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LINE x TESTER ANALYSIS IN INDIAN MUSTARD [*BRASSICA JUNCEA* (L.) CZERN & COSS.]

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ABSTRACT

Line x tester analysis involving 40 females and 3 males from diverse origin revealed that both additive and nonadditive gene actions were important in controlling most of the characters studied. However, additive gene action was predominant. Variety Varuna, among the male parents, was the best general combiner for seed yield, oil content and most other important traits. Among the female parents, Pusa Bold and P 26/21 for seed yield and oil content; Laha Dholpur and No. 6 for oil content; TM-11 and Keshri for earliness and dwarfness were the good general combiners. The cross Yellow Appressed x RL-18 was best for seed yield and oil content. Hybridization systems, such as a multiple or reciprocal recurrent crossing, which exploit both additive and nonadditive gene effects, simultaneously, could be useful in the genetic improvement of the characters studied.

Key words: Indian mustard, combining ability, gene effects, heterosis.

Indian mustard [*Brassica juncea* (L.) Czern & Coss.] is an important oil seed crop and it occupies important position in the rainfed agriculture of this country. Though the increase in per ha productivity through breeding efforts in this crop has not been striking, it is now realized that suitable breeding procedures to incorporate desirable genes into existing commercial cultivars are needed for yield improvement. Thus, evaluation of promising strains for combining ability is needed to select good parents for hybridization [1–3]. Therefore, the present study of line x tester analysis was undertaken.

MATERIALS AND METHODS

Forty female parents (lines) and three pollen parents (testers), viz. Varuna, Durgamani and RL-18, were selected on the basis of per se performance, adaptation and geographical

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diversity. They were crossed in line x tester design. The 120 F_1s and their parents were sown in randomized complete block design with three replications under normal sown conditions. Each plot consisted of a 5 m long row with 30 x 15 cm spacing. The observations were recorded on five random plants from each plot for 13 characters (Table 1). The analysis of combining ability was done by the procedure of Kempthorne [4].

RESULTS AND DISCUSSION

The analysis of variance for thirteen characters revealed that variances due to the female and male parents were highly significant for all the characters except secondary branches and seed yield (in the males). However, mean squares due to males were greater than those due to females for all the characters studied except siliquae per plant and seeds per siliquae, indicating large diversity among the males than in females for these characters. The lower magnitude of variance in the males x females interactions suggested greater uniformity among the crosses than among the parent varieties.

The variance components of general combining ability (gca) and specific combining ability (sca) were significant for most of the characters, indicating role of both additive and nonadditive gene actions in the inheritance of these characters. However, additive gene effects showed predominance. The results of this study are in close conformity with the findings of earlier workers [5–9]. Since additive and nonadditive gene actions were important in controlling the characters studied, hybridization methods, such as, multiple or reciprocal recurrent crossing, which exploit both additive and nonadditive gene effects simultaneously, could be useful in the genetic improvement of the characters studied.

The gca estimates (Table 2) revealed that among males, Varuna was the best general combiner for all the characters studied except primary branches, number of secondary branches, number of siliquae on main axis, and siliquae per plant, for which Durgamani and RL-18 male parents were the best general combiners. Durgamani was also a good general combiner for early flowering and oil content, and RL-18 for seeds per siliquae. Among females, only 12 strains were good general combiners for seed yield and two or more important yield components (Table 2). Two females, i.e. Laha Dholpur and No. 6, were good general combiners for oil content, while TM-11, Keshri and Laha Dholpur were best general combiners for earliness and dwarfness. It is noteworthy that among females, Pusa Bold and P 26/21 were good general combiners for both seed yield and oil content. These parents should be utilized extensively in hybridization programme with Varuna and Durgamani to exploit maximum genetic variability and isolate transgressive segregates for seed yield and oil content. Previous studies substantiate these findings [8, 10]. Parent, TM-11, Keshri and Laha Dholpur should be used in crosses with Pusa Bold, P 26/21, Varuna and Durgamani to develop earlier dwarf varieties. Recurrent

Table 1. Analysis of variance (mean squares) for combining ability for

Source of variations	d.f.	Days to flowering	Days to maturity	Plant height	Primary branches	Secondary branches	Siliquae on main axis
Replications	2	2.9	0.1	63.0	39.9**	1490.8	480.6**
Females	39	173.4**	120.1**	1520.3**	2.2**	75.2	144.8**
Males	2	1702.3**	2096.3**	10038.5**	7.8**	112.2	400.7**
Females x males	78	19.7**	17.7**	197.5**	3.1**	94.7**	151.2**
Error	238	6.0	7.3	71.0	0.9	61.8	40.7
σ^2g (females)		31.5	12.4	31.5	–0.0	–0.5	–0.2
σ^2g (males)		1968.2	415.7	1968.2	0.9	3.5	49.9
σ^2sca (females x males)		126.4	10.4	126.4	2.2	33.0	106.5
Gca (females)/sca		7.7	6.8	7.7	0.7	0.8	1.0
Gca (males)/sca		50.8	118.4	50.8	2.5	1.2	2.7

*,**Significant at 5 and 1% levels, respectively.

Table 2. Estimates of general combining ability effects of selected lines and testers for

Parent	Days to flowering	Days to maturity	Plant height	Primary branches	Secondary branches	Siliquae on main axis	Siliquae per plant
Females:							
TM-4	–4.5**	–6.6**	–23.8**	0.9**	2.7	–1.0	59.2**
TM-7	–4.9**	–5.9**	–4.6	–0.0	0.7	2.6	16.4
UUR-12	–5.3**	–1.2	–19.7**	1.6**	5.8**	–0.9	85.2**
Pusa Bold	–0.5	2.2**	9.3**	0.2	–0.1	–1.3	58.7**
RH-30	1.4*	3.8**	11.8**	–0.1	3.4	1.1	–33.5
RLM-198	5.7**	3.1**	5.1*	0.1	1.7	–1.8	132.9**
UUR-751	–0.2	1.1	8.0**	–0.0	2.9	4.7*	63.9**
T-16	–0.5	–1.4	6.8**	0.3	0.5	5.2**	67.7**
RH-7811	3.1**	1.4	13.3**	–0.5	–3.8	6.2**	–31.5
P 26/21	–3.5**	–1.2	–1.8	0.3	3.9	–3.0	46.3*
T-6342	8.4**	3.2**	10.4**	–0.6	–6.4**	1.2	49.3*
Krishna	4.1**	2.8**	5.6*	–0.3	–1.4	–0.6	106.7**
TM-11	–5.3**	–5.3**	–28.9**	0.2	1.4	–5.4**	–37.2
Keshri	–5.3**	–0.1	–10.3**	–0.5	–3.8	–3.2*	–48.8*
NO-6	4.1**	1.4	7.3**	–0.0	1.8	–4.89	6.8
Laha Dholpur	–6.6**	–2.8**	–12.5**	0.1	4.6*	–4.9*	–93.7**
SE (females)	0.7	0.8	2.4	0.3	2.2	1.9	19.6
CD at 5%	1.4	1.5	4.7	0.5	4.4	3.7	38.4
Males:							
Durgamani	–0.2*	0.1	1.5**	0.3**	0.3	0.9*	11.0**
Varuna	3.7**	–4.2**	–9.8**	–0.2**	–1.1*	–2.1**	–16.7**
RL-18	–3.9**	4.2**	8.3**	–0.1*	0.8*	1.2**	5.7*
SE (males)	0.2	0.2	0.5	0.1	0.5	0.4	4.4
CD at 5%	0.3	0.3	1.1	0.1	1.0	0.8	8.7

*,**Significant at 5 and 1% levels, respectively.

seed yield and its component traits in Indian mustard

Siliquae per plant	Siliqua length	Seeds per siliqua	1000-seed weight	Harvest Index	Oil content	Seeds yield
331.0	3.7**	34.3**	0.3**	10.2	2.5	43.70
27429.2*	0.6**	4.5**	1.3**	40.9**	6.9**	213.61**
25890.0**	1.2**	3.4**	9.1**	140.0**	8.0**	10.42
8155.8**	0.2**	2.9**	0.2**	18.6**	3.7**	66.32**
4803.1	0.1	0.8	0.1	4.1	1.1	22.25
458.9	0.0	0.0	0.0	0.5	0.1	3.51
3546.8	0.2	0.1	4.8	24.3	0.9	-11.18
3352.7	0.1	2.2	0.1	14.5	2.6	44.07
3.4	3.6	1.5	8.3	2.2	1.9	3.22
3.2	8.1	1.2	56.9	7.5	2.2	0.16

seed yield and its components traits in Indian mustard

Siliqua length	Seeds per siliqua	1000-seed weight	Harvest index	Oil content	Seed yield
0.0	-0.6**	-0.1	2.0**	0.0	4.3**
0.3**	-0.3*	0.7**	-1.1*	-0.1	5.3**
0.1	0.7**	0.2**	5.0**	-0.5	8.3**
0.3**	-0.6*	0.8**	1.7**	2.7**	8.7**
0.5**	1.5**	0.9**	1.8**	0.5	6.0**
0.1	0.7**	0.1	1.1*	0.1	11.7**
0.1	1.0*	0.1*	3.1**	0.2	6.5**
-0.2**	-0.1	-0.3**	-2.7**	0.4	2.8*
0.2**	0.5*	0.6**	0.2	-0.8**	2.6*
-0.0	0.1	0.4**	3.0**	-0.8**	6.8**
0.3**	0.8**	-0.1*	0.9*	0.6	4.7**
0.2**	0.4*	-0.1*	-0.2	0.1	7.6**
-0.3**	-0.5*	0.0	2.8**	-1.4**	-1.5*
-0.3**	-1.3**	-0.5**	-0.1	-0.4	-7.8**
-0.0	-0.6*	-0.4**	-1.9**	0.6*	-3.7**
-0.0	-0.2	0.0	-0.3	1.6**	-7.1**
0.1	0.3	0.1	0.6	0.3	0.9
0.1	0.5	0.1	1.1	0.6	1.7
-0.1**	-0.2**	-0.1**	-0.1	0.2**	-0.1
0.1**	0.1*	0.3**	1.1**	0.1*	0.3*
-0.1**	0.1*	-0.2**	-1.1**	-0.3**	-1.2**
0.0	0.1	0.0	0.1	0.1	0.2
0.1	0.1	0.0	0.3	0.1	0.4

crossing in the segregating generation may be useful for advancement of seed yield with high oil content in Indian mustard.

Eighteen and 5 of the 120 F1s showed significant positive sca for seed yield and oil content, respectively (Table 3). However, the crosses TM-11 x Durgamani, RIK 78-6 x Durgamani, Rai 219 x Varuna, RCU 10 x RL-18 and No. 6 x RL-18 showed significant sca effects for both seed yield and oil content. Thus, it could be worthwhile to attempt biparental matings in the segregating generation among some of these selected crosses to permit greater recombinations. These results further indicate that there is no direct relationship between sca effects and BP heterosis. Only 5 out of 18 crosses for seed yield and 3 for oil content showed significant positive sca effects as well as BP heterosis. Thus, selecting a cross combination for hybrid production only on the basis of sca effects most of the times may not meet the desired goal. In other words, selection of crosses on the basis of heterosis appear to be more realistic (Table 3).

It is noteworthy that the crosses RH-30 x Durgamani; T-16 x RL-18, KRL 101 x RL-18, and P 26/21 x RL-18 for seed yield and crosses No. 6 x RL-18 and Rai-219 x Varuna for oil

Table 3. Best crosses selected for seed yield and oil content on the basis of sca and heterosis over better parent in Indian mustard

Cross	Seed yield		Oil content	
	sca	heterosis (%)	sca	heterosis (%)
TM-11 x Durgamani	2.5*	27.6	1.0*	-1.8
RH30 x Durgamani	4.0**	34.1*	0.1	4.6*
RIK 78-6 x Durgamani	6.4**	-0.9	1.7**	-1.5
UUR 513 x Durgamani	6.2**	10.0	-0.1	0.3
TM-7 x Varuna	12.1**	10.6	-1.7**	3.2
RC 781 x Varuna	4.6**	-11.7	-0.1	6.8**
P 26/21 x Varuna	4.4**	-16.7	0.6	8.1**
Kamphidiploid x Varuna	4.4**	-31.2**	0.0	2.8
Rai-219 x Varuna	2.7**	-11.4	1.0*	8.5**
UUR-513 x Varuna	4.4**	-29.9**	0.0	0.6
TM-2 x RL-18	3.2**	-10.8	-0.5	4.6*
UUR-12 x RL-18	6.9**	5.6	-0.1	3.9
RCU 10 x RL-18	2.8*	13.4	0.1	1.3
Yellow Appressed x RL-18	3.5**	59.0**	0.9*	6.3**
T-16 x RL-18	3.9**	50.1**	-1.4**	4.4*
KRL 101 x RL-18	5.0**	33.4*	-0.9*	-2.7
P 26/21 x RL-18	3.3**	42.9**	-0.1	4.0*
No. 6 x RL-18	3.3**	9.0	1.5**	8.9**
S.E.	1.2	3.6	0.4	0.8
C.D. at 5%	2.4	7.1	0.8	1.7
C.D. at 1%	3.1	9.4	1.1	2.2

*,**Significant at 5 and 1% levels, respectively.

content were the best with significant positive sca and BP heterosis. Therefore, these crosses could be fruitfully exploited with careful handling of segregating material to develop pure lines for high seed yield and oil content. Only the cross Yellow Appressed x RL-18 showed significant sca and BP heterosis for both seed yield as well as oil content. This cross could be utilized as such for hybrid production.

The parents involved in the crosses identified as promising were medium x high, medium x medium and medium x poor general combiner for seed yield and its component characters. This indicated that nonadditive type gene actions, which are nonfixable, were involved in these crosses. Therefore, nonconventional breeding methods, viz. biparental mating and/or diallel selective mating, which accumulate favourable genes in homozygous state or helps in breaking the linkage blocks, thereby generating maximum variability for further selection are advisable in such situations. The results of the present study suggest that heterosis coupled with high sca effects may be considered as a criterion for selecting the best cross combinations for further improvement of seed yield and oil content in Indian mustard.

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