake in Indian rape as affected by plant density and fertilizers. *Indian J. Agron.* 29 (4) : 522-52.

Tomer, Savita, Tomer, Sunita and Singh Subey., 1992. Effect of irrigation and fertilizer on nutrient uptake and moisture use of mustard. *Indian J. Agron.* 37 (1) : 97-99.

Wolfe, Tik. and Kipps, M.S., 1959. Production of field crops. Mc.Graw. Hill Book Company New York Toronto London.

J. Oilseeds Res. 12(1) 1995 : 30-32
ISSN 0970-2776

VARIABILITY STUDIES FOR OIL AND FATTY ACID COMPOSITION IN *Brassica campestris* var. *Toria*

PARAMJIT SINGH, V.P. GUPTA, M.L. GUPTA and D.R. SATIJA
Department of Genetics, Punjab Agricultural University, Ludhiana, Punjab

ABSTRACT

Fatty acid composition of thirty three genotypes of *Brassica campestris* var. *toria* indicated considerable genetic differences for six fatty acids namely palmitic, stearic, oleic, linoleic, linolenic and erucic acid. The correlation coefficient amongst different fatty acids revealed significant negative correlation of erucic acid with oleic, linoleic and linolenic acid. Genotypes with desirable oil content and quality have been identified.

Keywords: *Brassica campestris* var. *toria;* Fatty acid composition.

INTRODUCTION

Brassica campestris var. *toria* is an important oil seed crop which is grown as a catch and cash crop. It also offers a good scope for crop diversification. This crop is primarily raised for its edible oil. The oil of *Brassicas* in general has a limiting factor with regard to its quality as it has a high content of erucic acid which accounts for poor digestibility of the oil and also attributed to cause cardiac problems (Applequist, 1972). Recently, efforts have been initiated to develop genotypes with superior oil quality by selecting genotypes with low amounts of erucic acid. As very little systematic work has been done in *B. campestris* var. *toria* it becomes imperative to assess the genetic variability for oil content and quality in the available material. The present study is an attempt to identify genotypes with high oil content and desirable fatty acid composition.

MATERIAL AND METHODS

Thirty three genotypes of *B. campestris* var. *toria* were analysed for their oil content and fatty acid composition. Oil content was estimated with the help of NMR. For fatty acid composition the lipids were extracted from the seeds by cold percolation method (Folch *et al.* 1957). Lipids were converted into their methyl esters following the method of Luddy *et al.* (1968). The methyl esters were analysed using AIMIL gas chromatograph. The peaks obtained were identified using internal standard fatty acids. Relative proportion of different fatty acids was worked out from the areas of peaks.

RESULTS AND DISCUSSION

Investigations revealed presence of two saturated fatty acids namely palmitic acid (16:0) and stearic acid (18:0) and four unsaturated fatty acids, namely oleic acid (18:1), linoleic acid (18:2), linolenic acid (18:3) and erucic acid (22:1). Analysis of variance revealed significant differences between genotypes for the contents of these fatty acids as well as for oil content.

Received for publication on July 30, 1993

The mean and range for oil content and different fatty acids are presented in Table 1. The wide range of variation for different fatty acids indicates that there is a considerable potential in the genotypes for improving their fatty acid composition. Studies reveal that the genotypes TL88-2, TL88-3, TL88-7, TL88-8, TL88-9, TL88-10, TL88-13 and TL88-22 are the most desirable genotypes as they have either high amounts of desirable fatty acids (16:0, 18:1 and 18:2) or the relatively low amounts of undesirable fatty acids (i.e. 18:3 and 22:1). Among different fatty acids three fatty acids namely oleic, linoleic and linolenic acids are essential fatty acids and have to be provided through diet. Erucic acid and linolenic acid are undesirable from edible point of view. It is suggested that these two fatty acids should be considerably reduced if not eliminated completely in view of their nutritional quality (Applequist, 1972; Wowney and McGregor, 1975), as lower amounts of linolenic acid will improve the stability of the oil, while lower proportions of erucic acid will make the oil more palatable, nutritive and less vulnerable to metabolic disorders (Carroll and Nobel 1957; Rocquelin *et al.* 1971; Rutkowski, 1971). On the other hand, increased proportion of the two major fatty acids, oleic and linoleic will improve the nutritional value of the oil. The best genotype, therefore, is the one which possess high amount of oleic and linoleic acid and low amounts of linolenic acid and zero or very low amounts of erucic acid. In the present studies there is no single genotype which possesses this type of desirable fatty acid composition. However, there are certain genotypes which have relatively high amounts of oleic acid such as TL 88-2, TL 88-7, TL 88-9 and TL-15. The relative high amounts of linoleic acid has been found in TL 88-13, TL 88-3, TL 88-17 and TL 88-1.

Correlation coefficient amongst different fatty acids are presented in Table 2. Palmitic acid was found to be significantly and positively correlated with stearic acid whereas it was negatively and significantly correlated with linoleic and linolenic acid. Stearic acid was also found to be significantly but negatively correlated with linolenic acid. Linoleic acid was found to be significantly and positively correlated with linolenic acid. Erucic acid was found to be significantly but negatively correlated with oleic, linoleic and linolenic acid. Gross and Stafansson (1966) reported negative association between erucic acid and linolenic acid while Craig and Walter (1959) observed negative correlation between oleic and erucic acid in rape seed. Singh *et al.* (1991) have also

Table 1. Mean and range of different fatty acids and oil content along with desirable genotypes in *Brassica campestris* var. *toria*

	Mean	Range	Desirable genotypes
Oil content %	41.12 ± 0.42	39.45 to 42.48	TL88-21, TL-15, TL88-23, TL88-28
Palmitic acid %	3.56 ± 0.20	2.17 to 6.88	TL88-22, TL88-8, TL88-10, TL88-31
Stearic acid %	0.79 ± 0.05	0.35 to 1.69	TL88-8, TL88-10, TL88-22, TL88-20
Oleic acid %	12.90 ± 0.30	10.17 to 18.11	TL88-2, TL88-7, TL88-9, TL-15
Linoleic acid %	14.82 ± 0.29	10.46 to 17.78	TL88-13, TL88-3, TL88-17, TL88-1
Linolenic acid %	12.83 ± 0.28	8.47 to 17.44	TL88-8, TL88-11, TL88-1, TL88-10
Erucic acid %	55.11 ± 0.50	50.13 to 59.99	TL88-2, TL88-7, TL88-13, TL88-21

Table 2. Correlation coefficient amongst different fatty acids

	18:0	18:1	18:2	18:3	22:1
16:0	0.60**	-0.19	-0.46**	-0.44**	0.16
18:0		-0.13	-0.26	-0.35*	0.08
18:1			-0.10	0.20	-0.57**
18:2				0.44**	-0.56**
18:3					-0.73**

*,**: Significant at 5% and 1% level of significance respectively.

reported negative and significant correlation of erucic acid with linoleic acid in *B. napus*. The negative association of erucic with oleic, linoleic and linolenic acid is of great significance in breeding varieties/developing genotypes with very low erucic acid content and thus improving the nutritional quality of the edible oil.

LITERATURE CITED

Applequist, L.A. 1972. Chemical constituents of rape seed. *L.A.Applequist and B.Ohlson (eds.)*, **Rapeseed** *In* : Elsevier, Amesterdam. pp 123-173,

Carroll, K.K. and Nobel, R.L. 1957. Influence of a dietary supplement of erucic acid and other fatty acids on fertility in the rat. *Journal of Canadian Biochemistry and Physiology*. 39, 1093-1105.

Craig, B.M. and Walter, L.R. 1959. Varietal and environmental effects on rape seed II.Fatty acid composition of the oil. *Canadian Journal of Plant Sciences* 39,437-442

Downey, R.K. and McGregor, D.I. 1975. Breeding for modified fatty acid composition. *Current Advances in Plant Sciences*. 17, 151-167.

Folch, J., Lees, M. and Sloans, S. 1957. A simple modified method for the isolation and purification of total lipids from animal tissues. *Journal of Biological Chemistry*. 22, 497.

Gross, A.T.H. and Staffanson, B.R. 1966. Effect of planting date on protein, oil and fatty acid content on rape seed and turnip rape. *Canadian Journal of Plant Sciences*. 46,389-395.

Luddy, F.E., Barford, R.A., Herb, S.F. and Magidman, P. 1968. A rapid and quantitative procedure for the preparation of methyl esters of butter fat and other fat. *Journal of American Oil chemist Society*. 49, 549-552.

Rocquelin, G., Sergiel, J.P., Leclere, M.J. and Chizen, R. 1971. The nutritive value of refined rapeseed oil. - review. *Journal of American Oil chemist Society*. 48, 728-732.

Rutkowski, A. 1971. Feeding value of rapeseed meal. *Journal of American Oil chemist Society*. 48, 733.

Singh, Paramjit; Khehra, M.K. and Gupta, V.P. 1991. Variability and correlation studies for oil quality in *Gobhi* sarson. *Crop improvement* 18: 115-118.

J.Oilseeds Res. 12(1) 1995 :33-37
ISSN 0970-2776

OIL CONTENT, FATTY ACID COMPOSITION AND PROTEIN CONTENT IN RAPESEED-MUSTARD UNDER DIFFERENT PHOTOPERIODS*

NEELAM YADAVA, S.C. BHARGAVA, N.D. SHARMA and V.K. YADAV
Division of Plant Physiology, Indian Agricultural Research Institute, New Delhi 110 012

ABSTRACT

Oil content, its quality and protein content vary with the cultivar as well as with photoperiod; Pusa Kalyani (PK) had maximum oil content followed by Varuna, BO-15 and BS-2B-84 under different photo periods. Maximum seed protein was recorded in BS-2B-84, while the minimum in Pusa Kalyani. Oil content under natural day (ND) was at par with long day (LD) while minimum under short day (SD) in all the four cultivars. In general, there was inverse relationship between oil and protein content. Palmitic and stearic acids increased in Pusa Kalyani, BS-2B-84, while decreased in Varuna under long day (LD) relative to natural day (ND). Change in photoperiod did not have any effect on saturated fatty acids in BO-15. Short day (SD) was found to be most suitable for reducing linolenic acid in all the four cultivars and increasing oleic acid in BO-15 and BS-2B-84, ND favoured reduction in erucic acid in Varuna, BO-15 and BS-2B-84 while LD in Pusa Kalyani. Inverse relationship was found between linoleic and linolenic acid.

Keywords : Brassica; Photoperiod; Oil composition; Protein.

INTRODUCTION

Oil content and its composition varies due to change in environment (Sosulski and Gore, 1964). Transformation of carbohydrates which is influenced by nutrition affects accumulation of oil (Mendham and Scott, 1975). Date of harvest also affects the seed oil and protein content. Increasing the fertilizer dose decreased the oil content and increased linolenic and linoleic acids (Zhao *et al.*, 1991). Increasing temperature in the range of $10^{o}C$ - $20^{o}C$ decreased the oil content (Canvin, 1965). Oil content is also influenced by photoperiod, being minimum under long day (LD)and highest under natural day (ND) in Pusa bold and Pusa kalyani (Babu, 1985). One of the continuing aim of rapeseed plant breeding research is to improve the quality of rapeseed oil. Research in this direction has resulted in decreasing the level of undesirable long chain fatty acids viz., eicosenoic and erucic acid (Stefansson *et al.*, 1961, Downey, 1964). Further, desirable change in fatty acid composition would be an increase in linoleic acid to 35% and decrease in linolenic acid to 1%. High oil content with proper proportion of desirable fatty acids has greater importance for human nutrition. The present investigation was carried out with a view to study the effect of three different photoperiods on seed oil content and its composition in four cultivars of *Brassica* and to find out photoperiod suitable for reducing linolenic, erucic acid and increasing oleic acid in these four cultivars.

* Part of the Ph.D. thesis submitted by the senior author to IARI, New Delhi
Received for publication on November 29, 1993.

MATERIAL AND METHODS

The seeds were collected at harvest stage from four Brassica species viz., *B.campestris* (Pusa kalyani), *B. juncea* (Varuna), *B.napus* (BO-15) and *B. carinata* (BS-2B-84) grown under long day (24 hr photoperiod), short day (8 hr photoperiod) and natural day (10-12 hr, Delhi conditions) in split plot design in the field. Long days (LD) were maintained by supplementing natural day length with incandescent bulbs and tube light in the night hours. Short days were maintained by covering the crop with black curtain throughout the day and night except from 9 AM to 5 PM. The seed oil content was determined by nuclear magnetic resonance (NMR) method using Bruker Mini Spec-PC-20 model (Tiwari *et al.*, 1974). Seed protein was calculated by multiplying nitrogen content (estimated as described in Technicon Monograph, 1971) with a factor 5.73. Total lipids were extracted as described by Folch *et al.* (1957) with certain modifications which included addition of sodium sulphate to the lipid (Chloroform-methanol) fraction to remove last traces of moisture. Methyl esters of fatty acids of total lipids were prepared (Morrison and Smith, 1964) and methylated fatty acids were analysed by GLC (Amil-Nucon, 5500-model) equipped with flame ionization detector (FID) using diethylene glycol succinate (DEGS) as stationary phase on 80 : 100 mesh chromosorb P. Samples were taken in triplicate for determination of oil, fatty acids and protein content.

RESULTS AND DISCUSSION

The oil content varied not only with cultivar but also with photoperiod as shown in Table 1. Pusa Kalyani had highest oil content among the four cultivars under all the three photoperiods. The oil content was minimum under short day while natural and long day were at par. Thus, natural day (10-12 hr photoperiod) and long day (24 hr photoperiod) were equally useful for higher oil content as compared to short day (SD). Similar results have been reported in linseed (Sairam and Srivastava, 1977). In *B.napus* oil maximum content was attained at 18 hr photoperiod while increasing or decreasing the photoperiod reduced the oil content (Agarwal, 1971).

Highest seed protein under ND (25.78%) and LD (22.42%) was recorded by BS-2B-84 while, under SD (23.69%) by BO-15 (Table 1). The relationship between oil and protein content showed that Pusa Kalyani had highest oil content and minimum seed protein as compared to other three cultivars under different photoperiods. SD resulted in increasing seed protein and decreasing oil content in all the four cultivars except BS-2B-84. Present study shows minimum oil content under SD which was associated with maximum protein content, indicating inverse relationship between the two. Day length treatment implied to have effect on total number of fatty acids as well as their relative percentage in the cultivars studied (Table 2). Palmitic and stearic acids were the only saturated fatty acids present in all the four cultivars under three different photoperiods. Other saturated fatty acids were present in traces except caprylic, lauric and myristic acid under SD and lignoceric acid under LD in Pusa Kalyani and under ND in BO-15. Under LD, saturated fatty acids, palmitic and stearic acid increased in Pusa Kalyani and BS-2B-84, while they were decreased in Varuna as compared to ND. Changes in photoperiod did not seem to have any effect on saturated fatty acid content in BO-15. This confirms with the observation made by Agarwal (1971) for this cultivar.

Table 1. **Effect of day length on oil and protein content of *Brassica* species**

Cultivar	Day Length	Oil content (%) of seeds from different order branches					Protein Content (%)
		Main	Primary	Secondary	Teritary	Mean	
Pusa Kalyani	SD	46.91	46.75	46.21	-	46.62	19.87
	ND	46.99	48.74	48.79	-	48.17	19.61
	LD	47.73	48.70	47.73	-	48.05	16.85
Varuna	SD	42.74	42.46	39.13	-	41.44	22.63
	ND	43.42	44.43	45.29	-	44.38	21.04
	LD	44.73	44.68	45.37	-	44.93	21.36
BO-15	SD	38.35	38.75	34.48	-	37.19	23.69
	ND	42.15	42.67	43.63	-	42.82	19.93
	LD	42.80	43.79	42.78	-	43.12	20.03
BS-2B-84	SD	32.22	35.34	35.96	34.86	34.60	21.62
	ND	35.60	40.82	40.99	36.62	38.51	25.78
	LD	35.62	39.97	41.06	39.01	38.92	22.42
S.Em ±		0.832	0.568	0.674	-	0.602	0.526
C.D. at 5%		2.441	1.667	1.978	-	1.782	1.542

Lowest content of erucic acid (43.07%) was associated with highest amount of oleic (17.13%), linoleic (12.6%), linolenic (8.56%) and eicosenoic acid (11.5%) under LD in Pusa Kalyani. In case of Varuna, ND was most suitable for the highest content of oleic (11.74%), linoleic (15.5%), linolenic acid (13.86%) and lowest content of erucic acid (45.13%) as well as eicosenoic acid (9.1%). In BO-15 lowest content of erucic acid (48.76%) was obtained under ND but was associated with the highest content of linolenic acid (6.54%). Long day was most favourable for lowest production of linolenic acid (5.14%) while SD for highest amount of oleic acid (16.48%) and linoleic acid (12.07%) relative to other photoperiods in this cultivar. Short day (SD) was most effective for highest amount of oleic acid (12.51%) and lowest amount of linolenic acid (5.95%) in BS-2B-84. The lowest erucic acid (50.38%) in this cultivar was produced under ND.

Thus, natural day was helpful in reducing erucic acid content in Varuna, BO-15, BS-2B-84 and LD in Pusa Kalyani. The content of other undesirable unsaturated fatty acid viz., linolenic acid was decreased due to SD in all the cultivars. Short day was also useful in increasing percentage of oleic acid in BO-15 and BS-2B-84. Sairam and Srivastava (1977) have also reported increase in oleic acid under short day length, accompanied with decreased linolenic acid. The decrease in linolenic acid under SD is linked to higher content of erucic acid in Varuna, BO-15 and BS-2B-84 and lower level of linoleic acid in Pusa Kalyani, Varuna and BS-2B-84. This suggests inverse relationship between linolenic acid and erucic acid and a positive correlation between linoleic and linolenic acid. Such a correlation has also been reportedby Stafansson *et al*., (1961). However, Rakow and McGregor, (1975) reported that linolenic acid might be altered without changing linoleic acid.

Table 2. Effect of day length on fatty acid composition (per cent weight basis) in *Brassica* species

	Caprylic	Lauric	Myristic	Palmitic	Stearic	Behinic	Lignoceric	Palmitoleic	Oleic	Linoleic	Linolenic	Eicosenoic	Erucic
Pusa Kalyani													
SD	5.81	3.87	2.42	1.45	1.21	Tr	-	0.63	14.48	7.02	5.42	9.32	48.37
ND	-	-	-	1.14	1.04	Tr	Tr	Tr	16.56	9.18	5.76	9.91	56.30
LD	-	0.09	Tr	2.41	1.26	Tr	3.05	0.30	17.13	12.61	8.56	11.50	43.07
Varuna													
SD	-	-	-	2.84	1.17	Tr	-	Tr	10.78	13.71	7.67	10.00	53.52
ND	-	-	-	3.52	0.97	Tr	-	0.13	11.74	15.51	13.86	9.10	45.13
LD	-	-	-	2.08	0.92	Tr	-	0.12	6.26	11.98	10.18	17.37	49.63
BO-15													
SD	Tr	Tr	Tr	2.72	1.29	Tr	Tr	0.14	16.48	12.07	5.67	12.14	49.46
ND	Tr	Tr	Tr	2.91	1.34	Tr	6.50	0.15	13.88	11.47	6.54	8.41	48.76
LD	-	Tr	Tr	2.92	1.33	Tr	-	0.18	15.97	10.63	5.14	13.19	50.63
BS-2B-84													
SD	-	Tr	Tr	3.10	1.06	Tr	Tr	0.27	12.51	11.28	5.95	12.39	52.74
ND	Tr	Tr	Tr	2.64	1.00	Tr	Tr	Tr	10.11	11.53	10.38	13.54	50.83
LD	-	Tr	Tr	2.81	1.04	Tr	-	Tr	11.27	12.01	9.06	12.25	51.56
S.Em ±	-	-	-	0.149	0.105	-	-	-	1.049	0.665	0.587	0.749	2.063
CD at 5%	-	-	-	0.439	0.308	-	-	-	3.076	1.952	1.721	2.199	6.051

In Pusa Kalyani highest content of erucic acid (56.30%) was due to lowest content of saturated fatty acids as seen under ND but minimum erucic acid under ND was possibly due to increased content of other unsaturated fatty acids.

The results of the present study indicated that natural day (10-12 hr photoperiod) was the best for higher oil content accompanied with reduced erucic acid in Varuna, BO-15 and BS-2B-84. For reducing the level of undesirable fatty acid linolenic, short day (8 hr photoperiod) was the best suited for all the cultivars.

LITERATURE CITED

Agarwal, P.K. 1971. Effect of photoperiod on oil content, fatty acid composition and protein content of rape (*Brassica napus*. L.) and flax (*Linum usitatissimum* L.) seeds. *Ind. J. Exp. Biol.* 9: 252-254.

Babu, L.C.1985. Physiological analysis of growth, development with reference to planting date of rapeseed - mustard. Ph.D. Thesis, IARI, New Delhi, India.

Canvin, D.T. 1965. The effect of temperature on the oil content and fatty acid composition of oils from several oilseed crops. *Can. J. Bot.* 43 : 63-69.

Downey, R.K. 1964. A selection of *Brassica campestris* L. containing no erucic acid in its seed oil. *Can. J. Pl. Sci.* 44:295.

Folch, J., Lees, M. and Sloane-Stanley, C.H. 1957. A simple method for the isolation and purification of total lipids from animal tissue. *J. Biochem.* 226 : 497-506.

Mendham, N.J. and Scott, R.K. 1975. The limiting effect of plant size at inflorescence initiation on subsequent growth and yield of oilseed rape (*B.napus*). *J. Agric. Sci.* 84 : 487-502.

Morrison, W.R. and Smith, L.M. 1964. Preparation of fatty methyl esters and dimethyl acetate from lipids with boron fluoride-methanol. *J. Lipid Res.* 5 : 600-608.

Rakow, G. and McGregor, D.I. 1975. Oil, fatty acid and chlorophyll accumulation in developing seeds of Linolenic acid lines of low erucic acid rapeseed. *Can. J. Pl. Sci.* 55 : 197-203.

Sairam, R.K. and Srivastava, G.C. 1977. Changes in oil and fatty acid composition of linseed (*Linum usitatissimum* L.) under varying photoperiods. *Curr. Sci.* 46 : 115.

Stefansson, B.R., Hougen, F.W. and Downey, R.K. 1961. Note on the isolation of rape plants with seed oil free from erucic acid. *Can. J. Pl. Sci.* 41 : 218-219.

Sosulski, F.W. and Gore, R.F. 1964. The effect of photoperiod and temperature on the characteristics of flax seed oil. *Can. J. Pl. Sci.* 44 : 381-382.

Technicon Monograph I. 1971. Technicon Private Ltd. Tarryfach, New York.

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

Zhao, H.J., Li, P.W., G. M.Li. S.G. 1991. The effect of fertilizer application on biochemical qualities of rape. *Acta Agronomica sinica* 17 (4) : 255-260 .

J.Oilseeds Res. 12(1) 1995 : 38-41
ISSN 0970-2776

RESPONSE OF RAPESEED (*Brassica campestris*) AND MUSTARD (*B. juncea*) VARIETIES TO SOWING DATES

R.C. SAMUI, B. ROY, S.K. TRIPATHY and A.K. PATRA
Department of Agronomy, B.C.K.V.V. Mohanpur, Nadia 741 252, West Bengal,

ABSTRACT

A field experiment with different varieties of rapeseed (*Brassica campestris* Var. *toria* and yellow sarson) and Indian Mustard (*B.juncea*) was conducted during 1988-89 and 1989-90 at the University farm to study the effect of sowing dates. November 4 sowing had given more branches, siliquae/plant, seeds/siliqua and 1000 seed weight. Delay in sowing beyond November 18 significantly reduced yield attributes and seed yield by 38 per cent. Among mustard varieties 'Sarama' and 'Sanjukta' which were at par gave significantly higher seed yield over 'Bhagirathi'. Among Rape seed varieties 'Binoy' recorded significantly superior seed yield over 'Panchali' and was at par with 'YSB NC-1,' 'YSB 19-7C'.

Keywords: Mustard; Rapeseed; Dates of sowing; Variety

INTRODUCTION

Rapeseed (*Brassica campestris* var. *toria* and yellow sarson) and mustard (*B.juncea*) are sown from last week of October to first week of December in different districts of West Bengal. The optimum sowing time for rapeseed is from first week of October to first week of November and for mustard from middle of October to middle of November. Growing mustard under double cropping system after low land paddy delays sowing and affect the yield. The information on performance of different racently developed varieties of rapeseed and mustard under late sown condition is rather limited under West Bengal conditions. Rapeseed and mustard is cultivated after harvest of low land paddy in some areas particularly southern districts of West Bengal, where sowing extends to December. A study was therefore, under taken to evaluate the relative performance of some recently developed varieties of rapeseed and mustard under different sowing dates.

MATERIAL AND METHODS

A field experiment on Indian mustard and rapeseed varieties was conducted at the University farm, Bidhan Chandra Krishi Viswavidyalaya, Kalyani during winter seasons (*rabi*) of 1988-89 and 1989-90. The soil was sandy loam in texture, medium in fertility status (0.7% Organic Carbon, 0.07% total nitrogen and 35 and 160 kg/ha of available phosphorus and potash respectively) and neutral in reaction (pH 7.4). The experiment was laid in Factorial Randomised Block Design with 3 replications. The plot size was 4.5 m x 4.0 m. The treatments comprised 3 dates of sowing (4th November, 18th November, and 6th December) and 7 varieties ('YSBNC-1', 'YSB 19-7C', 'Panchali' and 'Binoy' of rapeseed and 'Sanjukta', 'Sarama' and 'Bhagirathi' of Indian mustard). A basal dose of 40 kg N : 60 kg P_2O_5 and 40 kg K_2O/ha was applied. All the varieties were sown at 30 cm row spacing and maintained a uniform plant population of about 3.3 lakhs/ha by thinning. The crop received three

Received for publication on January 3, 1994.

irrigations including one pre-sowing. A dose of 40 kg N/ha was applied as top dressing at 40 days after sowing (pre-flowering stage). Plant protection measures were undertaken as and when found necessary.

RESULTS AND DISCUSSION

Effect of sowing date

Seed yield and yield attributes of rapeseed and mustard significantly influenced by sowing dates (Table 1). The number of branches, siliquae/plant, seeds/siliqua and 1000 seed weight significantly decreased by delayed sowing. In early sowing the crop gets favourable weather condition for vegetative growth and pods develop before the peak period of aphid attack resulting in better yield components and higher yield. Shastry and Kumar (1981) reported similar results. Harvest index was also decreased gradually with delay in sowing. The seed oil content was higher in early sowing. The oil yield declined significantly in delayed sowings after November 4th. It might be due to the fact that in late sown crop comparitively higher temperature at seed formation hamper oil synthesis. Seed yield in all varieties significantly decreased due to delay in sowing time, and the lowest yield was recorded in December 6 sowing (Table 2).

Effect of variety

Growth, yield attributes and seed yield of different rapeseed and mustard varieties varied significantly (Table 1). 'YSB 19-7C' and 'Binoy' recorded significantly higher plant height than 'Panchali' and 'YSB NC-1' variety. Number of seeds/siliquae was significantly higher in 'YSB NC-1' in 1988-89 as well as 1989-90 over 'Binoy', 'Panchali' and 'YSB 19-7C'. 1000 seed weight was higher in 'YSB 19-7C' followed by 'YSB NC-1', 'Binoy ' and 'Panchali'. Oil yield was significantly higher in 'Binoy' and 'YSB NC-1' than 'Panchali' and 'YSB 19-7C'. In mustard varieties, 'Sanjukta' recorded significantly lower plant height as compared to 'Sarama' and 'Bhagirathi'. However, 'Sanjukta' had highest harvest index among mustard varieties. Number of branches per plant in 1988-89 was significantly higher in 'Sarama' variety than 'Sanjukta' and 'Bhagirathi', 'Sanjukta' and 'Bhagirathi' recorded significantly higher number of siliqua/plant as compared to 'Sarama' in both the years. There was no significant difference in number of seeds/siliqua in 1989-90 among different mustard varieties but in 1988-89 'Sarama' had lower number of siliqua/plant than other two varieties. Variety 'Sanjukta' had significantly lower 1000 seed weight than 'Sarama' and 'Bhagirathi' (Table 1). 'Bhagirathi' recorded significantly lower oil yield than 'Sarama' and 'Sanjukta'. Mustard variety 'Sarama' recorded significantly higher seed yield in 1988- 89 and in pooled data over 'Bhagirathi' (Table 2). The higher seed yield might be due to higher seed weight in 'Sarama'. The result confirms the findings of Singh *et al.* (1986).

Interaction of variety and date of sowing

The interaction effect of sowing dates and varieties (Table 2) revealed that all the varieties sown on 4th November recorded highest seed yield, followed by 18th November sowing in both years, except 'Panchali' during 1988-89. However, the yield of 'YSB NC-1' in 1988-89 when sown on 4th November was at par with 18th November sowing. 'Sarama' recorded consistently higher yield over all rapeseed and mustard varieties in 4th November and 18th November sowing. The reduction in yield in later dates was due to reduction in number of

Table 1. Effect of sowing dates on growth, harvest index, yield attributes and oil yield of rapeseed and mustard varieties.

Treatment	Plant height (cm)		Harvest index (Pooled)	Branches/plant		Siliquae/plant		Seed/siliqua		1000 seed wt (g)		Oil yield (kg/ha) (Pooled)
	1988-89	1989-90		1988-89	1989-90	1988-89	1989-90	1988-89	1989-90	1988-89	1989-90	
Varieties												
Rapeseed												
YSB NC-1	96.1	110.6	30	6.17	6.43	55.3	62.4	25.2	31.3	3.13	2.75	290.9(39.0)
YSB 19-7C	107.1	129.4	24	7.63	7.20	69.5	107.5	18.7	17.9	3.31	2.92	275.2(38.2)
Panchali	102.6	107.8	30	8.19	8.86	90.0	149.6	14.2	14.5	2.93	2.54	241.9(34.2)
Binoy	108.8	122.3	30	7.30	5.24	85.3	61.1	18.9	23.1	3.03	2.76	300.3(39.0)
Mustard												
Sanjukta	99.1	101.4	27	10.1	8.7	111.3	152.2	12.1	12.6	2.57	2.53	276.1(35.2)
Sarama	138.2	145.8	19	13.2	7.2	92.9	132.2	11.2	13.9	3.35	3.30	276.1(34.6)
Bhagirathi	139.5	142.0	17	9.2	8.6	96.9	148.0	13.6	13.6	3.30	3.15	237.1(34.6)
S.Em ±	1.54	3.82		0.20	0.35	5.62	5.32	0.55	0.58	0.07	0.06	5.49
CD 5%	4.41	10.92		0.57	1.01	16.12	15.19	1.57	1.64	0.19	0.16	15.70
Dates of Sowing												
4 Nov.	113.4	131.6	26	11.5	6.7	129.9	119.4	16.6	17.9	3.27	2.95	387.5(36.8)
18 Nov.	128.6	129.8	25	9.9	8.3	98.7	123.7	18.5	17.4	2.94	2.91	309.7(36.3)
6 Dec.	97.7	106.8	18	5.5	7.4	29.1	105.3	13.7	19.2	3.06	2.68	111.3(36.1)
S.Em ±	1.01	2.50		0.13	0.23	3.69	3.48	0.36	0.38	0.05	0.04	3.60
CD 5%	2.89	7.15		0.37	0.66	10.56	9.94	1.03	1.07	0.13	0.10	10.28

Figures in the parentheses indicate the oil per cent.

Table 2. Seed yield (kg/ha)of rapeseed and mustard varieties as influenced by sowng dates.

Variety/ date	Seed yield (kg/ha)							
	Rapeseed				Mustard			
	'YSB NC-1'	'YSB 19-7C'	'Panchali'	'Binoy'	'Sanjukta'	'Sarama'	'Bhagirathi'	Mean
				1988-89				
4 Nov	913.7	892.3	692.0	943.3	814.0	878.0	661.0	827.8
18 Nov	903.3	624.0	716.0	853.0	718.0	766.0	421.0	714.5
6 Dec.	288.0	277.0	293.7	300.0	249.3	244.0	260.7	273.2
Mean	701.7	597.8	567.2	698.8	593.8	629.3	447.7	
CD 5%			121.0					45.73
				1989-90				
4 Nov	1105.0	1288.5	1183.0	1155.0	1366.0	1416.5	1305.5	1259.9
18 Nov	866.0	861.0	927.5	910.5	1077.5	1105.0	1083.0	975.8
6 Dec.	383.0	388.5	349.5	479.0	294.0	299.5	349.5	363.0
Mean	784.7	846.0	820.0	847.5	912.5	940.3	912.7	
CD 5%			124.91					47.21
				Pooled				
4 Nov	1009.3	1090.4	937.5	1049.2	1090.0	1147.3	983.3	1043.9
18 Nov	884.7	742.5	821.8	881.8	897.8	935.5	752.2	845.2
6 Dec.	335.5	332.8	321.6	388.5	276.3	272.6	305.1	318.9
Mean	743.2	721.9	693.6	773.1	754.7	785.1	680.2	
CD 5%			75.18					28.41

siliquae/plant. It may be concluded from the study that rapeseed varieties 'YSB NC-1', 'Binoy' and 'Panchali' and mustard varieties 'Sarama', 'Sanjukta' and 'Bhagirathi' may be sown by middle of November without much reduction in yield. However, highest yield could be obtained through sowing of the crop by first week of November.

LITERATURE CITED

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

Singh, R.K., Giri,G., Ganga Saran and Turkheda, B.B. 1986. Effect of spacial arrangement in mustard under rainfed conditions. *Indian J. Agron.* 31(4) : 367-369.

J.Oilseeds Res. 12(1) 1995 : 42-46
ISSN 0970-2776

EFFECT OF FERTILITY AND PLANT DENSITY OF SESAME ON THE PRODUCTIVITY OF PIGEONPEA-SESAME INTERCROPPING SYSTEM

T.K. SINGH, J.S. BOHRA and KALYAN SINGH
Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi 221 005, U.P.

ABSTRACT

In order to study the effect of fertility and plant density of sesame as intercrop in pigeonpea under rainfed conditions, a field experiment was conducted. Increasing levels of fertility up to 100% of the recommended fertilizer dose to each of the component crops markedly improved the yield attributing character and the yield of component crops. Intercropping reduced the yield of component crops as compared to the respective sole crops. However, the LER values significantly improved in intercropping. Intercropping of 100% pigeonpea with 50% sesame in 1:1 row ratio was recorded the maximum yield advantage of 83%.

Keywords: Pigeonpea; Sesame; Intercropping; Productivity.

INTRODUCTION

Pigeonpea (*Cajanus cajan*) is a long duration crop but its initial growth is very slow. Therefore, it is considered good for intercropping with early maturing non-leguminous and leguminous crops (Rao and Willey, 1983; Patra and Chatterjee, 1986). Sesame (*Sesamum indicum* L.) which is early in maturity and having errect type of growth, has also been found good for intercropping with pigeonpea in additive series (Kharwar and Singh, 1986; Singh *et al.*, 1990). However, the information on fertilizer use and plant density of sesame in pigeonpea-sesame intercropping system is lacking, particularly for the rainfed conditions of Varanasi. Therefore, the present investigation was planned to find out the optimum fertilizer level and sesame population in pigeonpea-sesame intercropping system.

MATERIAL AND METHODS

Field investigations were carried out at the Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi during rainy and post-rainy seasons of 1984-85, 1985-86 and 1986-87. However, in 1985-86 season, crops failed due to heavy rain and it was treated as failure crop season for experimentation. The experimental site was sandy loam in texture having 7.7 pH and 0.405% organic carbon. It was low in available nitrogen (176 kg N ha^{-1}) and medium in available phosphorus (14.6 kg P ha^{-1}) and potassium (159 kg K ha^{-1}).

The experiment was laid out in split plot design with three replications. The treatments involved four fertility levels (F_1 : 100% recommended dose (20:40:20 NPK) to pigeonpea + no fertilizer to sesame, F_2 : 100% NPK to

Received for publication on February 3, 1994

pigeonpea + 50% recommended dose (20:10:10 NPK) to sesame, F_3 : 100% NPK to both pigeonpea and sesame; and F_4 : 100% NPK to pigeonpea + 150% NPK to sesame) in main plots and plant density (T_1 : pigeonpea sole at 60 x 20 cm spacing, T_2 : sesame sole at 45 x 10 cm, T_3 : 100% pigeonpea + 50% sesame, T_4 : 100% pigeonpea + 100% sesame and T_5 : 100% pigeonpea + 150% sesame) in sub-plots. In pigeonpea-sesame intercropping 1:1 row ratio was adopted. The distance between the rows was kept 30 cm in both pure crops as well as in intercropping whereas the plant to plant distance was maintained according to population. 'Bahar' and 'T-13' varieties were used for pigeonpea and sesame, respectively. Sowings were done in June-July. Sesame was harvested during September-October and pigeonpea was harvested during March-April. The total rainfall during crop period was 1118.0 mm in 1984-85 and 847.1 mm in 1986-87.

RESULTS AND DISCUSSION

Yield and yield attributes of component crops

Increasing levels of fertility markedly improved the number of fruits (pods/capsules) plant^{-1}, test weight and grain/seed weight plant^{-1} of both the crops and seed number capsule^{-1} of sesame up to F_3 where 100 per cent recommended fertilizer dose was applied to each crop (Table 1 and 2). Similar effect of fertilizer application was observed on grain/seed yield of component crops (Table 3). Further increase in fertility level, however, decreased the values of all yield traits and yields of respective component crops during both the years as well as in pooled analysis. This can be attributed to the better establishment of sesame in plots fertilized with highest level of fertilizers (150 per cent of the recommended dose) resulting in its lush vegetative growth which affected grain and stalk yield of pigeonpea (Singh *et al.*, 1976)

Table 1. Effect of fertility and sesame population on the yield attributing characteristics of pigeonpea in pigeonpea-sesame intercropping

Treatment	Pods plant^{-1}		1000-grain weight (g)		Grain weight	
	1984-85	1986-87	1984-85	1986-87	1984-85	1986-87
Fertility level						
F_1	237.1	194.0	100.4	102.1	45.4	43.1
F_2	176.9	210.2	108.2	104.8	56.8	52.9
F_3	296.8	253.4	110.6	106.9	67.1	65.2
F_4	283.1	221.1	108.8	106.1	64.4	63.4
S.Em ±	0.8	3.3	0.2	0.9	1.0	0.9
C.D. 5%	2.7	10.6	0.8	2.8	3.5	2.8
Plant density						
T_1	303.7	245.6	110.6	107.7	62.4	59.5
T_2	-	-	-	-	-	-
T_3	285.8	232.4	108.6	106.7	59.5	56.7
T_4	261.2	210.9	106.6	103.9	56.7	55.3
T_5	243.2	189.8	102.2	101.6	55.1	53.1
S.Em ±	1.9	2.1	0.9	0.7	0.8	1.1
C.D. 5%	5.6	6.2	2.8	2.1	2.4	3.1

and the seed yield of sesame was also affected because of the lower harvest index (data not reported). These findings are in conformity with the results of Subramaniam *et al.* (1978).

Intercropping adversely affected the yield attributing characters of component crops as compared to respective sole crops (Table 1 and 2). Similarly, the grain/seed yield of both the crops in different intercropping treatments were significantly reduced as compared to respective sole crops during both the years as well as in pooled analysis (Table 3). The magnitude of difference was low at low plant density but became wider at higher plant density treatments. These effects were virtually attributed to higher competetion for desired plant resources (Reddy and Havanagi, 1986). The higher values of economic yield and yield attributes of pigeonpea at modest plant density of sesame in the system might be due to better competitive ability of pigeonpea (Reddy and Havanagi, 1986) and its recovery after the harvest of sesame.

Land Equivalent Ratio (LER)

Data presented in Table 3 show that the LER values improved with increasing fertility levels up to F_3 (100% of the recommended fertilizer dose to each of the component crops) in both the years. However, the differences were not significant. Thus, application of fertilizer at 100% of the recommended dose to each of the component crops appears optimum for pigeonpea-sesame intercropping. All the intercropping treatments recorded significantly higher LER values than sole crops in both the years (Table 3). However, LER values decreased significantly with increasing plant

Table 2. Effect of fertility and sesame population on the yield contributing characteristics of sesame in pigeonpea-sesame intercropping.

Treatment	Capsules plant^{-1}		Seeds capsule^{-1}		1000 seed weight (g)		Seed weight Plant^{-1}	
	1984-85	1986-87	1984-85	1986-87	1984-85	1986-87	1984-85	1986-87
Fertility level								
F_1	33.3	29.2	48.3	44.2	2.4	2.4	2.7	2.6
F_2	37.6	34.4	53.3	47.2	2.7	2.7	3.6	3.0
F_3	42.1	39.2	57.5	54.2	2.9	2.8	3.6	3.4
F_4	34.6	34.5	55.1	47.9	2.9	2.7	3.0	2.9
S.Em ±	0.8	0.6	1.0	1.1	0.06	0.08	0.03	0.05
C.D. 5%	2.6	1.8	3.0	3.5	0.19	0.25	0.10	0.16
Plant density								
T_1	-	-	-	-	-	-	-	-
T_2	42.2	39.5	55.9	53.9	3.0	2.8	3.7	3.7
T_3	38.6	35.4	53.6	49.9	2.7	2.7	3.7	3.6
T_4	35.3	33.6	53.6	46.2	2.7	2.6	3.0	2.8
T_5	32.0	28.8	52.1	43.5	2.5	2.5	2.0	1.8
S.Em ±	0.6	0.5	1.0	1.2	0.03	0.08	0.03	0.06
C.D. 5%	1.8	1.6	3.0	3.4	0.10	0.23	0.10	0.17

Table 3. Effect of fertility and sesame population on the yield of component crops and LER in *pigeonpea* - sesame intercropping

Treatment	Yield of component crops (q ha^{-1})						LER		
	Pigeonpea			Sesame			1984-85	1986-87	Mean
	1984-85	1986-87	Pooled	1984-85	1986-87	Pooled			
Fertility level									
F_1	12.6	10.2	11.4	2.4	1.9	2.2	1.75	1.69	1.72
F_2	15.6	11.9	13.8	3.4	2.9	3.2	1.77	1.70	1.74
F_3	17.9	15.9	16.9	4.3	3.8	4.1	1.81	1.77	1.79
F_4	16.5	14.6	15.6	3.3	2.9	3.1	1.79	1.75	1.77
S.Em ±	0.9	0.5	0.6	0.2	0.1	0.2	0.03	0.03	-
C.D. 5%	2.8	1.6	1.7	0.7	0.4	0.6	NS	NS	-
Plant density									
T_1	17.3	14.9	16.1	-	-	-	1.00	1.00	1.00
T_2	-	-	-	3.8	3.4	3.6	1.00	1.00	1.00
T_3	16.2	13.5	14.9	3.4	3.1	3.2	1.83	1.82	1.83
T_4	15.1	12.6	13.9	3.3	2.7	3.0	1.74	1.63	1.69
T_5	14.0	11.6	12.8	2.9	2.3	2.6	1.57	1.46	1.52
S.Em ±	0.4	0.4	0.3	0.1	0.1	0.1	0.02	0.04	-
C.D. 5%	1.3	1.3	1.0	0.3	0.3	0.4	0.06	0.12	-

NS = Not significant

densities of sesame in the system. Intercropping of 100% pigeonpea with 50% sesame recorded the maximum yield advantage of 83 per cent. The results are in conformity with the findings of Singh *et al.* (1990) and Goyal *et al.* (1991).

Based on this study, it may be concluded that in pigeonpea-sesame intercropping under additive series, sesame be intercropped at 50% of its recommended plant density along with the application of 100 per cent recommended dose of fertilizer to component crops.

LITERATURE CITED

Goyal, S.N., Patel, N.L., Patel, N.M. and Ahlawat, I.P.S. 1991. Intercropping studies in pigeonpea under rainfed conditions. *Indian J. Agron,* 36 : 49-51.

Kharwar, P.C. and Singh, L.N. 1986. Studies on intercropping with pigeonpea. *International Pigeonpea Newsletter* 5 : 27-29.

Patra, A.P. and Chatterjee, B.N. 1986. Intercropping of soybean with rice, maize and pigeonpea in the plains of West Bengal. *Indian J. Agric. Sci.,* 56 : 413-417.

Rao, M.R. and Willey, R.W. 1983. Effect of genotype in cereal/pigeonpea intercropping on the Alfisols of the semi-arid tropics of India. *Expl. Agric.*, 19 : 67-78.

Reddy, G.S. and Havanagi, G.V. 1986. Planting pattern, population density and fertilizer effects in pigeonpea + finger millet intercropping system. I. Yield and yield advantage. *Indian J. Agric. Res. Dev.*, 1 : 33-47.

Singh, K., Prasad, R. and Chaudhuri, S.L. 1976. Effect of N, P and *Rhizobium* inoculation on growth and yield of pigeonpea under rainfed conditions. *Indian J. Agron.*, 2 : 59-63.

Singh, R.A., Singh, V.P., Chandola, V.K. and Sant Prasad. 1990. Production potential of pigeonpea/sesame intercropping system in rainfed Diara (flood prone) areas of eastern U.P. *Sesame and Safflower Newsletter*, 5 : 19-22.

Subramaniam, A., Palaniappan, S.P., Thirunavukkarasu, D.R. and Venkatachelam, C. 1978. A note on the fertilizer and spacing requirement of redgram (Co-2). *Madras Agric. J.*, 65 : 52-53.

J. Oilseeds Res. 12(1) 1995 : 47-50
ISSN 0970-2776

YIELD - INFESTATION RELATIONSHIP AND ECONOMIC INJURY LEVEL OF MUSTARD APHID

C.P. SINGH and G.C. SACHAN

Department of Entomology, College of Agriculture, G.B.Pant University of Agriculture and Technology, Pantnagar-263 145, Dist. Nainital, U.P

ABSTRACT

Field experiments were conducted to establish yield-infestation relationship and to determine the economic injury level (EIL) of aphid in Mustard. Every increase of one aphid per plant resulted in reduction of 0.064 g and 0.063 g seed weight per plant, 0.036% and 0.039% oil content, 0.006 and 0.006 g per 1000 grain weight during the first and second year of experimentation respectively. The corresponding reduction in grain yields were 2.9 kg and 3.39 kg per hectare beyond 15 and 19 aphids per plant per 10 cm terminal shoot length. Every increase by one day in exposure to the aphid beyond 55 days after sowing of crop resulted in a decrease of 0.302 g and 0.338 g seed weight per plant, 0.207% and 0.217% in oil content and 0.035 g and 0.385 g for 1000 grain weight and yield decreased by 17.5 kg and 17.2 kg per hectare during first and second year respectively. The EIL at 0, 7, 14, 21, 28, 35 and 42 days of exposure were computed and found as 41, 40, 37, 31, 27, 11 and 6 aphids per plant per 10 cm terminal shoot length respectively during first year. During second year, the EIL, at the same exposure periods and same age of crop were found as 41, 38, 33, 28, 25, 17, 12 and 9 aphids.

Keywords: Economic Injury Level; *Lipaphis erysimi;* Mustard.

INTRODUCTION

The demand of pest management of today is to control the pest with economic and ecological justification of pesticidal use. Earlier the importance of pest density were emphasized for the pest control (Stern 1976). Later, Stone and Pedigo (1972) stressed the significance of Economic Injury Level (EIL) in an integrated pest control programme for a judicious and efficient use of an insecticide. Estimation of EIL of crop pests is considered as an essential pre-requisite which forms the basis for evolving integrated pest management. This had added significance in case of mustard aphid also, a serious pest of rapeseed and mustard, where many sprays are usually required for its control. So to minimize the frequencies of sprays, it is necessary to establish yield-infestation relationship and EIL of the aphid. Such information for *Lipaphis erysimi* (Kalt.) on mustard is not reported so far, for *Tarai*, an important mustard growing region of Uttar Pradesh.

The present study was carried out to establish yield-infestation relationship and determine EIL for natural population of *L. erysimi* on mustard at varying exposure periods for developing a need based effective strategy to control mustard aphid by insecticides.

MATERIAL AND METHODS

Studies were conducted at Crop Research Centre, of G.B. Pant University of Agriculture and Technology, Pantnagar during *Rabi* season of 1989-90 and 1990-91. The mustard variety,

Received for publication on February 21, 1994

'Varuna' was sown in Randomized Block Design with three replications. The plot size was 4 m x 3.6 m with 45 cm row to row and 15 cm plant to plant spacing. The crop was raised under normal recommended agronomical practices. As soon as there was incidence of aphid, the crop was exposed to the natural aphid population for different exposure periods. Various treatments with respect to aphid exposure are given in Table 3. Methyl-O-demeton (0.025%) was sprayed for control of the aphid at desired exposure period.

The aphid population was recorded at weekly interval before and after sprays in each treatment on ten randomly selected plants on 10 cm terminal shoot per plant. The data on grain yield and its components were recorded at harvest. The relationships between aphid population and seed weight per plant, 1000 grain weight, oil content and seed yield per hectare were worked out. The EIL were worked out following the method of Stone and Pedigo (1972).

RESULTS AND DISCUSSION

An inverse and significant relationship was found between the natural aphid population at respective exposure period and grain yield and its components. Every increase of one aphid per 10 cm terminal shoot per plant beyond 15 aphid per plant at 55 days after sowing (late vegetative or/and flower initiation stage) resulted in reduction of 0.664 g seed weight/plant, 0.0062 g per 1000 grain wt. 0.036% oil content and 2.9 kg/ha grain yield during 1989-90. During 1990-91 the corresponding reductions were 0.0627 g, 0.006 g, 0.038% and 3.36 kg/ha beyond 19 aphids per plant at 59 days after sowing, (flower initiation stage Table 1). The reduction in yield varied with the density of aphid population, age of the crop, and the time of the aphid incidence with congeneal environmental conditions (Balraj Singh *et al*., 1983 and Suri *et al*., 1988).

A Significant and inverse relationship between exposure period and grain yield and its components was recorded during both the years of investigation. Every increase by one day, beyond 55 days after sowing (late vegetative and/or flower initiation stage), in exposure of the crop to natural aphid population resulted in a decrease of 0.302 g seed weight per plant, 0.035 g 1000 grain weight, 0.207% oil content and 17.5 kg/ha during 1989-90. During 1990-91 the corresponding values were 0.338 g,

Table 1. Relationship between the aphid population and yield components

Parameters	1989-90			1990-91		
	Coefficient of correlation (r)	Coefficient of determination (R^2)	Regression equation	Coefficient of correlation (r)	Coefficient of determination (R^2)	Regression equation
Seed weight $plant^{-1}$ (g)	-0.878	0.772	Y = 20.076-0.064X*	-0.799	0.639	Y = 21.816-0.0627X*
1000 grain weight (g)	-0.745	0.555	Y = 4.547-0.0062X*	-0.697	0.486	Y = 4.676-0.006X*
Oil content (%)	-0.709	0.504	Y = 42.384-0.036X*	-0.767	0.589	Y = 43.275-0.0387X*
Seed yield (g/ha)	-0.726	0.527	Y = 17.049-0.029X*	-0.789	0.622	Y = 17.33-0.0336X*

* Significant at 0.05% probability.

0.039 g, 0.217% and 17.2 kg/ha beyond 59 days after sown (flower initiation stage Table 2). Similar results were reported by Rajwant Singh *et al.* (1984) who observed that every increase by one day in exposure of crop to the aphid infestation resulted in a decrease of 0.0479 seed yield per plant, 0.001 g 1000 grain weight and 0.079 per cent oil content.

Economic injury level (EIL) for *L. erysimi* on *B. juncea* varied from 6 to 41 and from 9 to 41 aphids per 10 cm terminal shoot per plant during 1989-90 and 1990-91 respectively. However, EIL differed with the number of sprays, age of crop and duration of exposure to crop. The EIL at 0, 7, 14, 21, 28, 35, 42 and 49 days of exposure to crop were 41, 40, 37, 31, 27, 17, 11 and 5 aphids per plant during 1989-90. At corresponding days of exposure of crop the EILs were 41, 38, 33, 29, 25, 17, 12 and 9 aphids per plant during 1990-91 (Table 3).

Relatively low values of EIL indicate that the seed loss caused due to aphid is sufficiently high to assume economic significance.

The EIL of *L. erysimi* varied with a number of factors such as prices of crop produce and insecticides, crop age and duration of exposure to the crop. The EIL was affected by the change in price of insecticide. Variation is reported in EIL values for *L. erysimi* due to fluctuations in prices of crop produces (Balraj Singh *et al.*, 1983; Mishra and Singh 1986 and Singh and Mishra 1986).

Increase in EIL values was also observed with an increase in the total cost of protection, including operating cost also. Rajwant Singh *et al.* (1984) also reported similar variation in EIL values due to increase in the cost of control operation as well as tolerance level of plant against the aphid attack. It is thus, revealed that infestation at vegetative stage or initiation of flower (at 57 days after sowing) and its continuation until the pod formation stage would cause maximum loss in yield.

LITERATURE CITED

Balraj Singh., Rajwant Singh., Mahal, M.S. and Brar, H.S. 1983. Assessment of loss in yield of *Brassica Juncea*

Table 2. Relationship between duration of exposure and yield components.

Parameters	1989-90			1990-91		
	Coefficient of correlation (r)	Coefficient of determination (R^2)	Regression equation	Coefficient of correlation (r)	Coefficient of determination (R^2)	Regaression equation
Seed Weight plant^{-1} (g)	-0.966	0.935	Y = 19.30-0.302*	-0.967	0.936	Y = 22.05-0.338X*
1000 grain weight (g)	-0.964	0.931	Y = 4.855-0.035X*	-0.984	0.968	Y = 4.678-0.0385X*
Oil content (%)	-0.975	0.951	Y = 43.822-0.207X*	-0.948	0.900	Y = 43.42-0.217X*
Seed yield (g/ha)	-0.974	0.948	Y = 17.662-0.175X*	-0.961	0.928	Y = 17.629-0.1720X*

* Significant at 0.05% probability.

Table 3. Economic injury levels of *L. erysimi* at different exposure periods to mustard

Exposure periods	1989-90			1090-91		
	Total cost of protection	Gain threshold	EIL	Total cost of protection	Gain threshold	EIL
(week)	(Rs.)	(q/ha)		(Rs.)	(g/ha)	
Zero (CP)	889.00	1.19	41.15	1109.5	1.40	41.05
One	858.50	1.15	39.74	1055.0	1.30	38.29
Two	788.65	1.05	36.50	905.0	1.14	33.48
Three	669.50	0.90	31.03	780.5	0.98	28.87
Four	582.00	0.78	26.94	668.0	0.84	24.71
Five	459.85	0.49	16.92	447.50	0.56	16.53
Six	239.56	0.32	11.03	314.5	0.39	11.63
Seven	118.85	0.16	5.52	243.5	0.31	9.00
Control (Complete exposure)	-	-	-	-	-	-

EIL = Aphid population per 10 cm terminal shoot length per plant (Economic injury level).

CP = Complete protection.

by *Lipaphis erysimi* (Kaltenback). I. Influence of varying levels of aphid population. *Indian Journal of Ecology*, 8. 116-118.

Mishra, D.S. and Singh, W. 1986. Estimation of mustard yield and aphid, *Lipaphis erysimi* (Kalt.) infestation relationship and optimum protection. Proc. 2nd Nat. Semi. on Recent Trends in Aphids studies S.P.Kusul, M.M. (Ed). Postgraduate College, Modinagar, pp. 319-326.

Rajwant Singh., Balraj Singh and Mahal, M.S. 1984. Assessment of loss on yield of *Brassica juncea* by *Lipaphis erysimi* (Kalt.) III. Timing and duration of infestation, *Indian Journal of Ecology*, 11 (1) 139-145.

Singh, W. and Mishra, D.S. 1986. Economic injury level of mustard aphid, *Lipaphis erysimi* (Kalt.) on mustard. ed. Aphidology in India. *In:* Agrawal, B.K. Printers, A.R. Calcutta pp. 105-112.

Stern, V.M. 1966. Significance of the economic threshold in integrated pest control. Proceedings FAO Symposium Integrated pest Control. October 11-15, 1965 Rome, Italy, 2, 41-56.

Stone, J.D. and Pedigo, L.P. 1972. Development and economic injury level of the green Cloverworm on soybean in Iowa. *Journal of Economic Entomology*, 65, 1, 197-201.

Suri, S.M.., Durshan Singh and Brar, K.S. 1988. Estimation of losses in yield of Brown sarson due to aphids in Kangra Valley. I. Effect of crop growth stage and aphid feeding exposure. *Journal of Insect Science*, 1, 2, 162-167.

J. Oilseeds Res. 12(1) 1995 :51-54
ISSN 0970-2776

REACTION OF BRASSICA SPECIES AND THEIR HYBRIDS TO MUSTARD APHID, *Lipaphis erysimi* (Kalt) INFESTATION

B. RAI and H. KUMAR
Department of Genetics and Plant Breeding, Institute of Agricultural Sciences
Banaras Hindu University, Varanasi 221 005 (UP)

ABSTRACT

Reactions of six *Brassica* species, *Eruca sativa* and the two interspecific hybrids of *Brassica* species to mustard aphid have been recorded. *Eruca sativa, Brassica nigra* and *Brassica carinata* showed comparatively better tolerance to this insect- pests as compared to the two largely cultivated species *B. juncea* and *B. campestris* in India. The interspecific hybrid '*B. juncea* x *B. nigra*' in which P_1 was susceptible and the P_2 was resistant, the F_1 reaction was observed to be moderately resistant. In the other hybrid '*B. carinata* x *B. juncea*', the F_1 reaction was observed to be susceptible, while the parental population involved had either susceptible or very high susceptible reaction to this insect-pest of the cruciferous crop plants.

Keywords: Brassicas; Interspecific hybrid; Aphids; Pest-resistance.

INTRODUCTION

In oilseed crop *Brassicas*, incorporation of genetic resistance to the mustard aphid is now being considered essential for controlling this key insect-pest in commercial production programme. Crop losses due to this pest alone have been estimated to vary from 35.4 to 73.3% with a mean loss of 54.2% on all India basis (Bakhetia, 1983; Bakhetia and Sekhon, 1989 and Rai *et al.*, 1987). Some observations on the reaction of different oilseed *Brassica* species to this pest have been reported (Bakhetia, 1980; Bakhetia and Banga, 1991; Bakhetia and Sandhu, 1973, 1978). In the present study, an effort has been made to evaluate the comparative reactions of some important oilseed *Brassicas* now being cultivated on large scale, *Eruca sativa* and some of the interspecific hybrids to the mustard aphid.

MATERIAL AND METHODS

The experimental material for the present study comprised a total of 78 elite selections belonging to some of the oilseed *Brassica* species, *Eruca sativa* and the two interspecific hybrids obtained from crossing *B. carinata*, *B. juncea* and *B. nigra*. The F_1s were made during *Rabi* 1992-93 and the experimental materials alongwith the parental species were grown during *Rabi* 1993-94 at the Crop Research Centre, BHU, Varanasi. Three rows of 5 meters length of each entry were planted at 45 cm apart with plant to plant distance of 10 cm. The crop was planted rather late and was adequately irrigated which favoured very heavy infestations of mustard aphids during January-February. All around the field, the highly susceptible lines of *B. campestris* var. yellow *sarson* were also planted, which ensured adequate

Received for publication on March 28, 1994

infestor populations for the spread of the aphids. Observations were recorded at peak aphid infestation during February on all competitive plants at adult plant stage on 0 to 5 scale (Bakhetia and Sandhu, 1973), where 0 was the stage absolutely free from aphid and 5 represented the very highly infested plants. These ratings were based on the quantification of no aphid 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. On this basis, 5 twigs in each plant were visually scored and averaged first on the per plant basis, which was again averaged out for each entry. For better understanding, the rating score of 1 to 2 was considered as Resistant (R), 2.1 to 2.5 as Moderately Resistant (MR), 2.6 to 3.5 as Susceptible (S) and 3.6 to 5 as Highly Susceptible (HS). The aphid infestation ratings served as good measure of aphid resistance, higher the rating, lower the resistance.

RESULTS AND DISCUSSION

The average scores of mustard aphid infestation on different selections studied alongwith their seed yield ratings have been briefly given in Table 1 and the reactions of two interspecific crosses with their parental populations in Table 2. Among the species studied, *Eruca sativa* had the lowest (1.90) rating. It was followed in ascending order by *B. nigra*, *B. carinata*, *B. juncea*, *B. oleracea* var. *botrytis*, *B. napus* and *B.campestris*. At peak infestation, no plant or entry in any of the species studied was absolutely free from the mustard aphid. Cultivated species, *B. juncea*, which had, otherwise, comparatively better seed yield rating, was either in the susceptible or highly susceptible range for its reaction to this insect-pest. Among the 48 elite selections of *B. juncea* studied, the score varied from 2.5 (PR 8805) to 4.5 (DIRA 3137) with an average value of 3.29. Likewise, in 10 selections of *B. campestris* studied, the range observed was from 3.0 (SSK-10) to 4.5 (SSK-1) with an average of 4.0. These selections are being tried in the initial and advanced level yield testing in All India Coordinated Varietal Trials of these species groups. Only the local selections (LS) of *B. nigra*, *B. oleracea* and *Eruca sativa* were taken for study for the sake of comparison. The average rating for the commercially cultivated species *B. juncea* was, however, comparatively better than that of *B. campestris*. Comparatively better level of field tolerance/ resistance has also been reported for *B. juncea* as compared to that of *B.campestris* (Rai and Sehgal, 1975). Non-preference as the component of field tolerance to aphid has been suggested to be operative in case of early maturing mustard varieties (Teotia and Lal, 1970) and tolerance for providing field resistance to aphid has been suggested in case of *B. carinata* and *B. tournefortii* (Bakhetia and Sandhu, 1973). In gobhi sarson (*B. napus*) antibiosis has been observed to play a major role (Singh *et al.*, 1965 and Jarvis, 1970). Rai and Sehgal (1975) observed that *B. juncea* had better tolerance than that of *B. campestris* primarily because it possessed long, slender, hardy and hairy inflorescence with loosely packed buds on the inflorescence axis than that of *B. campestris*. Anand (1976) reported that better tolerance of the exotic *B. juncea* varieties was due to their comparatively higher concentration of the glucosinolates (sinigrin) than that of the susceptible indigenous varieties.

In general, the two monogenomic species, *B. campestris* and *B. oleracea* var. *botrytis* supported comparatively larger populations of aphids than that of the digenomic species, *B. carinata* and *B. juncea*.

Table 1. Characterization of the six oilseed *Brassica* species and *Eruca sativa* with respect to their reaction to mustard aphid and their seed yield.

Species	Number of entries studied	Average aphid infestation score (on 0-5 scale)			Seed yield per plant (g)	Seed yield rating ***
		Score	Comparative performance*	Level of Resistance**		
B. campestris	10	4.00	-	HS	9.10	+
B. nigra (LS)	1	2.22	+	MR	4.50	-
B. oleracea var. *botrytis* (LS)	1	3.50	-	S	5.70	-
B. juncea	48	3.29	-	S	14.30	+
B. napus	13	3.80	-	HS	7.50	-
B. Carinata	4	2.30	+	MR	8.40	+
Eruca sativa (LS)	1	1.90	+	R	4.90	-
Average		3.03			7.60	

* - Above the average value, + below the average value

** Up to 2 = Resistant (R), 2.1 to 2.5 = Moderately Resistant (MR), 2.6 to 3.5 = Susceptible (S) and 3.6 to 5.0 = Highly Susceptible (HS).

*** - indicates value below average, + above average and + + indicates mean value very close to the double of the average value of the species studied.

Table 2. Reaction of two interspecific crosses to infestation of mustard aphid.

Interspecific cross	Rating for the aphid infestation on the inflorescence (on 0-5 scale)			Level of Resistance observed*		
	Parental	populations	Hybrid			
	P_1	P_2	F_1	P_1	P2	F1
B. carinata x *B. juncea* (PC RS S4) (SDS)	2.80	3.80	3.16	S	HS	S
B. juncea x *B. nigra* (Varuna) (LS)	3.50	2.00	2.50	S	R	MR

* R = Resistant; MR = Moderately Resistant; S = Susceptible; HS = Highly Susceptible

Better tolerance of these two digenomic species to the aphid may be a contribution of the BB genome of *B. nigra*, which possess some field tolerance to aphid because of its considerably high glucosinolate content and form one of the constitutent genome in the digenomic constitution of these two species. It could as well be the favourable intergenomic interaction. The digenomic species in oilseed crop Brassicas exhibit strong intergenomic interactions for their mating system as the monogenomic species (*B. campestris* with AA and *B. oleracea* with CC and *B. nigra* with BB genomes) are all highly cross pollinated, while their cross product, *B. juncea* (AA BB), *B.*

napus (AA CC) and *B. carinata* (BB CC) are all predominantly self-pollinated.

As could be seen in Table 1, *Eruca sativa*, *B. nigra* and *B. carinata* were observed to have average scores of 1.90, 2.22 and 2.30, but straight hybridization of *Eruca sativa* with other species did not succeed. The crosses, where there was some success as also there was some difference in the rating for the mustard aphid, were pursued for observing the reaction of the hybrid population. In one of the two crosses studied (*B.juncea* x *B.nigra*), the P_2 (*B.nigra*)parent had the resistant rating of 2.22 and P_1 had rating of 3.29 (Table 1), the F_1 reaction rating was 2.50. In the cross (*B. carinata* x *B. juncea*), both the parents were in the susceptible to highly susceptible rating, though, there was some difference in their relative rating value, the F_1 reaction was towards *B. carinata*. Parents with very clear-cut high degree of resistant reaction were not observed. But in the case of the '*B. juncea* x *B. nigra*' cross, it would be worthwhile to further study and analyse the genetics of aphid resistance and utilize the information obtained in developing *B. juncea* cultivars with acceptable levels of seed yield and aphid tolerance. This study, however, does indicate that some measure of genetic field resistance to this insect-pest could be available from the interspecific crosses, which could meaningfully be studied and utilized.

LITERATURE CITED

Anand, I.J. 1976. Oil quality *vis a vis* aphid resistance in Brassica. Proc. Seminar-cum-Workshop on Oilseed Research in India, held at PKV, Nagpur (AICORPO, Hyderabad), India, April 5- 9, 1976.

Bakhetia, D.R.C. 1980 Screening of breeding materials for insect-pest resistance in Oilseed crops. *In* K.S. Gill Breeding Oilseed Crops ed. P.A.U., Ludhiana pp 155-174.

Bakhetia, D.R.C. 1983.Losses in rapeseed/mustard due to *Lipaphis erysimi* Kalt. in India. Proc. 6th *International Rapeseed Conference*, Paris, May 16-22, pp. 1142-1147.

Bakhetia, D.R.C. and Banga S.S. 1991. Aphid resistance in crop plants. Golden Jubilee Symposium on Genetic Research and Education, New Delhi, (Abstr) Vol II : 104-105.

Bakhetia, D.R.C. and Sandhu, R.S. 1973. Differential response of Brassica species/varieties to aphid (*Lipaphis erysimi* Kalt) infestation. *J. Res., Punjab Agric. University.* 10 (3) : 272-279.

Bakhetia, D.R.C. and Sekhon, B.S. 1989. Insect-pests and their management in rapeseed-mustard. *J. Oilseeds Res.* 6 (2) : 269-299.

Brar, K.S. and sandhu, G.S. 1978. Comparative resistance to different Brassica species/varieties to mustard aphid under natural and artificial infestation conditions. *Indian J. agric. Res.* 12(3) : 198-200.

Jarvis, J.L. 1970. Relative injury to some cruciferous oilseed by turnip aphid. *J. Econ. Entom.* 63: 498-502.

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

Rai, Lallan, Rai, B., Sanghmitra, M. and Rao, B.P. 1987. Control of aphid in mustard and safflower crops. *Indian Farming.* 37:16-19.

Singh, S.R., Narain, A., Srivastava, K.P. and Siddiqui, Q.A. 1965. Fecundity of mustard aphid on different rape and mustard varieties. *Indian Oilseeds J.* 9: 215-219.

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

J. Oilseeds Res. 12(1) 1995 :55-59
ISSN 0970-2776

INFLUENCE OF PLANT POPULATION AND PLANTING GEOMETRY ON YIELD, YIELD ATTRIBUTES AND QUALITY OF INDIAN RAPE (*Brassica campestris* var. *toria*)

ARVIND KUMAR, V.K. GUPTA and R.P. SINGH
G.B. Pant University of Agriculture and Technology, Pantnagar, Dist. Nainital 263 145. (UP)

ABSTRACT

An experiment was conducted to study the influence of plant population and planting geometry on yield, yield attributes and quality of Indian rape var. *toria*. Though, wider planting geometry, increased pod bearing capacity and productivity of individual plants, higher plant population compensated this effect and higher total seed and oil yield/ha was recorded at 2.2 lakh plants/ha (30 cm X 15 cm). Oil content increased and protein content decreased with increase in plant density.

Keywords : Indian rape; Plant density; Planting geometry.

INTRODUCTION

Indian rape (*Brassica campestris* var. *toria*) is extensively grown in the Himalayan region. It constitutes an important part of the economy of the farmers. Often, inadequate plant population and proper plant geometry lead to poor productivity of *toria* (Gangwar and Kumar, 1986). Seed yield is the product of individual plant productivity and plant population per unit area. In Indian rape, plant population influenced the seed yield to a greater extent (Tomar, 1988). Therefore, the present investigation was aimed at studying the effect of plant population and planting geometry on yield, yield attributes and quality of *toria*, and working out the optimum plant population for higher productivity.

MATERIAL AND METHODS

The experiment was conducted at Crop Research Centre of G.B.Pant University of Agriculture and Technology, Pantnagar (U.P.) during winter seasons of 1989-90 and 1990-91 on silty clay loam soils having pH 7.2, total N-0.087 per cent, available P_2O_5 -56 kg per ha and available K_2O-234 kg per ha. The experiment was laid out in Randomised Block Design with three replications under irrigated conditions. Variety PT 303 of Indian rape was sown on 5th October and 8th October in 1989-90 and 1990-91, respectively. Treatments comprised of twelve planting geometry levels to provide a plant population ranging from 1.6 lakh to 5 lakh per ha and with line sowing, without thinning and broadcasting as checks (Table 1). Plant to plant spacing was maintained by dibbling the seeds at requisite distance, using wooden dibbler and later thinning at 15 days of stage. In the treatments of no thinning and broadcast sown, seed rate was kept @ 4 kg/ha. A basal application of 45 kg N and 40 kg P_2O_5 per hectare was made and the remaining 45 kg N per hectare was top dressed after first irrigation. Other cultural practices were followed as per the recommendation. Observations on various yield attributes were recorded from five randomly selected plants in each plot. Oil

Received for publication on April 10, 1994

content was determined using Soxhlet's extraction method (ADAC, 1975) and N percentage was determined by the micro Kjeldahl's method (Jackson, 1973). The amount of protein content was obtained by multiplying the N content with a constant factor of 6.25.

RESULTS AND DISCUSSION

Yield attributes

Significantly higher number of branches/plant were recorded at 1.6 lakh plant density/ha but both the planting geometry (30 cm x 20 cm and 40 cm x 15 cm) were at par at this density in both the years. In 1990-91, 30 cm x 20 cm planting geometry was also at par with 40 cm x 12.5 cm level (Table 1). Higher number of branches/plant at reduced plant density may be due to efficient utilization of moisture, nutrients, etc. by the individual plant. This is also evident from the fact that in broadcast sown and line sown crop- 30 cm (without thinning)number of branches per plant had reduced due to higher competition. Reduction in branches at closer spacing have also been reported by Singh *et al*. (1963). The number of siliquae per plant at 3.3 lakh/ha (30 cm x 10 cm) level in 1989-90 was at par with all other treatments, except in 1.6 lakhs/ha plant population (30 cm x 20 cm). In 1990-91, it was at par with different treatments, except line sowing (without thinning), 5.0 (40 cm x 5 cm) and 1.6 (40 cm x 15 cm) lakhs/ha. The pooled data indicated that the number of siliquae per plant was higher at 3.3 lakhs (30 cm x 10 cm) plants/ha but did not differ significantly over 20 cm x 15 cm planting geometry at the same plant population. Within the same plant population level the planting geometry had no significant effect on siliquae number.

Different planting geometry levels significantly influenced the seed weight per plant. Plant density of 1.6 lakh/ha recorded significantly higher seed weight/plant over other treatments and the two planting geometry levels i.e. 30 cm x 20 cm and 40 cm x 15 cm were at par at this plant density. In 1989-90, it was also at par with 2.0 (40 cm x 12.5 cm) and 2.5 (20 cm x 20 cm) lakh/ha plant density. At 5.0 lakh/ha plant density, the lowest seed weight was recorded at 40 cm x 5 cm in 1989-90 and 20 cm x 10 cm in 1990-91. Similar trend was also reported by Tomar (1988). The pooled data indicated that highest seed weight/plant was recorded at 1.6 lakh (40 cm x 15 cm) plant density but remained at par with 1.6 lakh (30 cm x 20 cm) and 2.0 lakh/ha (40 cm x 12.5 cm). Higher plant density reduced the seed weight/plant. Lowest seed weight/plant was recorded at 5.0 lakh/ha (40 cm x 5 cm) plant density. However, seed weight at this level was at par with 2.5 (40 cm x 10 cm), 3.3 (20 cm x 15 cm and 30 cm x 10 cm), 5.0 lakh/ha (20 cm x 10 cm), line sown 30 cm (without thinning) and broadcast sown treatments.

Seed and Oil yield

Plant density and planting geometry levels significantly influenced the seed yield per hectare (Table 2). At 2.2 lakh/ha plant density, seed yield/ha was significantly higher in both the years. In 1989-90, seed yield at this level was higher over line sowing - 30 cm (without thining), broadcast sowing, 40 cm x 15 cm (1.6 lakh/ha) and 40 cm x 12.5 cm (2.0 lakh/ha) levels. However, in 1990-91, 2.2 lakh/ha was significantly higher over all other treatments except 2.0 lakh/ha plant density. when pooled over two years, the data indicated that highest seed yield was recorded at 2.2 lakh plant den-

Table 1. Influence of planting geometry on yield attributes of *toria*

Plant density/ planting geometry (cm)	No. of branches/ plant			No. of siliquae/plant			1000-seed weight (g)			Seed weight/plant (g)		
	1989-90	1990-91	Pooled	1989-90	1990-91	Pooled	1989-90	1990-91	Pooled	1989-90	1990-91	Pooled
1.6 lakh/ha												
30 x 20	15.2	21.0	18.1	139.0	279.8	209.4	3.31	3.35	3.33	9.89	14.31	12.10
40 x 15	13.8	19.7	16.8	157.6	226.5	192.0	3.30	3.35	3.26	11.96	13.79	12.88
2.0 lakhs/ha												
40 x 12.5	12.7	17.9	15.3	191.6	265.4	228.5	3.31	3.37	3.34	8.91	12.48	10.67
2.2 lakhs/ha												
30 x 15	12.0	15.5	13.8	173.9	264.9	219.4	3.42	3.44	3.43	9.45	9.32	9.38
2.5 lakhs/ha												
20 x 20	12.1	15.7	13.9	195.4	301.3	248.4	2.95	2.99	2.97	9.57	9.81	9.69
40 x 10	11.7	15.3	13.5	196.1	274.1	235.1	2.90	2.99	2.95	8.21	8.45	8.33
3.3 lakhs/ha												
20 x 15	10.8	13.9	12.4	226.1	298.4	262.3	2.83	2.85	2.84	6.53	6.41	6.47
30 x 10	9.1	12.7	10.9	248.0	326.0	287.0	2.74	2.85	2.80	6.44	7.83	7.14
5.0 lakhs/ha												
20 x 10	10.0	13.4	11.7	177.3	244.3	210.8	2.70	2.81	2.76	7.01	5.20	6.11
40 x 5	8.7	11.2	10.0	181.3	256.7	219.0	2.70	2.80	2.75	5.85	6.03	5.94
Line sowing-30 cm (WT) *	8.9	10.4	9.7	164.6	226.6	195.6	2.85	2.85	2.85	7.03	6.19	6.61
Broadcast sowing @ 4 kg/ha	10.1	13.4	11.8	178.7	274.8	226.8	2.62	2.74	2.68	7.00	6.18	6.59
S.Em ±	0.8	1.3	0.6	27.9	23.2	11.0	0.02	0.02	0.02	1.20	0.25	0.91
CD at 5%	2.5	3.6	2.0	83.5	68.2	34.1	0.06	0.06	0.06	3.52	0.75	2.84

* @ 4 kg seed/ha without thinning.

Table 2. **Influence of planting geometry on seed and oil yield, oil content and protein per cent in seeds of *toria***

Plant density/ planting geometry (cm)	Seed yield (q/ha)			Oil yield (kg/ha)	Oil content(%)	Protein content (%)
	1989-90	1990-91	Pooled	1990-91	1990-91**	1990-91**
1.6 lakhs/ha						
30 x 20	18.45	20.12	19.29	733.8	37.1 (36.4)	22.2 (14.3)
40 x 15	15.58	19.78	17.67	722.4	37.2 (36.7)	22.6 (17.4)
2.0 lakhs/ha						
40 x 12.5	17.03	23.04	20.04	841.4	37.1 (36.5)	24.6 (17.4)
2.2 lakhs/ha						
30 x 15	19.47	23.11	21.29	848.6	37.3 (36.7)	22.2 (14.3)
2.5 lakhs/ha						
20 x 20	18.64	20.15	19.40	735.9	37.1 (36.3)	24.6 (17.4)
40 x 10	17.96	20.89	19.43	764.8	37.2 (36.5)	22.5 (14.6)
3.3 lakhs/ha						
20 x 15	18.60	20.47	19.54	747.6	37.2 (36.5)	24.7 (17.5)
30 x 10	18.23	20.45	19.34	756.9	37.3 (36.7)	22.2 (14.3)
5.0 lakhs/ha						
20 x 10	17.12	18.34	17.73	683.7	37.6 (37.2)	24.2 (16.9))
40 x 5	17.40	17.79	17.60	661.8	37.6 (36.6)	24.6 (17.4)
Line sowing-30 cm (WT) *	12.38	17.56	14.97	644.8	37.3 (36.7)	24.6 (17.3)
Broadcast sowing @ 4 kg/ha	14.62	15.71	15.17	572.9	37.1 (36.4)	25.1 (18.0)
S.Em ±	0.74	0.21	0.88	14.4	0.1	0.2 (-)
CD at 5%	2.35	0.60	2.73	42.2	0.2	0.5(-)

* @ 4 kg seed/ha without thinning.

** Figures in parenthesis denote original value.

Note : Plant population in line sown (WT) was 63 per m^2. Broadcasting it was 60 per m^2

sity/ha (30 cm x 15 cm) but did not differ in comparison with 2.0 (40 cm x 12.5 cm), 2.5 (20 cm x 20 cm and 40 cm x 10 cm) and 3.3 (20 cm x 15 cm and 30 cm x 10 cm) lakh plant density/ha. Similarly, the lowest seed yield/ha was recorded in crop sown in lines at 30 cm without thinning but was at par with broadcast sown crop and 5.0 lakh/ha (40 cm x 5 cm) plant density. It is, therefore evident that line sowing is only beneficial when thinning is done. Though, higher number of branches/plant was recorded at 1.6 lakh/ha (30 cm x 10 cm) and more seed weight/plant at 1.6 lakh/ha (40 cm x 15 cm) plant density, the seed yield was maximum at 2.2 lakh/ha. This may be justified as the improvement in yield attributes at lower plant density failed to compensate for lower number of plants/unit area. (Kumar and Gangwar, 1985).

The oil yield was significantly higher at 2.2 lakh/ha plant density (30 cm x 15 cm) but did not differ with 2.0 lakh/ha (40 cm x 12.5 cm) level. Broadcast sown crop gave lowest oil yield per hectare.

Oil and Protein content

Oil and protein content had an inverse relationship with the plant population. With the increase in plant population oil content also increased significantly. This is attributed to more number of main shoots, which got longer duration for the seed development. Besides, seed got less time for development, hence the amount of protein was higher. (Shastry and Kumar, 1981). Gangwar and Kumar (1986) also reported more oil content and lower protein at higher plant density and the reverse.

LITERATURE CITED

AOAC, 1975. Official Methods of Analysis of Analytical Chemistry. (Ed. W. Hartwitz), 12th ed. AOAC, Washington DC, USA.

Gangwar, K. S. and Kumar, A. 1986. Nitrogen fertilization and plant density levels in relation to yield, its attributes and quality of *toria*. *J. Oilseeds Res.* 3 (2) : 151-157.

Jackson, M. L. 1973. Soil chemical analysis. Prentice Hall of India, New Delhi, India.

Kumar, A. and Gangwar , K. S. 1985. Analysis of growth, development and yield of Indian rapeseed (*B. campestris* var. *toria*) in relation to nitrogen and plant density. *Indian J. Agron.* 30 (3) : 358-363.

Shastry, A. B. and Kumar, A. 1981. Variations in yield, its attributes and quality of Indian mustard in relation to planting time and levels of plant population. *Indian J. agric. Sci.* 51 (1) : 27-32.

Sing, S. M., Saxena, H. K. and Wattal, P. M. 1963. Effect of spacing, sowing dates and nitrogen supply on growth and yield of *toria*. *Indian Oilseed J.* 1 (1) : 20-28.

Tomar, R. K. S. 1988. Effect of dates of sowing and plant population on yields of *toria*. *J. Oilseeds Res.* 6 (1) : 162-164.

J. Oilseeds Res. 12(1) 1995 : 60-64
ISSN 0970-2776

EFFECT OF CROPPING SYSTEMS AND NITROGEN ON THE YIELD, OIL CONTENT AND NODULATION IN SUMMER GROUNDNUT

A.K. BARIK and A.K. MUKHERJEE
Bidhan Chandra Krishi Viswavidyalaya, Department of Agronomy
Mohanpur, Nadia, West Bengal

ABSTRACT

The yield, yield attributes, oil content and nodulation in groundnut were analysed under four levels of nitrogen and five cropping systems (sole & intercrop). Pod, kernel and husk yield and oil content was maximum with 40 kg N/ha and declined with higher doses of nitrogen supply (80 & 120 kg N/ha) in both the years. Sole groundnut yielded maximum pod (12.08 q/ha), kernel (8.97 q/ha), husk (3.3 q/ha) and recorded the highest oil percentage (48.10) as compared to other cropping systems. Nodulation was greater at 40 kg N/ha compared with control and decreased significantly in higher doses of nitrogen. The sole crop of groundnut produced higher number of nodules/plant which was significantly different from all the intercropped groundnuts and at par with Sorghum : Groundnut in 1:2 row arrangement.

Keywords : *Arachis hypogaea*; Cropping systems; Nitrogen; Yield

INTRODUCTION

In India there is a great competition for land between food and fodder production. There is very little scope for increasing production through horizontal expansion but there is a great scope of vertical expansion through intensive cropping. To achieve self sufficiency in livestock feed production, crop production in the cultivable area need to be intensified by growing fodder crops along with food crops. The demand for vegetable oils in the country, has been steadily increasing at the rate of more than 4 per cent *per annum*, whereas the rate of increase in its production is found to be around 2 per cent per annum. The Planning Commission estimated that by 2000 AD, the demand for vegetable oil will increase to about 26 million tonnes (Ninan, 1989). To meet the demand, production of oil seeds has to be increased by 6.5 to 7 per cent per annum compared to present. Utmost priority is to be given for increasing the production of oilseeds. Groundnut, which is a major oilseed crop, is becoming popular as cash crop after the harvest of potato, toria etc. during the summer season in Indo Gangetic plain region.

Intercropping is considered as one of the optimum resource utilization attempt for achieving maximum production per unit area per unit time. Grasses preferably mixed with legumes, have been reported to build up soil fertility, economise the requirement of fertilizers and improve and enrich the quality of herbage. Instead of taking sorghum (forage) as a sole crop with higher doses of nitrogen application, sorghum and groundnut combination gave higher returns with moderate level of

Received for publication on April 15, 1994

nitrogen where from both green forage and oilseed may be obtained.

Keeping in view, the deficit situation of both fodder and oilseed production, present study was conducted to examine the effect of nitrogen and different intercropping systems on pod yield, kernel yield, husk yield, nodulation and oil content in groundnut.

MATERIAL AND METHODS

The present study was conducted during summer season (March to June) of 1988 and 1989, at Central Research Farm, Gayeshpur, Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India, 23°N latitude, 89°E longitude at an elevation of 9.7 m above mean sea level. The experimental soil was sandy loam in texture with 0.063% N, 15.72 kg/ha available P, 152.87 kg/ha available K and pH 6.8. The experiment was laid out in split plot design with 3 replications, with 4 nitrogen levels (0, 40, 80 & 120 kg N/ha) as main plot treatments and 5 cropping systems (viz. sole sorghum; sole groundnut; sorghum + groundnut (1:1); sorghum + groundnut at (2 : 1); sorghum + groundnut at (1 : 2)) as subplots. Spacing was maintained at 30 cm between rows and 10 cm between plants within row for both sorghum, M.P.Chari and groundnut, JL 24. The seed rate of sorghum and groundnut in sole crops was 50 and 100 kg/ha respectively, where as the seed rate for component crops in intercropping systems were based on land use by different crops. Nitrogen was applied as per treatment in the form of urea. Phosphorus and potash was applied @ 60 and 40 kg/ha respectively, in the form of single super phosphate and muriate of potash. Half of nitrogen and full dose of P and K were applied as basal before sowing and remaining half of N was top dressed at 30 days after sowing. The crops were grown under irrigated condition. Four irrigations were given at 20 to 25 days interval. Groundnut plants randomly uprooted with a block of soil measuring approximately 15 cm x 15 cm. Then the soil block was carefully washed to remove the soil from the roots and the nodules were then counted. After the harvest of groundnut plots, from each plant pods were stripped off and dried in sun and weighed for recording yield. To obtain kernel yield, pod yields per hectare were multiplied by the respective shelling percentage. To obtain husk yield, kernel yield was substracted from pod yield. Oil content was determined by solvent extraction method in Soxhlet's apparatus with petrolium ether (BP 40-60°C) as solvent.

RESULTS AND DISCUSSION

Pod yield

Effect of N

Groundnut pod yield was significantly influenced with different doses of nitrogen in both the years. Highest mean pod yield of groundnut was obtained (9.89 q/ha) with 40 kg N ha^{-1} (Table 1) in both the years. Higher doses of nitrogen application reduced the yield of groundnut. similar observation was made by Jakhro (1984).

Effect of cropping systems

Sole groundnut produced the highest pod yield to the tune of 12.55 q/ha and 11.62 q/ha in 1988 and 1989 respectively which was significantly higher as compared to pod yield obtained from 1S : 2G row intercropping system followed by 1S : 1G row intercropping over 2S : 1G row intercropping system (Table 1) which are in conformity with Mandal *et al*., (1989).

Table 1. Effect of nitrogen and cropping systems on pod, kernel, husk and oil yield of groundnut during summer season

Treatments	Pod yield (kg ha $^{-1}$)		Kernel yield (kg ha $^{-1}$)		Husk yield (kg ha $^{-1}$)		Oil content (%)	
	1988	1989	1988	1989	1988	1989	1988	1989
N levels (N) (kg ha $^{-1}$)								
N_0	742	679	529	491	214	188	46.81	46.10
N_{40}	1041	938	759	695	283	242	49.33	50.06
N_{80}	819	735	577	539	241	196	48.18	47.00
N_{120}	556	543	391	392	165	151	46.72	46.09
S.Em (±)	40.50	31.90	30.5	23.40	11.30	8.50	0.09	0.15
C.D. at 5%	99.30	78.10	74.6	57.30	27.70	20.90	0.23	0.37
Cropping systems (C)								
Groundnut	1255	1162	899	852	356	310	48.39	47.84
S + G (1 : 1)	676	586	485	432	191	154	47.79	47.06
S + G (2 : 1)	419	379	295	277	125	102	47.25	47.23
S + G (1 : 2)	808	769	578	558	230	211	47.62	47.13
S. Em (±)	11.80	11.00	9.00	8.10	5.60	3.00	0.10	0.09
C.D. at 5%	24.50	22.60	18.60	16.70	11.60	6.20	0.21	0.19

S = Sorghum, G = Groundnut

Kernel yield

Effect of N

Kernel yield of groundnut obtained with different doses of nitrogen application differed significantly among each other (Table 1). The highest kernel yield was recorded with 40 kg N/ha (759 and 695 kg/ha during 1988 and 1989 respectively), kernel yield decreased significantly with further increase in rates of nitrogen supply. This result was in agreement with the findings of Reddy *et al.* (1984).

Effect of cropping systems

The kernel yields of groundnut was found to vary among different systems of cropping (Table 1). The sole crop of groundnut recorded highest kernel yield (899 and 852 kg/ha during 1988 and 1989 respectively) followed by 1S : 2G intercropping systems.

Husk yield

Effect of N

Nitrogen application @ 40 kg N/ha recorded the highest husk yield of groundnut (283 and 242 kg/ha during 1988 and 1989 respectively) which was significantly higher than other levels of Nitrogen (Table 1).

Effect of cropping systems

Husk yield of groundnut when compared among the different cropping systems, varied significantly during both the years of experimentation (Table 1). Sole groundnut produced the highest husk yield (356 and 310 kg/ha during 1988 and 1989 respectively) which was significantly higher as compared to husk yield obtained from other intercropping systems.

Table 2. **Effect of nitrogen and cropping systems on number of nodules/plant of groundnut at different days after sowing during summer season**

Treatment	Number of nodules / plant of groundnut							
	30 DAS		45 DAS		60 DAS		75 DAS	
	1988	1989	1988	1989	1988	1989	1988	1989
N levels (N) (kg ha^{-1})								
N_0	31	37	47	51	78	108	164	165
N_{40}	40	56	54	68	81	111	123	145
N_{80}	38	40	58	67	70	88	94	116
N_{120}	20	26	35	48	54	64	78	81
S.Em (±)	1.26	1.28	1.15	0.66	1.57	0.91	1.51	1.27
C.D. at 5%	3.08	3.14	2.81	1.61	3.84	2.22	3.71	3.11
Cropping systems (C)								
Groundnut	33	39	51	59	83	97	138	133
S + G (1 : 1)	32	40	49	57	67	97	114	126
S + G (2 : 1)	24	36	40	55	62	83	96	116
S + G (1 : 2)	40	44	54	62	72	93	111	132
S. Em (±)	1.18	1.42	1.49	1.46	1.31	1.44	1.62	1.46
C.D. at 5%	2.43	2.94	3.07	3.02	2.69	2.98	3.35	3.00

S = Sorghum, G = Groundnut

Nodulation

Effect of N

Number of nodules/plant were significantly greater at 40 kg N/ha compared with control during both the years (Table 2). The significant increase is up to 60 DAS and thereafter declined significantly with the increasing rates of nitrogen supply (80 and 120 kg N/ha). It might be attributed to the shading of groundnut canopy by tall growing companion crop sorghum whose growth, in turn, was boosted up with higher levels of nitrogen. This observation was in agreement with the findings of Reddy and Chatterjee 1973; Franco 1977 and Nambiar and Dart 1980. At lower levels of nitrogen, the legumes grew better compared with higher doses of nitrogen (80 & 120 kg N/ha) and a greater advantage from intercropping and nitrogen economy at lower level as compared to higher level of nitrogen application was obtained.

Effect of cropping systems

Groundnut intercropped with sorghum at 1S : 2G ratio produced significantly higher number of nodules/plant up to 45 DAS as compared to sole crop of groundnut but at 60 and 75 DAS, sole crop of groundnut recorded higher number of nodules/plant compared with intercropped groundnut (Table 2). Reddy and Chatterjee, 1973 also reported more nodule number/plant in pure crop than in mixed crop.

Oil content

Effect of N

The content of oil in groundnut kernel significantly increased with 40 kg N/ha in comparison to other rates of nitrogen application during both the years of experimentation (Table 1). With increasing levels of N supply (80 and 120 kg/ha), oil content was found to be reduced which was in conformity with the results obtained by Krishnananda *et al.*, (1977).

Effect of cropping systems

Sole crop of groundnut recorded the highest oil content to the tune of 48.39 and 47.84 per cent in 1988 and 1989 respectively. The differences were significantly higher compared with oil contents in groundnut kernels estimated from different intercropped groundnut treatments.

LITERATURE CITED

Franco, C.A. 1977. Contribution of the legume - Rizobium symbiosis to the ecosystem and food production *In:* Exploiting the legume Rizobium symbiosis. *Tropical Agriculture.* pp. 237-252.

Jakhro, A.A. 1984. Growth, nodulation and yield of groundnut as affected by nitrogen rates. *Planter.* 60 (679) : 149-159.

Krishnananda, V.V.S., Satyanarayana, V. and Sankara, R. 1977. Studies on effect of different levels of N, P and K on growth, yield and quality of irrigated groundnut. *Andhra Agric. J.* 24 (1) : 18 - 23.

Mandal, B.K., Dhara, M.C., Mandal, B.B. and Patra, B.C. 1989. Growth of rice, mungbean, soybean, peanut, ricebean and blackgram as sole and intercrops. *Indian J. Plant Physiol.* 32 (4) : 294- 298.

Nambiar, P.T.C. and Dart, P.J. 1980. *In*: Proceedings International Workshop on groundnut. ICRISAT, Hyderabad, pp. 110.

Ninan, K.N. 1989. Self sufficiency in oilseeds with in grasp or elusive goal ? Economic and Political Weekly. XXIV (39) : A - 133 - 135.

Reddy, M.N. and Chatterjee, B.N. 1973. Nodulation in soybean grown as a pure and mixed crop. *Indian J. Agron.* 18 (4): 410-415.

Reddy, P.S. 1984 The role of groundnut in meeting the demand for edible oils in India by 2000 A.D. "Souvenir, Directorate of Oilseed Research. Rajendranagar, Hyderabad, May 19, PP. 23 - 29.

J. Oilseeds Res. 12(1) 1995 :65-68
ISSN 0970-2776

INTEGRATED WEED MANAGEMENT IN GROUNDNUT

A.K. GUGGARI, K. MANJAPPA, B.K. DESAI, and H.T. CHANDRANATH
All India Co-ordinated Research Project on Oilseeds, Regional Research Station
Raichur 584 101, Karnataka

ABSTRACT

A field experiment was conducted during *kharif* seasons of 1992 and 1993 on a red sandy soil to find out an efficient method of weed control in groundnut at the Regional Research Station, Raichur. The pod yield obtained with herbicides when they were combined with one hand weeding and intercultivation at 35 DAS were comparable with local method of weed control (2 Hand weedings + 3 intercultivations), but were significantly superior to application of herbicides alone and unweeded check. Similarly net returns, B:C ratio and weed control efficiency were higher in integrated and local methods than application of herbicides alone. Weed control efficiency of 82-85 per cent was achieved in integrated methods compared to 27-54 per cent with herbicides application alone. When herbicides alone were used, pendimethalin and metolachlor each at 1.0 kg a.i./ha were found superior in terms of pod yield and weed control efficiency.

Keywords: Groundnut; Weed control; Pod yield; Net returns; Weed control efficiency

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is an important oilseed crop of India which has low productivity and high cost of production. Among different agronomic practices, weed menace is one of the serious bottlenecks for increasing the yield. Competitional stress of weeds causes reduction in pod yield by about 17-84 per cent (Dharam Singh *et al.*, 1992). In view of the slow growth habit of the crop, mechanical control of weeds becomes difficult due to continuous rains and increasing cost and scarcity of labour. Under these situations the chemical control of weeds is found to be effective and economical in the initial stages of growth. However, pre-emergence application of herbicides allows the emergence of weeds after some time. Therefore, adoption of an integrated approach is essential and the present study was initiated with this in view.

MATERIAL AND METHODS

A field experiment was conducted for two years during *kharif* seasons of 1992 and 1993 under protective irrigation at the Regional Research Station, Raichur. The experiment was laid out in Randomised Block Design with three replications. There were 13 treatments as detailed in Table 1. The soil of the experimental site was red sandy having 156, 42 and 394 kg/ha of available N, P_2O_5 and K_2O with 7.7 pH and 0.39 per cent organic carbon. The crop was sown at 30 x 10 cm spacing and fertilized with 25:75:25 kg N: P_2O_5 : K_2O per ha, respectively, in the form of urea, single super phosphate and muriate of potash. The varieties used were JL-24 and KRG-1 (bunch types) during 1992 and 1993, respectively. The net plot size was 3.6 m x 2.4 m. Net returns were calculated based on the prevailing market prices during the period of experimentation.

Received for publication on April 18, 1994.

The benefit cost (B:C) ratio was calculated based on gross returns. Weed control efficiency was calculated by using the following formula (Somani, 1992).

Weed Control Efficiency (WEC)

$$= \frac{WDC - WDT}{WDC} \times 100$$

Where, WDC = Weed dry matter production in control plot

WDT = Weed dry matter production in treated plot

RESULTS AND DISCUSSION

Nature of weed flora

The predominant weed species observed in the experimental site were *Cyperus rotundus* L. (sedge), *Digitaria* sp., *Dactyloctenium aegyptium* Beauv, *Dinebra retroflexa* (Vahl.) Panz, *Echinochloa stagnina* (Retz.)Beauv. among grasses and *Oscimum canum* Sims., *Euphorbia hirta* L., *Phyllanthus fraternus* Webster, *Amaranthus spinosus* L., *Digera muricata* (L.) Mart., *Legasca mollis* Cav., *Trichodesma indicum* (L.)Lehm., *Tribulus terrertris* DC., *Tridax procumbens* L., *Commelina benghalensis* L. among broad leaf weeds.

Effect on crop yield

The data presented in Table 1 reveal that pod yield of groundnut differed significantly due to different weed control treatments during both the seasons as well as on the average of two years. During 1992, local method of weed control recorded higher pod yield (1550 kg/ha) compared to unweeded check (798 kg/ha), only intercultivation (1045 kg/ha) and Thiobencarb @ 1.25 kg a.i/ha (1163 kg/ha). The pod yield recorded with other treatments were on par with that of local method. Similar results were also reported by Karthikeyan *et al.* (1988) and Ramakrishna *et al.* (1991). During 1993, application of Pendimethalin @ 1.0 kg a.i/ha + 1 hand weeding(HW) and interculture(IC) at 35 DAS recorded significantly higher pod yield (1404 kg/ha) when compared to unweeded check (708 kg/ha), only intercultivation (867 kg/ha) and all herbicides applied alone except Pendimethalin @ 1.0 kg a.i/ha (1221 kg/ha). On an average over two years, the pod yield recorded with application of herbicides along with 1 HW and IC at 35 DAS was on par with that of local method (1428 kg/ha) but significantly superior to pod yield obtained with application of herbicides alone with a exception of Pendimethalin (1262 kg/ha). Rathi *et al.* (1986) also obtained higher pod yield with hand weeding thrice which was on par with pod yield obtained by application of Pendimethalin.

On an average, integrated methods recorded 24.9 per cent higher pod yield than application of herbicides alone. Among the herbicides, Pendimethalin recorded significantly higher pod yield (1262 kg/ha) when compared to Alachlor (1044 kg/ha) and Thiobencarb (971 kg/ha) but was on par with Metolachlor (1169 kg/ha) and Butachlor (1095 kg/ha). On an average, herbicides alone recorded 47.2 and 15.9 per cent higher pod yield when compared to unweeded check and only intercultivation, respectively.

Effect on weeds

On an average over two years, dry weight of weeds (kg/ha) recorded at harvest was significantly lower in integrated and local method of weed control as compared to unweeded check and application of herbicides alone (Table 1). Butachlor @ 0.75 kg ai/ha + 1 HW and IC gave the lowest weed weight (675 kg/ha)

Table 1. Pod yield, economics, dry weed weight and weed control efficiency as influenced by different weed control methods in groundnut.

	Treatments	Pod Yield (kg/ha)			Cost of Cultivation (Rs/ha)	Net returns (Rs/ha)			B:C Ratio	Dry weed weight (kg/ha)			Weed Control Efficiency (%)		
		1992	*1993*	Pooled		*1992*	*1993*	Mean		*1992*	*1993*	Pooled	*1992*	*1993*	Mean
1.	Local Method (2 Hw + 3 IC)	1550	1307	1428	6887	5902	3896	4899	1.71	1215	463	839	76.5	87.2	81.8
2.	Alachlor @ 2.0 kg ai./ha (Pre-emergence)	1255	833	1044	6518	3833	357	2095	1.32	3047	2662	2854	41.0	26.6	33.8
3.	Pendimethalin @ 1.0 Kg ai/ha (Pre-emergence)	1304	1221	1262	6883	3885	3191	3538	1.51	2623	1775	2119	49.3	51.1	50.2
4.	*Metolachlor @ 1.0 kg ai/ha (Pre-emergence)*	1382	957	1169	6521	4883	2050	3467	1.53	1543	2199	1871	70.2	39.4	54.8
5.	Butachlor @ 0.75 kg ai/ha (Pre-emergence)	1279	911	1095	5914	4641	1598	3119	1.53	3202	2276	2739	38.1	37.2	37.6
6.	Thiobencarb @ 1.25 kg ai/ha (Pre-emegrence)	1163	779	971	6220	3377	1179	2278	1.37	3202	2894	3048	38.1	20.2	29.2
7.	Tr. 2 + 1HW + 1 IC at 35 DAS	1449	1372	1410	7162	4796	4153	4474	1.63	733	694	714	85.8	80.9	83.4
8.	Tr. 3 + 1HW + 1 IC at 35 DAS	1443	1404	1424	7361	4549	4221	4385	1.60	1119	463	791	78.4	87.2	82.8
9.	Tr. 4 + 1HW + 1 IC at 35 DAS	1542	1361	1452	6994	5725	3902	4813	1.69	848	502	675	83.6	86.2	84.9
10.	Tr. 5 + 1HW + 1 IC at 35 DAS	1429	1324	1376	6491	5299	4436	4867	1.75	926	424	675	82.1	88.3	85.2
11.	Tr. 6 + 1HW + 1 IC at 35 DAS	1311	1214	1262	6806	4009	3214	3612	1.53	1119	617	868	87.4	82.9	80.6
12.	Unweeded Check	798	708	753	5500	1085	723	904	1.16	5170	3626	4398	-	-	-
13.	Only intercultivation (thrice)	1045	867	956	5695	2927	1457	2192	1.38	3472	2431	2952	32.8	30.9	32.8
	S.Em ±	82.6	83.7	66.4		701.5	616.8	467.1		623.9	211.5	307.2			
	C.D. at 5%	240.1	241.6	193.7		2047.6	1800.0	1327.6		1813.6	668.4	896.6			

Note: HW = Hand Weeding; IC = Intercultivation and higher weed control efficiency (85.2 %) followed by Metolachlor @ 1.0 kg a.i/ha (675 kg/ha and 84.9 %, respectively), Alachlor @ 2.0 kg a.i/ha (714 kg/ha and 83.4 %, respectively) and Pendimethalin @ 1.0 kg a.i/ha (791 kg/ha and 82.8 %, respectively).

Application of herbicides alone also recorded lower weed weight and higher weed control efficiency when compared to unweeded check and only intercultivation. Among the herbicides, Metolachlor (1871 kg/ha and 54.8 %, respectively) performed better than Pendimethalin (2119 kg/ha and 50.2 %, respectively) and *Butachlor* (2739 kg/ha and 37.6 %, respectively). These results were very much supported by the observations made on dry weight of weeds per unit area recorded at 60 DAS (Table 1).

Herbicides alone controlled 29.2 to 54.8 per cent of weeds. However, when they were combined with one hand weeding and intercultivation at 35 DAS, controlled 82.8 to 85.2 per cent weeds which was marginally higher than local method of weed control (81.8 %)

Economics

Among all the Weed control treatments, Butachlor @ 0.75 kg a.i/ha with 1 HW and IC recorded higher net returns and Benefit cost (B:C) ratio (Rs. 4867/ha and 1.75, respectively) followed by local method (Rs. 4899/ha and 1.71, respectively) and Metolachlor @ 1.0 kg a.i/ha in addition to 1 HW and IC (Rs. 4813/ha and 1.69, respectively). Lowest net returns (Rs. 904/ha) and B:C ratio (1.16) were recorded with unweeded check. Though, the yield obtained with Butachlor @ 0.75 kg a.i/ha along with 1 HW and IC was lower (1376 kg/ha) when compared to other herbicides + 1 HW and IC, the higher net returns and B:C ratio obtained with Butachlor is because of its lower dose and price. On an average, integrated methods gave an additional returns of Rs. 1749, 3891 and 2403 per ha over application of herbicides alone, unweeded check and only intercultivation, respectively.

Under the circumstances where the labour is scarce and costly, one can use pre-emergence herbicides like Metolachlor (1.0 kg a.i/ha), Butachlor (0.75 kg ai/ha) and Pendimethalin (1.0 kg a.i/ha) in combination with 1 HW and IC at 35 DAS.

LITERATURE CITED

Dharam Singh, Dagor, T.C. and Gangavar, B. 1992. Infestation by weeds and their management in oilseed crops - a review. *Agricultural Reviews* 13(3) : 163-175.

Karthikeyan, R., Rajagopal, A. and Velayudham, K. 1988. Studies on chemical weed control in *groundnut* (*Arachis hypogaea* L.). *Pesticides 22 (4): 19-22.*

Ramakrishna, A., Ong, C.K. and Reddy, S.C.N. 1991. Integrated weed management in rainfed groundnut. J. *Plant Protection in the Tropics* 8(1): 111-119.

Rathi, G.S., Sharma, R.S. and Dubey, M.P. 1986. Studies on integrated weed control in Rainfed groundnut. *Indian J. Weed Sci.* 18(4): 220-225.

Somani, L.L. 1992. Dictionary of weed science. Agrotech Publishing Academy, Udaipur p. 175.

J. Oilseeds Res. 12(1) 1995 : 69-73
ISSN 0970-2776

INTEGRATED WEED CONTROL IN SOYBEAN

G.B. HALVANKAR, V.M. RAUT, S.P. TAWARE and V.P. PATIL
Agharkar Research Institute, Agharkar Road, Pune 411 004

ABSTRACT

A field experiment was conducted during the rainy seasons of 1988 and 1989 to find out the suitable weed control methods in soybean (*Glycine max* (L.) Merrill). The highest weed control efficiency was observed in two hand weedings (30 and 45 DAS). One hand weeding at 30 DAS alongwith application of weedicide increased the weed control efficiency compared to the application of weedicide alone. Weed control treatments had significant effect on plant height, pod number per plant, weed biomass at maturity and seed yield, whereas, days to flowering, maturity and 100 seed weight were not influenced. Two hand weedings recorded the highest seed yield and net returns. Next best treatment was application of fluchloralin + one hand weeding at 30 DAS. Among the weedicides, fluchloralin, metolachlor and alachlor were found to be relatively more effective in controlling weeds.

Keywords : Soybean; Weed control; Weedicides.

INTRODUCTION

Maharashtra is the second largest soybean (*Glycine max* (L.) Merrill) growing state in the country and area is increasing rapidly as the crop is remunerative. Several workers have reported losses in seed yield to the tune of 30-77% due to weed infestation and explored the possibility of use of weedicide to control weeds (Patra, 1987; Jain *et al.*, 1988; Tiwari and Kurchania, 1990; Porwal *et al.*, 1990). However, weedicides alone are unable to give full control of weeds because of their selectivity. Use of weedicides could be more effective if supplemented with inter culture with this in view, an experiment was conducted to find out the efficacy of weedicides in controlling weeds when used alone and supplemented with one hand weeding in soybean.

MATERIAL AND METHODS

The field experiment was conducted at Agharkar Research Institutes' experimental farm at Hol, Dist. Pune during *kharif* seasons of 1988 and 1989 under rainfed conditions in Randomised Block Design with 16 treatments replicated thrice (Table 1). The soil was vertisol, deficient in organic carbon (0.34%), available N (180 kg/ha), P_2O_5 (13 kg/ha), rich in K_2O (636 kg/ha) with 7.4 pH. A basal dose of 20 kg N, 80 kg P_2O_5 and 40 kg K_2O was given before sowing. The gross and net plot sizes were 6m x 3.6 m and 5m x 2.7 m with spacing of 45 cm between rows and 5 cm between plants. Seeds were treated with *Bradyrhizobium japanicum* culture and Bavistin @ 2.5 g/kg seed. Weedicides, namely fluchloralin, oxadiazon, metolachlor, alachlor, pendimethalin were sprayed immediately after sowing. Normally fluchloralin is used as preplant incorporation, however in this experiment one irrigation was given immediately after spraying the weedicides. Cultural methods included were hand weeding at 30 DAS along with weedicides, close sowing at 22.5 cm row spacing, hand hoeing at 15 DAS

Received for publication on May 3, 1994

and straw mulch at 5 t/ha. Soybean variety MACS - 58 was sown on 24-7-88 and 14-7-89 and harvested on 3-10-88 and 20-10-89. A total of 589 mm and 498 mm rainfall was received during first and second year of experimentation respctively. The intercultural operations were carried out as per treatments. Weed control efficiency was calculated by the formula given below suggested by Mani *et al.* (1973).

$$WCE = \frac{DMC - DMT}{DMC} x\, 100$$

where,

DMC = Dry matter production of weeds in control plot

DMT = Dry matter production of weeds in treated plot

RESULTS AND DISCUSSION

Weed control treatments had significant effects on plant height, pods/plant, dry weight of weeds and seed yield, whereas, days to flowering, maturity and 100 seed weight were not affected significantly (Table 1).

Effect on ancillary characters

Number of days required to flowering was not influenced by weed control treatments, though maturity was delayed by two days in treatments, viz., hand hoeing, straw mulch and unweeded control. Close sowing of soybean at 22.5 cm row spacing recorded significantly highest height of 83.3 cm whereas, application of oxadiazon @ 0.5 kg a.i/ha recorded the lowest height. Significantly more number of pods/plant was observed due to two hand weedings as compared to rest of the treatments, except application of fluchloralin @ 1.0 kg a.i/ha supplemented with one hand weeding at 30 DAS. Supplementing the hand weeding at 30 DAS increased the pod number compared to application of weedicide alone, however, the difference was non-significant. Close sowing of soybean recorded the highest 100-seed weight.

Effect on weeds

Dominant weeds associated with the crop were *Parthenium hysterophorus, Dinebra retroflexa, Acalypha ciliata, Digera arvensis, Commeline hasskarlii, C. forskalaci, Triumbetta rotundifolia*, etc.

Dry weight of weeds was highest in unweeded check (420.64 kg/ha) which was followed by application of straw mulch (215.77 kg/ha) and oxadiazon @ 0.5 kg a.i/ha (144.8 kg/ha). The lowest dry weight of weeds was observed in two hand weedings (11.85 kg/ha). It was further observed that herbicide supplemented with one hand weeding reduced the dry weight of weeds considerably as compared to use of herbicide alone. These results corroborate with those of Gogai *et al.* (1991). Among five weedicides tested, fluchloralin, metolachlor and alachlor were found to be relatively more effective in controlling weeds than oxadiazon and pendimethalin. Two hand weedings registered highest weed control efficiency (97.2%) followed by application of fluchloralin + one hand weeding (95.3%) and alachlor + one hand weeding (94.4%). Sowing of soybean at 22.5 cm row spacing showed significant effect in reducing the dry weight of weeds as compared to application of straw mulch @ 5 t/ha, oxadiazon @ 0.5 kg a.i/ha and hand hoeing at 15 DAS.

Effect on seed yield

Seed yield was significantly influenced by weed control treatments. The highest seed yield was

Table 1. Effect of weed control methods on weed biomass, yield components and yield of soybean (Pooled data)

Sr. No.	Treatment	Days to		Plant height (cm)	Pods/Plant	100- seed wt. (g)	Sun dry wt. of weed biomass (kg/ha)	Weed control efficiency (%)	Seed yield (kg/ha)	% increase in yield over control
		Flowering	Maturity							
1.	Fluchloralin @ 1.0 kg a.i/ha	40	89	77.2	42.2	13.7	57.55	86.3	2396	21.3
2.	1. + one hand weeding at 30 DAS	40	89	77.6	44.7	13.8	19.63	95.3	2524	27.8
3.	Oxadiazon @ 0.5 kg a.i/ha	40	89	73.6	36.4	13.3	144.80	65.6	2092	5.9
4.	3. + One hand weeding at 30 DAS	40	90	75.9	39.4	12.8	31.48	92.5	2250	13.9
5.	Metolachlor @ 1.0 kg a.i/ha	40	90	81.7	40.9	13.1	86.59	79.4	2392	21.1
6.	5. + One hand weeding at 30 DAS	40	90	82.2	42.1	13.3	39.29	91.4	2449	24.0
7.	Alachlor @ 2.0 kg a.i/ha	40	90	79.3	37.9	13.4	76.29	81.9	2260	14.4
8.	7. + One hand weeding at 30 DAS	40	89	77.3	41.4	13.4	23.3	94.4	2373	20.2
9.	Pendimethalin @ 1.0 kg a.i/ha	40	90	80.5	40.4	13.5	101.26	75.9	2087	5.7
10.	9. + One hand weeding at 30 DAS	40	89	78.6	42.6	13.6	24.81	94.1	2368	19.9
11.	Sowing of soybean at 22.5 cm row spacing	40	90	83.3	39.5	13.9	95.55	77.3	2213	12.1
12.	11. + One hand weeding at 30 DAS	40	89	75.6	42.2	13.7	32.96	92.2	2229	12.9
13.	Two hand weedings at 30 & 45 DAS	40	89	81.4	46.5	13.4	11.85	97.2	2632	33.3
14.	Hand hoeing at 15 DAS	40	91	75.5	38.9	13.6	139.78	66.8	2131	7.4
15.	Straw mulch @ 5 t/ha	40	91	81.9	39.1	13.8	215.77	48.7	2275	15.2
16.	Unweeded control	40	91	82.0	34.0	13.6	420.64	-	1975	-
	S.E ±	-	0.7	1.18	1.27	0.35	8.75	-	59.8	-
	C.D. (P = 0.05)	-	-	3.34	3.59	-	24.7	-	169.1	-

recorded in two hand weedings(2632 kg/ha) which was significantly superior over rest of the treatments except application of fluchloralin + one hand weeding (2524 kg/ha). Singh and Sharma (1989,1991) and Arya (1991) have also reported higher yields with manual weedings as compared to herbicide application. The increase in seed yield over control was to the extent of 33.3% in two hand weedings, 27.8% due to application of fluchloralin + one hand weeding and 24.0% due to application of metolachlor + one hand weeding. Lowest soybean seed yield of 1975 kg/ha was recorded in unweeded control plot. The one hand weeding at 30 DAS along with application of weedicide increased the seed yield to the tune of 57-281 kg/ha than application of weedicide alone, though the difference was non-significant. Sowing of soybean at 22.5cm row spacing recorded the seed yield (2213 kg/ha) which was significantly superior over that of the treatments, hand hoeing at 15 DAS (2131 kg/ha), application of oxadiazon @ 0.5 kg a.i/ha (2092 kg/ha) and pendimethalin @ 1.0 kg a.i/ha (208 kg/ha).

Economics

The economics of different weed control treatments (Table 2) revealed that highest additional gross returns (Rs. 3285/ha) and net returns (Rs. 2345/ha) over control were obtained due to two hand weedings, followed by, application of fluchloralin + one hand weeding, fluchloralin alone, metolachlor + one hand weeding and metolachlor alone. However, highest benefit cost ratio was observed with close sowing of soybean at 22.5 cm (10.9) and one hoeing at 15 DAS (6.30) mainly due to relatively lower cost of inputs as compared to other treatments. On an average, use of weedicides along with one hand weeding at 30 DAS increased the net returns of Rs. 417/ha over that of use of weedicides alone. Further it was observed that the net returns due to close sowing of soybean at 22.5 cm row spacing to be higher than the application of weedicides like oxadiazon @ 0.5 kg/ha and alachlor @ 2.0 kg a.i/ha.

Thus, it may be concluded that weed control in rainfed soybean can be effective and economical with two hand weedings at 30 and 45 DAS. However, among weedicides, pre-emergence application of fluchloralin and metolachlor @ 1.0 kg a.i/ha and alachlor @ 2.0 kg a.i/ha appears to be relatively more effective and beneficial. Likewise, an application of weedicide supplemented with one hand weeding at 30 DAS is more economical than application of weedicide alone.

LITERATURE CITED

Arya, M.P.S. 1991. Effect of different herbicides on *Oxalis latifolia* weed in soybean (*Glycine max* L.) under rainfed conditions. *Ann. Agric. Res.* 12 : 57-63.

Gogoi, A.K., Kalita, H., Pathak, A.K. and Deka, J. 1991. Integrated weed management in soybean. (*Glycine max L.). Indian J. Agron.* 36 (3) : 453-454.

Jain, H.C., Dubey, S.K. and Bisen J.S. 1988. Influence of weed control and fertility levels on soybean (*Glycine max* (L.) Merrill). *Indian J. Weed Sci.* 20 (2) : 68-74.

Mani, V.S., Pandita M.L., Gautam, K.C. and Bhagwandas 1973. Weed Killing chemicals in potato cultivation *PANS* 23 (8) : 17-18.

Patra, A.P. 1987. Weed control in soybean. *Indian J. Weed Sci.* 19 : 47-51.

Porwal, M.K., Nanawati, G.C. and Bhatnagar, G.S. 1990. Efficacy of herbicidal control of weeds in soybean

Table 2. Economics of weed control methods in soybean based on pooled mean

Sr. No.	Treatments	Increase in yield over control (kg/ha)	Additional gross returns over control (Rs./ha)	Additional cost due to treatment (Rs./ha)	Net returns over control (Rs./ha)	Benefit: cost ratio
1.	Fluchloralin @ 1.0 kg a.i./ha	421	2105	488	1617	3.31
2.	1. + One hand weeding at 30 DA	549	2745	808	1937	2.40
3.	Oxadiazon @ 0.5 kg a.i./ha	117	585	525	60	0.11
4.	3. + One hand weeding at 30 DAS	275	1375	845	530	0.63
5.	Metolachlor @ 1.0 kg a.i./ha	417	2085	505	1580	3.13
6.	5. + One hand weeding at 30 DAS	474	2370	825	1545	1.87
7.	Alachlor @ 2.0 kg a.i./ha	285	1425	925	500	0.54
8.	7. + One hand weeding at 30 DAS	398	1990	1245	745	0.60
9.	Pendimethalin @ 1.0 kg a.i./ha	112	560	653	-93	-
10.	9. + One hand weeding at 30 DAS	393	1965	973	992	1.02
11.	Sowing of soybean at 22.5 cm row spacing	238	1190	100	1090	10.90
12.	11. + One hand weeding at 30 DAS	254	1270	420	850	2.02
13.	Two hand weedings at 30 & 45 DAS	657	3285	960	2325	2.42
14.	Hand hoeing at 15 DAS	146	730	100	630	6.30
15.	Straw mulch @ 5 T/ha	300	1650	300	1350	4.50
16.	Unweeded control	-	-	-	-	-

Cost of weedicides - Fluchloralin Rs. 165/L, Oxadiazon Rs. 200/L, Metolachlor Rs. 190/L, Alachlor Rs. 200/L,
Pendimethalin Rs. 16/L; Weedicide application - 5 men labour/ha @ Rs. 20/ day; Pump hire charge - 5 days @ Rs. 5/day
Close sowing Rs. 100/ha; Two hand weedings 60 women labour @ Rs. 16/day
Hand hoeing - 5 men labour @ Rs. 20/day; Straw mulch @ Rs. 60/T; Sale price of soybean @ Rs. 500/Q.

(*Glycine max* L.). *Indian J. Agric. Sci.* 60 (2) : 132-136.

Singh, D. and Sharma, K.C. 1989. Integrated weed management in soybean (*Glycine max* (L.) Merrill). *Indian J. Weed Sci.* 21 : 22-26.

Singh, D. and Sharma, K.C. 1991. Economics of soybean (*Glycine max* (L.) Merril. cultivation under different methods of weed control. *Indian J. Weed Science,* 22 : 7-11.

Tiwari, J.P. and Kurchania S.P. 1990. Survey and management of weeds in soybean (*Glycine max* L.) ecosystem in Madhya Pradesh. *Indian J. Agric. Sci.* **60 (10)** : 672-676.

Acknowledgements

Authors are grateful to Dr. A.D.Agate, Director, Agharkar Research Institute for providing facilities. We are also thankful to Mr. S.D. Thorat for his help in recording field observations. This work has been carried out under the All India Co-ordinated Research Project on soybean sponsored by the Indian Council of Agricultural Research, New Delhi.

J. Oilseeds Res. 12(1) 1995 : 74-82
ISSN 0970-2776

COMBINING ABILITY FOR YIELD COMPONENTS AND OIL CONTENT OVER SALINE ENVIRONMENT IN INDIAN MUSTARD.

N.K. THAKRAL and HARI SINGH
Department of Plant Breeding, Chaudhry Charan Singh, Haryana Agricultural University, Hisar 125 004, Haryana

ABSTRACT

The 6 x 6 diallel analysis in F_1 generation without reciprocals in Indian mustard revealed that variances due to *GCA* and *SCA* were significant over both normal and saline environments for all the characters. The general predictability ratio suggested greater importance of *GCA* or additive genetic variance for plant height in normal environment, number of primary branches, 1000 seed weight in saline environment and siliqua length in both environments. The parents RH 7859 and RH 781 were good combiners for most of the characters under both the environments. The crosses RH 7846 x RH 8315, RH 7859 x RH 781 in normal environment and RH 781 x RWH-1 and RH 781 x RH 8113 in saline environment were the best cross combinations for seed yield. The cross RH 7859 x RWH-1 was adjudged to be the best cross only for oil content in both the environments.

Keywords: Combining ability; Indian mustard; Saline environment.

INTRODUCTION

The combining ability studies furnish useful information regarding the selection of suitable parents for effective hybridization programme and at the same time elucidate the nature and magnitude of different types of gene action. Because the nature of gene action is known to vary with the genetic architecture of population involved in the hybridization, it is necessary to evaluate the parents for their combining ability. No reports on the nature and magnitude of combining ability on problem soils (salinity/alkalinity) are available on Indian mustard. Therefore, the present study was taken to estimate the general and specific combining ability effects from six parental diallel cross of Indian mustard under normal and saline environments.

MATERIAL AND METHODS

A half diallel set (excluding reciprocals) was made involving six parents (RH 7859, RH 7846, RH 781 - tolerant to salinity and RH 8315, RWH-1, RH 8113 susceptible to salinity). The resultant 15 F_1 hybrids along with parents were planted in Randomized Block Design with three replications in earthen pots saturated with salt solution of 0 (E_1) and 125 meq/1≈ 10 dsm^{-1} (E2) chloride dominated salts during *rabi* 1991-92. The saline pots were fitted with hollow pipe for irrigation of the pots so that salts can move upwards and downward. Ten seeds per pot were sown and two uniform plants per pot and 12 plants per treatment were retained. All cultural practices and plant protection measures recommended for this crop were adopted. Observations on three ran-

Received for publication on June 6, 1994

domly selected plants were recorded for seed yield, oil content, specific leaf area, days to maturity, plant height, number of primary and secondary branches per plant, number of siliquae per plant, siliqua length, seeds per siliqua and 1000 seed weight. The combining ability analysis were carried out according to Griffing's (1956) Model 1, Method 2.

RESULTS AND DISCUSSION

Analysis of variance revealed significant differences for all the characters, indicating wider genetic variability among genotypes. The mean squares due to general and specific combining ability were significant for all the traits (Table 1) over both the environments. This indicated that both additive and non-additive types of gene actions were involved in the control of these characters. The values of predictability ratio, derived from equivalent component variance, less than unity indicated that the gene actions were predominantly of the non-additive type. However, it suggested greater importance of *gca* or additive genetic variance for plant height in normal environment, number of primary branches per plant, 1000 seed weight in saline environment and siliqua length under both the environments. The value of predictability ratio for these characters was approaching unity. The earlier results of Chote Lal and Singh (1974) in Indian mustard and Kumar and Yadav (1985) in brown sarson are in agreement with the findings in this study.

The *gca* effects presented in Table 2 show that no parental genotype was a good general combiner for all the traits in both the environments. The parent RH 7859 was found to be a good general combiner for number of siliquae per plant, siliqua length, 1000 seed weight and seed yield per plant in both the environments. RH 781 was identified as good combiner for number of primary and secondary branches per plant and number of siliquae per plant in both the environments. RH 8315 was also good combiner for siliqua length, 1000 seed weight and specific leaf area in both the environments. RH 8113 for normal environment and RH 8315 for saline environment were good general combiners for oil content. These parents also had high mean performance for these characters.

The *sca* effects of yield and its attributes (Table 3) indicated that generally crosses were inconsistant in performance over environments. However, some common crosses also occurred. The cross RH 781 x RH 8315 had high *sca* effects alongwith high mean values for secondary branches per plant under stress environment involving good and poor combiner. The best specific crosses for number of siliquae per plant were RH 781 x RH 8113, RH 781 x RWH-1 in both normal and saline environments. For seed yield per plant RH 7846 x RH 8315, RH 7859 x RH 781 in normal environment and RH 781 x RWH-1, RH 781 x RH 8113 in saline environment had high *sca* effects and higher mean values. The cross RH 7859 x RWH-1 was adjudged as the best cross only for oil content in both the environments. Other prominent crosses with significant *sca* effects and high mean values were RH 7846 x RH 781 in normal and RH 7859 x RH 8113 in saline environment for seeds per siliqua; RH 7846 x RH 8315 in normal and RH 7846 x RWH-1 in salinity for 1000 seed weight. RH 7846 x RWH-1 in both the environments for specific leaf area. These crosses also had either both or at least one of the parents as good general com-

Table 1. Mean squares from ANOVA of combining ability (Griffing's Method 2, Model1) for seed yield and its component characters in Indian mustard.

Source of variation	d.f.	Specific leaf area	Days to Maturity	Plant height	No. of primary branches per plant	No.of secondary branches per plant	No. of siliquae per plant	Siliqua length	Seeds/ siliqua	1000-seed weight	Seed yield per plant	Oil content
Environment 1(E1)												
General combining ability (*gca*)	5	0.033*	21.370*	775.837*	16.121*	5.254*	4608.958*	1.629*	1.532*	2.067*	5.947*	3.575*
Specific combining ability (*sca*)	15	0.054*	11.349*	54.900*	5.646*	4.856*	3095.178*	0.069*	1.141*	0.269*	8.922*	4.468*
Error	40	0.0005	1.645	10.167	3.567	0.164	31.811	0.009	0.106	0.001	0.037	0.274
Environment 2(E2)												
General combining ability (*gca*)	5	0.006*	22.193*	381.233*	2.241*	7.446*	3628.753*	1.349*	3.928*	1.636*	5.068*	3.378*
Specific combining ability (*sca*)	15	0.026*	4.171*	74.667*	0.163*	2.086*	704.930*	0.087*	1.083*	0.145*	2.371*	2.026*
Error	40	0.0005	1.113	5.164	0.030	0.075	20.714	0.010	0.105	0.002	0.018	0.229
Predict-ability ratio	E_1	0.133	0.337	0.823	0.602	0.213	0.272	0.871	0.256	0.658	0.166	0.165
	E_2	0.055	0.596	0.515	0.806	0.479	0.569	0.813	0.494	0.741	0.349	0.305

* Significant at P = 0.05

Table 2. Estimates of general combining ability effects for oil content, seed yield and its component characters under two environments in Indian mustard

Parents	Specific leaf area		Days to maturity		Plant height		No. of primary branches per plant		No. of secondary branches / plant		No. of siliquae per plant	
	E_1	E_2	E1	E2	E1	E2	E1	E2	E1	E2	E1	E_2
RH 7859	0.070*	-0.038	-0.597	1.681*	-5.244*	-3.407*	-0.733*	-0.300*	0.158	0.540*	14.536*	10.571*
RH 7846	0.006	-0.013	-0.764	-0.069	-10.174*	-4.703*	-0.608*	-0.308*	-0.129	-0.431*	-16.197*	-11.329*
RH 781	-0.092*	0.005	3.319*	2.181*	9.618*	10.960*	0.888*	1.000*	1.325*	1.649*	33.486*	38.662*
RH 8315	0.018*	0.036*	-0.047	-0.486	-10.324*	-7.582*	0.075	-0.400*	-1.204*	-1.106*	-32.647*	-17.300*
RWH 1	0.058*	-0.017*	0.055	-2.194*	11.585*	5.172*	0.538*	0.171*	0.038	-0.218*	-10.064*	-7.021*
RH 8113	-0.061*	0.028*	-0.931*	-1.111*	4.539*	-0.440	-0.158*	-0.163*	-0.188	-0.435*	10.886*	-13.583*
S.E. (g_i)	0.007	0.007	0.414	0.341	1.029	0.733	0.056	0.056	0.131	0.089	1.820	1.469
S.E. ($g_i - g_j$)	0.011	0.011	0.641	0.528	1.594	1.136	0.086	0.086	0.203	0.137	2.820	2.276

Table 2 contd...

Parents	Siliqua length		Seeds per siliqua		1000-seed weight		Seed yield per plant		Oil content	
	E_1	E_2	E1	E2	E1	E2	E1	E2	E1	E2
RH 7859	0.451*	0.338*	0.115	0.560*	0.449*	0.391*	1.347*	1.590*	-0.278	-1.161
RH 7846	0.481*	0.558*	0.207	0.264*	0.475*	0.358*	0.506*	-0.256*	0.014	0.089
RH 781	-0.598*	-0.396*	-0.118	0.797*	-0.646*	-0.659*	-0.444*	-0.235*	-0.936*	-0.240
RH 8315	0.201*	0.092*	0.165	-0.319*	0.435*	0.411*	-0.228*	-0.239*	0.039	0.597*
RWH 1	-0.411*	-0.392*	-0.814*	-1.144*	-0.386*	-0.173*	-1.182*	-0.218*	0.031	0.564*
RH 8113	-0.124	-0.250	0.444*	-0.157	-0.327*	-0.329*	0.001	-0.643*	1.131*	0.151
S.E. (g_i)	0.030	0.032	0.105	0.105	0.012	0.014	0.062	0.044	0.169	0.154
S.E. ($g_i - g_j$)	0.047	0.050	0.163	1.162	0.036	0.022	0.097	0.068	0.262	0.239

* Significant at $P = 0.05$

Table 3. **Estimates of specific combining ability effects for seed yield and its component characters under two environments in Indian mustard**

Crosses	Specific leaf area		Days to maturity		Plant height		No. of primary branches per plant		No. of secondary branches /plant	
	E_1	E_2	E_1	E_2	E_1	E_2	E_1	E_2	E_1	E_2
RH 7859 x RH 7846	-0.115*	-0.163*	1.060	-1.690	0.420	-2.793	0.899*	0.370*	0.847*	-1.835
RH 7859 x RH 781	0.054*	0.059*	4.310*	2.276*	1.928	-9.506*	-0.697*	-0.471*	-0.140	-2.048*
RH 7859 x RH 8315	-0.007	-0.102*	-2.232	2.726*	3.970	-1.114	0.849*	0.129	2.155*	0.040
RH 7859 x RWH 1	-0.110*	-0.213*	-5.149*	-1.565	8.495*	2.665	-0.680*	0.691*	-1.653*	0.019
RH 7859 x RH 8113	0.002	0.289*	-1.107	-1.982*	-1.726	-13.089*	0.049	0.024	-3.461*	-0.831*
RH 7846 x RH 781	0.084*	0.051*	-4.524*	-1.524	-10.376*	-6.560*	0.378*	-0.230	-0.186	-0.490*
RH 7846 x RH 8315	-0.173*	0.173*	5.601*	2.143*	5.565	-2.485	0.224	0.404*	0.910*	0.577*
RH 7846 x RWH 1	0.270*	0.226*	1.685	-0.482	-1.143	-2.806	0.728*	-0.401*	2.968*	0.390
RH 7846 x RH 8113	-0.204*	-0.159*	-2.274	1.232	-5.764*	-3.293*	-0.243	0.366*	-0.140	-0.760*
RH 781 x RH 8315	0.185*	0.015	0.185	-1.774	3.207	3.086	-0.072	0.429*	-1.245*	1.598*
RH 781 x RWH 1	0.095*	0.025	-1.399	2.601*	-0.701	8.532*	-0.335*	0.258	1.047*	2.611*
RH 781 x RH 8113	-0.089*	-0.017	-3.357*	-0.482	9.811*	2.477	-0.172	0.424*	3.605*	-1.073*
RH 8315 x RWH 1	0.035	-0.130*	3.393*	-0.065	3.450	7.773*	-0.255	-0.409*	1.043*	-0.768*
RH 8315 x RH 8113	-0.296*	-0.145*	1.101	-1.185	-0.380	9.086*	-0.693*	-0.209	-2.365*	0.915*
RWH 1 x RH 8113	-0.419*	-0.162*	1.851	2.893*	-15.522*	-13.002*	0.645*	-0.380*	2.126*	-0.073
S.E. (S_{ij})	0.020	0.020	1.137	0.935	2.826	2.014	0.153	0.153	0.359	0.243
S.E. ($S_{ij} - S_{ik}$)	0.031	0.030	1.697	1.396	4.218	3.006	0.228	0.228	0.536	0.363

Table 3. Contd...

Crosses	No. of siliquae per plant		Siliqua length		No. of seeds per siliqua		1000 - seed weight		Seed yield per plant		Oil content	
	E_1	E_2	E_1	E_2	E_1	E_2	E_1	E_2	E_1	E_2	E_1	E_2
RH 7859 x RH 7846	41.255*	-23.837*	0.022	-0.170	0.462	-0.836*	-0.487*	-0.492*	1.130*	-1.789*	0.018	-0.040
RH 7859 x RH 781	-10.729*	-31.595*	-0.165	0.251	-0.880*	1.264*	0.661*	-0.108*	2.813*	-0.843*	-0.565	1.055*
RH 7859 x RH 8315	72.071*	3.467	0.035	0.064	-0.463	-0.153	-0.261*	0.022	0.863*	-0.572*	-2.640*	-2.015*
RH 7859 x RWH 1	-53.079*	-6.612	-0.320*	-0.286*	0.383	-0.228	-0.666*	-0.454*	-4.116*	-2.126*	4.801*	2.985*
RH 7859 x RH 8113	-122.229*	-22.149*	0.060	0.205*	0.124	1.951*	0.315*	-0.078*	-5.466*	-1.735*	2.968*	-0.536
RH 7846 x RH 781	7.871	-2.795	0.439*	0.414*	0.962*	0.760*	-0.158*	-0.495*	-0.479*	-1.230*	2.343*	0.472
RH 7846 x RH 8315	-20.162*	-10.866*	-0.095	-0.007	0.912*	0.110	1.180*	-0.005	4.438*	-0.493*	-0.165	0.835
RH 7846 x RWH 1	48.021*	16.421*	-0.515*	0.076	-2.142*	-0.322	0.515*	0.826*	0.459*	-0.047	-1.224*	1.135*
RH 7846 x RH 8113	-18.829*	11.217*	0.164	-0.232*	0.866*	-0.353	0.016	0.112*	-0.824*	-0.022	0.376	0.780
RH 781 x RH 8315	-15.879*	27.042*	0.018	0.114	-1.696*	-1.457*	-0.131*	-0.102*	0.321	0.820*	1.851*	0.630
RH 781 x RWH 1	44.005*	56.896*	-0.236*	-0.103	-1.017*	-0.399	0.164*	0.269*	-0.491*	1.065*	-2.440*	0.297
RH 781 x RH 8113	54.488*	14.759*	-0.090	0.255*	-0.476	1.514*	-0.009	0.032	3.292*	1.424*	0.026	0.210
RH 8315 x RWH 1	27.805*	-0.841	0.164	0.310*	0.299	0.750*	0.269*	0.313*	1.092*	-0.097	0.165	0.460
RH 8315 x RH 8113	-47.479*	6.255	0.043	0.401*	0.108	-0.036	-0.577*	-0.058	-3.524*	0.561*	1.085*	-0.361
RWH 1 x RH 8113	38.338*	-12.558*	-0.111	-0.049	0.187	-0.745	0.284*	-0.000	0.763*	-0.826*	-0.840	0.472
S.E. (S_{ij})	4.999	4.034	0.083	0.088	0.288	0.287	0.032	0.039	0.172	0.120	0.464	0.424
S.E. (S_{ij} - S_{ik})	7.461	6.021	0.124	0.131	0.430	0.429	0.047	0.058	0.256	0.179	0.692	0.633

* Significant at P = 0.05.

Table 4. **Mean performance of parents and crosses for seed yield and its component characters under two environments in Indian mustard**

Genotype	Specific leaf area (meter/g)		Days to maturity		Plant height (cm)		No. of primary branches / plant		No. of siliquae per plant	
	E_1	E_2	E_1	E2	E1	E2	E1	E2	E_1	E2
RH 7859	2.17	1.71	139.00	148.00	123.57	112.57	4.43	4.80	322.23	228.43
RH 7846	2.02	1.63	136.00	146.00	125.90	107.00	3.90	4.90	195.33	149.20
RH 781	1.59	1.66	147.00	149.00	157.90	130.37	8.33	7.57	283.90	212.10
RH 8315	2.11	1.89	133.00	142.00	112.00	84.10	6.23	4.80	183.33	119.80
RWH 1	2.12	1.81	137.00	139.00	116.43	116.20	7.13	6.23	184.13	126.33
RH 8113	2.32	1.87	138.00	143.00	156.47	115.47	6.00	5.33	326.43	141.00
RH 7859 x RH 7846	1.90	1.51	138.00	145.00	125.60	96.53	5.67	5.53	296.40	142.33
RH 7859 x RH 781	1.97	1.75	145.00	152.00	146.90	105.43	5.57	6.00	294.10	184.57
RH 7859 x RH 8315	2.02	1.62	135.00	149.00	129.00	95.33	6.30	5.20	310.77	163.67
RH 7859 x RWH 1	1.96	1.45	132.00	143.00	155.43	111.87	5.23	6.33	208.20	163.87
RH 7859 x RH 8113	1.95	2.00	137.00	144.00	138.17	90.50	5.27	5.33	160.00	141.77
RH 7846 x RH 781	1.94	1.76	136.00	146.00	129.67	107.13	6.77	6.23	281.97	191.47
RH 7846 x RH 8315	1.79	1.92	143.00	147.00	125.67	92.67	5.80	5.47	187.80	127.43
RH 7846 x RWH 1	2.28	1.92	139.00	142.00	140.87	105.10	6.77	5.23	278.57	165.00
RH 7846 x RH 8113	1.68	1.58	134.00	143.00	129.20	99.00	5.10	5.67	232.67	153.23
RH 781 x RH 8315	2.05	1.78	141.00	145.00	143.10	113.90	7.00	6.80	241.77	215.33
RH 781 x RWH 1	2.00	1.73	140.00	148.00	161.10	132.10	7.20	7.20	324.23	255.47
RH 781 x RH 8113	1.70	1.74	137.00	146.00	164.57	120.43	6.67	7.03	355.67	206.77
RH 8315 x RWH 1	2.05	1.61	141.00	142.00	145.40	112.80	6.47	5.13	241.90	141.77
RH 8315 x RH 8113	1.60	1.64	138.00	145.00	134.43	108.50	5.33	5.00	187.57	142.30
RWH 1 x RH 8113	1.52	1.57	139.00	145.00	141.20	99.17	7.13	5.00	295.97	133.17
S.E. (Difference)	0.032	0.032	1.814	1.492	4.509	3.214	0.244	0.243	7.976	6.435

Table 4 contd...

Genotype	Siliqua length (cm)		Seed per siliqua		No. of secondary branches / plant		1000-seed weight(g)		Seed yield per plant(g)		Oil content(%)	
	E1	E2	E1	E2	E_1	E_2	E_1	E_2	E_1	E2	E1	E2
RH 7859	5.00	4.83	11.67	12.17	13.33	12.03	5.16	4.83	14.37	12.57	39.23	37.10
RH 7846	4.87	5.17	11.13	12.90	9.43	8.33	4.46	4.23	7.93	7.13	41.43	38.73
RH 781	2.73	2.83	12.57	12.80	13.00	11.13	2.49	2.37	5.67	4.77	39.60	38.33
RH 8315	4.23	3.83	12.00	11.80	9.23	8.77	4.67	4.23	7.23	5.27	42.00	41.57
RWH 1	3.60	3.33	10.77	10.23	9.20	7.10	2.99	2.67	8.07	6.43	41.90	38.60
RH 8113	3.63	3.30	11.73	10.57	11.63	8.67	3.37	2.83	12.17	4.87	42.53	40.17
RH 7859 x RH 7846	4.87	4.87	12.03	12.03	12.77	6.90	4.48	3.75	12.27	5.40	41.83	39.03
RH 7859 x RH 781	3.60	4.33	10.37	14.67	13.23	8.77	4.51	3.11	13.00	6.37	40.30	39.80
RH 7859 x RH 8315	4.60	4.63	11.07	12.13	13.00	8.10	4.67	4.31	11.27	6.63	39.20	37.57
RH 7859 x RWH 1	3.63	3.80	10.93	11.23	10.43	8.97	3.44	3.25	5.33	5.10	46.63	42.53
RH 7859 x RH 8113	4.30	4.43	11.93	14.40	8.40	7.90	4.48	3.47	5.17	5.07	45.90	38.60
RH 7846 x RH 781	4.23	4.67	12.30	13.87	12.90	10.33	3.71	2.69	8.87	4.13	43.50	40.47
RH 7846 x RH 8315	4.50	4.73	12.53	12.10	11.47	7.67	6.13	4.25	14.00	4.87	41.97	41.67
RH 7846 x RWH 1	3.47	4.33	8.50	10.83	14.77	8.37	4.65	4.50	9.07	5.33	40.90	41.93
RH 7846 x RH 8113	4.43	4.17	12.77	11.80	11.43	7.00	4.21	3.63	8.97	4.93	43.60	41.17
RH 781 x RH 8315	3.53	3.90	9.60	11.07	10.77	10.77	3.70	3.14	8.93	6.20	43.03	41.13
RH 781 x RWH 1	2.67	3.20	9.30	11.30	14.30	12.67	3.17	2.93	7.17	6.47	38.73	40.77
RH 781 x RH 8113	3.10	3.70	11.10	14.20	16.63	8.77	3.06	2.53	12.13	6.40	42.30	40.27
RH 8315 x RWH 1	3.87	4.10	10.90	11.33	11.77	6.53	4.36	4.04	8.97	5.30	42.33	41.77
RH 8315 x RH 8113	4.03	4.33	11.97	11.53	8.13	8.00	3.57	3.51	5.53	5.53	44.33	40.53
RWH 1 x RH 8113	3.27	3.40	11.07	10.00	13.87	7.90	3.61	2.99	8.87	4.17	42.40	41.30
S.E. (Difference)	0.132	0.140	0.460	0.458	0.573	0.388	0.051	0.062	0.274	0.191	0.740	0.677

biner. Thus, these crosses are of worth exploitation in varietal breeding programmes. But in some cases average x average, average x good or poor x poor combinations associated with significant *sca* effects indicating the presence of inter-allelic interactions. Such crosses and their derivatives may or may not be of immense utility in hybrid breeding programme.

LITERATURE CITED

Chote Lal and Singh, A.B. 1974 Line x tester analysis in Indian mustard. *Indian J. Agric. Sci.* 44 : 508-512.

Griffing, B. 1956. Concepts of general and specific combining ability in relation to diallel crossing systems. *Aust. J. Biol. Sci.* 9: 465-493.

Kumar, D. and Yadav, I.S. 1985. Line x tester analysis for certain quantitative traits in brown sarson on normal and alkaline soils. *Sabrao Journal* 17: 21-28.

J. Oilseeds Res. 12(1) 1995 : 83-86
ISSN 0970-2776

RESPONSE OF SUMMER GROUNDNUT TO POTASSIUM WITH VARYING LEVELS OF NITROGEN

A.K. PATRA[1], S.K.TRIPATHY[2] and R.C. SAMUI
Department of Agronomy, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur
Nadia - 741 252, West Bengal

ABSTRACT

A field study was conducted in new alluvial zone of West Bengal to study the response of summer groundnut to N and K fertilization. Application of 40 kg N and 45 kg K_2O/ha gave highest number of pods/plant and 100 -Kernel weight. Oil content in kernel increased up to the application of 60 kg N and 60 kg K_2O/ha. Pod and oil yield increased significantly with applied N and K_2O up to 40 and 45 kg/ha respectively and further increase in N or K had no beneficial effect. Application of 40 kg N/ha increased pod yield by 14.9 % and oil yield by 20.1% over control (no nitrogen) and 45 kg K_2O /ha increased pod yield by 25.9% and oil yield by 36.3% over control (no potassium).

Keywords: Groundnut; Nitrogen; Potassium; Yield components; Pod and haulm yield; Oil content; Oil yield.

INTRODUCTION

Appreciation of potassium supplying capacity of soils has been changing with time. It is now well known that almost all the crops require potassium application. Progressive intensification of agriculture is tending to create greater demand for external supply of potassium. The edible oil economy in India primarily depends upon groundnut production. Though India leads the world both in area and production of groundnut, the country ranks eighth in productivity which is lower by about 150 kg/ha than the world average. Nutrient deficiencies are one of the reasons for the low yields of groundnut. The present investigation was carried out to study the response of nitrogen and potassium on yield components and yield of groundnut (*Arachis hypogaea* L.)during summer in new alluvial zone of West Bengal.

MATERIAL AND METHODS

A field experiment on groundnut was conducted at University Agricultural Farm, Kalyani (West Bengal) during summer seasons of 1993 and 1994. The soil was loam in texture, medium in fertility status (0.7 % organic carbon, 0.07 % total N, 35 and 120 kg/ha of available P_2O_5 and K_2O respectively) and neutral in nature (pH 7.3). The factorial experiment was laid out in Randomised Block Design with 4 levels of nitrogen (0, 20, 40 and 60 kg N/ha) and 5 levels of potassium (0, 15, 30, 45 and 60 kg K_2O/ha) in 3 replications. The crop was sown during last week of January. 40 kg P_2O_5/ha along with N and K_2O as per the treatments was applied as basal. Urea, single super phosphate and muriate of potash were the sources of N, P and K respectively. The crop was kept free from major incidence of insect pests and

1.Regional Research Station, OUAT, Chiplima, Orissa.
2. Agricultural Research Station, OUAT, Berhampur 761 001
Received for publication on September 8, 1994.

diseases and was provided with irrigation as and when required. The variety used was JL 24 (Phule Pragati).

RESULTS AND DISCUSSION

Yield components

Number of pods per plant and 100 kernel weight increased significantly with the application of 40 kg N/ha over the lower dose during both years (Table 1). But application of nitrogen had no beneficial effect on shelling percentage. Nitrogen dose beyond 40 kg/ha had negative effect on yield components of groundnut. Similar results were reported by Reddy *et al*. (1981). Application of K_2O up to 45 kg /ha significantly increased pods/plant, shelling percentage and 100-kernel weight over the lower dose and further increase in dose had no significant effect. Similar results were reported by Gnanamurthy and Balasubramanian (1992) and Yakadri *et al.* (1992).

Pod yield

Highest pod yield was recorded with 40 kg N/ha and further increase to 60 kg significantly decreased pod yield (Table 2). An increase of 14.9% in pod yield was recorded with 40 kg N/ha over control. Pod yield increased up to the application of 45 kg K_2O/ha and further increase in dose had no significant effect. An increase of 25.9% in pod yield was recorded with 45 kg K_2O/ha compared to no application of potassium. This increase was due to the fact that K influences the physiological processes that are directly related to symbiotic nitrogen fixation, photosynthesis and carbohydrate translocation for pod growth. Similar results were also reported by Deshmukh *et al*. (1992). Interaction effect due to application of N and K on pod yield was also significant during both years. Significantly higher pod yield (23.06 q/ha) was recorded when the crop was grown with 40 kg N and 45 kg K_2O/ha (Table 2).

Oil content and oil yield

Oil content in kernel increased with increase in N and K level and the highest oil content was recorded with 60 kg N and 60 kg K_2O/ha (Table 1). However, oil yield significantly increased up to the application of 40 kg N and 45 kg K_2O/ha and further increase in fertility level decreased the oil yield (Table 1). Application of 40 kg N/ha increased 20.1% and 45 kg K_2O/ha increased 36.3 % oil yield compared to no application of nitrogen and potassium respectively. Deshmakh *et al.* (1992) reported that oil content and oil yield increased up to the application of 60 kg K_2O/ha.

LITERATURE CITED

Desmukh, V.N., Warokar, R.T. and Kanakpure, B.T. 1992. Yield quality and nutrient uptake by groundnut as influenced by potash fertilization and time of application. *Journal of Potassium Research* 8(4): 367-370.

Gnanamurthy, P. and Balasubramanian, P. 1992. Influence of phosphorus and potassium on rainfed groundnut (*Arachis hypogaea* L.). *Indian Journal of Agronomy* 37 (4): 755-757.

Reddy, P.R., Rao, L.M. and Subbarao, I.V. 1981. Nitrogen nutrition in groundnut (*Arachis hypogaea* L.) *Indian Journal of Experimental Biology* 19: 966-970.

Yakadri, M., Hussain, M.M. and Satyanarayana, V. 1992. Response of rainfed groundnut (*Arachis hypogaea* L.) to potassium with varying levels of nitrogen and phosphorus. *Indian Journal of Agronomy* 37(1): 202-203.

Table 1. **Effect of N and K on yield components and oil yield of summer groundnut.**

Treatments	No. of Pods/plant		Shelling(%)		100 Kernel weight (g)		Oil content in kernel (%)		Oil yield (g/ha)	
	1993	1994	1993	1994	1993	1994	1993	1994	1993	1994
N levels (kg N/ha)										
0	13.6	14.0	69.8	70.0	40.0	40.5	46.02	46.30	5.90	6.12
20	15.8	15.6	69.8	70.2	42.9	43.0	47.78	47.22	6.72	6.70
40	16.7	17.4	70.1	70.1	43.4	43.3	48.15	48.05	7.06	7.38
60	16.1	17.0	70.1	70.0	43.0	43.2	48.38	48.87	6.93	7.24
S.Em ±	0.16	0.14	0.11	0.08	0.13	0.15			0.09	0.07
C.D.(P = 0.05)	0.47	0.40	N.S	N.S	0.38	0.44			0.26	0.21
K levels (kg K_2O/ha)										
0	13.3	13.2	68.7	68.9	38.7	38.4	45.88	46.07	5.53	5.53
15	14.6	15.1	69.5	69.8	40.9	40.4	46.65	46.84	6.12	6.22
30	16.0	16.7	69.8	70.3	43.7	43.7	47.93	47.62	6.81	7.06
45	16.9	17.5	70.2	70.6	44.2	44.9	48.60	48.65	7.34	7.74
60	17.0	17.6	70.2	70.6	44.1	45.0	48.77	48.83	7.39	7.79
S.Em ±	0.18	0.16	0.12	0.09	0.15	0.17			0.10	0.08
C.D.(P = 0.05)	0.52	0.46	0.36	0.26	0.43	0.49			0.30	0.23

N.S = Not significant

Table 2. Interaction effect of N and K on pod yield (q/ha) of summer groundnut

Levels of N (kg N/ha)	Levels of K (kg K_2O/ha)					Mean	S Em ±		C.D. (P = 0.05)
	0	15	30	45	60				
1993									
0	15.90	17.04	18.57	20.22	20.12	**18.37**	N	0.13	**0.38**
20	17.82	19.03	20.47	21.80	21.65	20.15	K	0.15	**0.42**
40	18.48	19.93	21.55	22.20	22.46	**20.92**	N X K	0.29	0.85
60	17.92	19.50	20.85	21.76	22.08	**20.42**			
Mean	17.53	18.87	20.36	21.50	21.58				
1994									
0	16.24	17.58	19.25	20.63	**20.70**	**18.88**	N	0.11	0.32
20	17.20	18.97	20.64	22.08	**22.17**	**20.21**	K	0.13	0.36
40	18.50	20.22	22.70	23.93	**24.18**	**21.91**	N X K	0.25	0.72
60	17.74	19.30	21.75	**23.50**	**23.41**	21.14			
Mean	17.42	19.02	21.08	**22.53**	**22.61**				
Pooled									
0	16.07	17.31	**18.91**	**20.43**	**20.41**	18.63	N	0.09	0.24
20	17.51	19.00	**20.56**	**21.94**	**21.91**	20.18	K	0.10	0.27
40	18.49	20.08	**22.12**	**23.06**	23.32	21.41	N X K	0.19	0.54
60	17.87	19.40	**21.30**	**22.63**	22.75	20.79			
Mean	17.48	18.95	20.72	22.01	22.10				

J. Oilseeds Res. 12(1) 1995 : 87-90
ISSN 0970-2776

EFFECT OF ORGANIC MATTER AND PHOSPHORUS ON QUALITY AND NUTRIENT UPTAKE BY SOYBEAN*

V. RAMAMURTHY[1] and K. SHIVASHANKAR
Department of Agronomy, UAS, GKVK, Bangalore-560 065, Karnataka

ABSTRACT

Field experiments were conducted on a red sandy loam soil at UAS, Bangalore during summer seasons of 1991 and 1992 to study the effect of organic matter(1:1 ratio of Farm Yard Manure + paddy straw) and phosphorus levels on seed yield, oil and protein content and uptake of nutrients by soybean cv. Hardee. Application of 10 t/ha organic matter significantly enhanced the seed yield, oil and protein content in the soybean seed. Sulphur content and uptake of N, P and K by soybean showed an increasing trend with increase in levels of organic matter from 0 to 10 t/ha and phosphorus from 37.5 to 56.25kg P_2O_5/ha.

Keywords : Soybean; Organic matter; Phosphorus; Nutrient uptake.

INTRODUCTION

Soybean (*Glycine max* (L.) Merrill) has acquired an important position as a grain legume cum oilseed crop in India. Many workers have reported an improvement in contents of quality parameters like oil and protein in addition to increased concentration and uptake of nutrients with phosphorus fertilization to soybean (Kesavan and Morachan, 1973; Heque *et al*., and Hanson and Sebaugh, 1982 and Hassan *et al*., 1985). Nimje and Seth (1988) reported that application of phosphorus and Farm Yard Manure (FYM) significantly enhanced the nutrient uptake by soybean. With a view to utilize paddy straw along with FYM, the present study is aimed to know the effect of combination of organic matter with phosphorus fertilization on productivity, quality and nutrient uptake by soybean.

MATERIAL AND METHODS

Field experiments were conducted in a Factorial Randomised Block Design with three replications in summer seasons of 1991 and 1992 at Main Research Station, Hebbal, University of Agricultural Sciences, Bangalore. The plot size is 19.2m x 12.0m (gross) and 14.4m x 9.6m (net). The treatments consisted of combination of three levels of organic matter (1:1 ratio of FYM and paddy straw) i.e., 0, 5 and 10 t/ha and two levels of phosphorus i.e., 37.5 (recommended dose) and 56.25 kg (50% more than recommended dose) P_2O_5/ha applied through single super phosphate. As per the treatments, chopped paddy straw and FYM were mixed well and incorporated into soil by digging two weeks before sowing of soybean. The nutrient content of paddy straw was 0.42% N, 0.11% P, 0.8% K, in 1990 and

1. IGFRI, Regional Station, UAS Campus, Dharwad - 580 005
* Part of Ph. D thesis is submitted to UAS, GKVK, Bangalore 560 065.
Received for publication on September 5, 1994.

0.38% N, 0.8% P and 0.71% K in 1991 and in FYM 0.52% N, 0.3% P, 0.6% K and 0.48% N, 0.27% P, 0.55% K, respectively in 1990 and 1991. The soils of the experimental area was red sandy loam. It tested medium in available N (276.5 kg/ha), P_2O_5 (48.9 kg/ha) and K_2O (207.5 kg/ha). Soybean cv. Hardee was sown on March 1 and 4 in 1991 and 1992, respectively in rows 30 cm apart. The estimation of oil content was determined by Nuclear Magnetic Resonance spectro meter (NMR minispec 20 P) against the standard reference sample. The per cent protein in the grain was calculated from the per cent N in the grain by multiplying with the factor 6.25. At harvesting, whole soybean plant was analysed for N, P and K contents by employing standard methods.

RESULTS AND DISCUSSION

Seed yield

Application of 10 t organic matter (OM) recorded significantly higher seed yield of 2690 kg/ha compared to 5 t (2300 kg/ha) and control (2070 kg/ha). The seed yield of soybean increased significantly with increased levels of phosphorus from 2270 kg/ha (37.5 kg P_2O_5/ha) to 2410 kg/ha (56.25 kg P_2O_5/ha) (Table 1). The seed yield of soybean increased linearly with increase in organic matter and phosphorus levels as reported by Kesavan and Morachan (1973) and Shivashankar and Shantaram (1980). The interaction effects of OM and Phosphorus were not significant.

Quality attributes of soybean

The results revealed an increasing trend in yield per hectare of oil and protein in soybean seeds with increasing levels of organic matter applied to soil. Application of 10 t organic matter recorded maximum values for oil (19.38%), Protein (38.54%), oil yield (522.72 kg/ha) and protein yield (103.64 kg/ha) which were significantly higher than those observed at 5 t organic matter/ha and no application of organic matter (Table 1). The increase in oil

Table 1. Seed yield, oil and protein content and oil and protein yield of soybean as influenced by levels of organic matter and phosphorus (mean of 2 years)

Treatment	Seed yield kg/ha	Oil (%)	Crude/Protein (%)	Oil yield (kg/ha)	Protein yield (kg/ha)
Organic matter (t/ha)					
0	2,070	18.34	34.95	370.35	707.32
5	2,300	18.84	37.25	433.23	857.38
10	2,690	19.38	38.54	522.72	1038.64
S.Em ±	40	0.14	0.32	7.90	17.79
C.D. (P = 0.05)	120	0.42	0.95	23.18	52.10
P_2O_5 (kg/ha)					
37.50	2,270	18.72	36.83	425.25	838.96
56.25	2,410	18.98	37.00	458.95	896.60
S.Em ±	30	0.12	0.26	6.45	14.05
C.D. (P = 0.05)	90	NS	NS	18.93	42.54
OM x P_2O_5	NS	**	NS	*	NS

OM = Organic Matter

and protein contents over no organic matter were to the tune of 5.7 and 10.3 per cent. The higher oil content may be due to significantly higher sulphur content in seed from the respective treatments (Table 3). The sulphur activates the co-enzyme in fat metabolism there by enhancing the production of oil. Higher crude protein and yield with OM application have been also reported by Shivashankar and Shantaram (1980).

The application of phosphorus at higher level (56.25 kg/ha) could only enhance the oil and protein yields significantly. Contrary to these observations, Kesavan and Morachan (1973) and Hassan *et al.* (1985) observed increase in oil content while Dickson *et al.* (1983) observed increased crude protein content with increase in P levels. In the present study, though the higher P_2O_5 resulted in higher sulphur content in seeds, it could not raise the oil content to the level of significance over lower application of P_2O_5 (37.5 kg/ha).

The oil content and oil yield per hectare remained at par with the two levels of phosphorus both at zero and 5 t OM levels. Application of 10 t OM with 56.25 kg P_2O_5/ha was found to be superior both in oil content and oil yield (Table 2). At 37.5 kg P_2O_5/ha, oil content was superior with 5 t OM over control and the oil yield increased with increasing levels of OM.

Nutrient uptake

The uptake of major nutrients was found to increase significantly with increasing levels of OM application. The maximum values for uptake of N, P and K were 225.1, 23.4 and 86.5 kg/ha for application of 10 t/ha of OM and differed significantly over 5 t/ha and no OM application (Table 3). It may be due to solubilising effects of OM on fixed forms of nutrients in soil (Yoshida, 1979 and Sinha *et al.*, 1981).

Increasing application of P_2O_5 from 37.5 kg/ha to 56.25 kg/ha resulted in significant improvement in N, P and K contents of soybean. These results are in confirmity of those observed by Singh and Saxena (1973) and Nimje and Seth (1988). The increased N uptake with increased phosphorus levels might be due to enhanced N fixation and improved

Table 2. Oil percentage and oil yield of soybean as influenced by interaction of organic matter and phosphorus levels

	Oil %			Oil yield (kg/ha)		
	Phosphorus levels (kg/ha)					
	37.50	56.25	Mean	37.50	56.25	Mean
Organic matter (t/ha)						
0	18.31	18.36	18.34	363.55	377.15	370.35
5	19.00	18.67	18.84	425.80	440.65	433.23
10	18.86	19.91	19.38	486.39	559.05	522.72
Mean	18.72	18.98		425.25	458.95	
S.Em ±	0.20			11.18		
C.D. (P = 0.05)	0.59			32.78		

Table 3. Sulphur content of soybean seed, nitrogen, phosphorus and potash uptake by soybean as influenced by levels of organic matter and phosphorus (mean of 2 years)

Treatment	S content in grain (%)	N uptake (kg/ha)	P uptake (kg/ha)	K uptake (kg/ha)
Organic matter (t/ha)				
0	0.26	147.34	17.00	60.60
5	0.32	190.40	19.90	75.70
10	0.37	225.10	23.40	46.50
S.Em ±	0.004	3.30	0.40	1.00
C.D. (P = 0.05)	0.011	9.70	1.10	3.00
P_2O_5 (kg/ha)				
37.50	0.30	179.80	19.50	71.80
56.25	0.33	195.74	20.70	76.80
S.Em ±	0.003	2.70	0.30	0.80
C.D. (P = 0.05)	0.009	7.90	0.90	2.50
OM x P_2O_5	NS	NS	NS	NS

growth of soybean plant (Hanson and Sebaugh, 1982). Enhanced P and K uptake with increasing levels of phosphorus were noticed by several workers including Sinha *et al.* (1981), and Hanson and Sebaugh (1982).

The results in the present study clearly brought out that application of 10 t OM and 56.25 kg P_2O_5/ha improved the oil and protein yield and nutrient uptake by soybean.

LITERATURE CITED

Dickson, T., Hydow, G.F. and Dwyer, J.C. 1983. Mineral nutrition of soybean grown in the south Burnett region of South Eastern Queensland. *Australian J. Experimental Agriculture and Animal Husbandry* 23 (120) : 30-37.

Hanson, R.G. and Sebaugh, J.L. 1982. Influence of lime and phosphorus on soybean yield, leaf and seed composition of a Paleudlt soil (Brazil). *Soil Sci. Pl. Analysis* 13 : 775-792.

Kesavan, G. and Morachan, Y.B. 1973. Response of soybean varieties to graded doses of nitrogen and phosphorus. *Madras Agric. J.* 60 (1) : 23-26.

Nimje, P.M. and Seth, J. 1988. Effect of phosphorus and FYM on nutrient uptake by soybean. *Indian J. Agron.* 33 (2) : 139-142.

Shivashankar, K. and Shantaram, M.V. 1980. Nodulation, growth and yield of soybeans as affected by paddy straw application to soil. *Z. pflanzen. Bodenk* 143 : 163-173.

Sinha, Prasad, B. and Ghosh, A.B. 1981. Effect of continuous use of fertilizers on yield and nutrient uptake in a wheat soybean - potato cropping system. *J. Indian Soc. Soil Sci.* 29 : 537-542.

Singh, N.P. and Saxena, M.C. 1973. Pattern of drymatter accumulation in soybean as affected by nitrogen, inoculation and phosphorus fertilization. *Indian J. agric. Sci.* 43 : 62-66.

Yoshida, S. 1979. Effect of Farm Yard Manure on the nitrogen nutrition of soybean. *Japanse J. Crop Sci.* 48 : 17-24.

J. Oilseeds Res. 12(1) 1995 : 91-94
ISSN 0970-2776

MONITORING OF TOBACCO CATERPILLAR IN GROUNDNUT WITH SYNTHETIC SEX PHEROMONE TRAPS

S.A. GHORPADE [1] and S.G. THAKUR [1]
Oilseeds Research Station, Jalgaon 425 001

ABSTRACT

The sex pheromone traps arranged for monitoring *Spodoptera litura* (Fab.) in groundnut fields during 1988 to 1992 showed peak catches of moths in the first fortnight of August and in the first week of September. The weekly trap catches were positively correlated with minimum and maximum relative humidity and minimum temperature, while negative correlation was observed with sun shine hours per day. There was a significant positive correlation between number of caterpillars per ten plants in groundnut fields and mean moth trap catches. These observations indicated that the sex pheromone traps can work as promising tool for monitoring of *S. litura* out breaks in groundnut fields.

Keywords : *Spodoptera litura;* Pheromone traps; Meteorological parameters.

INTRODUCTION

The tobacco caterpillar, *Spodoptera litura* (Fab.) has become a major pest of groundnut in many regions in India (Amin, 1988). In order to formulate a suitable programme for management of *S. litura*, it is essential to monitor the occurrence of pest. The trapping of *Spodoptera* male moths by synthetic sex pheromones was undertaken in the groundnut fields to detect the adult peaks in the *kharif* season.

MATERIAL AND METHODS

Studies were conducted at the Oilseeds Research Station, Jalgaon (Maharashtra) for five years from 1988 to 1992. Two pheromone traps supplied by the ICRISAT, Hyderabad were fixed in the groundnut fields at a distance of 100 m starting in the beginning of June. Each trap had a white plastic funnel of 20 cm diameter with an aluminium plate covered above. The traps were placed one meter above ground level. The synthetic pheromone septum supplied by ICRISAT was hung below the centre of the aluminium plate above the plastic funnel. The funnel was covered by a polythene bag with one corner cut and tied up with a wire to remove the trapped moths. Septa were replaced at an interval of four weeks. Trapped moths were removed and recorded daily. The average weekly *S. litura* male moth catches in pheromone traps, meteorological parameters and the number of caterpillars per 10 groundnut plants are given in Table 1.

Meteorological parameters and correlation with trapped moths were worked out for each year and for the mean of five years and presented in Table 2. The *S. litura* larval population was recorded on 10 groundnut plants in a unsprayed plot of 20 m^2 at weekly intervals and correlation with male moths trapped was calculated. The moth catch and its relation to larval population is shown in figure 1.

1. Mahatma Phule Krishi Vidyapeeth, Rahuri, 413 722, Ahmednagar Dist. Maharashtra
Received for publication on October 15, 1994.

RESULTS AND DISCUSSION

The data on catches of *S. litura* in pheromone traps showed that the pest was active throughout the *kharif* season during 1988 to 1992. During the period of observations, the moth catches increased progressively from 25th to 33rd meteorological weeks followed by a good peak in September first week (Fig.). The size of catches were minimum during November and December. The observations recorded on the seasonal activity of the *S. litura* in groundnut fields indicated the maximum larval population (12.3 to 16.0 larvae/10 plants) during the period from 32nd to 36th meteorological weeks. Thus, these observations indicated that the sex pheromone traps can work as a monitoring or warning device for *S. litura*. Similar results were earlier reported by Pawar and Prasad (1983) and Dhandapani (1985).

Correlation coefficients between pheromone male moth trap catches and meteorological parameter/larval population of *S. litura* revealed that the relative humidity and minimum temperature significantly influenced the trap catches. The pheromone trap catches were positively correlated with morning and evening relative humidity as well as minimum temperature except during the year 1989-90. These observations agree with the results reported by Mishra and Sontakke (1992). A significant positive correlation between moths trapped and rainfall (1990-91) and larval population was observed except during the year 1988-89. However, significant negative correlation was observed with trap catches and sunshine hours per day during the year 1988-89 (Table 2).

LITERATURE CITED

Amin, P.W. 1988. Insects and mite pests and their control. pp: 393-453. *In*: Groundnut. Ed. P.S. Reddy. Indian Council of Agricultural Research, New Delhi.

Dhandapani, N. 1985. Trapping of *Spodoptera litura* (Fab.) moths using sex pheromone. *Madras Agricultural Journal* 72:235-238.

Mishra, P.R. and B.K. Sontakke, 1992. Monitoring of *Spodoptera litura* (Fab) by pheromone trap catches. *Indian J. of Plant Protection*, 20 : 188-190.

Pawar, A.D. and Jagdish Prasad. 1983. Field evaluation of synthetic pheromone trap 'Litlure' as an attraction for males of *Spodoptera litura* (Fab) (Lepidoptera : Noctuidae) *Indian Journal of Plant Protection*, 11 : 108 - 109.

Table 2. Correlation coefficient between pheromone trap moth catches and meteorological parameters/spodoptera larval population during 1988 to 1992.

Year	Rain fall (mm)	Temperature (°C)		Relative humidity (%)		Sun shine hrs/day	Spodoptera larval population
		Maximum	Minimum	Morning	Evening		
1988-89	0.41 *	-0.23	0.61 **	0.79 **	0.79 **	-0.71 **	0.35
1989-90	-0.12	0.28	0.31	0.28	0.16	-0.04	0.49 **
1990-91	0.64 **	0.04	0.47 **	0.39 *	0.41 **	-0.34	0.47 **
1991-92	0.01	0.29	0.59 **	0.52 **	0.56 **	-0.15	0.85 **
1992-93	0..36	0.36	0.73 **	0.59 **	0.76 **	-0.24	0.70 **
Average	0.62 **	-0.16	0.63 **	0.79 **	0.75 **	-0.65 **	0.75 **

Asteriks indicates significant correlation at 5% (*) and 1% (**) probability

Table 1. **Mean weekly catches of *Spodoptera litura* (Fab.) male moths in pheromone traps at Jalgaon during 1988-89 to 1992-93.**

Observation period		Met. week	Mean male moth per trap per week	Av. no. of *S.litura* larvae per ten plants	Meteorological parameters (Mean of five years)					
					Temp °C		Relative humidity (%)		Average rainfall(mm)	Sun shine hours per day
					Max.	Min.	Morn.	Even.		
June	04-10	23	29.5	-	41.0	27.0	68	29	20.2	8.7
	11-17	24	34.0	-	37.5	25.8	77	48	40.1	6.8
	18-24	25	19.0	-	37.4	25.0	78	48	13.7	4.9
	25-01	26	52.3	-	35.1	25.1	80	53	77.9	5.4
July	02-08	27	58.5	-	34.0	24.9	82	55	35.1	4.8
	09-15	28	56.8	0.5	34.4	24.7	82	53	52.7	5.1
	16-22	29	63.4	5.3	32.6	24.6	85	65	93.6	4.4
	23-29	30	66.4	8.3	30.5	24.1	88	74	70.7	2.6
Aug.	30-05	31	105.2	8.0	31.1	23.9	87	64	37.8	2.8
	06-12	32	100.2	12.3	31.5	24.2	89	70	41.1	4.8
	13-19	33	104.2	10.0	30.4	24.4	91	73	69.8	3.0
	20-26	34	67.0	9.0	29.8	23.6	91	74	47.1	1.9
	27-02	35	59.4	16.0	30.8	23.5	89	68	24.7	3.5
Sept.	03-09	36	133.0	12.3	31.9	23.1	88	62	49.9	5.8
	10-16	37	81.4	5.8	32.7	22.8	85	55	10.3	7.4
	17-23	38	60.8	4.3	33.1	23.4	80	52	37.4	7.6
	24-30	39	58.2	3.0	33.5	23.4	81	54	35.4	7.0
Oct.	01-07	40	49.8	2.3	34.6	21.6	76	46	16.1	7.9
	08-14	41	62.4	-	34.0	20.7	74	37	28.6	8.2
	15-21	42	64.0	-	34.8	19.7	68	31	0.0	8.8
	22-28	43	29.0	-	34.2	17.4	62	30	06.6	9.4
	29-40	44	37.8	-	33.7	16.3	66	31	00.0	9.4
Nov.	05-11	45	16.6	-	33.1	15.3	61	26	00.0	9.6
	12-18	46	14.8	-	32.6	16.1	66	37	00.3	9.2
	19-25	47	12.6	-	31.8	16.6	65	37	00.0	8.4
	26-02	48	17.6	-	31.9	14.8	65	33	00.0	9.5
Dec.	03-09	49	23.8	-	31.6	14.3	67	36	00.5	8.9
	10-16	50	15.2	-	30.3	12.0	68	33	01.0	9.1
	17-23	51	09.8	-	29.8	12.3	65	32	00.0	9.4
	24-31	52	10.6	-	29.4	10.8	75	37	00.0	8.8

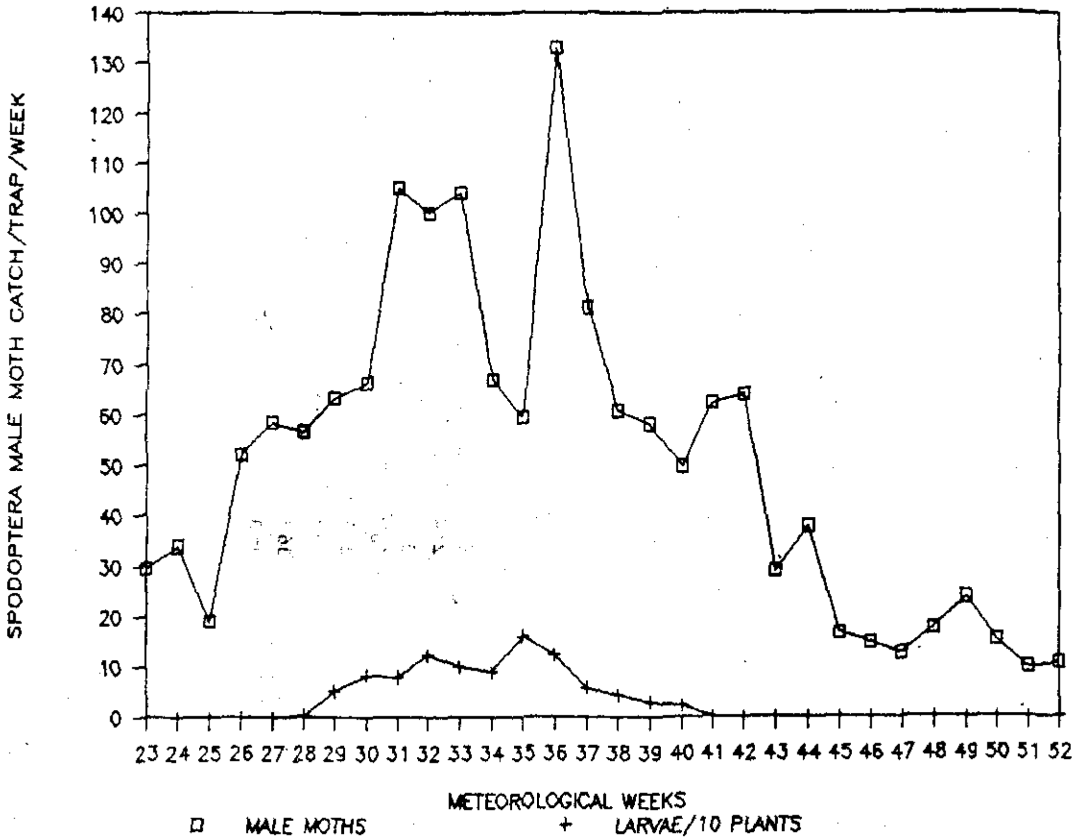


Figure Catches of male moths in pheromone traps and incidence of *S. litura* on groundnut at Jalgaon during 1988 to 1992

J.Oilseeds Res. 12(1) 1995 : 95-99
*ISSN*0970-2776

RESPONSE OF LINSEED TO NITROGEN LEVELS IN VERTISOLS

J.P. KHARE, R.S. SHARMA[1], V.S. TOMAR[2], and K.C. SHUKLA
Regional Agricultural Research Station, JNKVV, Sagar, M.P.

ABSTRACT

Field experiments were carried out on irrigated linseed (*Linum usitatissimum* Linn.) in Vertisols of Sagar (M.P.) during *rabi* seasons of 1990-91 and 1991-92 to determine optimum N requirement. Results revealed that J-23 variety gave higher seed and straw yield over LCK-8407 mainly due to higher number of capsules/plant. Significant increase in seed yield was recorded up to 90 kg N/ha and yield markedly reduced with 120 kg N/ha. But straw yield significantly increased due to N application up to 120 kg/ha. Increased plant height and branches/plant up to the highest level of N contributed for increased straw yield while yield attributes viz., capsules/plant and seeds/capsule declined beyond 90 kg N/ha resulting in low seed yield. Seed index and oil content were unaffected due to varieties and N levels. J-23 markedly fetched higher net profit and benefit cost ratio over LCK-8407. Both net profit and profitability increased due to N application up to 90 kg/ha level.

Keywords:- Linseed; Nitrogen levels; Irrigation; Seed yield

INTRODUCTION

Linseed (*Linum usitatissimum* Linn.) cultivation is preferred by the farmers due to higher monetary gains over cereal crops under limited irrigation, (Sharma and Rathi, 1989). It responds to nitrogen application under different agro-climatic conditions (Nema *et al.*, 1977, Tomar *et al.*, 1985, Tiwari *et al.*, 1988). However, information with regard to optimum nitrogen requirement for high yielding linseed varieties grown under irrigation in Sagar region of M.P. are scanty. Hence, the present investigation was undertaken.

MATERIAL AND METHODS

Field experiments were conducted on linseed during *rabi* seasons of 1990-91 and 1991-92 with irrigation in clay loam soil (Vertisols) at Regional Agricultural Research Station, Sagar. The soil of the experimental field was near neutral (pH 7.4) in reaction and had 215, 15 and 336 kg/ha in available N, P and K respectively. Ten treatments consisted of two varieties (J-23 and LCK-8407) and five nitrogen levels (0, 30, 60, 90 and 120 kg N/ha) were tested in Randomised Block Design with four replications. Sowing was done by drilling 30 kg seed/ha in rows of 25 cm apart on November 8 and 15 in the two consecutive years. A uniform basal dose of 40 kg P_2O_5/ha through single superphosphate and 30 kg K_2O/ha through muriate of potash was given to all plots. Nitrogen was applied through urea as per treatments in two equal splits i.e. first half as basal with P and K fertilizers, and rest at 35 days after sowing.

1. Department of Agronomy, JNKVV, Jabalpur, MP.
2. Department of Soil Science and Agricultural Chemistry, JNKVV, Jabalpur, MP.
Received for publication on October 28, 1994.

Three irrigations were given at pre-sowing, 35th and 70th day after sowing. Harvesting was done on April 1 and 8 in the two respective years. Data on various growth and yield parameters, seed and straw yield were recorded and monetary returns were computed.

RESULTS AND DISCUSSION

Performance of varieties

Seed and straw yields were consistently higher with J-23 over LCK- 8407 in both the years, but the differences were significant only in first year (Table 1). Mean seed and straw yield were 10.05 and 24.29 q/ha, respectively in J-23 which were 6.24 and 8.94% higher than that of LCK-8407. Growth parameters viz., plant height and primary branches/plant were similar in both the varieties (Table 2), but J-23 had an edge over LCK- 8407. Seeds/capsule, 1000 seed weight (seed index) and oil content in seed did not vary between the two varieties. However, significant superiority in capsules/plant in J-23 is observed.

Effect of nitrogen levels

Both varieties exhibited significant response to varying levels of N application in both years (Table 1). Mean seed yield showed a progressive increase (22 to 48%) with increasing levels of nitrogen from 30 to 90 kg/ha over control (7.11 q/ha) and then significantly decreased at 120 kg N/ha. Similar increasing trend in mean straw yield (11 to 58%) was noticed with increasing levels of N up to 120 kg N/ha over control (18.08 q/ha). Vegetative growth (plant height and branches/plant) significantly increased up to the highest level of N and contributed to increased yield. Yield attributes viz., capsules/plant and seeds/capsule markedly increased up to 90 kg N/ha and then decreased with 120 kg N/ha over 90 kg N/ha explaining the reduction in seed yield at the highest level of N. Seed index and oil content of seed were unchanged due to different levels of nitrogen. Similar results have been reported by Nema *et al.* (1977) and Jain *et al.* (1989). Excessive vegetative growth with 120 kg N/ha caused low capsule formation and seed setting explaining low seed yield over 90 kg N/ha. Koshta and Baltawar (1981) reported similar findings.

Monetary advantage

Variety J-23 proved to be superior with regard to net profit (Rs.5631/ha.) over LCK-8407 (Rs.5061/ha.) with the same investment for the cultivation (Table 1.). Thereby the benefit: cost ratio was higher with J-23 (2.21) than LCK-8407 (2.09).

The results of the investigation suggest that increase in yield levels of linseed could be achieved with higher profitability by supplementing nitrogen up to 90 kg/ha along with recommended P and K. Further increase in levels of nitrogen is utilized in promoting vegetative growth only and hamper the partitioning of photosynthates for reproductive phase of crop.

LITERATURE CITED

Jain, V.K., Chauhan, Y.S., Khandekar, M.P., Sharma, R.P. and Yadav, M.P. 1989. Effect of N and P on growth and yield of linseed. *Indian J. Agron.* 34(1): 122-124.

Koshta, L.D. and Baltawar, H.B. 1981. Effect of various irrigation schedules on the growth and yield of linseed. *Indian J. Agron.* 26(2): 194-195.

Table 1. Effect of varieties and nitrogen levels on yield and monetary advantage in linseed

Treatment	Seed yield (q/ha)			Straw yield (q/ha)			Net profit (Rs./ha)			Benefit cost ratio		
	1991	1992	Mean	1991	1992	Mean	1991	1992	Mean	1991	1992	Mean
Variety												
J-23	11.52	8.58	10.05	27.48	20.85	24.29	7134	4128	5631	2.53	1.89	2.21
LCK-8407	10.43	8.48	9.46	23.49	20.44	22.29	6009	4024	5016	2.31	1.86	2.09
S.Em ±	0.18	0.13	0.17	0.34	0.27	0.31	81	37	-	0.04	0.02	-
C.D.(P=0.05)	0.57	NS	NS	1.07	NS	NS	247	NS	-	0.14	NS	-
Kg N/ha												
0	8.51	5.71	7.11	24.04	13.56	18.80	4650	1745	3197	2.13	1.43	1.78
30	10.37	6.98	8.68	26.34	15.32	20.83	6308	2808	4558	2.46	1.65	2.06
60	11.41	8.73	10.27	28.64	22.34	25.49	7146	4403	5774	2.57	1.97	2.27
90	13.32	11.44	12.39	29.40	24.36	26.88	8849	6938	7893	2.84	2.39	2.62
120	11.27	9.81	10.54	32.13	27.36	29.74	6581	5056	5818	2.32	2.00	2.16
S.Em ±	0.31	0.18	0.22	0.53	0.32	0.43	124	84	-	0.06	0.03	-
C.D. (P=0.05)	1.01	0.53	0.65	1.62	0.97	1.30	373	250	-	0.17	0.10	-

NS = Not significant

Table 2. Effects of varieties and nitrogen levles on growth and yield parameters of linseed

Treatment	Plant height (cm)			Branches/plant			Capsules/plant			Seeds/Capsule			1000 seed weight (g)			Oil content %		
	1991	1992	Mean	1991	1992	Mean	1991	1992	Mean	1991	1992	Mean	1991	1992	Mean	1991	1992	Mean
Variety																		
J-23	69.2	62.8	66.00	3.82	2.67	3.25	38.3	25.8	32.15	8.2	9.1	8.7	7.0	7.8	7.4	44.8	45.5	45.2
LCK-8407	68.9	62.2	65.55	3.57	2.50	3.04	36.4	24.9	30.76	8.5	9.4	9.0	7.1	7.8	7.45	44.2	46.1	45.2
S.Em ±	0.2	0.2	0.2	0.04	0.03	0.04	0.4	0.1	0.30	0.05	0.1	0.08	0.02	0.01	0.02	0.2	0.3	0.3
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	0.90	NS	NS	NS	NS	NS	NS	NS	NS	NS
Kg N/ha																		
0	63.7	60.3	62.00	2.70	1.88	2.29	22.2	17.4	19.8	7.8	8.4	8.1	6.9	7.6	7.25	44.0	45.2	44.6
30	66.8	61.9	64.30	3.33	2.25	2.79	31.8	21.8	26.8	8.2	9.2	8.7	7.0	7.7	7.35	45.0	45.9	45.5
60	69.2	62.3	65.75	3.80	2.70	3.25	40.5	27.2	33.9	8.6	9.5	9.0	7.0	7.8	7.40	44.5	46.0	45.3
90	71.1	63.5	67.30	4.10	2.90	3.50	45.8	31.5	38.7	8.7	9.6	9.1	7.3	8.0	7.65	44.7	45.8	45.3
120	74.4	64.9	69.65	4.56	3.20	3.88	43.3	28.8	36.1	8.5	9.5	9.0	7.1	7.9	7.50	44.8	46.1	45.5
S.Em ±	0.3	0.3	0.3	0.08	0.04	0.06	0.7	0.2	0.5	0.1	0.2	0.15	0.05	0.03	0.04	0.4	0.5	0.5
CD (P = 0.05)	0.9	0.9	0.9	0.23	0.12	0.18	2.3	0.7	1.5	0.3	0.6	0.45	NS	NS	NS	NS	NS	NS

NS = Not significant

Nema, B.L., Dubey, K.M. and Goswami, U. 1977. Yield response in two varieties of linseed under different combinations of nitrogen and phosphorus. *JNKVV. Res. J.* 11(3): 177-179.

Sharma, R.S. and Rathi, G.S. 1989. Growing of oilseeds and pulses is more remunerative than cereals under resource constraints. *Indian Fmg.* 39 (8): 28-29.

Tiwari, K.P., Dixit, J.P. and Saran, R.N. 1988. Effect of nitrogen and irrigation on linseed. *Indian J.Agron.* 33(1): 44-46.

Tomar, G.S., Sharma, R.S., Sharma, S.M. and Kurmi, N. 1985. Effect of different irrigation schedules and fertility levels on yield and yield attributes of linseed. *J. Oil seeds Res.* 2(2): 210-217.

J.Oilseeds Res. 12(1) 1995 : 100-102
ISSN 0970-2776

HETEROSIS AND INBREEDING DEPRESSION IN SESAME

C.R. ANANDA KUMAR
Agricultural Research station, Kovilpatti-627 701, Tamil Nadu

ABSTRACT

Nine genotypes consisting of six cultures (lines) and three varieties (testers) formed the base material and were crossed in "line x tester" method. Thus, the resultant 18 hybrids were selfed to get F_2 generation. The F_1 and F_2 generations were simultaneously evaluated. Observations were recorded for five economic traits including yield. In general, crosses with significant heterosis expressed significant inbreeding depression in F_2 generation. The presence of dominance and non additive gene action for controlling these traits in sesame is revealed.

Keywords: Heterosis; Inbreeding depression; Line x Testers; Sesame

INTRODUCTION

Sesame(*Sesamum indicum* D.C. and L.) is one of the ancient oilseed crops cultivated and originated probably in Africa where the genus exhibited greater diversity (Osman, 1985). India stands first in area under sesame but only second in production. This is mainly due to the low productivity of 221 kg/ha, in India as against the world average yield of 348 kg/ha. (1990). This necessitates to augment the yield by evolving high yielding varieties or hybrids in sesame.

To achieve this objective, it is essential to know the genetics of yield and its components. For enhansing the yield potential of varieties and hybrids, it is necessary to reshuffle the genes by crossing and study the heterotic effect in the first and subsequent generations. Though sesame is predominantly a self pollinated crop, considerable level of cross pollination also noticed (Paramanantham, 1992). Hence an attempt was made to find out the level of hybrid vigour and inbreeding depression in sesame.

MATERIAL AND METHODS

Six high yielding homozygous genotypes from different regions of Tamil Nadu viz., TSS 6, TNAU 12, TNAU 17, TNAU 86, VS 117, and DPI 1589 were used as female parents and the high yielding varieties viz., CO 1, TMV 3 and TMV 6 were used as male parents in a "line x tester" method to get eighteen cross combinations.

Hybridization was effected between parents in " l x t" fashion in order to get fresh F_1 seeds. Simultaneously the F_1's were selfed to obtain F_2 seeds. The parents were also selfed to maintain their purity. The generated materials viz., F_1 and F_2 of 18 crosses were raised along with the respective parents in a Randomised Block Design replicated thrice. Each replication consisted of three rows of parents and F_1 and six rows of F_2 generation. Spacing adopted was 45 cm between rows and 15 cm within the row. Thus, a total of 90 plants in parents and F_1 and 180 plants in F_2 were raised for each cross per replication. Among these, 20 plants per plot in parents and F_1's;

Received for publication on November 12, 1994.

and 60 plants in F_2's were selected randomly in each replication and tagged for recording observations on important traits viz., plant height, number of capsules, leaf area, oil content in seeds and seed yield per plant. The percentage of hybrid vigour over mid parental value (heterosis) and reduction of vigour in F_2 compared to F_1 generation i.e., inbreeding depression were worked out.

RESULTS AND DISCUSSION

The percentage of heterosis and inbreeding depression shown by the 18 cross combinations are given in Table 1. The heterosis percentage for plant height ranged from -14.3 (DPI 1589/TMV 3) to 34.1 (VS 117/CO 1). Significant and positive expression for heterosis was shown by five hybrids. For capsule number, eight hybrids had positive and significant heterosis which ranged between 7.1 in DPI 1589/TMV 3 and 190.9 per cent in VS 117/CO1. Ten hybrids each, showed positive heterosis for leaf area and oil content respectively, while, sixteen hybrids showed positively significant heterotic expression for seed yield and the values ranged from 1.6 (DPI 1589/CO 1) to 169.9 per cent (TSS 6/TMV 6). The findings by Sasikumar and Sardana (1990) also indicate significant and positive heterosis for number of capsules per plant, number of seeds per capsule and seed yield per plant. However, they observed negative heterosis for plant height and number of branches per plant, whereas Sodani and Bhatnagar (1990) indicated positive heterosis for number of capsules and branches per plant, while plant height and capsule length showed negative heterosis.

The inbreeding depression was maximum in yield per plant with 12 combinations registering inbreeding depression. This was followed by number of capsules and leaf area with seven crosses each showing inbreeding depression. Among the crosses, the cross TNAU 86/TMV 6 registered significant inbreeding depression for all the traits.

The inbreeding depression was maximum in seed yield per plant as exhibited by 12 crosses, which also showed high heterotic expression.

Godawat and Gupta (1985) reported that heterosis was followed by inbreeding depression in all the crosses. They attributed this to involvement of non additive gene action in the control of seed yield, number of capsules per plant and plant height. Sodani and Bhatnagar (1990) reported that inbreeding depression for capsules per plant was maximum followed by seed yield and number of branches per plant.

Hence, the presence of dominance and non additive gene action for controlling these traits in sesame is indicated. Also the study showed that in general, crosses with significant heterosis expressed significant inbreeding depression in F_2 generation.

LITERATURE CITED

Godawat, S.L. and Gupta, S.C. 1985. Inheritance of grain yield and its components in sesame. *J. Oilseeds Res.* 2 : 260-267.

Osman, H.E. 1985. Studies in sesame : II. Heterosis., Sesame and Safflower: Status and potentials, FAO, 66 : 157-162.

Paramanantham, S. 1992. Insect pollination of cotton and sesame. M.Phil. Dissertation, Madurai Kamarajar Univ.

Sasikumar, B. and Sardana, S. 1990. Heterosis for yield and yield components in sesame. *Indian J. Genet.* 50 (1) : 45-49.

Sodani, S.N. and Bhatnagar, S.K. 1990. Heterosis and inbreeding depression in sesame. *Indian J. Genet.* 50(1) : 87-88.

Table 1. Heterosis (Het.) and inbreeding depression (I.D.) in sesame

Cross	Plant height		Capsule no.		Leaf area		Oil %		Seed yield/plant	
	Het.	I.D.	Het.	I.D.	Het.	I.D.	Het.	I.D.	Het.	I.D.
TSS6/CO1	12.6*	-5.3	59.0**	7.2	-2.3	23.3**	1.9	-11.9	80.9**	35.0**
TSS6/TMV3	-0.2	-7.8	7.4	5.4	42.5	35.8**	5.4**	-17.9	41.3**	-2.4
TSS6/TMV6	-7.8	-1.8	24.1	3.0	53.7**	34.2	0.6	-6.3	69.9**	37.9**
TNAU12/CO1	18.5**	11.2**	37.9*	9.7	69.5**	40.2**	7.4**	-2.1	34.8**	-11.2
TNAU12/TMV3	23.7**	8.6**	56.8**	16.0**	22.7	0.2	7.3**	0	109.3**	44.3**
TNAU12/TMV6	4.1	3.9	23.9	30.9**	0.9	18.6	2.7**	2.9	23.5**	-26.0**
TNAU17/CO1	0.1	-1.5	53.7**	24.6**	32.1	43.7**	8.1**	7.7*	34.4**	28.4**
TNAU17/TMV3	15.4**	-1.5	28.0	2.2	39.2**	24.5	-1.4	4.6*	49.4**	24.9**
TNAU17/TMV6	-6.3	-6.3	32.9	30.0**	58.7**	36.8**	-4.1**	1.9	87.9**	36.3**
TNAU86/CO1	1.7	1.6	55.3**	20.9*	59.6**	16.4	13.2**	3.1	49.2**	22.3**
TNAU86/TMV3	8.0	2.8	16.0	-5.7	187.6**	57.4*	7.5**	7.2**	37.9**	21.4**
TNAU86/TMV6	7.0	22.7**	26.9	44.8**	201.1**	49.5**	1.4	7.9**	71.5**	64.9**
VS117/CO1	34.1**	7.8**	190.9**	30.7**	14.9	25.5	13.9**	4.4	97.3**	26.5**
VS117/TMV3	5.3	-17.1**	59.7**	18.6	51.3**	36.3**	-9.1**	-6.5	150.7**	35.1**
VS117/TMV6	7.6	3.4	112.6**	21.5	-9.7	12.9	-11.4**	-7.3	93.2**	20.2*
DPI1589/CO1	1.6	4.0	17.1	2.3	-34.3**	-36.8*	7.3**	2.3	1.6	-15.9
DPI1589/TMV3	-14.3*	-29.2**	7.1	0.8	-1.2	22.1	3.7**	3.1	14.2	-11.1
DPI1588/TMV6	-2.7	0.6	17.6	-7.1	-38.5**	14.7	-0.6	-0.8	69.5**	8.9
S.E	4.7		6.7		2.2		0.5		0.4	

*,** = Significant at 5% & 1% respectively

J.Oilseeds Res. 12(1) 1995 :103-108
ISSN 0970-2776

FACTORS INFLUENCING SEED DORMANCY IN SPANISH AND VIRGINIA GROUNDNUT GENOTYPES

P.VENU, M.B. CHETTI, D.S.UPPAR, M.B.DODDAMANI and U.V. MUMMIGATTI
Department of Crop Physiology, University of Agricultural Sciences, Dharwad - 580 005

ABSTRACT

Laboratory experiments were conducted during *kharif*, 1991 to understand the relationship of seed moisture content with dormancy and seedling vigour in spanish and virginia genotypes of groundnut. It was observed that the whole seed dormancy was higher in both spanish and virginia types as compared to embryo dormancy. The genotype Dh-3-30 indicated dormancy period of 20-30 days with whole seeds but did not show embryo dormancy, indicating the presence of dormancy factors in seed coat. On the contrary, the removal of seed coat in ICGS-30, DER, Bidar local and Mardur local improved the germination but failed to release the dormancy completely, thereby indicating that the factors responsible for dormancy might be residing both in seed coat and embryo. The seed treatment with 0.1 per cent ethrel removed all the dormancy factors and facilitated complete seed germination in all the genotypes. The embryo of Dh-3-30 which had no dormancy exhibited higher seedling vigour index values than the whole seeds of the same genotype as well as whole seeds and embryos of other dormant genotypes. Though 0.1 per cent ethrel treatment could release the dormancy, the SVI values were reasonably low.

Keywords: Groundnut; Moisture content; Dormancy; Seedling vigour index

INTRODUCTION

Groundnut (*Arachis hypogaea* L.)is an important oilseed crop, occupying nearly 46 per cent of area under oilseeds in India, but, its yields are very low as compared to USA and China. Several reasons could be ascribed to its low productivity, of which nearly 20 per cent loss in the field is by the *in situ* germination due to lack of dormancy (Anon., 1979). Hence, there is a need to identify sources of short duration with certain period of dormancy to minimise yield losses due to *in situ* germination (Ashok Kumar, 1989 and Patil *et al*., 1991). On the other hand, spreading and semi-spreading types have a long period of dormancy, which results in crop emergence problems.

The seed may fail to germinate due to mechanical or metabolic blocks in the seeds. There is very little information on physiological basis of dormancy and hence the present study was carried to find out the factors influencing seed dormancy and seedling vigour in some selected spanish and virginia genotypes of groundnut.

MATERIAL AND METHODS

Seed material of five varieties from the harvest of *kharif* crop was used for the laboratory studies at the Department of Crop Physiology, College of Agriculture, Dharwad. Immediately after the harvest of the crop, the pods were subjected to germination tests at 10 days inter-

Recived for publication on January 11, 1995

val until 80 days after harvest. Seeds were separated into embryo and whole seeds were soaked in water. Similarly, whole seeds were treated with 0.1 per cent ethrel for 16 hours in all the varieties and were subjected to moisture content analysis (Agrawal, 1980). Whole seeds soaked in water served as control. The observations on germination and seedling length (root + shoot) were recorded and seedling vigour was calculated by using the method of Abdul Baki and Anderson (1973), as follows: Seedling vigour index (SVI) = Germination per cent X Seedling length (cm). In all the measurements, three replications were maintained and the statistical analysis was done following the concept of Factorial Completely Randomized Design. Transformation for germination per cent was applied wherever necessary.

RESULTS AND DISCUSSION

Seed moisture content decreased steadily from 0 to 80 days after harvest (DAH) in all the genotypes and physiologically active range of 14 to 15 per cent was observed between 20-30 DAH (Table 1). Among the genotypes, Dh-3-30 had the maximum moisture content initially and the minimum was in Bidar local.

Varying periods of dormancy was observed in whole seeds, embryo and seeds *treated with 0.1 per cent ethrel.* The whole seeds dormancy ranged from 20-30 days in Dh-3-30 to 50 days in Mardur local (Table 2). The seeds treated with 0.1 per cent ethrel did not show any dormancy in any of the genotypes. Whole seeds had longer dormancy period than that in embryos in general, but there was genotypic variation in this characteristic.

Table 1. Moisture content (%) of seeds at differnt time periods after harvest in groundnut genotypes

Days after harvest	Genotypes				
	Dh-3-30	ICGS-30	DER	Bidar local	Mardur local
0	39.9 (41.2)	39.3 (40.1)	38.6 (39.0)	37.4 (36.9)	37.5 (37.1)
10	26.4 (19.8)	27.3 (21.0)	25.1 (18.0)	25.8 (19.0)	24.5 (17.2)
20	23.9 (16.4)	23.8 (16.3)	22.8 (15.0)	23.2 (15.5)	23.4 (15.8)
30	22.7 (14.9)	22.1 (14.1)	22.0 (14.0)	22.1 (14.1)	22.9 (15.2)
40	21.7 (13.7)	21.7 (13.7)	21.2 (13.1)	21.7 (13.7)	21.4 (13.3)
50	21.0 (12.8)	20.5 (12.3)	19.9 (11.6)	20.5 (12.3)	20.2 (11.9)
60	20.4 (12.1)	19.5 (11.1)	19.2 (10.8)	19.5 (11.1)	18.5 (10.1)
70	18.6 (10.2)	18.6 (10.2)	17.5 (9.0)	18.7 (10.3)	17.5 (9.0)
80	16.7 (8.3)	18.0 (9.6)	17.3 (8.8)	18.0 (9.6)	17.1 (8.6)
For comparing			S.Em ±	CD at 1%	
Days			0.325	0.858	
Genotypes			0.240	0.633	
Interaction			0.739	NS	

Figures in parenthesis indicate original values.

NS = Non-significant.

Table 2. Germination percent of whole seed, embryo and ethrel treated seeds at different time periods after harvest in groundnut genotypes

Days after harvest	Genotypes														
	Dh-3-30			ICGS-30			DER			Bidar Local			Mardur Local		
	Whole seed	Embryo	0.1% Ethrel	Whole seed	Embryo	0.1% Ethrel	Whole seed	Embryo	0.1% Ethrel	Whole seed	Embryo	0.1% Ethrel	Whole seed	Embryo	0.1% Ethrel
0	33 (29)	79 (96)	90 (100)	18 (9)	24 (16)	90 (100)	13 (5)	42 (45)	71 (89)	13 (5)	48 (55)	90 (100)	8 (2)	12 (4)	90 (100)
10	49 (57)	81 (97)	90 (100)	32 (25)	39 (40)	90 (100)	20 (12)	46 (51)	72 (91)	15 (7)	49 (57)	90 (100)	12 (4)	21 (13)	90 (100)
20	62 (77)	81 (97)	90 (100)	34 (31)	48 (56)	90 (100)	21 (13)	56 (68)	75 (93)	18 (9)	64 (81)	90 (100)	13 (5)	23 (15)	90 (100)
30	66 (84)	90 (100)	90 (100)	39 (39)	52 (63)	90 (100)	23 (15)	71 (89)	75 (93)	19 (11)	74 (92)	90 (100)	41 (43)	63 (79)	90 (100)
40	72 (91)	90 (100)	90 (100)	45 (49)	60 (75)	90 (100)	29 (24)	72 (91)	79 (96)	43 (47)	90 (100)	90 (100)	60 (75)	90 (100)	90 (100)
50	79 (96)	90 (100)	90 (100)	56 (68)	84 (99)	90 (100)	33 (29)	81 (97)	81 (97)	64 (81)	90 (100)	90 (100)	68 (85)	90 (100)	90 (100)
60	79 (96)	90 (100)	90 (100)	71 (89)	84 (99)	90 (100)	34 (32)	81 (97)	84 (99)	84 (99)	90 (100)	90 (100)	81 (97)	90 (100)	90 (100)
70	81 (97)	90 (100)	90 (100)	74 (92)	90 (100)	90 (100)	54 (65)	81 (97)	84 (99)	90 (100)	90 (100)	90 (100)	90 (100)	90 (100)	90 (100)
80	81 (97)	90 (100)	90 (100)	84 (89)	90 (100)	90 (100)	64 (81)	81 (97)	84 (99)	90 (100)	90 (100)	90 (100)	90 (100)	90 (100)	90 (100)
For comparing		S.Em ±	CD at 1%	S.Em ±	CD at 1%		S.Em ±	CD at 1%			S.Em ±	CD at 1%	S.Em ±	CD at 1%	
Days		1.9	5.1	1.1	2.9		2.0	5.4			0.8	2.2	1.0	2.6	
Treatments		1.1	2.9	0.6	1.7		1.2	3.0			0.5	1.3	0.6	1.5	
Interaction		2.8	7.6	1.9	5.1		3.5	9.3			1.4	3.8	1.7	4.5	
For Comparing The genotypes		S.Em ±	CD at 1%				S.Em ±	CD at 1%					S.Em ±	CD at 1%	
Days		1.3	3.5			Days	1.2	3.1				Days	0.9	2.3	
Whole seed		1.0	2.6			Embryo	0.9	2.3				0.1% Ethrel	0.6	1.7	
Interaction		2.9	7.7			Interaction	2.6	7.0				Interaction	1.9	5.1	

Figures in parenthesis indicate original values

Though the genotype Dh-3-30 had 20-30 days of dormancy period with whole seeds, the embryos did not show any dormancy. This clearly indicates the presence of dormancy factors in seed coat in Dh-3-30. On the contrary, the removal of seed coat in ICGS-30, Dharwad Early Runner (DER), Bidar local and Mardur local did improve the germination but did not completely release the dormancy, indicating that the factors responsible for dormancy might be residing in both seed coat and embryo. Vaithialingam and Rao (1973) observed that the dormancy either of seed coat, embryo or whole seeds may not be entirely due to moisture content but also due to the presence of inhibitors in them. The seed treatment with 0.1 per cent ethrel removed all the dormancy factors and facilitated complete seed germination in all the genotypes, except in DER where the germination per cent ranged from 89.3 to 98.7 between 0 to 60 DAH. Narasimha Reddy and Swami (1979) identified that the dormant seeds have higher amount of ABA and low level of cytokinins.

It is clear from the present study that ethrel can overcome seed and embryo dormancy. The decrease in the duration of dormancy or germinability of some genotypes (ICGS-30, DER, Bidar local and Mardur local) during post ripening period might be associated with low levels of ABA like substances, inhibitory phenolic acids and synergistic phenolic acids. Also ethrel treatment might have acted directly or indirectly in counteracting dormancy factors (Ketring, 1977).

Results on seedling vigour index varied significantly due to treatments and the vigour was improved during post ripening period in all the genotypes and in all the treatments (Table 3). The embryo of Dh-3-30 which had no dormancy exhibited higher SVI values than the whole seeds of the same genotype as well as whole seed and embryo of other dormant genotypes. Though 0.1 per cent ethrel treatment could release the dormancy, the SVI values were reasonably low as compared to embryos at initial stages of harvest in Dh-3-30. The decrease in SVI values due to 0.1 per cent ethrel treatment in Dh-3-30 could be ascribed to reduced root length and shoot length (data not shown). Thus, SVI could be considered as an important tool for knowing the seedling vigour. Sreeramulu (1974) also observed higher SVI values during initial stages after harvest due to 0.1 per cent ethrel treatment and the dormant seeds produced stunted seedlings. Whereas, after 40 days of storage, which overcome the dormancy and produced normal seedlings.

It is inferred from the present study that genotypic differences exist in the nature and period of dormancy in both dormant and non-dormant genotypes of groundnut and seed treatment with 0.1 per cent ethrel could be advocated for the release of dormancy.

LITERATURE CITED

Abdul Baki A.A. and Anderson, J.D. 1973. Vigour determination in soyabean seed by multiple criteria. *Crop Sci.*, 13: 630 - 633.

Agrawal, R.L. 1980. Seed Testing. pp. 395 - 520. *In* : Seed Technology, Oxford and IBH Publishing, New Delhi.

Anonymous, 1979. All india Co-ordinated Research Project on oilseeds, 12th Annual Workshop (*Kharif*) p.19.

Ashok Kumar, T.S. 1989. An assessment of genetic potential of some dormant cultures for improving erect bunch varieties of groundnut (*Arachis hypogaea* L.).

Table 3. Seedling vigour index (SVI) of whole seed, embryo and ethrel treated seeds at different time periods after harvest in groundnut genotypes

Days after harvest	Genotypes														
	Dh-3-30			ICGS-30			DER			Bidar Local			Mardur Local		
	Whole seed	Embryo	0.1% Ethrel	Whole seed	Embryo	0.1% Ethrel	Whole seed	Embryo	0.1% Ethrel	Whole seed	Embryo	0.1% Ethrel	Whole seed	Embryo	0.1% Ethrel
0	491	1747	1530	141	246	1290	80	725	1125	83	881	1380	18	64	1360
10	1037	1849	1590	428	656	1390	185	843	1197	109	997	1460	64	222	1390
20	1484	1917	1660	527	974	1460	214	1156	1297	163	1463	1510	92	254	1430
30	1680	2090	1740	687	1124	1560	250	1616	1353	191	1711	1600	747	1401	1560
40	1825	2070	1790	917	1411	1650	420	1723	1450	892	1970	1710	1389	1890	1620
50	1997	2150	1860	1333	2004	1770	533	1907	1547	1634	2120	1830	1638	2010	1710
60	2102	2170	1910	1902	2142	1910	602	2004	1658	2171	2300	1900	2014	2140	1790
70	2180	2280	1970	2125	2340	1960	1242	2121	1698	2360	2410	2010	2180	2280	1910
80	2316	2480	2120	2391	2440	2020	1659	2170	1757	2430	2460	2070	2320	2380	1970
For Comparing		S.Em ±	CD at 1%	S.Em ±	CD at 1%		S.Em ±	CD at 1%			S.Em ±	CD at 1%	S.Em ±	CD at 1%	
Days		58.3	156.8	49.7	133.7		43.0	115.8			51.5	138.5	40.4	108.7	
Treatments		33.6	90.5	28.7	77.2		24.8	66.8			29.7	80.0	23.3	62.8	
Interaction		101.0	271.7	86.1	231.6		74.5	200.6			89.2	239.9	70.0	188.4	
For Comparing The Genotypes		S.Em ±	CD at 1%				S.Em ±	CD at 1%					S.Em ±	CD at 1%	
Days		29.5	77.9			Days	37.9	100.0				Days	43.3	114.3	
Whole seed		22.0	58.0			Embryo	28.2	74.5				0.1% Ethrel	32.3	85.2	
Interaction		66.0	174.1			Interaction	84.7	223.6				Interaction	96.9	NS	

NS = Non-significant

M.Sc. (Agri) Thesis, Univ. Agric. Sci., Dharwad, pp.1-188.

Ketring, D.L. 1977. Physiology of oilseeds, 6. A means to break dormancy of peanut (*Arachis hypogaea* L.) seeds in the field. *Peanut Sci.*, 4 : 42 - 45.

Narasimha Reddy, S.B. and Swamy, P.M. 1979. Abscisic acid like inhibitors and cytokinins during after ripening of dormant peanut seeds (*Arachis hypogaea* L.) *Physiol. Plant.* 46: 191 - 193.

Patil, V.K., Quader, M.A. and Shinde, V.S. 1991. Oilseed production-constraints, technology and future research needs in Maharashtra. *Agric. Situation India.* 46: 401 - 407.

Sreeramulu, N. 1974. Changes in endogenous growth regulation compounds during the after-ripening of the dorman' seeds of groundnut. *Z. pflanzenphysiol.* 71: 101 - 107.

Vaithialingam, R. and Rao, J.S. 1973. Physiological comparision of dormant and non-dormant groundnut-rate of water absorption, role of outer covering and inhibitors in seed coat. *Madras Agric. J.* 60: 1465 - 1470.

J. Oilseeds Res. 12(1) 1995 : 109- 113
ISSN 0970-2776

PHYSIOLOGICAL FACTORS LIMITING CROP PRODUCTIVITY IN SUNFLOWER - A CRITICAL ANALYSIS

Y.A. NANJA REDDY, M.S. SHESHSHAYEE, R. UMA SHAANKER
K. VIRUPAKSHAPPA[1], M. UDAYA KUMAR and T.G. PRASAD
Department of Crop Physiology, University of Agricultural Sciences
G K V K. Bangalore 560 065

ABSTRACT

Some of the physiological parameters limiting the productivity in sunflower were discussed. Assimilation rate or photosynthetic rate is not a major limiting factor for the productivity. However, leaf area index and crop duration were found to be major constraints for the productivity in sunflower. Thus *selection of genotypes should go for high leaf area types with medium duration to achieve high dry* matter production and seed yields.

Keywords: Sunflower; Leaf area index; Crop duration; Crop productivity

INTRODUCTION

Productivity of sunflower (*Halianthus annuus* L.) in recent years is increasing through release of several high yielding inbreds and hybrids (Ravishankar *et al.*, 1991). However, for enhanced productivity, effective crop breeding needs to critically consider the specific factors that limit the productivity. Infact, productivity in most crop plants is constrained by the amount of light interception governed by leaf area index (LAI), the efficiency of carbon fixation (NAR) to form stable organic matter and the crop duration. In this paper, a few important physiological parameters that limit productivity in sunflower have been discussed.

Is Net Assimilation Rate (NAR) a limiting factor for productivity in sunflower?

A comparative study of a few C_3 and C_4 species indicated that sunflower had significantly high net assimilation rate (Table 1). Sunflower also exhibited a very high photosynthetic rate as measured by gas exchange techniques (Sheshshayee, 1992) and is well above that of most C_3 plants (Connor and Sadras, 1992). Sunflower also exhibited a significantly high carboxylation efficiency measured by the initial slope of the CO_2 response curve (dA/dCi) compared to other C_3 and C_4 species (Sheshshayee, 1992). The high carboxylation efficiency in sunflower

Table 1. NAR and photosynthetic rates in few C_3 and C_4 species.

Species	NAR ($mg.\ dm^{-2}.\ d^{-1}$)	Photosynthetic rate ($\mu mol.\ m^{-2}.\ s^{-1}$)
C_3 species		
Sunflower	156.0	30.4
Cowpea	85.0	20.6
Soybean	78.7	19.5
C_4 species		
Amaranthus	151.2	35.0
Sorghum	135.1	34.9
Finger millet	123.6	29.1

(Source: *Ravishankar*, 1988)

1. AICRP, Sunflower unit, UAS, GKVK, Bangalore -560 065.

Received for publication on March 23, 1994.

is found to be due to a relatively high RUBISCO content and its efficiency as measured by the ratio of assimilation rate to RUBISCO content (Mahabaleswar, 1992). Again a trial conducted at the Project Coordinating unit (Sunflower) showed that dry matter production and seed yield differed distinctly with the similar photosynthetic rates (Table 2). These studies clearly suggest that NAR of photosynthetic rates may not constrain the productivity in sunflower, though further improvement in this feature cannot be precluded. Infact, there exist considerable genotypic variability for NAR, suggesting the possibility of breeding for higher NAR types (Shivaram, 1986).

Table 2. Photosynthetic rate, Total dry matter production (TDM) and seed yield in sunflower genotypes

Genotypes	Photosynthetic rate (μmol.m^{-2}.s^{-1})	TDM at harvest (g. 10m^{-2})	Seed yield (g.10m^{-2})
Acc 1600	22.9	6645	1767
Acc 1648	22.6	8334	2750
Acc 1616	22.2	8278	2111
Acc 1630	20.2	11845	3339
Mean	22.0	8776	2492
Acc 1610	27.2	3895	778
Acc 1599	27.2	3900	1383
62 B	19.6	3067	845
339 B	16.3	2806	906
Mean	22.6	3417	978
CD for varieties (P = 0.05)		1011	333

(Source: Nanja Reddy *et al.*, 1994)

Can Leaf area index (LAI) limit productivity?

Despite a high NAR in sunflower, the total biomass accumulated over the crop growth period is considerbly less compared to several other crop species. This is often attributed to the poor LAI in sunflower (Table 3). There exists a significant positive correlation between LAI and biological yield (r = 0.92, P = 0.01) and seed yield (r = 0.82, P = 0.01: Giriraj *et al.*, 1987; Abbate and Tuttobene, 1982). Thus selecting for high LAI would result in increased seed yield in sunflower.

Table 3. Leaf area indices of four crop species at different growth stages

Species	*Leaf area index*		
	52 DAS	71 DAS	84 DAS
Sunflower	1.34	1.48	0.55
Amaranthus	1.83	1.97	1.23
Groundnut	0.66	1.28	2.66
Finger millet	1.76	2.51	2.02

(Source: Uma, 1987), DAS : Days after sowing

Approaches to enhance LAI

Approaches such as identification of intrinsic genotypic variation in leaf area index and agronomic practice like increasing the population density and/ or enhancing the soil nutrient status could be successfully employed for enhancing LAI and thereby the yield in sunflower.

Considerable genotypic variability exists for LAI in sunflower (Shivaram, 1986; Nanja Reddy *et al.*, 1994). It is suggested that crop improvement programmes especially the heterosis breeding programmes should utilize such genotypes having high LAI.

Increasing plant density and the nutrient status also have resulted in significant increase in LAI and total biomass production in sunflower (Table 4 and Pasda and Diepenbrock, 1991). Further studies have shown that considerable variation exists for dry matter production and seed yields among sunflower genotypes for the response of in-

Table 4. Leaf area index (LAI) and total dry matter (TDM) at varying population density and nitrogen levels in sunflower hybrids.

Treatment	LAI (60 DAS)	TDM (g 10m $^{-2}$) at harvest
$P_1 N_1$	2.41	3300
$P_1 N_2$	2.85	4430
$P_2 N_1$	3.10	4990
$P_2 N_2$	3.75	5690

P: Plant populations N: Nitrogen levels
P1: 55, 500 plants ha^{-1} N1: 40 kg N ha^{-1}
P2: 1,11,000 plants ha^{-1} N2: 80 kg N ha^{-1}
(Source: Siddaraju, 1986)

creased plant density up to 1,11,000 plants/ha (Table 5). Twelve out of thirty eight genotypes studied have shown more than 50 per cent increase in seed yield when plant population was increased to 1,11,000 from 55,500 plants/ha. Selection for response to increased population has led to significant increase in yield. It would be worthwhile to understand the physiological basis of such a response and it seems to be associated with root growth in a given soil volume (Humphries and Thorne, 1964).

Table 5. Yield responses of sunflower genotypes to increasing plant population density

Per cent increase or decrease in seed yield of P_2 compared to P_1	(No. of genotypes	TDM (g 10m^{-2}) P_1	P_2	Seed yield (g 10m^{-2}) P_1	P_2
Per cent increase in seed yield of P_2 compared to P_1					
>50 %	12	8207	12727	2273	3887
20 - 50 %	10	9453	13593	2947	3733
<20 %	5	8880	13040	2827	3080
Per cent decreasen in seed yield in P_2 compared to P_1					
	11	9633	12313	3273	2993
CD for populations (P = 0.05)		TDM = 2460		Seed yield = 318	

P_1: 55,500 plants ha^{-1}
P_2: 1,11,000 plants ha^{-1}
(Source: Shivaram, 1986)

Can Leaf area duration (LAD) influence productivity in sunflower?

The crop duration which influences LAD is yet another parameter that constrains productivity by determining the total canopy assimilation. It was observed that, the genotypes which have more crop duration (days to 50 % flowering) also had higher LAD and seed yield (Table 6; Dixon and Lutman, 1992; Baldini *et al.*, 1990). A positive correlation between total dry matter production and seed yield with leaf area duration (Fig 1) further reiterates the fact that LAD could also be an important constraint for sunflower productivity.

Table 6. Days to 50% flowering, Leaf area duration and seed yield in sunflower genotypes

Genotypes	Days to 50% flowering (days)	LAD upto flowering (days)	Seed yield (g.10m^{-2})
Acc 1653	51	64.2	1211
Morden	52	66.2	1100
Mean	51.5	65.2	1156
Acc 1651	71	92.4	2450
Acc 1628	77	100.1	2284
Acc 1616	71	92.9	2111
Mean	73	95.1	2282
CD (P = 0.05) for varieties		15.6	334

(Source: Nanja Reddy *et al.*, 1994).

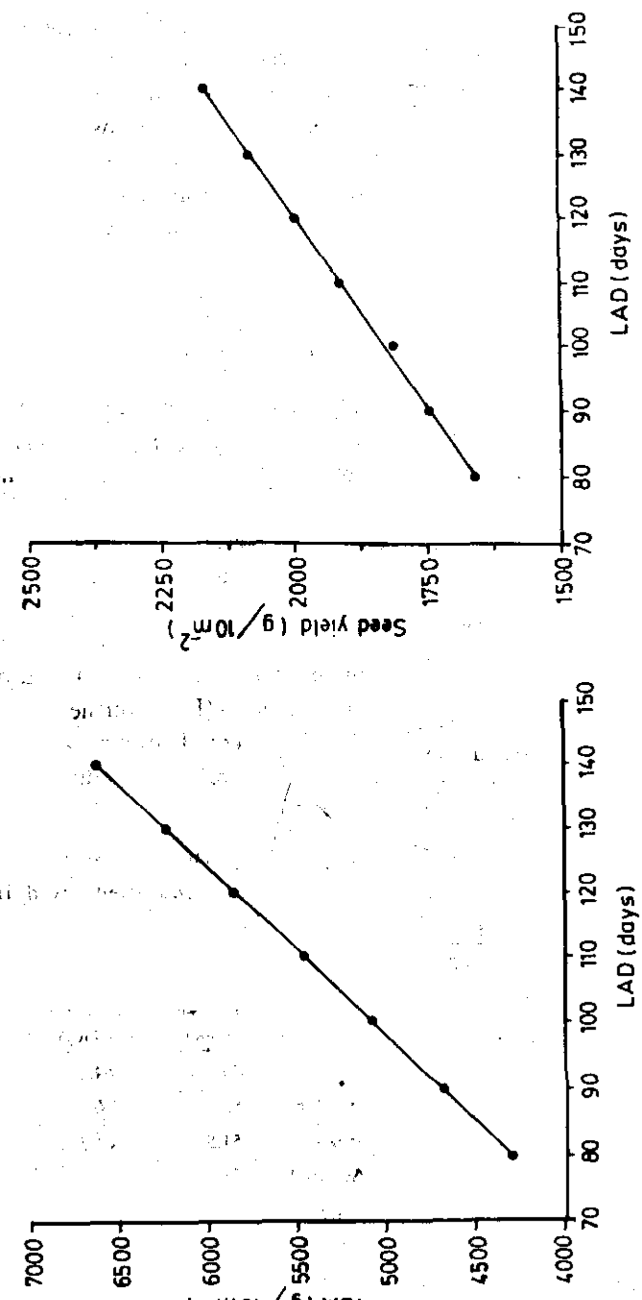


Fig. 1. Relationship between LAD and Total dry matter and Grain yield in sunflower
(Source : Shivaram, 1986)

CONCLUSIONS

It is concluded that low LAI and short duration of crop growth are the most important constraints to sunflower productivity, although selecting for high NAR could not be undermined. These physiological parameters can infact be integrated to improve the leaf area duration of the crop to result in higher productivity. Hybrid breeding programmes must consider selection of inbreds with inherently high leaf area coupled with reasonably medium duration. At present, much of the improved cultivars fall short of their crop duration atleast under the local rainy season.

LITERATURE CITED

Abbate, V. and Tuttobene, R. 1982. First indications on growth analysis of sunflower in dry conditions. *Rivista di Agronomia*. 16: 203-213

Baldini, M., Megale, P. and Vannozzi, G.P. 1990. Delayed sowing for sunflower with cultivars of different maturity cycles. *Sementi Elette* 36:13-20

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

Dixon, F.L. and Lutman, P.J.W. 1992. Effects of drilling date on the growth and yield of sunflower in United Kingdom. *J. Agric. Sci.* 119: 197-204

Giriraj, K., Shivaraju, N., Shantha, R.H. and Prasad, T.G. 1987. Bioproductivity and its relationship to yield attributes and seed yield in inbreds, hybrids and populations of sunflower. *J. Oil Seed Res.* 4: 35-40

Humphries, E.C. and Thorne, G.N. 1964. The effect of root formation of photosynthesis of detached leaves. *Ann Bot.* 28: 391-400

Mahabaleswar. 1992. RUBISCO content and its efficiency- A major mesophyll factor responsible for the low photosynthetic rates in pulses. M.Sc. (Agri.). Thesis submitted to Univ. Agric. Sci., Bangalore.

Nanja Reddy, Y.A., Sheshshayee, M.S., Uma Shaanker, R., Virupakshappa, K. and Prasad, T.G. 1994. Selection for high canopy assimilation rate is a good strategy to increase productivity in sunflower. *Helia* (Communicated)

Pasda, G. and Diepenbrock, W. 1991. Physiological yield analysis of sunflower. III. Agronomic factors and production techniques. *Fett Wissenschaft Technologie*. 93: 235-243

Ravishankar, H.M. 1988. Water use efficiency and gas exchange characteristics in selected C_3 and C_4 species: An assessment under similar water limited conditions. M.Sc. (Agri.) Thesis, Univ. Agric. Sci., 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 influences their performance under imposed moisture stress. *Helia*. 14: 77-86

Sheshshayee, M.S. 1992. photosynthetic rates under abiotic stress and nonstress conditions in a few C_3 and C_4 species: An assessment for stomatal and mesophyll limitations. Ph.D. Thesis, Univ. Agric. Sci., Bangalore.

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

Siddaraju, S.R. 1986. Leaf area development, canopy carbon exchange rate and productivity at varying plant population and nutrient status in sunflower. M.Sc. (Agri.) Thesis, Univ. Agric. Sci., Bangalore.

Uma, M.S. 1987. Transpiration quotient -and water use efficiency in different C_3 and C_4 species and its relationship with biomass and productivity under moisture stress conditions. M.Sc. (Agri.) Thesis, Univ. Agric. Sci., Bangalore.

J. Oilseeds Res. 12(1) 1995 :114-117
ISSN 0970-2776

SHORT COMMUNICATIONS

SALT STRESS EFFECTS ON SUNFLOWER GENOTYPES AND STUDIES ON SALT TOLERANCE

Sunflower is one of the important oilseed crops grown extensively in Tungabhadra Project area of Karnataka. It is grown under irrigated conditions throughout the year. Due to continuous irrigation for the last two decades, the soils are turning saline and in some cases even to sodic. The information on the suitability of genotypes to saline conditions is scanty. Therefore, the present investigation was undertaken during 1989 to screen the commonly grown genotypes for their suitability to saline conditions. Further, an attempt was made to findout the possible ways to combat the salinity effects on sunflower by various pre-sowing chemical treatments.

Five commonly grown genotypes of sunflower viz., Morden, EC- 68414, Improved Peredovik, BSH-1 and KBSH-1 were subjected to salinity stress during their germination under laboratory conditions. Each genotype was allowed to germinate in four salinity concentrations (1.92, 3.60, 5.20 and 7.20 dS/m) and in best available water (BAW) of 0.99 dS/m which served as control. The experiment was replicated thrice. Fifty sterelised seeds were transferred on to the filter paper in a petriplate. Initially 10 ml respective saline solutions of different concentrations were added and incubated for germination. Two days later additional 5 ml was added. After ten days, observations on germination and seedling vigour were recorded. The results were analysed following Completely **Randomised** Design (Table 1).

In a separate experiment, the possible means of combating salinity effects were carried out using Morden as a test genotype at 5.20 dS/m salinity. The reduction in germination per cent and vigour parameters were the basis for the selection of Mordern as susceptible genotype and 5.20 dS/m as critical level of salinity. Morden seeds were pre-soaked for 12 hours with Gibberllic acid (GA) 100 ppm; Cytokinin (CK) 5 ppm; KNO_3 0.01 M; $Cacl_2$ 0.02 M and water. The pre-treated seeds were then transferred on to the filter paper in a petriplate containing saline water of 5.20 dS/m. The seeds allowed to germinate in saline water (5.20 dS/m) without any pre-treatment served as a control. The observations on germination and seedling vigour were recorded and analysed following Completely Randomised Design (Table 2).

Germination

The average germination of all the genotypes in BAW was above 97 per cent. A mean reduction of 19 per cent was observed in all the genotypes when salinity was raised to 7.20 dS/m. The average germination of Improved Peredovik was superior to others. The lowest response of 84 per cent was recorded in Morden. Similar results have been reportd by Chandru *et al.*, 1987 and Fatima Sultana *et al.*, 1985.

Recived for Publication on March 2, 1990

Table1. Influence of salinity levels on the germination of sunflower genotypes.

Treatment	Germination %	Root length cm.	Shoot length cm.	Seedling dry wt. mg.
Morden 0.99 dS/m	90.0	16.3	11.7	36.9
Morden 1.92 "	96.6	12.9	3.7	40.9
Morden 3.70 "	86.0	8.5	8.6	34.0
Morden 5.20 "	60.0	4.9	5.2	33.2
Morden 7.20 "	58.0	2.7	5.5	31.4
EC 68414 0.99 dS/m	96.7	15.6	10.7	38.6
EC 68414 1.92 "	95.0	11.3	3.0	41.0
EC 68414 3.70 "	95.0	10.4	7.7	33.7
EC 68414 5.20 "	93.3	7.2	6.6	34.0
EC 68414 7.20 "	71.7	4.3	5.3	32.7
Imp. Peru. 0.99 dS/m	100.0	11.3	11.7	38.7
Imp. Peru. 1.92 "	100.0	10.1	10.6	40.7
Imp. Peru. 3.70 "	100.0	6.0	9.8	35.1
Imp. Peru. 5.20 "	96.7	3.0	5.4	37.2
Imp. Peru. 7.20 "	93.3	1.5	3.3	32.0
BSH-1 0.99 dS/m	98.3	15.9	11.1	35.6
BSH-1 1.92 "	95.0	16.0	10.8	41.5
BSH-1 3.70 "	95.0	12.2	8.9	34.2
BSH-1 5.20 "	93.3	8.9	8.4	34.8
BSH-1 7.20 "	86.7	2.4	4.6	32.9
KBSH-1 0.99 dS/m	100.0	17.3	11.8	36.6
KBSH-1 1.92 "	91.7	13.8	11.0	46.0
KBSH-1 3.70 "	88.3	10.1	8.0	35.6
KBSH-1 5.20 "	80.0	5.3	5.3	31.5
KBSH-1 7.20 "	78.3	1.0	4.1	33.9
Mean	89.2	9.2	8.1	36.1
SEm ±	0.06	0.02	0.02	1.59
C.D. 1%	0.21	0.08	0.06	5.81

Root and shoot length

The mean effect of salinity on root growth indicated KBSH-1 and Morden as susceptible while, BSH-1 was tolerant. There was mean reduction of 56.3, 55.5 and 38.0 per cent in root length of KBSH-1, Morden and BSH-1 respectively. The average reduction in the root length of genotypes studied was nearly 85 per cent when salinity was raised from BAW to 7.20 dS/m. The results indicated that the reduction in root length of all genotypes was marked once the salinity was raised beyond 3.70 dS/m. Similar results have been reported by Chandru *et al.*, (1987) and Gupta and Singh (1970). As the salinity increased from 0.99 dS/m to 7.20 dS/m, the shoot length of all the genotypes

Table 2. Influence of per-treatment of Morden seeds with chemicals and their performance under salinity conditions (5.20 dS/m)

Treatment	Germination %	Root length cm.	Shoot length cm.	Seedling dry. wt. mg.
GA 100 ppm	71.3	4.6	9.6	27.6
CK 5 ppm	85.0	2.0	5.5	30.6
$CaCl_2$ 0.02 M	80.0	10.1	10.3	29.6
KNO_3 0.01 M	82.5	4.8	7.7	30.6
Water	65.0	5.7	8.4	30.1
Control	52.5	2.1	6.6	27.6
Mean	72.7	4.9	8.0	29.4
SEm ±	3.89	0.71	0.05	0.18
C.D. 1%	14.21	2.61	0.18	0.67

decreased. This reduction in the shoot length was 60 per cent over control.

Seedling dry weight

The dry weight was not affected up to 1.92 dS/m in all the genotypes. A further increase in the salinity beyond 1.92 dS/m resulted in the decrease of dry weights. The maximum reduction of 12 per cent was recorded at the highest salinity level.

Chemical pre-treatment Vs. Salinity effects on growth

Germination

Germination of Morden genotype in control was lowest. The seeds pre-treated with various chemicals showed improvement in the germination. The highest germination was recorded in seeds pre-treated with CK 5 ppm followed by KNO_3 0.01M. These results indicate the possiblities of improving the germination of susceptible genotypes under stress condition. Similar results showing improvement in germination in solution of high osmotic pressure by pre-treating with CK have been reported (Vishwanath *et al.*, 1972).

Root/Shoot length

The root length increased significantly with pre-treatment of seeds except in CK. This is in contrast to the germination of seeds where CK remained superior as it is known to promote germination and survival of seedlings (Ramesh and Kumar, 1975). The highest increase in root length was observed in seeds pre-treated with $CaCl_2$, 0.02 M. Shoot length was maximum in $CaCl_2$ pre-treated seeds.

It can be concluded that BSH-1 is more tolerant and Morden is susceptible to salinity and pre-treatment of Morden with CK and $CaCl_2$ improved germination and dry weight of the seedlings.

University of Agricultural Sciences, Dharwad
Raichur Campus, Karnataka

S.J. PATIL
P. PALAKONDA REDDY
S.G. PATIL
I.S. GOUD
S.A. PATIL.

Chandru, R., Prasad, T.G., Giriraj, K. and Merwade, M.N. 1987. Effect of Salinity on germination and seedling growth of sunflower *J. Oilseeds Res.* 4: 136-138.

Fatima Sultana, Satyanarayana, V. and Dutt, K.V. L.N. 1985. Effect of salt concentration on germination of sunflower genotypes *J. Oilseeds Res.* 2: 320-321.

Gupta, S.K. and Singh, T.A. 1970. Effect of some solute concentration of germination of some oilseeds. *Mysore J. Agric. Sci.* 4: 221-223.

Ramesh, B.V. and Kumar, S. 1975. Seed germination and early seedling growth of wheat (*Triticum aestivum* Linn) cv. 1553 under the influence of salinity and plant growth hormones. *Ann. Arid. Zone.* 14: 221-228.

Vishwanath, D.P., Sastry, K.S.K. and Rao, B.V.V. 1972. Effect of seed treatment on germination and growth of *Eleusine corecana* Gyaertn., in soils with high exchangeable sodium. *Mysore J. Agri. Sci.* 6: 24-24.

J.Oilseeds Res. 12(1) 1995 : 118-119
ISSN 0970-2776

CORRELATION STUDIES IN RAINFED NIGER UNDER THREE SOWING DATES

Seed yield of niger (*Guizotia abyssinica*) fluctuates with different sowing times. For higher yields, crop should be planted on a suitable date to avoid rains coinciding with the flowering period of crop when visit of honey bees is essential for seed set (Anonymous, 1988). In this paper, correlations among different characters under three sowing dates are reported. The extent of character association may help formulating the selection criterion for niger improvement.

Nine varieties of niger were studied under three dates of sowing (7th and 22nd July and 7th August) in a Randomized Block Design with three replications during *kharif*, 1988 at JNKVV, Zonal Agricultural Research Station, Chhindwara (M.P.). Each genotype was grown in a plot size of 1.8 m x 5.0 m, with 30 cm row to row and 15 cm plant to plant distance. A fertilzer dose of 20 kg N, 20 kg P_2O_5 and 10 kg K_2O per hactare was applied as basal. Data were recorded on five random plants for plant height, number of primary branches, number of productive capsules, seed yield and 1000-seed weight. Data on days to 50% flowering and days to maturity were recorded on plot basis. Coefficients of correlations were calculated as per the method suggested by Al- Jibouri, *et al*. (1958).

The genotypic (rg), phenotypic (rp) and environmental (re) correlation coefficients of different character pairs were calculated. Leaving aside a few exceptions, genotypic correlation coefficients were generally higher than others. Next lower values were generally those of phenotypic correlation coefficients. Environmental correlation coefficients were by and large the lowest ones except for the correlations with seed yield and plant height on 7th July sowing date.

For the first sowing date (the sub-optimal sowing date with regard to yield), only five character combinations showed significant correlations. This number increased to eight for the second sowing date whereas for the third sowing date which is optimal sowing date giving highest seed yield, fourteen character combinations possessed significant correlations. This indicates that as we move from sub-optimal (early sowing) towards optimal sowing date, the association between characters grow stronger and significant.

The number of branches (rp : 0.845) and number of capsules (rp : 0.863) were found to be most strongly and positively associated with the seed yield while days to 50% flowering (rp : -0.731) and days to maturity (rp: -0.730) were strongly and negatively associated with seed yield. Strong and positive correlation between seed yield and number of capsules was also noticed in niger by Payasi *et al*. (1987).

A numbr of other significant correlations were also observed. The most strong and positive correlations were recorded between days to 50% flowering and days to maturity (rp : 0.952) and between numbr of branches and number of capsules (rp : 0.894). The days to 50% flowering and days to maturity were significant and negatively associated with number of branches (rp: -0.868 and -0.682 respectively) and with number of capsules (rp:-0.888 and -0.873 respectively). The taller plants tend to

Received for publication on April 16, 1992.

flower late (rp: 0.777), mature late (rp: 0.801) and possess bolder seeds (rp: 0.687) whereas the plants that were laden with large number of capsules were filled with smaller seeds (rp: -0.868).

Though the number of branches and number of capsules had high positive association with seed yields, higher values of environmental correlation reduces the efficiency of selection. The magnitude of correlation of seed yield with days to 50% flowering and days to maturity was next in order thus, it may be concluded that in the first cycle of selection, emphasis be given for more number of capsules and branches per plant while final selection be made on the basis of early flowering and maturity for improving seed yield per plant in niger.

Zonal Agricultural Research Station,
JNKVV, Chhindwara - 480 001 (M.P.)

P.C. UPADHYAY

Al-jibouri, H.A., Miller, P.A. and Robinson, H.F. 1958. Genotypic and environmental variances and covariances in an upland cotton cross of interspecific origin. *Agron. J.* 50: 633-36.

Anonymous, 1988. Annual report of the All India Co-ordinated Research Project On Oilseeds (Niger) JNKVV, Zonal Agricultural Research Station, Chhindwara (M.P.) pp. 7

Payasi, S.K., Mishra, Y., Koutu, G.K., Bilaiya, S.K. and Yadav,L.N. 1987. Character association and component analysis in Niger. *J. Oilseeds Res.* 4: 70-74.

J.Oilseeds Res. 12(1) 1995 :120-122
ISSN 0970-2776

QUALITY OF MUSTARD SEED AS INFLUENCED BY CROPPING SYSTEM, IRRIGATION AND NITROGEN

A field experiment was conducted during *rabi* seasons of 1985-86 and 1986-87 at JNKVV, Zonal Agricultural Research Station Morena, to study the effect of cropping systems, irrigation schedule and nitrogen levels on the quality (protein and oil) of mustard. The experiment was laid out in split-split plot design with four replications. Three cropping systems (Fallow-mustard, Urid-mustard and Bajra-mustard) were kept in main plots; four irrigation schedules (no irrigation, irrigation at pre flowering stage, at siliqua development stage and at pre-flowering and siliqua development stages) in sub plots and three nitrogen levels (0, 50 and 100 kg N/ha) in sub-sub plots. A basal application of 35 kg P_2O_5 and 20 kg K_2O/ha and nitrogen as per treatment was given to all the plots. Mustard variety 'Pusa bold' was sown on 27th October and 9th November during 1985-86 and 1986-87 respectively. The soil was sandy loam in texture, with 188 kg/ha available N, 17 kg/ha available P_2O_5 and 312 kg/ha available K_2O. Results showed (Table 1) that the protein content and output (kg/ha) of mustard crop was significantly higher in fallow-mustard during both the years as compared to urid-mustard and bajra-mustard system. Similar results were also recorded in case of oil and seed yield of mustard during both the years, while the trend in respect of oil content under different cropping system was just reverse to that of oil yield. It may be due tohighly negative correlation between oil and protein content (Singh and Rathi, 1985). As far as protein and oil production through seed is concerned, significantly higher values were recorded under fallow-mustard. This was mainly due to the differential yield of mustard under different cropping systems .

Data in Table 1 reveal that protein content of mustard seed was significantly higher when irrigation was given at pre-flowering + siliqua development stages during both the years over rest of the irrigation schedules except irrigation at pre-flowering in 1986-87 which was at par. Whereas protein yield was significantly superior when irrigation was given at pre-flowering during both the years except irrigation at pre-flowering + siliqua development stages in 1985-86, which was at par. It was further, revealed that oil yield of mustard was significantly higher in the case of irrigation at pre-flowering during both the years, except control (no irrigation) in 1986-87. Similar trend was observed in case of seed yield of mustard. But the oil content was significantly higher in the case of no irrigation and irrigation at siliqua development during both the years. The reason may be that adequate supply of moisture helps in greater uptake of nitrogen which in turn, lowers the oil content in seed. Similar results were also reported by Pimkhin and Morozor (1968), Rana *et al.*, (1991) and Tomer *et al.*, (1992).

The protein content and yield of protein, seed and oil (kg/ha) increased significantly with the increase in the levels of nitrogen during both the years. Similar results have been reported by Khan and Agrawal (1985), and Tomer *et al.*, (1992). However, the oil content of mustard seed significantly decreased with the increasing levels of nitrogen during both the years. The oil and protein

Received for publication on November 1, 1992.

Table 1. Effect of cropping system, irrigation schedule and nitrogen levels on protein and oil contents and yield in mustard

Treatments	Protein content (%)		Protein yield (kg/ha)		Oil content (%)		Oil yield (kg/ha)		Seed yield (kg/ha)	
	1985-86	1986-87	1985-86	1986-87	1985-86	1986-87	1985-86	1986-87	1985-86	1986-87
Cropping system										
Fallow-mustard	20.34	22.08	331.0	403.6	38.34	37.14	615.2	669.1	16.11	18.23
Urid-mustard	19.54	21.29	255.9	332.5	39.16	37.96	500.3	584.5	12.89	15.48
Bajra-mustard	18.62	20.53	186.1	229.4	40.20	39.00	382.3	422.3	9.62	10.93
CD at 5%	0.71	0.65	20.3	33.9	0.058	0.13	39.5	54.5	0.99	1.40
Irrigation schedule										
No irrigation	18.79	20.66	224.3	312.4	40.09	38.89	466.3	567.7	11.75	14.93
Irrigation at pre flowering (PF)	19.79	21.47	290.6	344.5	38.98	37.78	563.9	604.5	14.31	15.79
Irrig. at siliqua development (SD)	19.03	21.15	237.6	312.9	39.85	38.65	466.3	543.5	12.14	14.55
Irrig. at PF + SD	20.46	21.92	278.2	317.4	38.01	36.81	499.0	518.8	13.28	14.42
CD at 5%	0.61	0.53	24.4	21.4	0.46	0.17	43.4	40.8	1.10	1.09
Nitrogen levels kg/ha										
0	17.66	19.68	154.6	227.8	40.72	39.52	347.5	442.8	8.58	11.43
50	19.83	21.29	273.9	326.1	39.21	37.87	533.9	576.5	13.67	15.27
100	21.00	22.93	344.5	411.5	37.76	36.70	615.3	656.6	16.35	17.93
CD at 5%	0.25	0.29	12.7	11.6	0.38	0.46	23.5	21.4	0.63	0.48

yields also increased due to nitrogen application because of increase in seed yield of mustard. These findings are supported by Singh and Rathi (1985), Singh (1988) and **Rana *et al.*,** (1991).

Zonal Agricultural Research Station,
JNKVV, PB No. 14 AB Road,
Morena 478 001 (M.P.)

N.S. YADAV
R.L. RAJPUT
S.S. TOMAR
O.P. VERMA

Khan, G.M. and Agrawal, S.K. 1968. Influence of sowing methods, moisture stress and nitrogen levels on growth, yield-components and seed yield of mustard. *Indian J.Agric. Sci.* 55 : 324-332.

Pimkhin, V.F. and Morozor, V.K. 1968. Accumulation of fatty and essential oil in seed of sarepta mustard. *Trudy Saratovsk, Sel. Khoz. Inst.* 17 (1) : 87-91.

Rana, D.S.: Singh, H.P. and Ahlawat, I.P.S. 1991. Oil yield and nitrogen uptake in mustard as affected by irrigation, plant density and nitrogen application. *Indian J. Agron.* 36 (Suppl.) 143-146.

Singh, R.A. and Rathi, K.S. 1985. Studies on nitrogen requirement of mustard. *Indian J. Agron.* 30 (2) : 257-259.

Singh, K.K. 1988. Comparative performance of mustard varieties under varying levels of nitrogen. M.Sc. (Ag). Thesis submitted to Agra-University, Agra.

Tomer, Savita. Tomer, Sunita. and Singh Subey. 1992. Effect of irrigation and fertilizer levels on growth, yield and quality of mustard (*Brassica juncea*) *Indian J. Agron.* 37 (1) : 76-78.

Acknowledgement

The present investigation was conducted under AICRP on Water Management at Morena Centre. The senior author is thankful to Dr R.K.Rajput, Director, D.W.M.R. Rahuri for suggesting the problem.

J.Oilseeds Res. 12(1) 1995 :123-125
ISSN 0970-2776

EFFECT OF DIFFERENT DATES OF SOWING ON GROWTH AND YIELD OF NIGER UNDER RAINFED CONDITION

Niger (*Guizotia abyssinica* Cass), locally known as '*Gujitil*' is an important oilseed crop of Lower Brahmaputra Valley Zone (LBVZ) of Assam and grown particularly in the districts of Dhubri, Goalpara, Kokrajhar, Nalbari and Barpeta during *rabi* season. Among various agronomic factors influencing the growth and yield of crop, date of sowing is the most important one. Importance of date of sowing on niger was also pointed out by Patil (1979) and Kachapur (1981). No systematic agronomic research has been done on this crop in Assam. Hence, the present study was undertaken to find out the optimum time of sowing for niger in LBVZ of Assam.

A field experiment was conducted at the Regional Agricultural Research Station, Gossaigaon (Assam), during *rabi*, 1987-88 and 1988-89 under rainfed conditions. The soil of the experimental area was sandy with pH 5.7 having high organic carbon (1.04%), high in total N (0.1%), high in available phosphorus (80.55 kg/ha) and medium in available potassium (188.35 kg/ha). Treatments comprise nine dates of sowing viz., 5th September, 15th September, 25th September, 5th October, 15th October, 25th October, 4th November, 14th November and 24th November. The experiment was laid out in Randomised Block Design with four replications having individual plots of 5 m x 4 m. In both the years, the plots were uniformly fertilized @ 20 kg N, 10 kg P_2O_5 and 10 kg K_2O/ha. Seeds of the variety 'NG 1' were sown @ 8 kg/ha with a spacing of 25 cm between rows.

Significant differences were observed in both the years on plant height, number of branches/plant and grain yield (Table 1). Tallest plants were recorded on 5th September and 25th September sowing in 1987-88 and 1988-89, respectively. In both the years, plant height and number of branches/plant decreased with delay in sowing. Grain yield decreased significantly beyond 15th october sowing in both the years. From the pooled data it revealed that the grain yield from 5th September to 15th October sowings were at par and significantly higher over other dates of sowing. The per cent yield decrease were 54.8, 53.1, 73.2 and 91.4 on 25th October, 4th November, 14th November and 24th November sowing over 15th October, respectively. The crop sown on 5th September received maximum rainfall of 1037.6 mm and 810.2 mm in 1987-88 and 1988-89, respectively, with gradual decline in rainfall as the sowing was delayed. The total rainfall received in the growth period of crops sown between 25th October and 24th November were 88.4 mm and 41.9 mm in 1987-88 and 1988-89, respectively. It is well documented from the rainfall data that the late sown crops suffered due to moisture stress conditions which might be the reason for lower grain yield in crops sown beyond 15th October. During 1987-88, the days to 50% flowering and maturity decreased up to 25th October sowing and then gradually increased but in 1988-89, these values decreased continuously with the delay of sowing from 5th September onwards. Patil (1979) also reported

Received for publication on September 4, 1992.

Table 1. Effect of different dates of sowing on plant height, number of branches/plant, grain yield, days to *50%* flowering *and* days to *maturity* of niger

Dates of sowing	Plant height (cm)		Number of branches/plant		Grain yield (q/ha)			Days to 50% flowering		Days to maturity		Cumulative rainfall (mm)	
	1987-88	1988-89	1987-88	1988-89	1987-88	1988-89	Pooled	1987-88	1988-89	1987-88	1988-89	1987-88	1988-89
5th September	80.50	79.90	10.00	6.70	5.16	3.44	4.30	58	59	100	104	1037.6	810.2
15th September	77.20	84.50	11.40	7.20	4.56	4.50	4.53	56	54	98	101	921.8	379.0
25th September	78.45	90.80	10.18	5.60	3.73	4.50	4.11	55	50	94	96	420.8	333.6
5th October	66.85	83.20	8.25	5.10	4.14	4.25	4.20	52	48	90	94	181.8	122.7
15th October	43.35	77.60	4.65	3.60	4.13	3.94	4.03	50	50	89	93	130.6	41.9
25th October	38.20	57.50	3.08	2.80	2.35	1.29	1.82	49	48	89	90	20.8	41.9
4th November	33.23	48.80	3.25	2.80	1.21	2.56	1.89	55	43	96	87	20.8	41.9
14th November	32.70	35.30	3.25	2.60	1.03	1.13	1.08	58	42	96	84	1.6	41.9
24th November	26.30	22.20	3.33	2.30	0.40	0.30	0.35	62	41	96	81	69.2	41.9
C.D. (5%)	3.85	6.98	0.96	0.41	0.76	0.73	0.67	-	-	-	-	-	-

similar trend in niger variety 'N-12-3'. Decrease of yield due to delay in sowing was also reported by Nayak and Paikray (1991) in niger.

Thus the findings of these studies revealed that the optimum time of sowing of niger during *rabi* season for LBVZ of Assam is 5th September to 15th October.

Regional Agricultural Research Station
Gossaigaon - 783 360, Assam
1 Regional Agricultural Research Station,Diphu
Assam, 782 460
2 Regional Agricultural Research Station,
Shillongoni, Navgaon, Assam

S.R. PAUL[1]
J. SUHRAWARDY
B. GUHA[2]

Kachapur, N.D. 1981. Effect of dates of sowing on yield of niger. *Indian J. Agron.* 26 (3) : 363-364

Nayak, B.C. and Paikray, R.K. 1991. Effect of time of sowing and plant density on yield of niger. *J. Oilseeds Res.* 8 (2) : 254.258.

Patil, C.B. 1979. Effect of sowing dates on yield of niger (variety N-12-3). *Indian J. Agron.* 24 (3) : 365-366.

J.Oilseeds Res. 12(1) 1995 : 126-127
ISSN 0970-2776

EFFICACY AND ECONOMY OF DIFFERENT FUNGICIDES AGAINST POWDERY MILDEW OF MUSTARD

Powdery mildew of mustard (*Brassica Juncea* L.),caused by *Erysiphe polygoni* D.C. is the most serious disease often causing serious yield losses to mustard crop. With a view to check losses due to occurrence of powdery mildew disease, field trials were conducted during the *rabi* seasons of 1988-89, 1989-90 and 1991-92 with systemic and non-systemic fungicides to find out effective and economical control measure for the disease. Mustard variety 'Varuna' was grown in Randomized Block Design with four replications. Each fungicidal treatment was assigned to a net plot size 4 mx 1.8 m. Details of treatment and dosage have been mentioned in Table 1. Three sprayings of fungicides were carried out using 750 lit of water per hectare. The first spray of fungicides was given at the appearance of disease. The second and third sprays were given at 15 days interval. Observation on disease intensity were recorded on ten randomly selected plants from each of the treatments in each replication, after 10 days of last spraying using 0-5 scale.

From the data presented in Table 1 revealed that all the fungicides under test reduced disease intensity as compared with check. The minimum disease intensity was observed in triadimefon 0.02 per cent. Mustard grain yield was also highest in the same treatment. Highest efficacy and economical control of the disease was obtained in the treatment of triadimefon and wettable sulphur. Efficacy of triadimefon against powdery mildew caused by *Erysiphe polygoni* and *E. graminis* were reported by Khosla *et al.* (1988) and Jenkyn and White (1988), respectively. Based on the cost-benefit ratio, use of wettable sulphur appears to be more remunerative than triadimefon, hence triadimefon 0.02 per cent wettable sulphur 0.2 per cent is recommended for the effective and economical control of powdery mildew of mustard.

Main Oilseeds Research Station
Gujarat Agricultural University
Junagadh - 362 001

V.A. PATEL
K.A. VAISHNAV
B. M. DHEDHI
B.K. KIKANI

Jenkyn, J.F. and White, N. 1988. Activity of triadimefon vapour against *Erysiphe graminis* f. sp. *hordei Ann. Appl. Biol.*, 113, (1): 15-27.

Khosla, H.K., Naik, S.L., Mandloi, S.C. and Goray, S.C. 1988. Control of powdery mildew of mung and urid in relation to losses and disease development. *Indian phytopath.*, 41 (1): 59-63.

Received for publication on December 17, 1992

Table 1. Average P.M. intensity, yield per hectare and economics of different fungicides against powdery mildew of mustard (Pooled analysis 1989, 1990 and 1992).

Chemicals	Concentration (a.i.)	Average P.M. intensity	Average yield (kg/ha)	Total expenditure	Total income (Rs/ha)	Income increased over control	ICBR
Chlorothalonil (Kavach-75% WP)	0.15	71.40* (57.78)	1216	1612.0	9278.0	728.0	1:0.45
Mancozeb (Dithane-M-45)	0.2	73.20 (58.83)	1220	636.0	9760.0	760.0	1:1.19
Zibneb (Dithane-Z-78) (75% WP)	0.2	72.10 (58.14)	1195	660.0	9560.0	560.0	1:0.85
Copper oxychloride (Blue copper 50% WP)	0.2	69.30 (56.84)	1231	870.0	9848.0	848.0	1:0.97
Wett. Sulpher (Sulfex 80% WP)	0.2	62.20 (52.05)	1275	244.0	10200.0	1200.0	1:4.90
Ziram (Ziride-80 % WP)	0.2	68.80 (56.02)	1283	620.0	10264.0	1264.0	1:2.0
Triadimefon (Bayleton 25% WP)	0.02	38.80 (38.52)	1475	1320.0	11800.0	2800.0	1:2.12
Control	0.2	87.50 (69.34)	1125	-	9000.0	-	-
	S.Em. ±	2.77	33.03				
	C.D.	8.41	100.18				

Price: Mustard Rs. 8.00 per kg.

* Angular transformed values

P.M. = Powdery mildew

J. Oilseeds Res. 12(1) 1995 : 128-129
ISSN 0970-2776

EFFECT OF MICRONUTRIENTS ON INDIAN MUSTARD

The response to micronutrients in crop production is increasing (Gangadhar, 1992; Sudarshan and Ramaswami, 1993). Hence the present study was undertaken to find out the effect of micronutrients on yield of Indian mustard.

Field experiment in a Randomized Block Design (plot size 4.5 m x 3.6m) was conducted at Regional Research Station, Madhurikund (Mathura) with Indian mustard (*Brassica juncea* (L) Czern & Coss) variety-'varuna' during *rabi* 1988-89 with 9 treatments, each replicated thrice. The crop was sown on 20th October 1988 with 45 cm row spacing and plant spacing at 15 cm was maintained by thinning. The field was irrigated twice at 35 and 65 days after sowing. Basal application of 40 kg N, 40 kg P_2O_5 and 40 kg K_2O per hectare was applied through urea, DAP and muriate of potash and 40 kg N/ha was top dressed 4 days after first irrigation. 30 kg elemental sulphur, zinc sulphate and manganese sulphate each @ 25 kg/ha, borax @ 5 kg/ha, ferrous sulphate @ 50 kg/ha, copper sulphate @ 20 kg/ha and ammonium molybdate @ 1 kg/ha were applied as basal. The soil of experimental plot was silty loam having pH of 8.2, E.C.of 0.36 mm hos/cm. Available iron and copper content of soil was 0.1 N HCL extract was found to be 4.0 and 0.5 ppm respectively.

Application of micronutrients influenced biological and seed yield per plant when these were applied along with N, P_2O_5, and K_2O. Application of $CuSO_4$ with N P K gave maximum biological and seed yield per plant, (17% and 21%) in comparison to NPK applied alone. However, it was at par with $MnSO_4$ and $ZnSO_4$ which increased the number of branches and siliquae per plant by 34.6% and 28.5%, respectively as compared to NPK applied alone (Table 1). The increase in seed yield due to application of micronutrient carriers excepting borax and Mo appears to have resulted due to collective action of both metallic and SO_4^- ion of the salt carriers which were absorbed and assimilated in greater proportions under the saline condition of experimental field, otherwise they were limiting the yield. The responses to $CuSO_4$ and $FeSO_4$ in this regard were more pronounced resulting in considerable increase in the number of branches and siliquae/plant with a correlation coefficient of 0.91 and 0.94 respectively. The beneficial effect of micronutrients was found to influence seed yield significantly. Thus $CuSO_4$ gave maximum seed yield of 31.6 q/ha which was superior to all other micronutrients tried. $FeSO_4$ proved next best (29.2 q/ha) but remained at par with $ZnSO_4$ and elemental sulphar. $MnSO_4$ and borax remaining at par but were inferior than $CuSO_4$ and $FeSO_4$ wheras ammonium molybdate failed to respond favourably over NPK. It is, therefore, inferred that application of $CuSO_4$ @ 20 kg/ha and $FeSO_4$ @ 50 kg/ha are useful for maximising yield of Indian mustard under the soil and agroclimatic condition of Madhurikund (Mathura) region.

These results are in conformity with the findings of Mehrotra and Saxena (1968) who obtained increased wheat yield with the use of borax, $CuSO_4$, $MnSO_4$ and $ZnSO_4$ applied either through soil or as foliar spray in central region of Utter Pradesh. Mehrotra *et al.* (1977) opined that by judicious use of micronutrients

Received for publication on May 8, 1993

Table 1. Effect of micronutrients on branches, yield components and yield of mustard.

Treatments	No. of branches/ plant	No. of siliquae/ plant	No. of seeds/ siliqua	Seed yield (g)/plant	Seed yield q/ha	Harvest Index (%)
Control	19.4	314.0	12.0	19.4	25.4	22.7
N.P K	20.5	330.5	12.2	21.6	26.1	23.8
N P K + El.sulphur 30 Kg/ha	23.4	349.9	12.6	22.9	28.2	24.2
N P K + $ZnSo_4$ 25 Kg/ha	26.3	402.8	12.7	23.6	28.3	23.3
N P K + $MnSo_4$ 25 Kg/ha	23.6	335.8	12.4	23.6	27.7	23.1
N P K + Borax 5 Kg/ha	22.9	351.7	12.3	22.7	27.6	23.8
N P K + $FeSO_4$ 50 Kg/ha	26.8	410.0	12.7	24.7	29.2	24.0
N P K + $CuSo_4$ 20 Kg/ha	27.6	424.9	13.3	26.2	31.6	24.8
N P K + A.M. 1 Kg/ha	21.7	340.9	12.2	22.4	26.3	23.6
C.D. @ 5 %	2.5	21.2	-	2.7	1.1	-
'r' value in relation to yield	0.94	0.91	-	-	-	-

Note :In all treatments except control 80 kg N, 40 kg P_2O_5 and 40 kg K_2O was applied

AM = Ammonium molybdate

seed yield of Indian mustard can be increased from 15.5 to 68.3 per cent.

Oilseed Section
C.S.A.University of Agriculture and Technology
Kanpur-208 002

LALLU
H. SHANKAR

Gangadhar, G.A., Manjunathaiah, H.M. and Satyanarayana, T. 1992. Effect of micronutrients on the yield and uptake by sunflower. *J. Indian Soc. Soil Sci.* Vol. 40: 591-593.

Mehrotra, O.N. and Saxena, H.K. 1963. Response of important crops to trace elements in Uttar Pradesh. *Ind. J. Agron.* 12(2) : 186-192.

Mehrotra, O.N., Srivastava, R.D.L. and Mishra, P.H. 1977. Effect of micronutrients on the growth, yield and quality of Indian mustard. *Ind. J. Agril. Chem.* 10 (1 & 2) : 81-86.

Sudarsan and Ramaswami, P.P. 1993. Micronutrients nutrition in groundnut blackgram cropping system. *Fertilzer News*, Vol. 38 (2). 51-57.

J. Oilseeds Res. 12(1)1995 : 130-132
ISSN 0970-2776

SCREENING OF PROMISING SAFFLOWER ENTRIES FOR MULTIPLE RESISTANCE TO APHID AND ALTERNARIA

Safflower (*Carthamus tinctorius* L.) is an improtant *rabi* oilseed crop grown in Maharashtra, Karnataka and Andhra Pradesh predominantly as dryland crop. Among different safflower pest, aphids (*Uroleucon compositae* Theobald) and alternaria leaf blight (*Alternaria carthami* Chowdhury) are the most destructive, limiting the production of safflower crop (Ray and Basuchoudhary 1984 and Patil and Parlekar, 1987). Therefore, attempts were made to locate the most multiple stable sources for both aphid and alternaria resistance in safflower crop at different locations. The most promising entries in respect of high degree of tolerance identified as stable sources for aphids and alternaria during past 3 to 4 years were taken into consideration for screening multiple resistance against aphid and alternaria.

The field experiments were conducted at GMU, Solapur, AICORPO, Solapur, Jalgaon and Annigeri under 3 different sowing dates (early, normal and late) during *rabi* 1992-93 in an Augmented Randomised Block Design with two replications. Already identified 10 aphid tolerant and 7 alternaria tolerant safflower entries supplied by GMU, Solapur with corresponding susceptible and standard checks (Table 1) were screened under 3 respective sowings. Each treatment was planted in a *single row of 5 meter* with a spacing of 45 cm x 20 cm at normal and 15 days prior and later sowings. The premature foliage drying (1 to 5 grades) due to aphid infestation was recorded on each entry and Aphid Infestation Index (A.I.I) was evaluated by the Formula (Anonymous, 1993)

$$\text{A.I.I} = \frac{1\times a + 2\times b + 3\times c + 4\times d + 5\times e}{a + b + c + d + e + \ldots\ldots j}$$

Where, 1 to 5 = Different drying grades
a to j = Number of plants in each line.

The observations of disease intensity on 0 to 9 scale were also recorded at flowering stage as per phytopathometry. The seed *yield/plant (g)* was recorded *at harvest. The pooled mean of 4 locations were worked out.*

Early sowing

The results revealed that comparatively low aphid population (19.8 to 75.5) was observed

Table 1. ***Method of categorising the entries on the basis of Aphid Infestation Index***

Grade	Range of per cent foliage drying due to aphid infestation	Category/Mechanism	Aphid Infestation Index
1	0 to 20	Highly tolerant lines (Healthy plants)	≤ 1
2	21 to 40	Tolerant lines	1.1 to 20
3	41 to 60	Moderately tolerant lines	2.1 to 3.0
4	61 to 80	Susceptible lines	3.1 to 4.0
5	81 and above	Highly susceptible lines (Death of plants before maturity)	4.1 to 5.0

Received for publication on October 8, 1993

on early sown crop than on normal (39.8 to 92.3) and late (65.8 to 121.3) sown. Earlier workers (Ghule *et al.,* 1987 and Jagdale *et al.*, 1990) reported the lowest aphid population on the crop sown in September than in October. All aphid tolerant entries possessed A.I.I. from 1.7 to 2.6 indicating tolerance whereas all the alternaria tolerant entries showed moderately tolerant A.I.I. (2.6 to 3.0) except GMU-1922 which possessed 3.6 A.I.I. As regards disease intensity only one entry from aphid tolerant group viz., PI- 307078 found tolerant (4.0) while rest possessed susceptible (4.5 to 6.0) disease scale.

Normal sowing

Aphid population was less (39.8 to 85.8) than late sown crop (65.8 to 121.3). All entries from aphid tolerant group scored A.I.I of 1.6 to 2.6 exhibiting tolerance to aphid as well as tolerant disease intensity scale (3.0 to 4.0) which indicated consistancy for multiple tolerance. The disease tolerant group possessed A.I.I. between 3.0 to 4.0 with disease rating of 2.0 to 3.0. These entries also produced better seed yield(g/plant) (4.0 to 35.0) than in early (3.0 to 18.0) and late sown (0 to 9.8). However, two entries from alternaria tolerant group viz., GMU-822 and GMU-1921 were moderately tolerant having A.I.I. 3.0 and 2.0 and 3.0 disease intensity scale which indicated consistancy for the multiple tolerance.

Late sowing

The aphid tolerant entries possessed less aphid population (90.3 to 124.7) and A.I.I (1.8 to 2.6) with comparatively good seed yield (5.9 to 9.8 g/plant), over disease tolerant group which possessed 146.9 to 166.6 aphid population and 4.5 to 5.0 A.I.I and no seed yield. Howerver, earlier workers (Ghule *et al.*, 1987 and Jagdale *et al.,* 1990) reported the higher seed yield in early and normal sown crop than that sown late. As regard disease rating, aphid tolerant entries exhibited tolerant (2.3 to 4.0) disease intensity scale whereas all entries from alternaria tolerant group possessed susceptible (4.5 to 6.0) disease intensity scale except GMU-822 (3.0) and GMU-1921 (4.0). It seems that the sowing time has profound effect on disease reaction. However, all the entries from both the groups showed tolerant reaction to both aphids and alternaria under normal sowing.

It is concluded from the study that only one entry viz., PI-307078 from aphid tolerant group was observed for aphid and alternaria tolerance during all the three sowing conditions. Rest of the entries from this group were found suitable for aphid and alternaria tolerance under normal and late sown conditions. Only two alternaria tolerant entries viz; GMU-822 and GMU-1921 exhibited better aphid tolrance under early and normal sown conditions and alternaria tolerance under normal and late sown conditions.

These three resistant entries with comparatively good seed yield need agronomic experimentation and can be exploited in breeding programme to develop high yielding varieties having tolerance to both aphids and altenaria.

Project Co-ordinating Unit (Safflower),
P.B. No.199, Solapur-2.
*AICORPO (Safflower), Solapur-2.

V.B. AKASHE
P.V. MAKAR*
C.D. DEOKAR
D.M. VEER

Anonymous, 1993. Annual Progress Report of AICORPO Safflower, 1992-93. Directorate of Oilseeds Research, Hyderabad. pp-E1-E4.

Ghule, B.D., Jagtap, A.B., Dhumal, V.S. and Deokar, A.B. 1987. Effects of sowing time on incidence of aphids on Safflower. *J. Maharashtra Agric. Univ.* 12(2) : 259.

Jagdale, G.B., Dhoble, S.Y., Deokar, A.B. and Ajri, D.S. 1990. Effects of planting time on incidence of aphid on different safflower varieties. *J. Maharashtra Agric. Univ.* 15(2) : 242- 243.

Patil, P.S. and Parlekar, G.Y. 1987. Safflower book published a ADR, NARP, Solapur. pp. 126-143.

Ray, S. and Basuchaudhary, K.C. 1984. Field evaluation of some improved lines of safflower to leaf blight casued by *A. Carthami* at Varanasi. *J. Oilseeds Res.* 1: 91-94.

J. Oilseeds Res. 12(1) 1995 : 133-136
ISSN 0970-2776

EFFECT OF ZINC AND MOLYBDENUM ON THE YIELD AND QUALITY OF GROUNDNUT

A field experiment was conducted on farmers' field at Venkateshpura Village, Bangalore (Dist.), Karnataka during *kharif* season of 1990 under adequate irrigation. The soil of the experimental field was red sandy loam and low in organic matter content. It was acidic (pH 5.8) in nature, low in electrical conductivity (EC 0.2 mm hos/cm), and low in organic matter content (0.57%). The status of available NPK and S content was 259.1, 12.4, 260.0 and 7.0 kg/ha respectively. the soil was low in available zinc (0.38 ppm) and molybdenum (0.56 ppm) content.

The experiment was laid out in a Factorial Randomized Block Design with three replications adopting gross plot size of 4.8 m x 2.4 m. Two sources of zinc viz., zinc sulphate and zinc oxide each tried at two levels, in combination with and without molybdenum. The treatment details are given in Table 1. Zinc sulphate was applied at the rate of 5.6 and 11.2 Zn kg/ha to soil and zinc oxide was seed dressed gently on seeds with dilute gum solution at the rate of one and two grams per kilogram of seed and were dried in shade. Molybdenum (2 g/kg seed) was also seed dressed with dilute gum solution without causing any injury to seeds. Recommended dose of 25 kg N, 75 kg P_2O_5 and 37.5 kg K_2O per ha was applied before sowing. Groundnut cultivar 'JL-24' was grown following the recommended package of practices. The estimation of oil and protein contents in kernels were done in well prepared flour samples of groundnut kernels.

Zinc application significantly enhanced the pod yield from 3990 at control to 4880 kg ha^{-1} at $Zn_{11.2}$ soil application. Zinc sulphate was more efficient in improving pod yields rather than zinc oxide (Table 1). The interaction of Zn and Mo was more marked (Table 2). The maximum pod yield of 4960 kg ha^{-1} was obtained at $Zn_{5.6}$ kg/ha + Mo which was on par with an yield of 4910 kg ha^{-1} at $Zn_{11.2}$ kg/ha + Mo.

An extra pod yield of 540 kg ha^{-1} was recorded at $Zn_{5.6}$ kg/ha without Mo as against 980 kg ha^{-1} at $Zn_{5.6}$ kg/ha + Mo. Similarly the recorded extra pod yield of 870 kg ha^{-1} at $Zn_{11.2}$ kg/ha without Mo was on par with 930 kg ha^{-1} at $Zn_{11.2}$ kg/ha + Mo. The positive response of groundnut to zinc application over control was associated with the low status of available zinc in soil (0.38 ppm) and also of molybdenum (0.56 ppm). It may be inferred that through the available status of molybdenum (0.56 ppm Mo) was above the critical limit of 0.25 ppm Mo (Dwivedi, 1986), the added molybdenum through seed dressing might have activated the enzymatic system in enhancing crop yields through growth parameters (Dhakshinamurthy *et al.*, 1987).

The pattern of improvement of kernel yield was similar to that of pod yield. Maximum kernel yield (3710 kg ha^{-1}) was recorded at $Zn_{11.2}$ kg/h a level as compared to control (2930 kg ha^{-1}). This accounted for extra yield of 780 kg ha^{-1} over recommended dose of fertilizer plus gypsum. In the case of seed dressing, the kernel yield of 3450 kg ha^{-1} was obtained with seed dressing of Zn @ 2g/kg compared to that of control (2930 kg ha^{-1}) resulting in extra yield of 550 kg ha^{-1}. The interaction of Zn x Mo

Received for publication on November 12, 1993

Table 1. Yield and quality parameters of groundnut as influenced by levels, source of Zinc and Molybdenum fertilization

Treatments	Pod yield (kg/ha)	Haulm yield (kg/ha)	Kernel yield (kg/ha)	Oil content per cent	Crude protein per cent
Zinc levels					
Control	3990	4930	2930	41.18	20.26
Soil application (Zinc sulphate)					
5.6 kg Zn/ha	4740	5600	3630	41.46	24.19
11.2 kg Zn/ha	4880	5710	3710	40.89	25.06
Seed dressing (Zinc oxide)					
1 g Zn/kg seed	4510	5200	3410	40.94	22.49
2 g Zn/kg seed	4630	5330	3480	41.47	25.81
S.Em ±	65.00	56.00	54.00	0.53	0.30
C.D. at 5%	190.00	160.00	170.00	NS	0.89
Zinc sources					
Zinc sulphate	4810	5650	3670	41.71	24.62
Zinc oxide	4570	5370	3450	41.21	24.15
S.Em ±	46.30	39.73	41.12	0.40	0.21
C.D. at 5%	137.50	118.04	122.18	NS	NS
Molybdenum levels					
Without molybdenum (-Mo)	4460	5380	3360	41.21	22.37
With molybdenum (+Mo)	4630	5320	3500	41.17	24.76
S.Em ±	41.40	35.53	36.78	0.34	0.19
C.D. at 5%	NS	NS	NS	NS	0.56

was significant at $Zn_{5.6}$ kg/ha soil application and recorded maximum kernel yield of 3830 kg ha^{-1}.

The haulm yield also appreciably increased with 11.2 kg/ha of zinc application (Table 1). The mode of application caused greater effect on haulm yield rather than levels of zinc. Molybdenum levels did not influence on haulm yield. The interaction effect of Zn and Mo was synergestic due to zinc application at $Zn_{5.6}$ kg/ha + Mo.

Molybdenum seed dressing of groundnut did not show any significant increase in oil content (Table 1) which was attributed to the existence of inverse relationship between oil and nitrogen content in seed (De and Chatterjee, 1976). Among the sources application of zinc sulphate was found superior over zinc oxide in enhancing all other characters under study.

The crude protein content was enhanced significantly due to zinc application and further improved due to interaction of Zn and Mo, signifies the synergestic effect. The role of zinc and sulphur in the synthesis of amino acids leading to the formation of protein

Table 2. **Yield and quality parameters of groundnut as *influenced* by interaction effect of Zinc and molybdenum fertilization.**

Treatment	Pod yield (kg/ha)		Haulm yield (kg/ha)		Kernel yield (kg/ha)		Oil content per cent		Crude protein per cent	
	-Mo	+Mo	-Mo	+Mo	-Mo	+Mo	-Mo	+Mo	-Mo	+Mo
Control	3980	4010	4920	4980	2870	3000	40.83	41.53	18.66	21.81
Soil application (Zinc sulphate)										
5.6 kg Zn/ha	4520	4960	5490	5700	3440	3830	41.09	41.84	22.85	25.53
11.2 kg Zn/ha	4850	4910	5730	5680	3690	3730	41.43	40.36	23.55	26.53
Seed dressing (Zinc oxide)										
1g Zn/kg seed	4420	4610	5390	5070	3330	3480	41.43	40.59	20.93	24.06
1g Zn/kg seed	4620	4640	5410	5180	3490	3480	41.42	45.53	25.81	25.81
S.Em ±	90.00		70.00		80.00		0.70		0.42	
C.D. at 5%	270.00		230.00		240.00		NS		1.26	

molecule was well known (Mengel and Kirkby, 1984).

Application of zinc sulphate has significantly enhanced the yield and quality parameters. The oil content was found non significant. Molybdenum application showed significant effect only on protein content in seed. The interaction of Zn and Mo was synergestic on all characters under study which signifies the role of zinc and molybdenum in synthesis and translocation of photosynthates to the seed formation and protein synthesis.

Department of Agronomy
University of Agril. Sciences,
G.K.V.K., Bangalore-65.

N. GOPALA GOWDA
B. SHIVARAJ
ANDANI GOWDA

De, M.K. and Chatterjee, B.N. 1976. Effect of trace elements on growth and yield of groundnut in leached sandy loam soil. *Indian J. Agron.*, 21: 209-216.

Dhakshina Murthy, Kumaresan, K.R., Devarajan, R., Vaman Bhat, M., Sathapathi, and Ramalingham, R. 1987. Micronutrient nutrition in groundnut. *Madras Agric.J.* 74: 475-478.

Dwivedi, R.S. 1986. Mineral nutrition and scope of breeding groundnut for nutrient deficiency resistant, Recent advances in groundnut productivity, *Res. Proc. Summ. Inst.* NRCG (ICAR), Junagadh, pp. 9-30.

Mengel, K. and Kirkby, E.A. 1984. Principles of plant nutrition (4th ed.) International Potash Institute, Bern, Switzerland.

J. Oilseeds Res. 12(1) 1995 : 137-140
ISSN 0970-2776

FROST INJURY VIS - A - VIS LEAF-ANATOMICAL CHARACTERS IN SOYBEAN

Soybean presently covers about four million hectare and is increasingly claiming new niches in India. The post rainy season (*rabi*) crop of soybean occasionally experiences frost injury. The occurrence of frost is not regular and screening against frost cannot be done regularly under field conditions. A study was, hence, taken up to(a) categorise soybean varieties for their resistance/tolerance to frost and (b) study the association of frost resistance/tolerance with different morpho-anatomical characters which could serve as selection criteria for frost resistance even during non frost years.

Seventeen representative varieties and strains of soybean were planted in replicated rows at National Research Centre for Soybean farm at Indore during the post rainy season (November- April). Consequent upon the occurrence of natural frost on the night of 23rd February, 1993 at the minimum temperature of 5.6 °C and low relative humidity of 19%, fully expanded soybean leaves in 10 randomly selected plants of each variety/strain were taken for per cent leaf injury on 24th Feb. 1993. Free hand sections of fully expanded terminal leaflets were examined for anatomical character under a 'Vanox-s' (Olympus) microscope fitted with an ocular micrometer. Correlation coefficient and path coefficients (Dewey and Lu, 1959) were computed. Step-down regression analysis was carried out.

Anatomical features in soybean leaf were found to be similar as it is observed in dorsi-ventral leaves i.e. palisade parenchyma was arranged contiguous to upper epidermis while the spongy parenchyma was below the palisade and towards the lower epidermis (Fig. 1 & 2). An interesting feature observed was the presense of the single layer of paraveinal mesophyll between palisade and spongy parenchyma as described by Fisher (1967). Palisade was found to be double layered or bi-seriate in nature as uniformly observed in case of all the soybean varieties/strains. The upper layer of palisade, just below the upper epidermis, was relatively thicker than the lower layer.

Soybean was found to be highly susceptible to frost when compared with other *rabi* crops like wheat, gram and safflower. The mean values and range for frost injury and leaf-anatomical characters in soybean are presented in Table 1. The level of frost injury in different varieties varied in the range of 5.33% to 86.38% with a mean value of 52.79%. Among anatomical characters, a high degree of variability was observed for total leaf thickness, thickness of spongy parenchyma and palisade thickness than other anatomical characters. These observations are in conformity with earlier reports (Lugg and Sinclair, 1980).

None of the soybean varieties in the study showed absolute resistance to frost injury. However, minimum frost injury (5.33%) was observed in one strain, 'G 2086 (S)', which was followed by 'Ugar Bold' with 11.71 % frost injury in leaf. Medium to high frost injury was exhibited by other varieties viz. 'JS 71-05' (27%), 'Bragg' (42%), 'PK 308' (67%), 'JS 335' (72%), 'Punjab 1' (75%), 'Monetta' (79%), 'Pk 472' (84%) and 'NRC 2' (86%). Leaf injury as high as 86.38% was observed in 'Kalitur'.

Received for publication on November 30, 1993

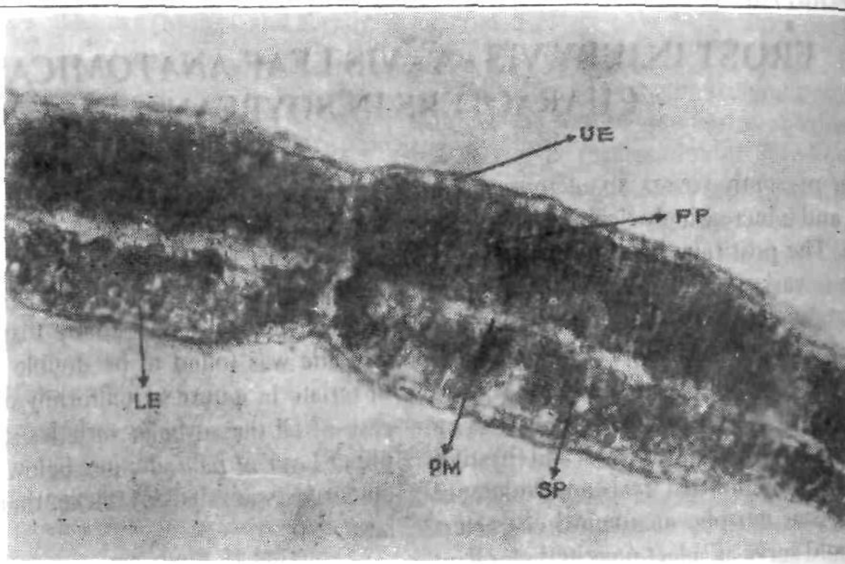


Fig. 1

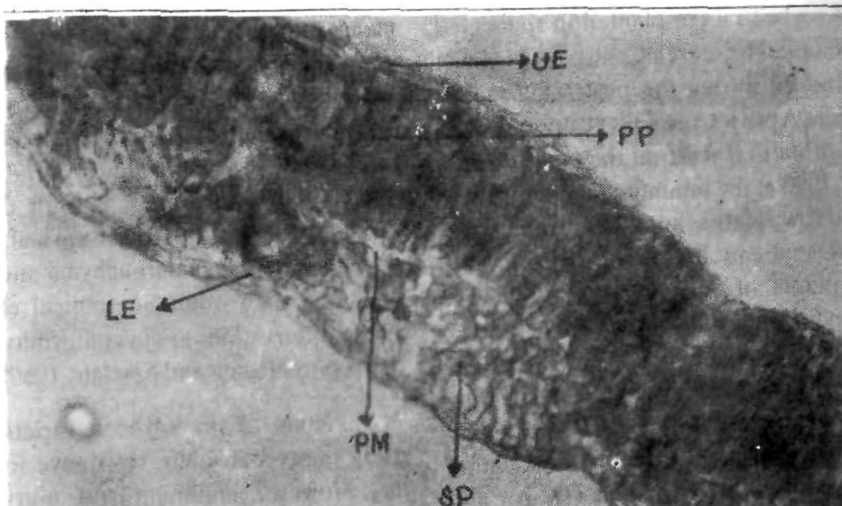


Fig. 2

Cross-section of lateral leaf-let of soybean cv. Punjab 1 (Fig. 1) and strain 'G 2086 (S)' (Fig. 2).
UE = Upper epidermis, PP = Palisade parenchyma, PM = Layer of paraveinal mesophyll,
SP = Spongy parenchyma, LE = Lower epidermis.

Table 1. Mean and range for leaf-anatomical characters and frost injury in soybean

	Character	Mean	SD*	Range
1.	Thickness of upper epidermis (μ)	16.34	1.87	13.7 - 20.5
2.	Thickness of lower epidermis (μ)	14.97	1.55	13.1 - 18.9
3.	Palisade thickness (μ)	115.04	23.69	84.2 - 167.4
4.	Thickness of spongy parenchyma (μ)	86.34	13.43	67.0 - 117.5
5.	Palisade proportion (%)	48.86	5.04	41.3 - 58.6
6.	Thickness of leaf (μ)	232.69	32.02	187.4 - 285.8
7.	Frost injury (%)	52.79	26.20	5.3 - 86.3

* Standard deviation

Frost injury showed a negative association with all the anatomical characters studied (Table 2). However, highly significant and strong negative correlation of frost injury was obtained with total leaf thickness ('r' = -0.743) followed by that with thickness of palisade parenchyma ('r' = -0.728). This indicated that increased thickness of leaf and palisade layer would lead to frost resistance/tolerance. The total thickness of leaf also showed a strong positive correlation with thickness of palisade parenchyma ('r' = 0.870) as well as other leaf anotomical characters.

Path-coefficients revealed total leaf thickness to be the highest direct contributor (Table 2) towards frost resistance by having a direct negative impact on frost injury. Palisade thickness, emerging to be the second important character in the context, showed a direct positive effect on frost injury. Leaf thickness affected the frost injury negatively whereas palisade thickness affected it positively. Since these two characters were also found to be strongly correlated with each other in a positive manner ('r' = 0.870), the situation demands for striking a balance between them while attempting to make improvement in frost resistance of soybean genotypes. Residual direct effect of unknown factor was low, indicating that a major proportion of variation (about 70%) for leaf injury could be associated with the factors included in the study. Step-down regression analysis also identified leaf thickness as the major predictor of frost injury.

It was, thus, consistently shown that genotypes with thicker leaves would have more resistance/tolerance to frost and the character could serve as a selection criterion for frost resistance even during non-frost years. The results broadly agree with earlier reports (Tiwari *et al.* 1986) but unlike in other systems where palisade thickness was more important, leaf thickness in soybean was found to have the predominant association with frost resistance/tolerance. Although soybean is more frost-prone than several other crops, identification of relatively resistant genotypes and selection criteria as reported presently could help in extending the niche of soybean to such regions and seasons where frost resistance/tolerance is a prerequisite for commercial adaptation of soybean.

Table 2. Correlation coefficients of frost injury with leaf-anatomical characters in soybean

Characters	Thickness of lower epidermis	Palisade thickness	Thickness of spongy parenchyma	Palisade proportion (%)	Thickness of leaf	Frost injury (%)	Direct effects
Thickness of upper epidermis	0.31**	0.46**	-0.01	0.31**	0.43**	-0.39**	20.779
Thickness of lower epidermis		0.37**	-0.08	0.30**	0.33**	-0.24**	19.391
Palisade thickness			0.14	0.80**	0.87**	-0.73**	207.065
Thickness of spongy parenchyma				-0.46**	0.60**	-0.32**	142.420
Palisade *proportion* (%)					0.40**	-0.44**	0.804
Thickness of leaf						-0.74**	-282.270

Note: 1. * and ** Significant at 0.05 P and 0.01 P respecively; n = 170

2. Direct effects are as per Dewey and LU (1959)

National Research Centre for Soybean,
Khandwa Road, Indore 452 001. M.P.

V.S. BHATIA
S.P. TIWARI

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

Fisher, D.B. 1967. An unusual layer of cells in the mesophyll of the soybean leaf. *Bot. Gaz.* 128: 215-218.

Lugg, D.G. and Sinclair, T.R. 1980. Seasonal changes and anatomy of field-grown soybean leaves. *Crop Sci.* 20: 191-196.

Tiwari, S.P., Sukumaran, N.P. and Khushu, C.L. 1986. Path-coefficient analysis of leaf-anatomical characters affecting frost injury in potato. *Pl. Breeding* 97: 272-274.

J. Oilseeds Res. 12(1) 1995 : 141-145
ISSN 0970-2776

RESPONSE OF GROUNDNUT TO SOURCES OF PHOSPHATE AND PHOSPHATE SOLUBILIZERS IN VERTISOLS

Plants absorb phosphorus from the water soluble phosphates which is present in very small quantities in the soil. Most of the phosphorus in soil is in the insoluble form. Besides, there are substantial deposits of low grade rock phosphate which cannot be profitably utilized as a source of phosphatic fertilizer particularly in non-acidic soils. In recent years the investigations were carried out to show that soil micro-organisms like bacteria and fungi play an important role in solubilizing phosphorus in soil and making available to the plants. Beneficial effect of inoculation with P-solubilizers on the growth, yield and uptake of phosphorus by plant has been reported by many workers. Gerretsen (1948) was the first to demonstrate that plants took up more phosphate from insoluble phosphatic fertilizers in the presence of microorganisms. Hence the present study was undertaken to study the response of groundnut to the inoculation of phosphomicrobes with and without different proportions of Mussoorie rock phosphate (MRP) and single super phosphate (SSP) in Vertisols.

A field experiment was conducted at Main Research Station of the University of Agricultural Sciences, Dharwad during *kharif* 1992 in Vertisols having pH 8.1., available 254 N; 35 P_2O_5 and 325 K_2O kg/ha. The fertilizer N and K_2O were given at the recommended level (25 kg/ha each). Phosphorus @ 50 kg/ha was supplied through two sources viz., MRP and SSP with 0, 25, 50, 75 and 100 per cent of the recommended dose in the presence and absence of P- solubilizers (*Pseudomonas striata* and *Aspergillus awamori*). These phosphomicrobes were used for seed inoculation of groundnut variety 'Dh-3-30'. The experiment was laid out in Randomised Block Design with 18 treatments and replicated thrice.

Crop was harvested at 105 days after sowing. Dry matter production, yield and yield components, P-uptake by plant and available P_2O_5 in the soil after harvest were recorded. Phosphorus content in the plant samples was determined by vanadomolybdo phosphoric yellow colour method as described by Jackson (1967).

Dry matter production

The dry matter production varied significantly at all the stages of growth (Table 1). In general inoculation of *Aspergillus awamori* or *Pseudomonas striata* recorded significantly higher dry matter production at all the stages of crop growth, than control. At harvest, inoculation of *A. awamori* (34.28 g/plant) or *P. striata* (37.08 g/plant) alone produced 28 and 38 per cent higher dry matter respectively than control (26.72 g/plant). At harvest, inoculation of *A. awamori* with different proportions of MRP and SSP recorded higher dry matter production than the respective uninoculated treatments. Taha *et al.* (1969) reported significant increase in dry matter yield of barley after one month of crop growth with the inoculation of P-solubilizing micro-organisms. Among all the treatments inoculation of *P. striata* along with the application of 75 per cent MRP + 25 per cent SSP recorded higher dry matter production per plant. The effect can be attributed to the better adaptability of *P. striata* in Vertisols than *A. awamori*. The differences in dry matter production of groundnut with

Received for publication on December 15, 1993.

inoculation of P-solubilizers might be due to better nodulation in groundnut (Tabel 1) owing to better availability of phosphorus. This improvement in nodulation with P-solubilizing micro-organisms might have resulted in higher amount of nitrogen fixation and thereby better vegetative growth and dry matter production.

Yield and yield attributing characters

The pod yield recorded with inoculation of *A. awamori* (4037 kg/ha) and *P. striata* alone (4286 kg/ha) were 19 and 26 per cent higher respectively when compared to control (2391 kg/ha). Guar (1984) reported 10 to 30 per cent increase in yield of bengal gram with inoculation of microphos alone. Inoculation of *A. awamori* along with the application of 100 per cent SSP (4899 kg/ha) recorded 20, 7.8, 21 and 11 per cent higher yield respectively when compared to the application of 100 per cent SSP, 25 per cent MRP + 75 per cent SSP, 50 per cent MRP + 50 per cent SSP, 75 per cent MRP + 25 per cent SSP and 100 per cent MRP alone (Table 2). In groundnut, Manjaiah (1989) reported that pod yield was significantly higher when MRP was applied along with FYM and *A. awamori*. Inoculation of *P. striata* along with the application of 75 per cent MRP + 25 per cent SSP and 100 per cent SSP recorded significantly higher pod yield when compared to the application of different proportions of MRP and SSP without phosphate solubilizers and were superior to all other treatments. The pod weight per plant and kernel yield followed the similar trend as that of pod yield ha^{-1} (Tabel 2).

Phosphorus uptake (kg/ha) by plant and available P_2O_5 in soil after harvest.

Inoculation of P-solubilizers alone influenced the P-uptake by groundnut crop at all the stages of crop growth. At harvest, inoculation of *A. awamori* (7.68 kg/ha) or *P. striata* (8.22 kg/ha) recorded 20 and 30 per cent higher P-uptake respectively by groundnut than control (6.05 kg/ha). Appliction of 100 per cent SSP along with the inoculation of *A. awamori* recorded significantly higher P-uptake at all the stages of crop growth when compared to the application of different proportions of SSP and MRP alone. Among all the treatments, inoculation of *P. striata* with the application of 75 per cent SSP recorded higher P-uptake by groundnut and this seems to be superior than other treatments (Table 1). The higher P-uptake may be due to the increased availability of phosphorus in the soil due to solubilization of native and added phosphorus by P-solubilizers by the production of organic acids namely, lactic, glycolic, citric and succinic acids. Kavimandan and Guar (1971) reported increased phosphorus uptake by wheat, gram and maize with the inoculation of phosphobacterin. Inoculation of P-solubilizers alone or in combination with different proportions of MRP and SSP had postitive influence on phosphorus status of soil after harvest (Table 1). Inoculation of *A. awamori* (36.44 kg/ha) or *P. striata* (36.94 kg/ha) alone were 29.8 and 31.6 per cent higher P_2O_5 in the soil, due to mineralization of organic and inorganic reserves. Inoculation of *A. awamori* along with the application of 100 per cent SSP recorded 26.6 per cent higher P_2O_5 in the soil after harvest when compared to the application of 100 per cent SSP alone. Inoculation of *P. striata* with the application of 75 per cent MRP + 25 per cent SSP recorded highest available P_2O_5 (44.87 kg/ha) in the soil and differed significantly over uninoculated treatments. Wani *et al.* (1978) found that about 25.41 per cent higher avilable P_2O_5 in soil was noticed due to inoculation of *P. striata* in gram when compared to control. The use of P-solubilizing culture alone or in combination

Table 1. **Dry matter production (g/plant) nodule number, phosphorus uptake by plant (kg/ha) at different growth stages and available P_2O_5 (kg/ha) in soil after harvest as influenced by sources of phosphate and inoculation of P - Solubilizers.**

Treatment	Dry matter production (g/plant)			Nodule number			Phosphorus uptake by plant (kg/ha)			Av. P_2O_5 in soil (kg/ha) after harvest
	50 DAS	75 DAS	At harvest	50 DAS	75 DAS	At harvest	50 DAS	75 DAS	At harvest	
Control	10	22	27	49	90	106	3	5	6	28
MRP (0%) :SSP (100%)	12	27	32	80	107	120	5	7	8	35
MRP (25%) :SSP (75%)	13	27	37	65	112	133	5	6	8	37
MRP (50%) :SSP (50%)	13	28	34	83	123	146	5	6	8	37
MRP (75%) :SSP (25%)	12	26	37	91	121	135	4	5	8	34
MRP (100%) :SSP (0%)	12	25	33	76	107	121	4	6	8	34
Aspergillus awamori	12	27	34	66	103	141	5	6	8	36
MRP (0%) :SSP (100%) + *A. awamori*	13	27	36	98	125	148	6	7	10	44
MRP (25%) :SSP (75%) + *A. awamori*	13	26	37	77	122	153	5	6	9	40
MRP (50%) :SSP (50%) + *A. awamori*	13	27	34	91	125	161	5	7	10	40
MRP (75%) :SSP (25%) + *A. awamori*	12	26	36	99	126	153	5	7	10	42
MRP (100%) :SSP (0%) + *A. awamori*	12	29	36	82	114	160	5	6	9	40
Pseudamonas striata	12	25	37	72	108	158	5	6	8	37
MRP (0%) :SSP (100%) + *P. striata*	13	29	40	115	131	155	7	8	11	43
MRP (25%) :SSP (75%) + *P. striata*	13	30	38	91	128	156	5	8	10	42
MRP (50%) :SSP (50%) + *P. striata*	14	29	39	103	125	155	6	7	11	43
MRP (75%) :SSP (25%) + *P. striata*	15	31	41	109	147	170	7	9	13	45
MRP (100% :SSP (0%) + *P. striata*	13	27	37	87	119	148	6	6	9	39
S.Em ±	0.47	0.81	0.82	4	3	3	0.1	0.1	0.3	0.87
C.D. at 5%	1.35	1.31	2.36	10	10	9	0.3	0.3	1.1	2.51

MRP = Mussoorie rock phosphate, SSP = Single super phosphate, DAS = Days after sowing.

Table 2. Pod yield (kg/ha), Shelling per cent, kernel yield (kg/ha), Oil per cent and oil yield (kg/ha) as influenced by Sources of Phosphate and inoculation of P-Solubilizers

Treatments	Pod yield (kg/ha)	Shelling (%)	Kernel yield (kg/ha)	Oil (%)	Oil yield (kg/ha)
Control	3391	74	2520	49	1235
MRP (0%) :SSP (100%)	4078	76	3101	50	1551
MRP (25%) :SSP (75%)	4390	75	3291	49	1613
MRP (50%) :SSP (50%)	4244	76	3224	49	1580
MRP (75%) :SSP (25%)	4047	74	2983	51	1521
MRP (100%) :SSP (0%)	4057	73	2970	49	1455
Aspergillus awamori	4037	79	3178	49	1557
MRP (0%) :SSP (100%) +*A. awamori*	4899	75	3665	49	1796
MRP (25%) :SSP (75%) +*A. awamori*	4541	74	3367	50	1684
MRP (50%) :SSP (50%) +*A. awamori*	4591	74	3406	49	1669
MRP (75%) :SSP (25%) +*A. awamori*	4610	72	3298	50	1649
MRP (100%) :SSP (0%) +*A. awamori*	4239	75	3191	49	1564
Pseudamonas striata	4256	72	3066	49	1502
MRP (0%) :SSP (100%) +*P. striata*	4961	75	3728	49	1827
MRP (25%) :SSP (75%) +*P. striata*	4691	77	3631	50	1816
MRP (50%) :SSP (50%) +*P. striata*	4897	76	3743	49	1834
MRP (75%) :SSP (25%) +*P. striata*	5069	78	3941	50	1971
MRP (100%) :SSP (0%) +*P. striata*	4332	76	3293	50	1647
S.Em ±	285	1.62	229	0.51	115
C.D. at 5%	820	NS	661	NS	331

MRP = Mussoorie rock phosphate; SSP = Single super phosphate; NS = Non Significant.

with phosphatic fertilizers increased the avilable phosphorus in the soil (Mohod *et al.*, 1989).

Inoculation of P-solubilizers to soils that are rich in native phosphorus makes the fixed phosphorus available to plants resulting in enhanced productivity. Inoculation of *Aspergillus awamori* increases the efficiency of SSP and application of 75 per cent MRP + 25 per cent SSP + *P. striata* resulted in higher growth, yield attributes when compared to the application of 100 per cent SSP alone. So this would be a boon to small and marginal farmers.

Department of Agronomy
University of Agricultural sciences,
Dharwad, Karnataka, India.

MUDALAGIRIYAPPA
C.A. AGASIMANI
M.N. SREENIVASA.

Gerretsen, F.C. 1948. The influence of micro-organisms on the P- uptake by the plant. *Plant* and *Soil.* 11: 51-81.

Guar, A.C. 1984. Biofertilizers and crop productivity *Advn. Soil Sci.* 1: 101-107.

Jackson, M.L. 1967. Soil chemical analysis. Prentce Hall of India, New Delhi. pp. 38-82.

Kavimandan, S.K. and Guar, A.C. 1971. Effect of seed inoculation with *Pseudomonas sp.* on phosphate uptake and yield of maize. *Curr. Sci.* 40: 430-440.

Manjaiah, K.M. 1989. Investigations on influence of rock phosphate on groundnut in acid soils. M.Sc (Agri) Thesis, University of Agricultural Sciences, Dharwad.

Mohod, S.P., Gupta, D.N. and Chavan, A.S. 1989. Enhancement of P- solubility and P-uptake in rice by phosphate solubilizing culture. *J.Maharashtra Agric. Univ.*, 14 (2) : 178-181.

Taha, S.M., Mahmoud, S.A.I., El-Danmy, A.H. and El-Ha fez., A.M. 1969. Activity of phosphate dissolving bacteria in Egyptian Soils. *Plant and Soil*. 31 : 149-160.

Wanij, P.V., More, B.B. and Patil. P.L. 1978. Effect of seed inoculation with some P-solubilizing micro-organisms on the phosphate uptake and yield of gram. *J. Maharashtra Agric. Univ.* 3: 271 - 272.

J.Oilseeds Res. 12(1) 1995 : 146-148
ISSN 0970-2776

SEVERITY OF RUST AND ALTERNARIA LEAF SPOT IN RELATION TO DIFFERENT SOWING DATES IN PARENTAL LINES OF SUNFLOWER HYBRIDS

The severity of diseases in many crops are known to be greatly influenced by many agro-cultural practices like planting geometry, planting density, mineral nutrition and drainage (Shaik Mohammed *et al.* 1985). Effect of sowing dates on severity of foliar diseases is an important factor to be considered in seed production plots. Information on disease incidence and severity among different parental lines of hybrid sunflower is very limited, though, hybrids do express resistance reaction to Alternaria leaf spot and rust (Shivaprakasam *et al.* 1977 and Nagaraju *et al.* 1994) which are considered to be very important foliar diseases causing considerable losses in seed yield of sunflower. In this context, an attempt was made to evaluate the incidence and severity of these diseases in relation to sowing dates on parental lines of the sunflower hybrids.

Parental seeds of sunflower hybrids viz., KBSH 1 (CMS 234A, RHA 6D-1), APSH 11 (CMS 7-1A, RHA 271) and LSH 3 (CMS 207A, MRHA 1) were obtained and evaluated by sowing at monthly intervals starting from September 1992 to February 1993 for the incidence and severity of Alternaria leaf spot (*Alternaria helianthi*) and rust (*Puccinia helianthi*) at the Seed Technology Research Unit, UAS, Bangalore. Each parental line was sown in seperate blocks in four replications. All recommended agronomical practices were carried out as per package of practices. Incidence and severity of diseases were recorded as percentage leaf damaged by the individual disease at 50 per cent grain filling stage following the procedure of Nagaraju *et al.* (1993).

The severity of Alternaria leaf spot and rust on different parental lines of sunflower hybrids sown at different dates are presented in the Table 1. The results indicated that the mean severity of Alternaria leaf spot ranged from 4.33 per cent in December sown crop to 11.67 per cent in September sown crop. Severity of this disease was more in September and October sown crop and decreased gradually towards the later sowings. Among the parental lines, MRHA 1 and CMS 207A were found comparatively more susceptible (up to 25 and 15.75%, respectively) than the other lines. Severity was less in RHA 6D-1 and CMS 234A (maximum of 6.5 and 7.25%, respectively) followed by CMS 7-1A and RHA 271 (up to 15.0 and 11.25%, respectively).

The severity of rust was least in September sown crop and started increasing on the subsequent sowings in all the parental lines. On an average, over the tested entries in September sown crop, the severity was 0.17 per cent and it was highest in February sown crop (26.22%). Among the parental lines, severity was less in CMS 207A and CMS 234A (maximum of 3.67 and 6.35%, respectively). It was moderate in RHA 6D-1 and very high in MRHA 1, RHA 271 and highest on CMS 7-1A (maximum of 45.0, 38.67 and 51.67%, respectively).

Received for publication on May 3, 1994.

Table 1. Severity of Alternaria leaf spot and rust on the parental lines of sunflower hybrids sown at different dates

Date of Sowing	CMS 234A	RHA 6D-1	CMS 7-1A	RHA 271	CMS 207A	MRHA 1	Mean
Alternaria leaf spot (% severity) (*Alternaria helianthi*)							
15.09.1992	5.0	5.0	15.0	5.0	15.0	25.0	11.67
15.10.1992	7.3	6.5	9.0	11.3	15.8	6.3	9.42
15.11.1992	4.7	4.7	5.7	6.3	6.0	6.7	5.67
15.12.1992	4.0	4.0	4.3	4.7	4.0	5.0	4.33
15.01.1993	5.0	4.0	8.0	10.0	5.0	10.0	7.00
25.02.1993	3.3	3.4	4.7	6.7	3.7	5.7	4.61
Leaf rust (% severity) (*Puccinia helianthi*)							
15.09.1992	0.0	0.0	0.0	0.0	0.0	1.0	0.17
15.10.1992	1.0	2.8	4.8	4.0	0.5	5.0	3.00
15.11.1992	6.3	10.0	51.7	28.3	1.7	9.7	17.95
15.12.1992	4.3	5.0	50.0	26.7	2.0	26.7	19.12
15.01.1993	2.3	3.3	46.7	38.7	3.7	30.0	20.72
25.02.1993	5.3	21.0	48.3	35.0	2.7	45.0	26.22

The severity of Alternaria leaf spot and rust varied among the parental lines tested and the sowing dates. Alternaria leaf spot is a serious problem during late *kharif* (September and October sowings). The parental lines, RHA 6D-1 and CMS 234A were less susceptible while, MRHA 1 was found to be more susceptible to this disease. The rust severity was more during January - February sowings because of the high relative humidity developed around the lower canopy of the plant due to regular irrigation and morning dew (Anon.1992). The behaviour of male and female parental lines of KBSH 1 and APSH 11 to Alternaria leaf spot and rust was almost same whereas in LSH 3, female parent (CMS 207A) was less susceptible to rust when compared to male parent, even though little severity of Alternaria leaf spot and rust were there. From this study, it can be concluded that *rabi* (October - November) season is best for quality seed production in sunflower.

1 National Seed Project,
2. P.C.Unit (Sunflower),
University of Agricultural Sciences,
GKVK, Bangalore - 560065, India.

VENKATARAMANA[1]
NAGARAJU[2]
G.V. JAGADISH[1]
JAYARAME GOWDA[2]

Anonymous, 1992. Annual Progress Report of the AICRP on Oilseeds (Sunflower) for the year 1992-93. Directorate of Oilseeds Research, ICAR, Hyderabad, India. 251pp.

Nagaraju, Gangappa, E., Reddy, P.G. and Channakrishnaiah, K.M. 1994. Evaluation of experimental hybrids of sunflower against Alternaria leaf spot under natural field conditions. *Curr. Sci.* 23 : 24-25.

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.*

Shaik Mohammed, R., Bener Raj and Dutt, K.V.L.N. 1985. Incidence of rust and Alternaria leaf spot in relation to plant population and fertility variation in sunflower. *J. Oilseeds Res.* 2 : 29-33.

Shivaprakasam, K., Pillayaswamy, K., Jagannathan, R. and Andavaradham, L. 1977. Efficacy of some chemicals in the control of rust. *Madras agric. J. 64 : 197-198.*

J.Oilseeds Res. 12(1) 1995 : 149-151
ISSN 0970-2776

RESPONSE OF SOYBEAN TO ROW SPACING, SEED RATE AND METHOD OF FERTILIZER APPLICATION

Soybean (*Glycine max* (L.) Merr.) is an important oilseed crop of Madhya Pradesh. Due to high cost of seed-cum-fertilizer drill most of the farmers sow soybean seed mixed with fertilizer to economize the sowing operation as against the recommended application of fertilizer and seed seperately. This situation necessitated for evaluation of previous recommendation of separate drilling of fertilizers and seed as well as suitable crop geometry in soybean under Vertisol of Central Narmada Valley.

A field experiment was conducted at JNKVV, Zonal Agricultural Research Station, Powarkheda in *kharif* 1992 on deep Vertisol. The soil had pH 8.2, 0.5 per cent organic carbon, 20.8 kg/ha available P_2O_5 and more than 120 kg/ha available K_2O. The experiment was laid out in Split Plot Design with four replications. The treatments comprise, combinations of 2 row spacing (22.5 & 45 cm) and 3 seed rates (100, 125 and 150 kg/ha) in main plots and 2 methods of fertilizer application (fertilizers placed below the seed and fertilizers mixed with seed) in sub-plots using soybean variety 'JS 75-46'. The plot size was 8m x 3.60 m. The crop received a fertilizer dose of 20 kg N + 60 kg P_2O_5 + 20 kg K_2O/ha at sowing through diammonium phosphate and muriate of potash applied as per treatments. A rainfall of 859 mm was received during the crop season. The crop was sown on 15th July 1992 and harvested on 20th October 1992.

Results (Table 1) show that the sowing in narrow row spacing resulted in 22.6, 29.0 and 62.4 per cent increase in bean yield, haulm yield and net return per hectare, respectively over wider spacing. The benefit : cost ratio was also higher by 0.49 in narrow spacing over wider one. The increased yield in narrow row spacing could be attributed solely to increased plant density per unit area. Similar results were reported by Hiremath *et al.* (1992).

The seedling/unit area, and yields of soybean increased with increasing seed rate, however, differences were not statistically significant. The net profit and benefit : cost ratio were highest with seed rate of 100 kg/ha because of additional cost involved in seed rates of 125 and 150 kg/ha respectively.

Fertilizers applied along with seed caused injury to seedlings which resulted in lower number of seedlings/m^2 as compared to separate drilling of fertilizers and seed (Table 1). Fertilizer placed below the seed gave significantly higher seed (17.5%) and haulm (32.6%) yield which resulted in more net return (Rs. 5905/ha) and B:C ratio (2.28) over the practice of sowing of seed and fertilizers together. Thus the improvement in the performance of individual plant due to lower density (40 plants/m^2) does not seem to be sufficient enough to compensate for higher yields obtained at higher plant density (67.3 plants/m^2). Soni *et al.* (1987) also reported similar results.

The interaction effect of seed rate and methods of fertilizer application (Table 2) in respect to seed yield revealed that the seed yield was reduced under separate drilling of fertilizer and seed with increasing the seed rate but the reverse trend was noted in sowing of

Received for Publication on June 13, 1994.

Table 1. Plant population, yield and economics as influenced by row spacing seed rate and method of fertilizer application

Treatments	Plant population/m^2	Grain yield (kg/ha)	Haulm yield (kg/ha)	Net return (Rs/ha)	B:C ratio
Row spacings (cm)					
22.5	57.1	1800	1700	6460	2.33
45.0	50.3	1393	1207	3978	1.89
S.Em ±	2.0	86	121	-	-
CD at 5%	6.1	257	371	-	-
Seed rates (kg/ha)					
100	48.8	1521	1271	4989	2.11
125	55.3	1593	1478	5196	2.08
150	57.0	1678	1614	5501	2.08
S.Em ±	2.4	106	151	-	-
CD at 5%	NS	NS	NS	-	-
Methods of fertilizer application					
Fertilizer -seed (separate)	67.3	1728	1657	5905	2.28
Fertilizer + seed (mixed)	40.0	1471	1250	4593	1.92
S.Em ±	2.1	40	86	-	-
CD at 5%	6.3	114	255	-	-

Table 2. Interection effect between seed rate (S) and method of fertilizer application (M) on grain yield of soybean

Method of fertilizer application (M)	Seed rate (kg/ha)		
	100	125	150
Fertilizer below the seed	1814 (6892)	1664 (5635)	1700 (5581)
Fertilizer along with seed	1221 (3153)	1521 (4786)	1657 (5401)
	S.Em ±	CD at 5%	
S within M	66	200	
M within S	116	350	

Figures in parentheses indicate the net return (Rs/ha).

seed + fertilizer mixture with significant difference between 100 and 125 kg seed/ha. This shows the compensation of seed yield with increased seed rate under sowing of seed along with fertilizer.

It was concluded that in Central Narmada Valley zone of Madhya Pradesh better yield of soybean with higher net return may be achieved with a inter row spacing of 22.5 cm, using seed rate of 100 kg/ha coupled with application of basal dose of fertilizer below the seed. If sowing of seed along with fertilizer is necessary under unavoidable circumstances then the seed rate should be increased to the extent of one and half times to that of recommended seed rate.

Zonal Agriculture Research Station,
JNKVV, Powarkheda 461 110 (M.P.)

M.P. JAIN
R.S. LIDDER
R.A. KHAN

Hiremath, S.M., Chittapur, B.M. and Hosmani, M.P. 1992. Response of soybean cultivars to row spacings during *rabi* season *J. Oilseeds Res.* 9 (1) : 154-156.

Soni, J.N., Singh, R.V., Rathore, R.S. and Awasthi, P.K. 1987. Response of soybean varieties to seeding rates. *Indian J. Agron.* 32 (3) : 275-276.

J.Oilseeds Res. 12(1) 1995 : 152-153
ISSN 0970-2776

RESPONSE OF SOYBEAN CULTIVARS TO WATER STRESS

Soybean is a short-day plant and comes up well in post-rainy season under irrigation. But water has become a precious and scarce commodity in semi-arid tropics. If the crop can withstand water stress at a particular physiological phase, considerable amount of water can be saved by skipping irrigations in that growth phase. It is reported that glossy cultivars (with light green foliage) are more drought resistant than non-glossy cultivars (with dark green foliage) in crops like sorghum (Maiti, 1980) and Foxtail millet (Rao, 1987). This aspect has not been studied in soybean.

A field experiment was conducted during post-rainy season of 1987-88 with water stress (50% flowering stage)and no water stress (control)as main plots and four soybean cultivars as sub-plot in a split-plot design with three replications. The water stress is imposed up to desiccation of leaves occurred from 50% flowering. The non-glossy cultivars are 'PK-471' and 'LBS-2'. The glossy cultivars are 'Hardee' and 'JS-72-184'. The soil was medium deep Alfisol. Nitrogen @ 30 kg ha^{-1} was applied as basal dose. Spacing adopted was 30 cm between rows and 10 cm between plants in a row. Based on chlorophyll content, the cultivars with more than 1 mg g^{-1} (fresh weight) chlorophyll were classified as non- glossy and those with less than 1 mg g^{-1} as glossy cultivars. Yield and yield components were recorded at the time of harvest of the crop. Proline was estimated as per the procedure given by Bates *et al.* (1973). The data are presented in Table 1.

Glossy cultivars recorded higher proline content than non- glossy cultivars. The increase in proline accumulation due to water stress was more in glossy than in non-glossy cultivars. Water stress imposed at the mid season reduced the number of pods per plant, 100 seed weight, harvest index (HI) and seed yield but the reduction was more in non-glossy than in glossy cultivars. These results are in conformity with the finding of Eck *et al.* (1987). But when comparison was made between glossy and non-glossy cultivars, glossy cultivars recorded more number of pods per plant, 100 seed weight and HI than the non-glossy cultivars both under non-stress and water stress conditions. Seed yield was more in non-glossy cultivars than in glossy cultivars in non-stressed plots while the reduction in seed yield due to water stress was more in non-glossy (45.6%) than in glossy (32.7%) cultivars. This might be due to the remobilization of photosynthates from stems to pods in glossy cultivars under water stress. Turner (1979) also reported similar results in sorghum.

Thus it is evident from the above discussion that glossy cultivars possessed drought resistance mechanisms through alternations in dry matter partitioning, drought tolerance by accumulation of more proline and stable yield under water stress conditions. Therefore incorporation of glossy trait in a suitable plant type background appears to be desirable for soybean crop.

Department of Plant Physiology , College of Agriculture
Rajendranagar, Hyderabad 500 030

P.S. SARMA

Received for publication on July 11, 1994.

Table 1. Effect of water stress on soybean cultivars

Treatment	*Seed yield* (kg/ha)	*No. of* pods/plant	*100 seed* wt. (g)	*HI (%)*	*Proline content* on 75 DAE (μ moles/g)
Control (no water stress)					
Non-glossy cultivars					
PK 471	2508	10.7	35.7	12.8	0.94
LBS 2	2144	10.7	33.0	8.7	0.92
Glossy cultivars					
Hardee	2241	11.3	39.1	12.8	1.01
JS 72-184	2274	11.3	36.2	10.6	1.16
Water stress					
PK 471	1386	7.0	34.5	10.9	1.73
LBS 2	1145	6.7	32.7	6.9	1.74
Hardee	1471	9.0	38.5	11.1	2.51
JS 72-184	1569	9.3	35.1	9.3	2.50
CD at 5%	109	NS	0.34	0.8	0.12
Main-treatment means					
Control	2292	11.0	36.0	11.2	1.01
Water stress	1392	8.0	35.2	9.5	2.12
CD at 5%	*207*	*0.95*	*0.34*	*0.5*	0.40
Control					
Non-glossy	2326	10.7	34.4	10.8	0.93
Glossy	2258	11.3	37.7	11.7	1.09
Water stress					
Non-glossy	1266	6.9	33.6	8.9	1.74
Glossy	1520	9.2	36.8	10.2	2.51
CD at 5%	105	1.2	0.36	0.9	0.12

Bates, L.S.,Waldren, R.P. and Tear, I.D. 1973. Rapid determination of proline for water stress studies. *Plant and Soil*.30 : 205-207.

Eck, H.V.A.C., Matters and Musion, J.T. 1987. Plant water stress at various growth stages and growth and yields of soybeans. *Field Crops Res.* 17 (1) : 1-16.

Maiti, R.K. 1980. The role of glossy trichome traits in sorghum improvement. Paper presented at the AISCIP Annual Workshop, 12-14 May, 1980, Coimbatore.

Rao, K.L.N. 1987. Effect of water stress on growth and yield of glossy and non-glossy cultivars of *Setaria italica* (L) Ph.D. thesis submitted to A.P. Agricultural University, Hyderabad.

Turner, N.C. 1979. Drought resistance and adoptation to water deficits on crop plants, pp.343-372. *In*: Mussel, M. and Staple, R.C. (Eds). Stress Physiology in Crop Plants. John Willey and Sons, N.Y.

J.Oilseeds Res. 12(1) 1995 : 154-155
ISSN 0970-2776

COBALT AND PHOSPHORUS NUTRITION OF SOYBEAN

Soybean (*Glycine max* (L.)Merrill) is a multiple use crop with higher protein (40-45%), oil (20-21%) and enriching the soil by fixing atmospheric nitrogen (65-100 kg ha^{-1}). Oilseeds and pulses are relatively low yielders than cereals and can be made more productive by increasing sink strength, source size and their activity with the use of macro-nutrient like phosphorus and beneficial element like cobalt.

A field experiment was conducted during rainy season of 1987 with 9 treatment combinations of 3 treatments of cobolt nitrate and 3 levels of phosphorus applications as shown in Table 1. The factorial experiment was laidout in a Randomised Block Design with three replications on medium deep Alfisols with 'Hardee' soybean cultivar. The seeds were treated with Dithane M-45 @2 g kg^{-1} of seed and also with *Rhizobium* at the same concentration. The first foliar spray of cobalt nitrate was done before flowering (30 DAS) and the second on 15th day after flowering. At the time of sowing, a basal dose of 20 kg N ha^{-1} in the form of urea and 20 kg K_2O ha^{-1} in the form of muriate of potash was given. Phosphorus was applied as per treatments in the form of single superphosphate. The spacing adopted was 30 cm between rows and 5cm between plants in a row. The yield and yield components were recorded at harvest. The oil content was estimated by nuclear magnetic resonance (NMR)spectrometer method (Tiwari *et al.*, 1974). Nitrogen was estimated by Kjeltec system as described in the Technical Bulletin by Tecator (1982) while protein was computed by multiplying the N content with a factor 6.25.

Cobalt nitrate as seed treatment along with foliar spray significantly improved the total dry matter production, number of nodules and pods, 100 seed weight, harvest index (HI) and protein content, finally leading to increased seed yield by 19.7 per cent (Table 1). Cobalt stimulates the growth and development of nodules (Danilova and Demikina, 1967) leading for higher N content and ultimately protein content. Rao *et al.* (1980) also observed increase in yield due to cobalt application while it has no effect on oil content. Nodules developed in the presence of cobalt fixed more nitrogen than those developed in the absence of cobalt (Delwiche *et al.* 1961).

Phosphorus application at 90kg P_2O_5 ha^{-1} improved the total dry matter production, number of nodules and pods, 100 seed weight, HI, protein and oil contents, and increased seed yield by about 26 per cent (Table 1). The increase in the number of nodules with P application could be due to increased efficiency of the Rhizobial bacteriods. Applied phosphorus significantly increased both oil and protein contents. Seed yield was positively and significantly correlated with number of pods (0.8272), 100 seed weight (0.7707), HI (0.8103) and total dry matter (0.7665).

Received for publication on July 11, 1994.

There was no significant interaction between cobalt and phosphorus levels and almost similar seed yields were obtained with the application of cobalt and phosphorus. It is possible to improve seed yield with cobalt use also.

Department of Plant Physiology, College of Agriculture
Rajendranagar, Hyderabad 500 030.

P.S. SARMA

Table 1. Effect of cobalt and phosphorus on yield and yield components of soybean

Treatment	Yield (kg/ha)	Total dry matter (g/m^2)	No.of nodules /plant (at 60 DAE)	No.of pods/ plant	100 seed wt. (g)	HI (%)	Protein (%)	Oil (%)
No cobalt (control)	2083	701.0	9.4	20.3	14.4	29.7	40.0	20.1
Seed treatment with cobalt nitrate	2384	743.9	13.4	24.5	15.2	32.0	40.8	20.2
Seed treatment + foliar application with cobalt nitrate	2495	772.8	18.6	26.7	16.6	32.3	42.3	21.2
C.D. at P = 0.05	97	20.0	0.4	1.0	0.9	0.8	1.1	NS
No phosphorus (control)	2013	691.4	9.5	19.7	14.4	29.1	39.7	19.4
Phosphorus at 45 kg ha^{-1}	2422	750.3	13.7	24.9	15.4	32.3	42.0	20.7
Phosphorus at 90 kg ha^{-1}	2546	777.1	18.1	26.9	16.4	32.8	43.3	21.4
C.D. at P = 0.05	97	20.0	0.5	1.0	0.9	0.8	1.1	1.2

Rao, A.V., Sarma, R.L. and Dua, L.S. 1980. Effect of foliar application of Mo and Co on soybean Rhizobium symbiosis. *Legume Res.* 1 : 97-100.

Tecator, 1982. Nitrogen estimation by Kjeltec system method. *Technical Bulletin*, Sweden. 1-53.

Tiwari, P.N., Gambhit, P.N. and Rajan, T.S. 1974. Rapid and non- destructive determination of seed oil by pulse nuclear magnetic resonance technique. *J. Am. Oil Soc.* 57 : 104-9.

J.Oilseeds Res. 12(1) 1995 : 156-157
ISSN 0970-2776

STUDIES ON SYNCHRONIZATION OF FLOWERING IN PARENTAL LINES OF SUNFLOWER HYBRIDS

Sunflower (*Helianthus annuus* L.), a cross pollinated crop, is ideally suited for exploitation of heterosis. The discovery of cytoplasmic genetic male sterility in sunflower has led to the development of hybrids for commercial cultivation. Hybrid seed production is dependent on several factors. Information on flowering behaviour of parental lines of hybrids is a prerequisite to ensure timely and continuous supply of sufficient pollen to receptive stigma of female parent which finally decides seed yield. Flowering behaviour of parental lines vary from season to season (Patil *et al.* 1993). There is, therefore, need to study the flowering behaviour of parental lines of hybrids in different sowing dates to achieve better synchronization of flowering.

A field experiment was conducted at Seed Technology Research Unit, NSP, UAS, Bangalore to study the flowering behaviour of parental lines of three sunflower hybrids viz., Karnataka Bangalore Sunflower hybrid (KBSH-1), Andhra Pradesh Sunflower Hybrid (APSH-11) and Latur Sunflower Hybrid (LSH-3). Parental seeds of the three hybrids were sown at monthly intervals starting from September 1992 to February, 1993, in four replications. Each parental line was sown in 15 m^2 area with a spacing of 60cm x 30cm. All recommended agronomical and plant protection measures were carried out. Observation on days to 50% flowering was recorded in all the parental lines.

Significant differences were observed among genotypes for days to 50% flowering. 6D-1 took maximum days (70.3) followed by MRHA-1 (67.7). Days to 50% flowering was minimum in September (58.6) and it was maximum in December sowing (70.8). In parental lines of KBSH-1, the difference in 50% flowering between male and female parent was more in September and November sowing (9 days), as compared to January and February sowing (3-4 days). In APSH-11, it was 1-2 days in almost all sowing dates, while in LSH-3 the difference ranged from 2-6 days (Table1).

Table 1. Days to 50% flowering as influenced by genotypes and sowing dates.

Genotype	Sowing date (monthly)						Mean
	Sep. 1992	Oct. 1992	Nov. 1992	Dec. 1992	Jan. 1993	Feb. 1993	
CMS-234A	56.25	62.50	67.50	73.00	67.00	63.25	64.91
6D-1	65.00	67.00	75.00	77.00	70.75	67.25	70.33
7-1A	56.25	61.50	67.25	66.75	63.25	60.00	62.50
RHA-271	54.50	61.00	66.75	66.25	62.25	59.00	61.62
207-A	60.75	61.75	70.00	69.00	63.25	62.25	64.50
MRHA-1	59.25	66.25	74.75	72.75	69.00	64.25	67.70
Mean	58.66	63.81	70.12	70.79	65.91	62.66	
	S.Em. ±	0.91	C.D(P = 0.05) = 2.50				

Received for publication on August 9, 1994.

In KBSH-1 seed production, for better synchronization, male (6D- 1) has to be sown 7-9 days before female parent (CMS-234A) during the month of September, October and November, and 3-5 days early if sown in the month of January and February (Kempegowda, 1992). In parental lines of APSH-11 hybrid difference in flowering between male and female was constant in all the sowing dates, thus female parent (7-1A) has to be sown 2 days earlier to male (RHA-271), in all the sowing dates. In LSH-3 hybrid seed production, male parent (MRHA-1) has to be sown 5-6 days before female (207A) line between October to January month sowing, and 2-3 days early during September and February sowing, under Bangalore condition.

National Seed Project,
University of Agricultural Sciences,
GKVK, Bangalore Karnataka.

VENKATARAMANA
G.V. JAGADISH
H. RAMAIAH

Kempegowda, H. 1992. Effect of planting design and staggered sowing of parental lines on seed yield and quality in KBSH-1 Hybrid Sunflower, M.Sc (Agri) Thesis submitted to University of Agricultural Sciences, Bangalore-65.

Patil, M.A., Boriker, S.T., Bilapate, G.G. and Phod, H.P. 1993. Studies on seed production problems and Technology for increasing production of Sunflower Hybrids and their parental lines. *Seed Tech. News,* 23(3) : 3-12.

J.Oilseeds Res. 12(1) 1995 : 158
ISSN 0970-2776

PERSISTENCE OF QUINALPHOS AND CHLORPYRIPHOS IN SOIL AND THEIR ACCUMULATION IN HAULM AND KERNEL OF GROUNDNUT

Summer crop of groundnut suffers losses due to infestation of white grubs and termites. Seed treatment with chlorpyriphos or quinalphos emulsifiable concentrate or soil application of quinalphos granules prior to sowing is practiced by the farmers to protect the crop. Seed treatment is necessary for endemic areas (Anonymous, 1992). However, the information on persistence of these chemicals in soil and their accumulation in haulm and kernel is essential to decide the safety for consumption.

Field trial was laid out in Randomized Block Design with three replications in summer 1993 (Sowing date : 5-2-1993) using groundnut variety 'SB-11'. Quinalphos 25 EC (Sandoz Ekalux 25 EC) and chlorpyriphos 20 EC (AIMCO) were evaluated as seed treatment by using the formulation at 25 and 50 ml/kg seeds. Pre-sowing soil application of quinalphos (Ekalux 5G) at the rate of 25 and 50 kg granules/ha was done. For studying the persistence, first soil sample was drawn 3 hrs after sowing and subsequently at 10, 20, 30, 40 and 50 days after sowing and also at harvest. Samples of kernel and haulm were drawn at final harvest of crop i.e. 17-7-1993. Residues in soil, haulm and kernel were estimated by gas-liquid chromatograph equipped with Nitrogen-phosphorus detector which was sensitive to 0.05 ppm of analytes (F.D.A. 1989). An average recovery of quinalphos from the fortified samples of soil, haulm and kernel was 88, 90 and 86%, respectively. Similarly, the corresponding values of recoveries for chlorpyriphos were 89, 88 and 85%, respectively.

The levels of residues were below detectable limit of 0.05 ppm in sown with groundnut seeds treated with emulsifiable concentrate of quinalphos or chlorpyriphos. However, soil samples drawn 3 hrs and 10 days after application of quinalphos granules showed residue level of 0.87 and 0.06 ppm, respectively at the dose of 25 kg granules/ha. Such level in respect of double dose i.e. 50 kg/ha was 1.45 and 0.19 ppm. Detectable levels of quinalphos was not noticed in the soil samples drawn at 30, 40 and 50 days after sowing. In case of samples of soil, kernel and haulm drawn at final harvest, residues of concerned insecticides were below detectable limit. Thus, from the residue point of view, the seed treatment with EC formulation of quinalphos or chlorpyriphos or soil application of quinalphos granules can be considered safe.

Mahatma Phule Argicultural University
Rahuri - 413 722, District - Ahmednagar. (MS)

V.D. KALE
S.D. RANE
M.D.DETHE

Anonymous. 1992. Crop protection recommendations April, 1992. Department of Agriculture, Government of Maharashtra State, Pune.

F.D.A. 1989. Pesticide analytical manual Vol. II. U.S. Dept. of Health and Human Services, Food and Drugs Administration EPA, Washington.

Received for publication on November 24, 1994.

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 your 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), Literature Cited, Acknowledgement.

6. Editor reserves the privilege of rejecting the manuscripts and illustrations which do not conform to the guidelines.

Abstracts

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 an 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 .
2. Illustrations should be numbered according to their sequence in the text. Reference should be made in the text to each figure.
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.
4. Each illustration should have a caption. The caption to all figures should be typed on a separate sheet of the manuscript.
5. Only high contrast (preferably black & white) photographs are to be included.

Literature Cited

1. All publications cited in the text should be presented in the list of literature cited arranged in alphabetical order with respect to the first author.
2. Use the following system for citing your references:

a. For a periodical

Bradbury, J.F. 1970. Isolation and preliminary study of bacteria from plants. *Review of Plant Pathology* 49 : 213-218 (Do not abbreviate the name of the periodical).

Agnihotri, V.P.,Sen,C. and Srivastava, S.N. 1975. Role of fungitoxicants in the control of Sclerotium root rot of sugarbeet, *Beta vulgaris* L. *Indian Journal of Experimental Biology* 13 : 89-91.

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.

c. For books

Bartik, M. and Piskac, A. 1981. Veterinary toxicology: Developments in animal and veterinary sciences. Elsevier Scientific Publishing Company, Amsterdam/Oxford /New York, 346 pp.

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.

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.

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/-
Others (Foreign)	:	$ 50
Postage extra (in India)	:	Rs. 40/-

Orders may be placed with :

The Secretary, Indian Society of Oilseeds Research, Direcorate of Oilseeds Research, Rajendranagar, Hyderabad - 500030, by sending the cheque/draft/M.O in favour of Indian Society of Oilseeds Research.

619

CORRIGENDUM

The article entitled " Development of suitable germination medium for trinucleate pollen grains : An illustration with sunflower" published in Volume 11(2) of Journal of Oilseeds Research on page numbers 304-307 with the omission of one author R. Uma Shaanker. The authors name is added and it is read as "M.N. Keshava Murthy, Y.A. Nanja Reddy, K. Virupakshappa and R. Uma Shaanker"

EDITOR

The Article entitled "Intercropping of Oilseed crops with niger in" published in Volume 11(2) of Journal of Oilseeds Research on pages 269-272 is to be entitled as "Intercropping of oilseed crops with niger"

EDITOR

INFORMATION FOR CONTRIBUTORS

Contributions from the members on any aspects of oilseeds research will be considered for publication in the Journal of Oilseeds Research. Papers for publication (in triplicate) and book reviews should be addressed to the Editor, Journal of Oilseeds Research, Directorate of Oilseeds Research, Rajendranagar. Hyderabad - 500 030, India.

Manuscript should be prepared strictly according to the **GUIDELINES FOR AUTHORS** published in Volume 11, No.2 and should not exceed 15 typed pages including tables and figures. *Short communications should not exceed five typed pages including tables and figures.*

Articles from the Journal of Oilseeds Research are being regularely indexed in AGRINDEX and abstracted in CABI abstracting Journal and Biological Abstracts.

Annual Subscription

India	Abroad
Individuals : Rs. 50.00 + Admission fee (Rs.10/-)	U.S.$ 50.00
Institutions: Rs. 350.00	U.S.$ 100.00
Students : Rs. 30.00	(Postage extra)

Life membership : Rs. 600.00

For subscription, please contact the General Secretary, Indian Society of Oilseeds Research, Directorate of Oilseeds Research, Rajendranagar, Hyderabad - 500 030, India.

TARIFF FOR ADVERTISEMENTS

Location	2 issues (Rs.)	1 issue (Rs.)
Back Cover (Inside)	8000/-	5000/-
Page facing back cover	3000/-	1500/-
Inside full page	2500/-	1500/-
Inside half page	1500/-	750/-

Over all size	:	21.0 cm height (max.) x 14.0 cm width (max).		
Print area	:	1) Back cover & full page	:	18.00 cm x 14.0
		2) Half page	:	9.00 cm x 14.0 cm

Indian Society of Oilseeds Research thankfully acknowledges the financial assistance received from Indian Council of Agricultural Research, New Delhi for Printing of the Journal of Oilseeds Research.

Edited and Published by the Indian Society of Oilseeds Research
Directorate of Oilseeds Research, Rajendranagar, Hyderabad - 500 030
Typesetting and Printed at K.S. Latha Photo Offset Printing works
Sultan Bazar, Hyderabad. Phone : 514907