RESEARCH PAPER

Estimation of heterosis in linseed (*Linum usitatissimum* L.)

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Abstract : A field experiment was conducted during 2008 at Experimental Research farm Nawabganj, C. S. Azad University of Agriculture and Technology, Kanpur (U.P.), to estimate the effect of heterosis in different genotypes of linseed *viz.,* RLC-29 or Sheetal, LCK-88062, EC-1465 and Kangra Local for different characters.A significant heterosis over better parent was observed in cross LCK-88062 x EC-1465 for days to flowering, days to maturity. Crosses LCK-88062 x Kangra Local showed positive heterosis for plant height, number of tillers and number of primary branches per plant. Sheetal x EC-1465 cross for number of capsules per plant, three crosses (Sheetal x LCK-88062, Sheetal x Kangra Local and EC-1465 x Kangra Local) fortest weight and two crosses showed positive results (LCK-88062 x EC-1465 and LCK-88062 x Kangra Local) for seed yield per plant. The heterosis over economic parent (sheetal) showed significant results. Cross LCK-88062 x Kangra Local for plant height, crosses Sheetal x LCK-88062, Sheetal x EC-1465 and LCK-88062 x Kangra Local for number of tillers per plant, number of primary branches per plant, number of seed per capsule and test weight, two crosses *viz.*, Sheetal x LCK-88062 and EC-1465 x Kagra Local for seed yield per plant.

Key Words : Heterosis, Linseed

INTRODUCTION

Linseed (*Linum usitatissimum* L.) also called flax, is an important oilseed crop which belongs to the family Linaceae having 14 genera and over 200 species. Among these Linseed is the only widely grown and economically important species. It is believed that this crop species may have originated from *Linum angustifolium* Huds which is native to the Mediterranean region. Almost all the species are annual herbs and some are shrubs.Linseed is the only species with non-dehiscent or semi-dehiscent capsules suitable for modern cultivation from the family Linaceae (Getinet and Nigussie, 1997). Linseed is one of the oldest plant species cultivated for oil and fiber. The crop is predominantly self-pollinated, but out crossing occasionally results from (less than 2%) insect activity (Dillman, 1928). Its oil is largely of drying type.It contains saturated and unsaturated fatty acids fatty acids *viz.*palmitic acid and stearic acid, oleic, linoleic and linoleinic acids. Oil content in linseed ranges from 33-45 % with protein content of 24% (Gill, 1987). Singh and Marker (2006) reported that its oil is high in omega-3 fatty acid which is believed to be helpful in lowering cholesterol level when included in the diet chain. Linseed cake containing 3 per cent oil and 36 per cent protein serves as a superior supplement for the dairy cattle due to its excellent palatability. It is also a good source of calcium (170 mg 100g^{-1}), phosphorus (370 mg100g^{-1}), potassium, manganese, waxes (0.012-0.450 %), sterols and

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phospholipids (0.11-0.21 %).

The term heterosis accounts for any increase or decrease in performance of F_1 over parents. The heterosis has been extensively, exploited in both self and cross pollinated crops for obtaining higher yield. Wang *et al.* (1996) reported positive heterosis in linseed. Kushalkar*et al.* (2002) noted positive heterotic effect of linseed using four tester and eight lines for characters *viz.*, number of branches, number of capsules, number of seed per capsule, oil content, seed yield and test weight. Srivastava *et al.* (2003) studied heterosis for 13 characters in 45 F_1S and 45 F_2S. Out of 45 crosses 21 showed desirable and significant heterosis for seed yield. Keeping this in view, the present investigation was carried out for the estimation of heterosis for different characters of linseed.

MATERIAL AND METHODS

A field experiment was carried out during 2008 at Experimental Research Farm Nawabganj, C.S. Azad University of Agriculture and Technology, Kanpur (U.P.), to evaluate the effect of heterosis in linseed for different characters. The experimental material consisted of RLC-29 or Sheetal, LCK88062, EC-1465 and Kangra Local and seeds were obtained from the project co-ordinator (linseed unit) C.S. Azad University of Agriculture and Technology, Kanpur. All the treatments including 6 F_1S, 6F_2S, and 6B_1S along with four parents were grown in Randomized Block Design with three replications. Each treatment was sown in a line with spacing 30x15 cm. fertilizers, irrigation, plant protection measures were applied as per the recommendations to the requirement of crop.

Five plants in each parent, 10 plants in F_1S, B_1S, B_2S and 20 plants in F_2S in each replication were selected and tagged for recording observations.Days to flowering were recorded at first opening of flowers. Plant height was measured from the base of the stem to the top of the apex with the help of meter scale in centimeter. Number of tillers per plant, number of primary branches, number of capsules per plant, days to maturity, number of seed per capsule, test weight (1000 seed) and yield were measured/ counted/ recorded.

Heterosis and inbreeding depression were calculated by following formulas;

$$\text{Heterosis (\%) over better parent (BP)} = \frac{\overline{F_1}S - \overline{B}P}{\overline{B}P} \times 100$$

$$\text{Heterosis (\%) over economic parent (EP)} = \frac{\overline{F_1} - \overline{E}P}{\overline{E}P} \times 100$$

where; $\overline{F_1}$= mean of F_1
$\overline{B}P$ = mean of better parent.
$\overline{E}P$ = mean of economic parent.
Statistical analysis was based on the method analysis

of variance as suggested by Panse and Sukhatme (1967) and the critical differences were computed by at 5 % level of significance.

RESULTS AND DISCUSSION

Estimation of heterosis over BP and EP in $F_1$and F_2 generation was recorded and presented in Table 1. Days to flowering heterosis was worked out in the percentage over BP. The extent of over BP ranged from -5.43 to 5.19 per cent. Out of six crosses, only cross LCK 88062 x EC1465 showed highly significant and negative heterosis for early flowering. The heterosis over EP ranged from 14.99 to 6.70 per cent. All the 6 crosses showed significant positive heterosis over EP for lateness.

The heterosis over BP varied -7.17 to 10.34 per cent. In all the 6 crosses, only one cross LCK-88062 x Kangra Local showed positive and significant heterosis for maximum plant height.The heterosis over EP ranged from-20.48 to 1.51 per cent. A similar trend was observed for economic parent.

The range of heterosis over BP for tillers production was observed from -0.92 to 1.48 per cent. Out of 6 only one crossSheetal x EC-1465 showed positive and significant heterosis. The heterosis over EP varied from -10.11 to 12.5 per cent. Only 3 cross *viz.*, sheetal x LCK-88062, Sheetal x EC-1465 and LCK-88062 x Kangra Local showed positive and significant results.

The range of heterosis over BP for days to maturity was observed from -5.00 to 8.00 per cent. Out of 6 only one cross LCK-88062 x EC-1465 showed negative and significant value. The heterosis over EP varied from -0.73 to 5.83 per cent. None of the crosses exhibited negative significant heterosis.

The range of heterosis over BP for primary branches was observed from -3.67 to 40.00 per cent. Out of 6 only one crossesLCK-88062 x Kangra Local showed positive and significant heterosis. The heterosis over EP varied from -5.03 to 133.82 per cent. Only 3 cross *viz.*, Sheetal x LCK-88062, LCK-88062 x Kangra Local and EC-1465 x Kangra Local showed positive and significant results.

The range of heterosis over BP for capsules per plant was observed from -103.67 to 7.67 per cent. Out of 6 only one crossSheetal x EC-1465 showed positive and significant heterosis. The heterosis over EP varied from -32.70 to 2.42 per cent. Only 3 cross *viz.*, sheetal x LCK-88062, Sheetal x EC-1465 and LCK-88062 x Kangra Local showed positive and significant results.

Heterosis for number of seeds per capsules over BP varied from 2.67 to 0.20 per cent. The heterosis over EP ranged from-31.90 to 3.58 per cent. Only three crosses *viz.,*Sheetal X LCK-88062, Sheetal x Kangra Local and EC-1465 x Kangra Local showed significant and positive heterosis.

Cross	Days of flower		Plant height		Number of tiller per plant		Days to maturity		Number of primary branches per plant		Number of capsules per plant		Number of seed per plant		1000 seed weight		Oil content		Seed yield per plant	
	BP	EP	BP	EP	BP	EP	BP	EP	BP	EP	BP	EP	BP	EP	BP	EP	BP	EP	BP	EP
Sheetal x 88062	5.19**	6.70**	1.40	2.33	0.58	7.60**	-1.00	-0.73	-0.67	40.06**	30.00*	9.46	0.13	1.55**	0.67*	9.30**	0.18	-3.42**	0.29	1.86**
Sheetal x EC-1465	-1.25	8.28**	3.90	-20.48**	1.48*	12.50**	8.00**	5.83**	-2.33	-5.03	7.67	2.42	-2.67*	-31.90**	0.02	0.24	-0.53	-1.28**	-3.07*	-19.67**
Sheetal x Kangra Local	-0.32	14.56**	-7.17	-15.63**	-0.92*	-10.11**	-1.33	2.43	-2.00	-4.32	-103.67**	-32.70**	0.20	2.39**	2.18**	25.98**	-0.73	-8.81**	1.04	-12.35**
LCK-88062 x EC-1465	-5.43*	9.83*	-6.74	-14.45**	0.22	-1.30**	-5.00**	1.70	-3.67	4.32	-4.67	6.41	-1.67*	-27.95**	0.33*	5.74**	0.82	-0.52	1.44*	-11.77**
LCK 88062 x Kangra Local	-1.83	14.48**	10.34**	14.00**	0.63	8.15**	0.33	3.64**	40.00**	133.82**	-27.33	4.10	-0.35	-17.55**	-0.19	-0.95**	0.32	-6.23**	2.14**	-5.22*
EC-1465 x Kangra Local	-1.98	14.99**	3.13	1.51	0.03	0.22	-1.67	2.18	0.00	38.85	8.00	15.25	-0.11	3.58**	0.64**	-21.93	0.09	-2.31**	0.55	2.56**

* and ** indicate significance of values at P=0.05 and 0.01, respectively

The range of heterosis (for 1000 seed weight) over BP and heterosis over EP ranged from -21.93 to 25.98 and -0.19 to 2.18, per cent, respectively. Only three crosses Sheetal X LCK-88062, Sheetal x Kangra Local and EC-1465 x Kangra Local showed significant and positive heterosis.

The range of heterosis for oil content over BP and over EP ranged from -0.73 to 0.82 and -8.81 to 0.52 per cent, respectively. However, the results were not found significant.

The range of heterosis for yield increment over BP was observed from-3.07 to 2.14 per cent. Two crosses i.e. LCK-88062 x EC-1465 and LCK-88062 x Kangra Local showed positive and significant value for higher yield. The range of heterosis over EP varied from -19.67 to 2.56 per cent. Crosses Sheetal x LCK-88062 and EC-1465 x Kagra Local exhibited significant heterosis.

In general considerable amount of significant desirable heterosis over BP was observed for all the characters except for number of seeds per capsule and oil content. Significant and desirable heterosis was observed in one cross each for days to flowering, plant height, number of tillers per plant, days to maturity, number of primary branches, number of capsules per plant, three crosses for number of seeds per capsule and two crosses for seed yield per plant. Similar findings were also reported by Patil and Chopde (1983), Verma and Singh (1993) and Singh et al. (2011).

As regards to over EP (Sheetal) significant desirable heterosis was observed for all charecters except days to flowering, days to maturity, number of capsules per plant and oil content. Significant and desirable heterosis was observed in cross (LCK-88062 x Kangra Local) for plant height, number of tiller per plant, number of primary branches per plant, number of seeds per capsule and test weight and two crosses(LCK-88062 x EC-1465 and LCK-88062 x Kangra Local) for seed yield per plant. These results are in conformity with the work of Verma and Singh (1993), Hasamani et al. (2008) and Singh et al. (2011).

A considerable amount of significant desirable heterosis over better parent was observed in one cross (LCK-88062 x EC-1465) for days to flowering, plant height, number of tillers per plant, days to maturity, number of primary branches per plant and number of capsules per plant, three crosses (Sheetal x LCK-88062, Sheetal x EC-1465 and LCK-88062 x Kangra Local) for test weight and two crosses (Sheetal x LCK-88062 and EC-1465 x Kagra Local) for seed yield per plant.

The heterosis over economic parent (sheetal) was observed in for plant height, number of tillers per plant, number of primary branches per plant, number of seed per capsule and crosses Sheetal x LCK-88062, Sheetal x EC-1465 and LCK-88062 x Kangra Local Local for test weight, two crosses (Sheetal x LCK-88062 and EC-1465 x Kagra Local) for seed yield per plant.

For important crop raising attributes,high heritability

estimates were observed for days to maturity and seed yield per plant whereas number of tillers per plant exhibited low heritability.

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