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COMBINING ABILITY ANALYSIS IN LENTIL

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ABSTRACT

Combining ability analysis, involving 10 lines of different ecogeographic origin and three well adapted and released varieties as testers, was carried out for eight characters in lentil. The variances due to gca and sca showed that gene action was predominantly additive for days to first flower, plant height, primary branches/plant, and seeds/pod; and primarily nonadditive for secondary branches/plant, pods/plant, 100-seed weight, and yield/plant. Among the parents, Pusa 4 was good general combiner for yield/plant, days to first flower, seeds/pod, and 100-seed weight, and average general combiner for all the remaining characters. The variety Ranjan was good general combiner for yield/plant and days to first flower. The cross EC 151015 x K 75 had significant positive sca effects for yield and some of its components.

Key words: Lentil, *Lens culinaris*, combining ability.

The knowledge of combining ability is useful to assess nicking ability of parents in self-pollinated crops and at the same time elucidate the nature and magnitude of gene actions involved. Combining ability analysis provides to the breeders an insight into the nature and relative magnitude of fixable and nonfixable genetic variance which is helpful in planning of a sound breeding programme. The present investigation aims to know the gene action for certain quantitative characters and to identify certain parents/crosses that can be used in the lentil improvement programmes.

MATERIALS AND METHODS

The material for the present study comprised 30 F_1s of lentil (*Lens culinaris* Medik.) involving 10 genetically diverse lines (NDL 1, Ranjan, Precoz, Pusa 4, IC 784013, EC 151015, IC 78415, E 153, E 258 and 1365) and three well adapted and released varieties (Pant L 234,

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Pant L 406 and K 75) as testers. The F_1s and the parents were randomized among themselves and were grown in contigous blocks in randomized block design in two replications. Each treatment was sown in 3 m long single-row plots, spaced 30 cm apart. Within the rows the seeds were sown 5 cm apart. In the crosses with less number of the hybrid seeds, the seed of filler variety Globe was sown on both sides and the hybrid seeds were sown in the centre of the row. Data were recorded on 5 random plants from each F_1 and parent on eight quantitative traits (Table 1). The character means in each replication were subjected to combining ability analysis as per Kempthorne [1] and Arunachalam [2].

RESULTS AND DISCUSSION

The analysis of variance revealed that sufficient variability existed in the experimental material for all the traits. The variation due to parents vs. hybrids was significant for all the characters studied, indicating the presence of substantial heterosis in the crosses. The partitioning of hybrid mean squares revealed that the variances due to lines were significant for days to first flower, plant height, seeds/pod, 100-seed weight and yield/plant but not significant due to testers for all the traits except for days to flower. The significant mean squares due to lines x tester interactions for days to first flower, pods/plant, 100-seed weight and yield/plant revealed that the testers showed markedly different combining ability effects for these traits.

Combining ability analysis revealed that the estimates of gca variance were higher than sca variance for plant height, primary branches/plant and seeds/pod, indicating preponderance of additive gene action in the expression of these characters (Table 1). Variance due to sca was higher than gca variance for days to flower, secondary branches/plant, pods/plant, 100-seed weight, and yield/plant, suggesting the predominance of nonadditive gene action for these traits. The importance of additive gene action for plant height and primary branches/plant [3] and seeds/pod [3, 4] and nonadditive gene action for secondary branches/plant [5], pods/plant [6] and yield/plant [5, 7] were reported earlier in lentil. Among the nonadditive

Table 1. Estimates of variance components and degree of dominance for different characters in lentil

Character	Variance		Degree of dominance
	gca	sca	
Days to first flower	4.13	5.32	1.34
Plant height	0.30	- 0.42	—
Primary branches/plant	0.01	- 0.01	—
Secondary branches/plant	0.07	3.90	7.63
Pods/plant	54.71	2411.06	6.64
Seeds/pod	0.00	0.00	—
100-seed weight	0.01	0.02	1.95
Yield/plant	0.15	2.97	4.49

gene actions, overdominance was recorded for days to flower, secondary branches/plant, pods/plant, 100-seed weight and yield/plant as their average degree of dominance values were greater than unity. However, for the remaining characters, it was not calculated due to negative sca variance.

The estimates of gca effects (Table 2) showed that the parents Ranjan, Pusa 4, IC 784013, EC 151015, IC 78415, Pant L 406 and K 75 with significant negative gca estimates were good general combiners for days to flower and possessed favourable genetic architecture for imparting earliness to their progenies. The parents Precoz for plant height; NDL 1 and 1363 for pods/plant; Pusa 4 for seed/pod; Precoz, Pusa 4, E 153 and E 258 for 100-seed weight; and Ranjan, Pusa 4 and Pant L 406 for yield/plant showed significant desirable gca effects. The variety Pusa 4 is a good choice for improvement in yield/plant, seeds/pod, 100-seed

Table 2. Estimates of general combining ability effects of lines and testers for different characters in lentil

Parent	Days to first flower	Plant height	Pods per plant	Seeds per pod	100-seed weight	Yield per plant
Lines:						
NDL 1	-1.81	-0.59	49.40*	0.04	-0.26**	1.60
Ranjan	-7.17**	-0.86	-4.61	0.03	0.03	1.92*
Precoz	17.26**	7.26**	24.16	-0.06	0.26**	-0.95
Pusa 4	-6.62	-0.09	45.37	0.11*	0.19**	3.85**
IC 784013	-6.81**	-1.16	-41.78	-0.04	-0.30**	-1.85*
EC 151015	-5.86**	-1.16	13.49	0.04	-0.11	-0.34
IC 78415	-5.77**	-3.99**	-83.34**	-0.06	-0.28**	-3.07**
E 153	0.20	0.58	-39.98	0.01	0.23**	-0.03**
E 258	11.45**	1.00	-43.16	-0.10*	0.61**	-2.09*
1363	4.76**	-0.39	80.46**	0.04	-0.37**	0.95
SE (gi) lines ±	0.91	1.52	24.29	0.04	0.07	0.89
Testers:						
Pant L 234	3.91**	0.30	6.61	-0.01	-0.03	-0.32
Pant L 406	-2.72**	-0.04	6.41	-0.01	0.04	0.96*
K 75	-1.18*	-0.34	-13.02	0.01	-0.01	-0.64
SE (gi) testers ±	0.50	0.83	13.30	0.02	0.04	0.49

Note. None of the parents showed significant gca effects for primary and secondary branches/plant.

*,**Significant at P = 0.05 and P = 0.01, respectively.

weight, and for imparting earliness for the progenies. However, none of the parents proved to be a good or poor general combiner for primary and secondary branches/plant.

The crosses with significant desirable sca effects for various traits along with mean performance and gca effects of the parents involved in the crosses are listed in Table 3. The crosses Pusa 4 x Pant L 234 and EC 151015 x K 75 expressed significant and desirable sca effects as well as high per se performance for yield/plant and for a few other characters. The crosses, which exhibited significant desirable sca effects as well as high mean performance, were IC 78415 x Pant L 406 and EC 151015 x K 75 for days to flower; E 258 x Pant L 406 for secondary branches/plant; Pusa 4 x Pant L 406 for pods/plant; and IC 78415 x Pant L 234 for seeds/pod. It was also observed that the desirable cross combinations included high x high, high x medium, medium x medium and poor x poor type of general combiners (Table 3). The desirable performance of cross combinations like medium x medium and poor x poor general combiners may be ascribed to complementary gene effects.

Two crosses, EC 151015 x K 75 and IC 78415 x Pant L 406, with high sca involving parents with good gca can be exploited effectively by simple conventional breeding procedures like pedigree method. However, those crosses which involved one good combiner and the other

Table 3. Lentil crosses sowing significant specific cobining ability (sca) effects (in parentheses) along with mean performance and general combining ability (gca) effects of the parents involved in the cross

Character	Crosses with significant sca effects	Mean performance	Gca effect of parents
Days to first flower	EC 151015 x K 75 (– 4.97**)	74.0	H x H
	IC 78415 x Pant L 406 (– 4.31**)	73.2	H x H
	1363 x Pant L 234 (– 3.36**)	91.3	L x L
Secondary branches/plant	Pusa 4 x Pant L 234 (4.12*)	32.0	M x M
	E 258 x Pant L 406 (6.66**)	31.8	M x M
Pods/plant	Pusa 4 x Pant L 406 (98.08*)	550.03	M x M
	E 258 x Pant L 406 (91.51*)	455.2	M x M
Seeds/pod	IC 78415 x Pant L 234 (0.15*)	1.7	M x M
100-seed weight, g	Pusa 4 x Pant L 234 (0.23*)	2.4	H x M
	EC 151015 x K 75 (0.31**)	2.2	M x M
Yield/plant, g	Pusa 4 x Pant L 234 (3.03*)	19.2	H x M
	EC 151015 x K 75 (3.76*)	15.4	M x M

Note. None of the hybrids sowing significant effects for plant height and primary branches/plant.

*,** Significant at P = 0.05 and P = 0.01, respectively.

medium or poor combiner could produce desirable transgressive segregates if additive genetic system was operating in good combining parent and epistatic effects also act in same direction. One of the crosses, Pusa 4 x Pant L 234, showed such combination of gca effects and high mean values for yield/plant (19.2 g), secondary branches/plant (32.0), and 100-seed weight (2.4 g). This cross can be profitably exploited for isolating transgressive segregates for these traits.

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