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RESEARCH ARTICLE

COMBINING ABILITY ANALYSIS FOR SEED YIELD AND ITS COMPONENTS IN LINSEED (*LINUM USITATISSIMUM* L.) UNDER LATE SOWN CONDITIONS IN THE NORTH CENTRAL PLATEAU ZONE OF ODISHA IN INDIA

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ABSTRACT

The experiment comprised of five lines, three testers and their 15 F_1s. They were grown in randomized complete block design under late sown conditions. The line x tester analysis of Kempthorne (1957) was carried out to estimate general combining ability (gca) and specific combining ability (sca) effects. The line 'OL 22-1' and tester 'OLC 10' recorded significantly positive gca effects for both number of capsules per plant and 1000-seed weight. They excelled others and may be involved in a crossing programme resulting in identification of superior genotypes with higher capsule number with moderate 1000-seed weight leading to higher seed yield. The crosses 'OL 2-3 x Padmini' and 'OL 4-1 x OLC 10' recorded significantly positive sca effects for capsule number, 1000-seed weight and seed yield. They may be exploited in heterosis breeding.

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INTRODUCTION

The success of a breeding programme depends on the proper choice of parents for hybridization and the ideal selection adopted in the early generations. The selection of parents for a hybridization programme is relatively difficult in the case of complex traits like yield and their components as they are governed by a large number of quantitative genes that are influenced by environment. Knowledge on the nature of gene action on such complex quantitative traits is necessary to plan and adopt appropriate selection techniques and breeding methodology. Combining ability analysis gives useful information regarding the selection of parents in terms of the performance of the hybrids. This analysis elucidates the nature and magnitude of various types of gene actions involved in the expression of the quantitative traits. Thus, the knowledge of combining ability serves as useful tool for the selection of parents for hybridization and further exploitation. The line x tester analysis is an efficient biometrical approach for assessing the combining ability of parents and hybrids (Kempthorne, 1957). The North Central Plateau Zone of Odisha comprising the districts of Mayurbhanj and Keonjhar contributes to about 50.6 % of the total linseed area of the state of Odisha (Anonymous, 2015). However, a significant number of farmers are forced to sow linseed one month late due to excess moisture in the field. Seed setting is highly affected due to higher temperature during later phase of growth decreasing seed yield significantly (Dash *et al*., 2011). So, the present study was undertaken to identify good combiners from the selected genotypes and to estimate the general and specific combining ability effects in linseed (*Linum usitatissimum* L.) under late sown conditions.

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MATERIALS AND METHODS

The experiment comprised of five lines (females), three testers (males) and their 15 F_1s (Table 2 and 3). The crosses along with lines and testers were grown one month late during November in randomized complete block design with two replications at the Regional Research and Technology Transfer Sub-station of OUAT at Jashipur, Mayurbhanj, Odisha (latitude : 21° 57' N, longitude : 86° 06' E, altitude : 400 m above mean sea level, annual rainfall : 1475 mm, soil : red lateritic, sandy loam and acidic). Each genotype was sown in a single row of 1 m length with a spacing of 30 cm ×10 cm between and within the row respectively. The sowing depth was 2-3cm. Recommended package of practices was followed to raise a good crop. Five randomly selected competitive plants from each row were used to record the biometric observations of

plant height (cm), number of primary branches per plant, number of capsules per plant, number of seeds per capsule and seed yield per plant (g). But 1000- seed weight (g) was recorded on whole row basis. The line x tester analysis of Kempthorne (1957) was carried out using SPAR 2 software of ICAR-Indian Agricultural Statistics Research Institute, New Delhi.

Parents vs crosses registered highly significant variation only for number of capsules per plant and 1000-seed weight. The crosses had highly significant differences for all the characters except plant height and number of seeds per capsule. For improvement of seed yield, the selection criteria should be more 'days to 50% flowering' and higher 'number of capsules per plant' with moderate '1000-seed weight' under late sown

Table 1. Analysis of variance for line x tester analysis including parents in linseed

Sources of variation	df	Mean sum of squares					
		Plant height (cm)	Nos. of primary branches/plant	No. of capsules/plant	No. of seeds/capsule	1000- seed weight (g)	seed yield/plant (g)
Genotypes `	22	44.1186	1.4740**	1871.4509**	1.3876*	1.8079**	3.4584**
Parents	7	35.1896	0.6771	1598.8396**	1.8625*	1.4968**	2.7137**
Parents vs Crosses	1	14.3861	0.8902	1384.2032**	0.6052	0.1554**	0.1924
Crosses	14	50.7068	1.9142**	2042.5599**	1.2060	2.0815**	4.0640**
Lines	4	111.9220**	1.8163	2366.5678	0.7328	2.9023	4.9046
Testers	2	53.3343	1.3123	2539.8070	1.0103	0.5008	3.2509
Lines x Testers	8	19.4423	2.1136**	1756.2441**	1.4916*	2.0663**	3.8469**
Error	22	24.7420	0.4386	135.3158	0.5576	0.0011	0.3396

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

Table 2. General combining ability (gca) effects of the parents in linseed

Parents	Plant height (cm)	Nos. of primary branches/plant	No. of capsules/plant	No. of seeds/capsule	1000- seed weight (g)	seed yield/plant (g)
Lines						
OL 1-3	0.4800	0.1900	-14.6700**	-0.1700	-0.7510**	-0.8593**
OL 2-3	0.1467	-0.9100**	-21.1533**	0.4467	0.4157**	-0.6577*
OL 4-1	-5.9533**	0.1900	-3.7376	0.1300	-0.4493**	-0.3193
OL 18-4	6.1800**	0.5567	27.4800**	-0.4867	-0.1943**	1.3123**
OL 22-1	-0.8533	-0.0267	12.0800*	0.0800	0.9790**	0.5240*
SE (g_i)	2.0307	0.2704	4.7490	0.3048	0.0136	0.2379
Testers						
Kiran	-1.0167	0.3133	2.9900	-0.1033	0.0953**	0.0573
Padmini	-1.6267	-0.3967	-17.2200**	0.3567	-0.2557**	-0.5967**
OLC 10	2.6433	0.0833	14.2300**	-0.2533	0.1603**	0.5393**
SE (g_j)	1.5730	0.2094	3.6785	0.2361	0.0105	0.1843

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

Table 3. Specific combining ability (sca) effects of the crosses in linseed

Crosses	Plant height (cm)	Nos. of primary branches/plant	No. of capsules/plant	No. of seeds/capsule	1000- seed weight (g)	seed yield/plant (g)
OL 1-3 x Kiran	0.3000	1.4700**	32.1100**	-1.3300*	-0.4920**	1.1493*
OL 1-3 x Padmini	-3.6900	-1.0700*	-4.4800	0.1600	1.1890**	0.0683
OL 1-3 x OLC 10	3.3900	-0.4000	-27.6300**	1.1700*	-0.6970**	-1.2177*
OL 2-3 x Kiran	0.4333	-0.1300	-10.4067	0.4033	-0.3487**	-0.6473
OL 2-3 x Padmini	-2.9067	0.3800	28.8033**	0.2433	0.1373**	1.5517**
OL 2-3 x OLC 10	2.4733	-0.2500	-18.3967*	-0.6467	0.2113**	-0.9043**
OL 4-1 x Kiran	-2.3167	0.4200	-2.3233	0.7200	0.7663**	-0.0107
OL 4-1 x Padmini	3.2933	0.1300	-36.3633**	0.1600	-1.8627**	-1.5617**
OL 4-1 x OLC 10	-0.9767	-0.5500	38.6867**	-0.8800	1.0963**	1.5723**
OL 18-4 x Kiran	0.2000	-1.2967*	6.8100	0.4867	-0.0637*	0.5177
OL 18-4 x Padmini	1.4600	1.0633*	-1.0300	-0.2733	0.0373	-1.1183*
OL 18-4 x OLC 10	-1.6600	0.2333	-5.7800	-0.2133	0.0263	0.6007
OL 22-1 x Kiran	1.3833	-0.4633	-26.1900**	-0.2800	0.1380**	-1.0090*
OL 22-1 x Padmini	1.8433	-0.5033	13.0700	-0.2900	0.4990**	1.0600*
OL 22-1 x OLC 10	-3.2267	0.9667	13.1200	0.5700	-0.6370**	-0.0510
SE (s_{ij})	3.5172	0.4683	8.2254	0.5280	0.0235	0.4120

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

RESULTS AND DISCUSSION

The analysis of variance (Table 1) indicated highly significant differences for number of primary branches per plant, number of capsules per plant, 1000- seed weight and seed yield per plant, and significant difference for number of seeds per capsule among genotypes and interaction of line x tester. The parents showed highly significant differences for number of capsules per plant, 1000- seed weight and seed yield per plant, and significant difference for number of seeds per capsule. conditions in the north central plateau zone of Odisha (Dash *et al*., 2016). The parents 'OL 22-1' and 'OLC 10' recorded significantly positive gca effects for both number of capsules per plant and 1000-seed weight. They excelled others and may be involved in a crossing programme resulting in identification of superior genotypes with higher capsule number with moderate 1000-seed weight leading to higher seed yield (Table 2). Similar positive gca effects for number of capsules and seed weight were also reported earlier by Khan *et al.* (1999), Ratnaparkhi *et al.* (2005), Abd El-Haleem and Abd Al-Sadek

(2015), and Singh *et al*. (2016). The crosses 'OL 2-3 x Padmini' and 'OL 4-1 x OLC 10' recorded significantly positive sca effects for capsule number, 1000-seed weight and seed yield. They may be exploited in heterosis breeding (Table 3). Khan *et al.* (1999), Ratnaparkhi *et al.* (2005), Abd El-Haleem and Abd Al-Sadek (2015), and Singh *et al*. (2016) observed similar positive sca effects in different crosses. The present combining ability analysis helped in identifying parents 'OL 22-1' and 'OLC 10' for crossing programme resulting in superior genotypes with higher seed yield, and the crosses 'OL 2-3 x Padmini' and 'OL 4-1 x OLC 10' for heterosis breeding.

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