Intercropping of cowpea with sorghum caused a significant reduction in the grain yield of sorghum. However, the effect of intercropping of blackgram on sorghum yield was less severe. Unweeded check recorded the lowest grain yield of sorghum during two seasons. Metolachlor @ 1.0 kg ha^{-1} + one hoeing on 40 DAS resulted in higher yield of sorghum. This may be due to increased nutrient uptake by crop and lower nutrient uptake by weeds. Similar findings were also made by Gangwar (1993). Pre emergence application of Metolachlor @ 1.0 kg ha^{-1} + hand hoeing on 40 DAS registered maximum intercrop yields which was comparable with pre-emergence application of Pendimethalin 1.0 kg ha^{-1} during summer season and Isoproturon @ 0.60 kg ha^{-1} during rabi season.

Reference

Gangwar, K.S. (1993). Integrated weed management in sorghum + pigeonpea intercropping system. In: Proc. of *Indian Soc. Weed Sci.*, Hisar. November 18-20, Vol.III pp.166-169.

Humpries, E.C. (1956). Mineral components and ash analysis. In: *Modern methods of plant analysis*. Springer verlag, London., p.:468-502.

Jackson, M.L., (1973). *Soil chemical analysis*. Prentice Hall of India Pvt. Ltd., New Delhi., pp.1-495.

Tiwari, N.P. and Kawatra, K.L. (1990). Effect of phosphate levels and planting geometry in sorghum - legume intercropping. In: Abstract of papers, Biennial conference. Indian Society of weed science.

Yadav, S.K., Bhan, V.M. and Ashok Kumar (1986). Studies on removal of nutrients by weeds and their control in groundnut. *Indian J. Agron.*, 31:177-180.

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Inheritance of seed characters in Indian mustard *(Brassica juncea(L.) Czerm and Coss)*

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Abstract : Combining ability studies using 9 x 9 half diallel cross over four environments for two seed characters in Indian Mustard, revealed that additive gene effects were predominant for 1000-seed weight while non-additive gene actions were more important for oil content. The best general combiners were NDR-8501 and BHUR-5 for 1000-seed weight and PR-16 and NDR-8501 for oil content. Difference among environments as well as both general combining ability (gca) x environment and specific combining ability (sca) x environment interaction were significant. Non-additive x environment interaction components were higher magnitude than the additive x environment interaction components. *(Key Words : Indian mustard, Combining ability, Gene effects)*

The information on the nature of gene action controlling inheritance of various characters is very essential to evaluate the usefulness of parents while formulating any breeding programme. As environment plays an important role in the expression of a character and greatly influences combining ability estimates, the study in a single environment may not provide reliable information. The present study was therefore undertaken to determine the mechanism of gene action involved in the inheritance of two important seed characters viz., 1000 seed weight and oil content in Indian mustard over four environments.

Materials and Methods

The materials comprised of a 9 x 9 diallel set of crosses (excluding reciprocals) involving 9 inbreds i.e., RLM-619. Rohini, IC-73229, PR-16, NC-57354, NDR-8501, BHUR-5, RW 85-59 and Sita. All the 36 F_1s along with 9 parents were sown in two different dates first as normal (21st October) and second as late (9th November) in the rabi season of two consecutive years 1992-93 and 1993-94 in a randomized block design with three replication at the 'C' Block District Seed Farm, Kalyani (W.B.) of Bidhan Chandra Krishi

Viswavidyalaya. Each entry was sown in single row plot of 2 meter length. Rows were spaced 30 cm apart and plants were spaced 15 cm apart. Each experiment was guarded by one border row on either side to minimize the border effect. All the recommended agronomic practices were followed to raise the crop. Five competitive plants from each treatment were selected from each replication and seeds were bulked. Thousand seeds were counted from each treatment and weighed after drying. The progeny means were used for statistical analysis. Samples of 5 g dry seeds from the bulk seed of each genotype in each replication was taken and oil was extracted by Soxhlet apparatus as per the specification outlined in AOAC (1961). Seeds were crushed with the help of pestle and mortar and then transferred to an extraction thimber. The oil was extracted with petroleum ether for 6 hrs. The boiling temperature for first 30 minutes was at 10°C, for next two hours at 50°C and for last three and half hours at 70°C. The solvent was then evaporated on a boiling water bath and the oil percentage was determined after a constant weight was obtained. The percentage of oil was presented on dry weight basis. The combining ability analysis was done following the procedures of Griffing's Method 2, Model 1 (1956) and Singh (1973, 1979).

Results and Discussion

The mean squares due to general combining ability (gca) and specific combining ability (sca) were highly significant for both the characters (Table 1) in all the environments and over environments except in DS_1 for 1000-seed weight. It revealed the importance of additive and non-additive gene effects in the inheritance of these characters. The magnitude of gca variance, in general was higher than the sca variance. The difference among the environments was significant for both the characters. Both gca x environment and sca x environment interaction variances were significant and of similar magnitude indicating the role of environment influencing both the variances equally. Significance of interaction variances warrants collection of data over different environments for obtaining unbiased estimates of genetic variances.

Partitioning of genetic variances into additive and non-additive variances (Table 2) revealed that additive gene action played an important role in controlling oil content. Predictability ratios were closer to unity for 1000 seed weight and far from unity for oil content in all the four environments as well as over environments confirming precisely the nature of gene action. Badwal and Labana (1987), Hari Singh and Yashpal (1991) and Yadav *et al.*, (1992) also found non-additive gene action to be important for oil content while studying the nature of gene action over environments. On the contrary, Yadav *et al.*, (1992) reported both additive and non-additive gene action to be important for 1000 seed weight on the basis of gca and sca variances only. The additive x environment interaction (6^2gl) variances were of lower magnitude than the non-additive x environment (6^2sl) variances for both the traits which indicates that non-additive variance was more prone to environmental variations than additive variance.

Estimates of gca effects (Table 3) of nine parents revealed that NDR-8501 and BHUR-5 were good general combiners for 1000-seed weight in all the four environments as well as over environments followed by RLM-619 and Rohini which showed significant gca effects in three out of four environments and over environments. For oil content, PR-16 and NDR-8501 were good general combiners showing significant gca effects in all the four environments as well as over environments followed by Sita which showed significant gca effects in three out of four environments as well as over environments. Considering both the seed characters together NDR-8501 could be chosen as one of the prospective parent in hybridization programme for improvement of seed characters. The other parent BHUR-5 or PR-16 being good general combiner for one character showed undesirable gca effect for the other.

Five top ranking crosses (Table 4) selected on the basis of high pooled sca effect revealed that two crosses RLM-619 x Rohini and RLM-619 x NDR-8501 exhibited high sca effects, good per-se performances and involved medium and high general combiners for 1000-seed weight. On the other hand, two crossesPR-16 x NDR-8501 and PR-16 X RW 85-89 exhibited high sca effects, good per-se performances and involved high and medium general combiners for oil content. Therefore, these crosses would be useful for obtaining segregants with improved 1000-seed weight and oil content in segregating generations. Among them, the two crosses RLM-619 x NDR-8501 and PR-16 X NDR-8501 would be of better choice since these crosses involved NDR-8501 as one of the parents which showed high gca effects for both the traits. It needs to be mentioned that in a self-polinnated crop like Indian mustard conventional breeding method could exploit only the additive and additive x additive interaction portion of genetic variability. Therefore, the possibility of improving 1000-seed weight is very high while it is difficult to improve oil content except that portion which could be fixed through conventional breeding method. Other approaches like population improvement or diallel selective

Table 1. ANOVA (mean squares) of combining ability in Indian mustard

Source	d.f.	Mean sum of squares		
		Environments	1000-seed weight	Oil Content
Gca (G)	8	DS_1 1992-93	0.62**	3.22**
		DS_2 1992-93	0.70**	4.14**
		DS_1 1993-94	0.65**	1.65**
		DS_2 1993-94	0.53**	3.43**
		Pooled	2.41**	12.10**
Sca (S)	36	DS_1 1992-93	0.08	1.23**
		DS_2 1992-93	0.09**	1.67**
		DS_1 1993-94	0.04**	0.88**
		DS_2 1993-94	0.06**	1.27**
		Pooled	0.19**	4.56**
Env. (L)	3		0.05**	0.33**
Interaction (GxL)	24		0.030**	0.27**
Interaction (X x L)	108		0.034**	0.17**
Error	88	DS_1 1992-93	0.06	0.13**
		DS_2 1992-93	0.04	0.11
		DS_1 1993-94	0.02	0.09
		DS_2 1993-94	0.03	0.76
Pooled error	352		0.01	0.03

* Significant at P = 0.05; ** Significant at P = 0.01
DS_1, DS_2 - 1st and 2nd dates of sowing respectively.

Table 2. Estimates of genetic components in Indian mustard

Source	Environments	1000-seed weight	Oil Content
6^2A	DS_1 1992-93	0.10	0.56
	DS_2 1992-93	0.12	0.73
	DS_1 1993-94	0.11	0.28
	DS_2 1993-94	0.09	0.49
	Pooled	0.11	0.55
6^2D	DS_1 1992-93	0.02	1.10
	DS_2 1992-93	0.05	1.56
	DS_1 1993-94	0.02	0.78
	DS_2 1993-94	0.03	0.51
	Pooled	0.05	1.13
$\frac{6^2A}{6^2A + 6^2D}$	DS_1 1992-93	0.83	0.34
	DS_2 1992-93	0.71	0.32
	DS_1 1993-94	0.85	0.26
	DS_2 1993-94	0.75	0.49
	Pooled	0.70	0.33
Interaction components			
6^2gl		0.002	0.022
6^2sl		0.025	0.144

DS_1, DS_2 - 1st and 2nd dates of sowing respectively.

Table 3. Estimates of the gca effects of the parents in Indian Mustard

Characters	Env.	RLM-619	Rohini	IC-73229	PR-16	NC-57354	NDR 8501	BHUR-5	RW 85-59	Sita	S.E. qi
1000-seed weight	DS_1 1992-93	0.08	0.13	-0.04	-0.23**	-0.06	0.44**	0.20**	-0.17*	-0.34**	0.07
	DS_2 1992-93	0.21**	0.24**	-0.01	-0.32**	0.06	0.29**	0.15**	-0.25**	-0.36**	0.06
	DS_1 1993-94	0.14**	0.16**	-0.01	-0.24**	-0.10*	0.42**	0.15**	-0.17	-0.37**	0.04
	DS_2 1993-94	0.11*	0.16**	0.05	-0.29**	-0.06	0.33**	0.16**	-0.14**	-0.32**	0.05
	Pooled	0.13**	0.17**	-0.003	-0.27**	-0.04**	0.37**	0.16**	-0.18**	-0.35**	0.01
1000-seed weight	DS_1 1992-93	-0.51**	-0.12	-0.13	0.65**	-0.24*	0.84**	-0.89**	0.18	0.22*	0.10
	DS_2 1992-93	-0.63**	-0.13	-0.10	0.79**	-0.26**	1.12**	-0.80**	-0.01	0.02	0.09
	DS_1 1993-94	-0.38**	-0.18*	-0.04	0.37**	-0.14	0.59**	-0.64**	0.11	0.29**	0.09
	DS_2 1993-94	-0.37**	-0.13	-0.24**	0.69	-0.36**	0.98**	-0.81**	0.03	0.22**	0.08
	Pooled	-0.45**	-0.20**	-0.03	0.63**	-0.31**	0.88**	-0.78**	0.08**	0.19**	0.02

* Significant at P = 0.05; ** Significant at P = 0.01.
DS_1, DS_2 - 1st and 2nd dates of sowing respectively.

Table 4. Five top ranking crosses selected on the basis of pooled sca effect along with per-se performance and gca status

Cross	Per-se Performance	SCA effect	Gca Status
1000-seed weight			
RLM-619 x Rohini	4.37	0.43	MxH
RLM-619 x NDR-8501	4.55	0.42	MxH
Rohini x IC-73229	4.18	0.39	HxL
IC-73229 x NC-57354	3.97	0.38	LxL
PR-16 x NC-57354	3.62	0.30	LxL
Oil Content			
PR-16 x NC-57354	38.36	1.62	HxL
PR-16 x NDR-8501	39.49	1.55	HxH
PR-16 x RW 85-59	38.60	1.46	HxM
NDR-8501 x Sita	38.79	1.29	HxM
NC-57354 x BHUR-5	36.46	1.13	LxL

H - High; M-Medium L-Low general combiner

mating has been advocated for improving such characters.

Reference

AOAC (1961). Official methods of analysis of the association of official agricultural chemists, edn. 7 pp.12. Association of official agricultural chemists, Washington DC.

Badwal, S.S. and Labana, K.S. (1987). Diallel analysis for some metric traits in Indian Mustard. *Crop. improv.*, **14** (2) : 191-94.

Griffing, B. (1956). Concept of general and specific combining ability in relation to diallel crossing systems. *Aust. J. Biol. Sci.* 9: 463-93.

Singh Daljit (1973). Diallel analysis for combining ability over several environments-11. *Indian J. Genet.* 33:469-81.

Singh Daljit (1979). Diallel analysis for combining ability over environments. *Indian J. Genet.* 39:383-86.

Singh and Yashpal (1991). Combining ability analysis of oil content in Indian mustard. *J. Oilseeds Res.* 8(1):117-20.

Yadav, O.P., Yadava, T.P. and Kumar, P. (1992). Combining ability studies for seed yield, its component characters and oil content in Indian mustard (Brassica juncea (L.) Coss.). *J. Oilseeds Res.* 9(1) : 14-20.

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