Indian J. Genet., **67**(1): 87-88 (2007)

Short Communication

Inheritance of vegetative and reproductive growth period in Indian mustard (*Brassica juncea* Czern & Coss.) over environments

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(Received: July 2005; Revised: December 2006; Accepted: January 2007)

The present study on Indian mustard (*Brassica juncea* Czern & Coss.) was conducted to understand the nature of gene action of important characters and select suitable parents through the combining ability analysis over different environments.

Nine Indian mustard genotype, *viz.*, RLM-619, Rohini, IC-73229, PR-16, NC-57354, NDR-8501, BHUR-5, RW 85-59 and Sita, were crossed in all possible combinations exclusing reciprocals, Nine parents and their 36 F_1s were grown on two different dates i.e., 21st October and 9th November in the two consecutive years in RBD with three replications. Each treatment was grown in single row, 2 m long, spaced 30 cm apart, with the plant to plant distance 15 cm. 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 to record observations on days to first flowering, days to completion of flowering, maturity period (days reauired from the date of completion of flowering to the date of maturity) and days to maturity (Days required from date of sowing to date of maturity). The progeny means were used for statistical analysis. The combining ability analysis was carried out according to the procedure of Griffing's Method-2, Model-1 [1] and Singh [2].

The analysis of variance of combining ability showed that variances due to *gca* were significant for all the traits in the pooled analysis (Table 1). The variances due to *sca* were significant for days to completion of flowering, flowering period and for days to first flowering in the pooled analysis. The magnitude of *gca* variances was higher than the respective *sca* variances. The difference among the environments was highly significant for all the traits. Both *gca* × environment (G × L) and *sca* × environment (S × L) interactions were also highly significant for all the traits.

Estimates of predictability ratios further revealed higher estimates fo additive variances and lower estimates of non-additive variances (Table 1). Similar results were reported earlier for days to first flowering and days to maturity [3, 4]. Non-additive gene action played a preponderant role in the control of flowering period and maturity period as was evident from the lower predictability ratios. Beside vegetative phase, two reproductive phases namely flowering period and maturity period might be important to a breeder for manipulating earliness. The results showed that these two phases are controlled by separate genes or gene complex from days to flowering, days to completion of flowering and days to maturity. The additive × environment interaction components (σ^2 gl) were lower than the non-additive × environment interaction components (σ^2 S1) for all the traits, which indicated that non-additive variance was more prone to environmental variation than additive variance.

A perusal of *gca* estimates (Table 2) revealed the transcendency of the parent Sita as good general combiner for days to first flowering, days to completion of flowering and days to maturity in all the four environments as well as in the pooled analysis whereas for maturity period it showed significant *gca* effects atleast in two environments as well as in the pooled analysis. The next good general combiner for all the traits was RW 85-59 which showed significant *gca* effects atleast in two environments as well as in the pooled analysis except flowering period.

The five top ranking crosses (Table 3) selected on the basis of highly significant desirable *sca* effect revealed that in most cases, their high *sca* was not associated with *per se* performance thus, high mean performance of a cross does not reflect high *sca* effect. The cross NDR-8501 × Sita exhibited both high *sca* effect and good *per se* performance for days to first

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Table 1. Pooled analysis of variance (MS) for combining ability in Indian mustard

Source	df	Environ-ment	Days to first flowering	Days to completion of flowering	Flowering period	Maturity period
gca (G)	Pooled	91.56**	65.40**	3.76**	7.16**	79.23**
sca (S)	36	Pooled	5.13**	5.41**	2.75**	3.62**
Environment (L)	3		89.57**	259.13**	98.19**	104.63**
Interaction (G × L)	24		4.99**	–143.65**	–2.49**	8.85**
Interaction (S × L)	108		3.27**	36.51**	3.30**	3.87**
Pooled error	352		0.28	0.26	0.24	0.42

*,** Significant at 5% and 1% levels, respectively; DS_1, DS_2 1st and 2nd dates of sowing, respectively

Table 2. Estimates of *gca* effect of parents pooled over environment in Indian mustard

Characters	Environment	RLM-619	Rohini	IC-73229	PR-16	NC-57354	NDR-8501	BHUR-5	RW 85-49	Sita	S.E. gi
	Pooled	2.26**	0.44**	–0.43**	–0.56**	1.01**	–0.61**	1.33**	–0.79**	–2.66**	0.07
	Pooled	2.08**	0.58**	–0.30**	–0.65**	0.42**	–0.47**	1.22**	–0.80**	–2.07**	0.07
	Pooled	–0.22**	0.18**	0.09	–0.13	–0.48**	0.09	–0.14	0.03	0.57**	0.70
	Pooled	0.06	–0.08	–0.12	0.13	–0.21*	0.92**	0.15	–0.40**	–0.44**	0.09
	Pooled	2.17**	0.36**	0.35**	–0.51**	0.24**	0.37**	1.31**	–1.16**	–2.43**	0.07

*,** Significant at 5% and 1% levels, respectively; DS_1, DS_2 1st and 2nd dates of sowing, respectively

Table 3. Five top ranking crosses selected on the basis of pooled *sca* effect along with their mean performance and *gca* status in Indian mustard

Crosses	Mean performance	*sca* effect	*gca* status	Crosses	Mean performance	*sca* effect	*gca* status
Days to first flowering				**Flowering period**			
NDR 8501 × RW 85-89	46.24	–2.20	M × M	NC 57354 × NDR 8501	22.67	–2.10	H × L
NDR 8501× Sita	44.51	–2.07	M × H	RLM 619 × NDR 8501	23.83	–1.19	M × L
RLM 619 × Sita	47.88	–1.56	L × H	RLM 619 × RW 8559	24.25	–0.71	M × L
PR 16 × RW 85-59	46.98	–1.51	M × M	PR 16 × NC 57354	23.83	–0.71	L × H
IC 73229 × Sita	45.68	–1.28	M × H	Rohini × NC 57354	24.17	–0.69	L × H
Days to completion of flowering				**Maturity period**			
RLM 619 × Sita	73.03	–1.93	L × H	IC 73229 × NDR 8501	29.58	–1.53	L × L
PR 16 × RW 85-59	71.73	–1.77	M × M	RLM 619 × NC 57354	28.83	–1.34	L × M
Rohini × NC 57354	74.42	–1.55	L × L	PR 16 × BHUR 5	29.33	–1.27	L × L
NC 57354 × RW 85-59	73.32	–1.26	L × M	Rohini × NDR 8501	30.00	–1.15	L × L
PR 16 × NC 57354	73.53	–1.20	M × L	BHUR 5 × RW 85-59	29.08	–0.98	L × H
				Days to maturity			
				NDR 8501 × Sita	101.58	–0.62	L × H
				NDR-8501 × RW 85-59	103.08	–1.40	L × H
				RLM 619 × NC 57354	106.42	–1.26	L × L
				NC 57354 × RW 85-59	103.17	–1.18	L × L
				IC 73229 × NDR 8501	104.33	–0.95	M × L

flowering and days to maturity while the crosses PR-16 × RW 85-59, NC-57354 × NDR-8501 and RLM-619 × NC-57354 exhibited high *sca* effects was well as good *per se* performances for days to completion of flowering, flowering period and maturity period respectively. These crosses are expected to produce transgressive segregants in later generations.

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