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Combining Ability of Plant Height and Yield components in Indian Mustard (*Brassica juncea*L.Czern & Coss.) under Salt affected Soil using Line×Tester Analysis

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ABSTRACT

Line × tester analysis of twenty lines and three testers of Indian mustard (*Brassica juncea* L. Czern & Coss.) cultivars were used to estimate general combining ability (GCA), specific combining ability (SCA) effects, high parent heterosis and narrow-sense heritability estimate for plant height, yield components and seed yield. Significant variance of line x tester for the traits like pods per plant and seed yield indicating non additive genetic effects have important role for controlling these traits. Significant mean squares of parents v/s crosses which are indicating significant average heterosis were also significant for all the traits except seeds per pod. High narrow-sense heritability estimates for all the traits except seeds per pod exhibited the prime importance of additive genetic effects for these traits except seeds per pod. Most of the crosses with negative SCA effect for plant height had at least one parent with significant negative or negative GCA effect for this trait. For most of the traits except pods per plant, the efficiency of high parent heterosis effect was more than SCA effect for determining superior cross combinations.

Keywords:GCA, Heritability, Heterosis,Line × Tester, SCA

INTRODUCTION

Indian mustard [*Brassica juncea* (L.) Czern&Coss.], which is cultivated throughout the world, belongs to the family C*ruciferae* (*Brassicaceae*) under the genus Brassica, cultivated all over India, because of its wide adaptation to different diverse climatic conditions and it is the major *rabi* oilseed crop of northern India(Singh *et al*., 1014). It has 38 to 42% oil and 24% protein (Singh *et al*., 2013). Among mating designs, line x tester analysis helps in the identification of good general combiners and specific cross combinations as well as the choice of breeding procedure for genetic improvement of various polygenic characters. The information on combining ability of diverse parents for seed yield and its contributing characters is helpful in planning successful breeding programmes. Heritability and genetic advance are also important selection parameters in predicting the gain under selection. Information on the nature and degree of divergence provides a national basis and helps the plant breeders in choosing suitable parents for realizing recombination in breeding rogrammes.

*B. juncea*is valued for its intense flavors and healing properties. This plant is cultivated mainly as an oil crop (Fomina, 1962). All over the world, mustard is used for its appetizing flavor and preservative value and the seeds are used largely for tempering food. Mustard is available in the form of seeds, powders and oil. Recently, *B. juncea*has been explored for its biodiesel potential (Jham *et al*., 2009).Seed yield of canola is a quantitative trait, which is largely influenced by the different environmental effects and most of the cases it has low heritability (Habekotte 1997, Diepenbrock 2000 and Rameeh, 2010). An Indian mustard breeding program for hybrid and open pollinated varieties, general and specific combining ability effects (GCA and SCA) are important indicators of the potential of inbred lines in hybrid combinations. The line×tester analysis is one of the efficient methods of evaluating large number of inbred as well as providing information on the relative importance of GCA and SCA effects for interpreting the genetic basis of important plant traits (Singh and Chaudhury, 1977). By using this scheme, and other genetic designs like diallel analysis significant GCA and SCA effects of phonological traits, seed yield and other yield associated traits were reported in rapeseed (Shen *et al*., 2002; Nassimi *et al*., 2006a and Wang *et al*., 2007). In earlier studies on spring cultivars of rapeseed (Huang *et al*., 2010 and Rameeh, 2011) were stressed the important role of GCA and SCA effects for yield components.

MATERIALS AND METHODS

The present investigation entitled studies on Line × tester analysis for seed yield, its components and oil content in Indian mustard (*Brassica juncea*L. Czern&Coss.) under normal and salt affected soil.Line × tester mating design was conducted at Research Farm of Department of Genetics & Plant Breeding, Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumargaj), Faizabad (U.P.) under normal soil and salt affected soil sown conditions during *rabi*, 20013-14. Geographically, this place is located between 24.47^0 and 26.56^0 N latitude, 82.12^0 and 83.98^0 E longitudes and at an altitude of 113 m above from mean sea level. This area falls in sub-tropical climatic zone. The soil type is sandy loam. The annual rainfall is about 1270 mm. The

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climate of district Faizabad is semi-arid with hot summer and cold winter. All the plant protection measures were adopted to make the crop free from insects. The data were recorded on ten randomly selected plants of each entry of each replication for plant height, number of siliquea per plant, seeds per raceme and 1000-seed weight. Seed yield (adjusted to kg/ha) was recorded based on two middle rows of each plot. Data for the genotypes were subjected to line x tester analysis (Singh and Chaudhary, 1977) to estimate general combining ability (GCA) and specific combining ability (SCA). A t-test was used to test whether the GCA and SCA effects were different from 0. For each hybrid and each studied trait, the difference between hybrid and the mean of high parent was computed separately.

Experimental materials:

The material for present investigation comprised of 60 F'$_1$s (developed by crossing with 20 (females) lines *viz*., SKM-904, NPJ-153, RGN-303, SKM-513, RB-60, NDR 2001-1, DRMR IJ-118, RMM- 9-10, DRMR-659-49, KDM-1049, RGN-73, RN-0904, NDR-08-1, Maya, Albeli, RRN-73, Albeli-1, RRN-732, MCP-633 and Varuna with 3 testers (NDR-8501, CS-54 and Narendra Ageti Rai-4) in line x tester fashion design. A total of 83 treatments (60 F$_1$'s + 20 lines + 3 testers) were used for investigation. Genotypes used as lines and testers were made available from the Oilseed Section of Department of Genetics and Plant Breeding, Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumargaj), Faizabad.

RESULTS AND DISCUSSION

Line × tester analysis of variance

Line ×tester analysis of variance, significant mean square of the genotypes and parent for the traits under study including plant height, number of siliquea on main raceme, seeds per plant, 1000-seed weight and seed yield indication enough genetic variations for the genotypes and necessity of genetic analysis (Table1). Significant mean squares of parent's *vs* crosses which are indication significant average heterosis were also significant for all the traits except number of seeds per plant.

Table1 : Analysis of variance for plant height, yield components and seed yield of Indian mustard (*Brassica juncea*L.) based on Line × tester fashion

Source of Variance	d.f.	MS				
		Plantheight (cm)	Number of siliquea on main raceme	Seeds per plant	1000-Seed weight	Seed yield per plant
Replication	2	25.58	32.09	1.73	0.72*	0.35
Genotypes	82	770.97**	34.59**	3.08**	1.34**	8.69**
Parents	19	1457.80**	44.68**	3.22**	2.06**	5.93**
Parents vs crosses	1	5965.21**	40.45	0.05**	0.21	6.71**
Crosses	59	426.83**	30.72**	3.08**	1.80	8.35**
Testers	2	282.11	26.75	2.76	1.79	4.52
Line × tester	38	345.78**	25.18**	2.71**	0.99**	9.84**
Error	164	13.46	12.76	1.00	0.23	0.25
Narrow sense heritability						

Note: *, and ** Significant at P<0.05 and 0.01, respectively.

Specific combining ability effects of the crosses

The crosses including NPJ-153×NDR-8501 (-8.44), SKM-518×NDR-8501 (-12.80), RB-60×NDR-8501 (-5.31), DRMR IJ-118×NDR-8501 (-16.10), RMM-9-10×CS-54 (23.06), KDM-1049×NDR-8501 (-4.22) with negative specific combining ability (SCA) effects for the plant height were detected as good cross combinations for decreasing this trait (Table 2). Most of the crosses with negative specific combining ability effect for plant height had at least one parent with significant negative or negative general combining ability effect for this trait. (Nassimi *et al.* 2006a) noted in *Brassica juncea*(grown for seed yield), taller plants are susceptible to lodging. Medium or short-statured plants are therefore desirable, and accordingly negative general combining ability and specific combining ability values are sought for plant height. The more researchers have found the out of 28 crosses, 13 showed negative SCA effects for plant height. Whereas the 40 crosses in cross RMM-9-10×CS-54 (-4.95) had significant SCA effects for number of siliquea on main raceme per plant. The crosses SKM-904×CS-54 (9.91), NPJ-153×CS-54 (17.89), SKM-518×NDR-8501 (5.91), NDR-2001-1×NDR-8501 (4.24), DRMR IJ-11×CS-54 (6.07), RMM-9-10×NDR-8501 (9.93), DRMR-659-4×CS-54 (9.55) and KDM-1049×NDR-8501 (3.86) with significant positive SCA effectsfor the character number of seeds per siliquea were seed yield, selection of these crosses will improvement this seed yield. None of crosses had significant SCA effects for number of seeds per siliquea. The crosses including were NPJ-153×NDR-8501 (0.56) and KDM-1049×NDR-8501 (0.60) are calculated positive and significant specific combining ability (SCA) effect and NDR-2001-1×NDR-8501 (-0.73), DRMR IJ-11×CS-54 (-0.89) and KDM-1049×CS-54 (-1.19) negative SCA effects for 1000 seed weight. The crosses viz.,SKM-904×NDR-8501 (0.71), SK M-518×NDR-8501 (2.61), NPJ-153×CS-54 (3.60), NDR-2001-1×NDR-8501

(2.87), DRMR IJ-11×CS-54 (1.70), DRMR IJ-11×NDR-8501 (1.47) and DRMR-659-4×NDR-8501 (0.95) with positive specific combining ability effects for seed yield were considered as suitable combinations for improving this trait. The Similarly in earlier study (Nassimi *et al.*, 2006b) was reported significant SCA effects for plant height, the number of pods per main raceme, the number of primary branches per plant, days to 50% flowering and physiological maturity.

Table 2 : Estimation of specific combining ability (SCA) effects for plant height, yield components and seed yield in crosses of two testers and 20 lines of Indian mustards and their lines tester crosses

Crosses	Plant height (cm)	Number of siliquea on main raceme	Number of Seeds per siliquea	1000 - seed weight	Seed yield
SKM-904×NDR-8501	6.81**	2.47	-7.23**	0.04	0.71**
SKM-904×CS-54	9.02**	-1.11	9.91**	0.22	-0.54
NPJ-153×NDR-8501	-8.44**	-2.45	-12.18**	0.56*	-1.74**
NPJ-153×CS-54	-2.47	2.9	17.89**	-0.47	3.60**
RGN-303×NDR-8501	-2.15	2.31	0.84	0.37	-1.54**
RGN-303×CS-54	-3.28	-1.34	-11.09**	-0.18	-0.5
SKM-518×NDR-8501	-12.80**	-0.75	5.91**	0.37	2.61**
SKM-518×CS-54	2.14	-0.62	-11.63*	-0.15	-2.54**
RB-60×NDR-8501	-5.31*	0.43	-2.1	0.11	-1.00**
RB-60×CS-54	8.83**	1.32	-3.88**	0	-1.90**
NDR-2001-1×NDR-8501	1.28	-0.08	4.24**	-0.73*	2.87**
NDR-2001-1×CS-54	1.72	1.54	-4.48**	-0.01	-2.77**
DRMR IJ-11×NDR-8501	-16.10**	-1.28	-4.14**	0.35	-1.52**
DRMR IJ-11×CS-54	19.46**	3.01	6.07**	-0.89**	1.47**
RMM-9-10×NDR-8501	5.70**	2.9	9.93**	-0.39	-1.08**
RMM-9-10×CS-54	-23.06**	-4.95*	-7.65**	0.09	1.70**
DRMR-659-4×NDR-8501	2.24	3.08	-4.68**	-0.01	0.72*
DRMR-659-4×CS-54	-2.2	-3.5	9.55**	-0.14	-0.06
KDM-1049×NDR-8501	-4.22*	0.07	3.86**	0.60*	0.95**
KDM-1049×CS-54	1.05	-2.4	-6.45**	-1.19**	-0.79**
RGN-73×NDR-8501	7.16**	0.57	0.83	-0.33	-0.65*
RGN-73×CS-54	-1.97	-1.55	1.7	0.67*	0.03
RN-0904×NDR-8501	18.34**	1.89	-6.05**	-0.22	-0.57*
RN-0904×CS-54	1	2.54	-5.91**	0.03	1.45**
NDR-8501×NDR-8501	0.06	-2.54	-1.09	-0.07	-1.36**
NDR-8501×CS-54	-5.34*	1.5	-4.67**	0.61*	-0.51
Maya×NDR-8501	8.35**	4.30*	9.42**	0.1	0.97**
Maya×CS-54	6.12**	-4.45*	-2.72*	-0.02	-1.56**
Albeli×NDR-8501	-0.13	-1.38	-8.82**	0.21	-0.83**
Albeli×CS-54	1	-1.13	2.75*	-0.44	0.05
RRN-743×NDR-8501	1.82	-4.58*	-3.02**	-0.12	-1.62**
RRN-743×CS-54	4.69*	3.39	6.82**	1.24**	1.11**
Albeli-732×NDR-8501	-1.37	3.45	5.72**	0.32	2.23**

Albeli-732×CS-54	-4.78**	-1.49	-4.66**	-0.19	-0.72*
RRN- 732×NDR-8501	10.27**	-1.43	2.61*	-0.79**	-1.42**
RRN- 732×CS-54	-15.00**	1.73	2.63*	0.89**	0.73*
MCP-633×NDR-8501	-4.69*	-2.2	0.88	-0.4	1.26**
MCP-633×CS-54	3.82	1.46	5.11**	0.36	1.55**
Varuna×NDR-8501	-6.82**	-4.79*	5.10**	0.04	1.00**
Varuna×CS-54	-0.75	3.15	0.72	-0.42	0.21
CD 95% SCA	4.2	4.08	2.14	0.55	0.57

Note: *, and ** Significant at P<0.05 and 0.01, respectively.

General combining ability effects (GCA) of the parents

The parents included NPJ-153 (10.56), NDR-2001-1 (6.74), DRMR IJ-118 (5.63), DRMR-659-49 (2.79), kdm-1049 (5.18), RGN-73 (7.66), NDR-8501 (4.06), Maya (2.88), RRN-73 (3.33), Albeli-732 (10.0) and testers NarendraAgeti Rai-4 (1.22) expressed positive and significant general combining ability for plant height (Table 3). Among the number of siliquea on main raceme and number of seeds per siliquea showed positive and significant GCA effects (Verma *et al.*,2000) studied combining ability using 12 lines and 3 testers for seed yield and its contributing traits. Among parents are possessed superior specific cross combination for seed yield and its contributing traits. (Mall *et al.*, 2010) combining ability using 20 lines and 3 testers for seed yield and its components over two environments. Significant differences due to lines, testers and their interaction showed the importance of both additive and non-additive gene action with later being predominant was good general combiners for seed yield per plant, plant height, length of main raceme, siliquae per plant and seeds per siliqua were the most specific cross combinations for seed yield and other yield related traits. Narendra Ageti Rai-4 negative GCA for plant height, seed yield and 1000-seed yield its traits are expressed significant. Among the NDR-8501 line was significant for plant height and seed yield.

Table 3: Estimates of general combining ability (gca) effects for plant height, yield components and seed yield per plant of Indian mustard (*Brassica juncea* L.)

Lines	Plant height (cm)	Number of siliquea on main raceme	Number of Seeds per siliquea	1000-Seed weight	Seed Yield (g)
SKM-904	0.32	4.56**	1.13**	-0.05	0.92**
NPJ-153	10.56**	-1.31	0.03	0.51**	0.09
RGN-303	1.16*	-2.81**	0.53	0.34*	-1.01**
SKM-513	1.38	-1.15	0.37	-0.29	-0.86**
RB-60	0.14	-1.27	-0.07	-0.20	0.59**
NDR 2001-1	6.74**	0.04	0.08	0.30	1.41**
DRMR IJ-118	5.63**	0.77	0.31	-0.31	0.01
RMM- 9-10	17.01**	-1.27	-0.05	-0.42*	-0.30
DRMR-659-49	2.79*	1.95	0.31	-0.26	-1.18**
KDM-1049	5.18**	-1.55	-1.56**	0.07	-1.38**
RGN-73	7.66*	-0.14	-0.36	-0.21	1.29**
RN-0904	0.49	-0.79	-0.56	0.87**	-0.77**
NDR-08-1	4.06**	-4.13**	-0.79*	0.29	-1.93**
Maya	2.88**	3.30**	0.15	-0.07	-0.57**
Albeli	4.11**	1.00	-0.18	-0.55**	-0.63**
RRN 73	3.33**	2.34	-0.74*	-0.02	-0.47**

Albeli-732	10.00**	2.40*	0.57	0.03	1.45**
RRN-732	-21.18**	0.99	0.64	0.54**	0.81**
MCP-633 and	-6.39**	-0.70	0.93**	-0.39*	1.24**
Varuna	-7.62**	-2.23	-0.72*	-0.20	1.28**
S.E. [GCA {lines}]	1.2233	1.1908	0.3342	0.1612	0.1663
S.E. [GCA {testers}]	0.4738	0.4612	0.1294	0.0624	0.0644
Testers					
NDR 8501	1.22*	0.59	0.02	0.14*	0.19**
NarendraAgetiRai 4	-2.50**	-0.13	-0.21	-0.19**	-0.31**

Note: *, and ** Significant at P<0.05 and 0.01, respectively.

High Parent Heterosis

The result of high parent heterosis effects of crosses for all the traits is presented in Table 4. Out of 40 crosses, 12 crosses had significant high parent heterosis effects of plat height. The crosses including SKM-904×CS-54, NPJ-153×CS-54, RGN-303×CS-54, NDR-2001-1×CS-54, DRMR IJ-11×CS-54, KDM-1049×CS-54, RN-0904×NDR-8501, RN-0904×CS-54, RGN-73×CS-54, RGN-73×NDR-8501, Albeli×CS-54 and MCP-633×CS-54 with significant negative high parents heterosis for plant height were suitable combinations for deceasing this trail. Although most of the crosses had significant SCA effect for number of siliquea on main raceme, only one combination had significant high parent heterosis effect for this trait. Albeli-732×CS-54 and Varuna×CS-54 with significant positive high parent heterosis effects for seed yield was good combination for improving this trait (Table 5).

Table 4: High parent heterosis (Mid Parent) for plant height, yield components and seed yield in crosses of to testers and 20 lines of Indian mustard (*Brassica juncea* L.).

Crosses	Plant height (cm)	Number of siliquea on main raceme	Number of Seeds per siliquea	1000-seed weight	Seed yield (g)
SKM-904×NDR-8501	1.8	10.32	7.32	42.25**	36.51**
SKM-904×CS-54	14.48**	22.08**	13.40*	22.42*	14.74**
NPJ-153×NDR-8501	-1.08	-15.10*	-4.5	81.20**	-6.67
NPJ-153×CS-54	15.11**	13.95	-1.35	21.68*	52.16**
RGN-303×NDR-8501	-4.66*	-7.41	3.72	35.42**	-13.38**
RGN-303×CS-54	22.42**	1.28	-6.51	3.09	-6.43
SKM-518×NDR-8501	-11.83**	-10.71	23.68**	30.73**	37.98**
SKM-518×CS-54	2.25	0.48	0.96	-3.03	-27.87**
RB-60×NDR-8501	-9.50**	-8.2	-7.02	6.72	12.36*
RB-60×CS-54	-0.47	-2.98	-7.89	-10.72	-4.25
NDR-2001-1×NDR-8501	2.82	-6.32	14.49*	6.81	15.24**
NDR-2001-1×CS-54	4.43*	7.37	-2.87	7.13	-31.29**
DRMR IJ-11×NDR-8501	-11.03**	-11.41	-7.49	40.25**	-3.39
DRMR IJ-11×CS-54	12.05**	1.2	-3.96	-16.02	27.15**
RMM-9-10×NDR-8501	-10.49**	-2.39	-8.48	-4.6	-0.66
RMM-9-10×CS-54	-29.32**	-15.62*	-9.82	-8.3	26.36**
DRMR-659-4×NDR-8501	0.84	5.61	-6.51	7.18	-22.87**
DRMR-659-4×CS-54	1.74	-1.82	2.33	-11.51	-29.84**

KDM-1049×NDR-8501	-1.85	-9.73	-1.91	30.03**	-1.05
KDM-1049×CS-54	22.47**	-6.06	-15.31*	-27.90**	-19.94**
RGN-73×NDR-8501	7.30**	-5.22	-6.05	9.77	-8.22*
RGN-73×CS-54	5.16*	3.86	-5.12	16.43*	-2.86
RN-0904×NDR-8501	9.94**	-3.65	-9.09	41.09**	-17.77**
RN-0904×CS-54	16.21**	8.33	10.53	25.66**	1.16
NDR-8501×NDR-8501	-0.85	-21.92**	-8.96	19.07*	-30.10**
NDR-8501×CS-54	-4.33*	-7.11	-4.61	16.86*	-21.73**
Maya×NDR-8501	3.4	-3.18	-0.48	26.00**	9.04*
Maya×CS-54	1.99	-18.37**	8.13	3.37	-18.57**
Albeli×NDR-8501	-5.28**	-7.15	-11.85*	-8.5	-0.24
Albeli×CS-54	32.17**	7.03	8.53	-33.33**	3.95
RRN-743×NDR-8501	0.48	-15.40*	-26.42**	6.67	-20.55**
RRN-743×CS-54	2.41	5.49	-12.60*	20.54**	6.75
Albeli-732×NDR-8501	3.22	7.53	23.56**	41.60**	58.26**
Albeli-732×CS-54	14.26	15.15	-3.35	5.93	18.73**
RRN- 732×NDR-8501	-9.68**	-7.26	1.83	20.51*	-10.83**
RRN- 732×CS-54	-12.03**	6.65	-0.91	42.41**	9.32*
MCP-633×NDR-8501	-9.79**	-13.05	-4.69	-11.05	42.93**
MCP-633×CS-54	7.34**	4.44	10.82	-7.65	42.01**
Varuna×NDR-8501	-12.01**	-22.76**	7.37	20.67*	21.57**
Varuna×CS-54	-2.4	9.89	-5.74	-9.48	13.02**
CD 95% SCA					
LSD(α=0.05)					
LSD(α=0.01					

Note: *, and ** Significant at P<0.05 and 0.01, respectively.

Although none of crosses had significant SCA effect for Number of siliquea on main raceme, six crosses had significant high parent heterosis effects for this trait. SKM-904×CS-54 with significant positive high parent heterosis effect for number of siliquea on main raceme was good combination for increasing this trait and both of parents of this

Table 5: Genotypic Correlation among the yield associated traits in two testers and 20 lines of Indian mustard and their line × tester fashion

Genotypic Correlation					
Character	**Plant Height (cm)**	**Number of Siliquea on main racemes**	**Number of Seeds per Siliqua**	**1000-seed weight (g)**	**Seed yield (g)**
Plant Height (cm)	1.0000	0.5827	0.0983	0.0403	0.0544
Number of siliquea on main racemes		1.0000	0.4520	0.2581	0.0721
Number of seeds per siliqua			1.0000	0.3546	0.2003
1000-seed weight (g)				1.0000	1.0000
Seed yield (g)					1.0000

combination had positive GCA effect for number of siliquea on main raceme. Out of 40 crosses, 16 crosses had significant high parent heterosis effects of 1000-seed weight. For 1000-seed weight in Indian mustard hybrids, an average high parent heterosis of 30% with a range of 20–50% was observed, while for winter rapeseed hybrids an average high parent heterosis of 50% was reported, ranging from 20 to 80% as reviewed by (McVetty, 1995)(Table 6). In general high narrow-sense heritability estimates for all the traits except Number of Siliquea on main racemes exhibited the prime importance of additive genetic effects for these traits except seeds per pod. Significant variance of line x tester for Number of Siliquea on main racemes and seed yield, indicating additive genetic effects have important role for controlling these traits. Although most of the crosses had significant SCA effects for pods per plant, but one cross had significant high parent heterosis effect for this trait, therefore the efficiency of SCA effect is more important than heterosis effect for detecting superior combinations for pods per plant. For other studied traits, the efficiency of high parent heterosis effect is more than SCA effect for determining superior cross combinations (Table 7).

Table 6: Phenotypic Correlation among the yield associated traits in two testers and 20 lines of Indian mustard and their line × tester fashion

Phenotypic Correlation					
Character	**Plant Height (cm)**	**Number of Siliquea on main racemes**	**Number of Seeds per Siliqua**	**1000-seed weight (g)**	**Seed yield (g)**
Plant Height (cm)	1.0000	0.3521	0.0727	0.0370	0.0414
Number of siliquea on main racemes		1.0000	0.2371	0.1760	0.0767
Number of seeds per siliqua			1.0000	0.2356	0.1158
1000-seed weight (g)				1.0000	-0.0205
Seed yield (g)					1.0000

Table 7: Environmental Correlation among the yield associated traits in two testers and 20 lines of Indian mustard and their line × tester fashion

	Environmental Correlation				
Character	**Plant Height (cm)**	**Number of Siliquea on main racemes**	**Number of Seeds per Siliqua**	**1000-seed weight (g)**	**Seed yield (g)**
Plant Height (cm)	1.0000	0.0507	0.0657	-0.0109	-0.0007
Number of siliquea on main racemes		1.0000	0.1016	0.1168	0.0859
Number of seeds per siliqua			1.0000	0.0820	0.0322
1000-seed weight (g)				1.0000	0.11941
Seed yield (g)					1.0000

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CONCLUSION

Line × tester analysis of the genotypes and parent for the traits under study including plant height, number of siliquea on main raceme, seeds per plant, 1000-seed weight and seed yield indication enough genetic variations for the genotypes and necessity of genetic analysis. High narrow-sense heritability estimates for all the traits except seeds per pod exhibited the prime importance of additive genetic effects for these traits except seeds per pod. For most of the traits except pods per plant, the efficiency of high parent heterosis effect was more than SCA effect for determining superior cross combinations. Most of the crosses with negative SCA effect for plant height had at least one parent with significant negative or negative GCA effect for this trait.

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