Genetic Analysis of Seed Yield and its Components in some Cultivars of Linseed (*Linum usitatissimum* L.)

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The combining ability and gene action revealed contribution of both additive and non-additive gene effects playing an important role for the characters studied. Parents Kiran, NL 93, LCK 9312 and EC596A were found to be good general combiners, while the crosses LCK9312 x Kiran, NL 93 x LCK 9312, NL 93 x Kiran and EC596A x Kiran appeared to be some of the promising combinations for most the yield related traits. Since, significant genotypic variation was generated in majority of the crosses involving six divergent parents, it appears worthwhile to intermate the selects in segregating generations, enabling in the accumulation of more number of favourable genes for seed yield and its important attributes.

Key words: Linseed, *Linum usitatissimum*, Additive, Dominance gene action, GCV, SCV

Linseed (*Linum usitatissimum* L.) is basically an industrial oilseed crop occuping an important place among oilseeds having several commercial uses. The development of varieties for high seed and oil yield than the existing varieties is the main aim of linseed breeding. Since, selection of parents and genetic diversity in crop improvement programme is of immense significance, there is a need to augment the germplasm production by developing high yielding genotypes with sufficient variability in linseed crop. Therefore, knowledge of genetic control of character under improvement and combining ability of parents will help in developing better genotypes of linseed. The combining ability studies provide valuable information regarding selection of appropriate parents for hybridization programme as well as to assess the ability of parents. It also elucidates the nature and magnitude of different types of gene actions involved in the inheritance of various traits. The present study was undertaken to estimate the general and specific combining ability effects through diallel cross analysis in twenty one diverse genotypes of linseed comprising of six diverse parents and fifteen hybrids.

Materials and Methods

Six genetically divergent parents were selected, crossed in all possible combinations and analysed following half-diallel method excluding reciprocals. The material for the study comprises of 6 parents *viz.* NL 93, LCK 9312, EC596A, ICAR 3, R 552 and Kiran with 15 F_1's which were planted in a Randomized Block Design with four replications at research farm of Indira Gandhi Agricultural University, Raipur (Chhattisgarh) during *rabi* season. Row to row and plant to plant distances were kept 30cm and10 cm respectively. Observations on five randomly selected plants were recorded for ten characters *viz.* days to flower initiation, days to maturity, plant height, number of primary branches per plant, number of secondary branches per plant, number of capsules per plant, number of seeds per capsule, hundred seed weight, number of seeds per plant and seed yield per plant. The combining ability analysis was carried out by using method 2, model II (Griffing's 1956).

Results and Discussion

The combining ability and gene effects revealed contribution of both additive and non- additive gene action playing an important role for the characters studied. Predominance of additive gene effect was indicated in the expression of days to flower initiation, days to maturity and plant height. Dominance gene effect was noticed for number of secondary branches per plant, number of capsules per plant, seeds per capsule and seed yield per plant. Parents Kiran, NL 93, LCK 9312 and EC 596A were found to be good general combiners, while the crosses LCK9312 x Kiran, NL 93 x LCK 9312, NL 93 x Kiran and EC596A x Kiran appeared to be some of the promising combinations for most of the yield related traits.

Analysis of variance revealed significant differences for majority of the characters studied, indicating wider genetic variability among genotypes. The mean squares (Table 1) due to general combining ability (gca) and specific combining ability (sca) were significant for most of the traits like days to flower initiation, days to maturity, plant height, number of secondary branches per plant, number of capsules per plant and hundred seed weight.

Table 1. Analysis of variance for combining ability analysis of 6 parent half diallel in linseed

Name of the Character	Mean squares (F generation) GCA df=5	SCA Df=15	Error Df=60
Days to flower initiation	23.17**	2.57**	1.070
Days to maturity	57.02**	4.39**	0.640
Plant height (cm)	260.91**	12.35**	1.490
Number of primary branches per plant	0.66	0.51	0.088
Number of sec. branches per plant	19.19**	35.28**	5.410
Number of capsules per plant	921.77**	2079.58**	202.700
Number of seeds per capsule	0.93	0.46	0.038
Number of seed per plant	0.06	0.002	0.004
100 seed weight (g)	76938.98**	76801.49**	11007.220
Seed yield per plant	0.83	5.49**	0.360

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

This indicated that both additive and non-additive types of gene actions were equally important in the expression of these characters. The predictability ratio (Table 4), derived from equivalent component of variance, indicated that the gene actions were predominantly of the non-additive type for characters like number of primary branches per plant, number of secondary branches per plant, number of capsules per plant, number of seeds per capsule, hundred seed-weight and seed yield per plant and additive gene effect for characters like days to flower initiation, days to maturity, plant height and number of seeds per plant. The earlier results of Kumar and Chauhan (1980) and Khorgade *et al.* (1990) for plant height and Singh (2000) and Patel *et al.* (1999) for non-additive effects for seed yield per plant were in agreement with earlier findings of the study.

The gca effects (Table 2) showed that parent Kiran was found to be good general combiner for number of secondary branches per plant, number of capsules per plant, number of seeds per plant and seed yield per plant. The parent NL 93 was identified as good general combiner for days to flower initiation, days to maturity and plant height. The parent LCK 9312 was found to be a good general combiner for number of primary branches per plant. Parent EC596A appeared to be good general combiner for number of seeds per capsule whereas, ICAR 3 proves to be good general combiner for hundred seed weight followed by NL 93.

Table 2. Estimates of gca effects in six parent half diallel in linseed

Character	NL 93	LCK 9312	EC596A	ICAR 3	R 552	Kiran
Days to flower initiation	-2.72**	0.17	2.56**	0.54	-0.69*	1.20
Days to maturity	-4.36**	-0.41	2.84**	2.17**	1.23**	-1.47**
Plant height (cm)	-7.17**	-4.80**	8.36**	4.05**	0.84*	-1.27**
Number of prim. branches/ plant	0.10	0.31**	-0.38**	-0.93**	0.07	0.24*
Number of sec. branches/ plant	-0.65	1.12	0.39	-2.35**	-0.59	2.08**
Number of capsules/plant	2.12	-6.83	3.60	-14.18**	-2.19	17.48**
Number of seeds/capsule	-0.35**	-0.29**	0.56**	-0.03	-0.11	0.22**
Number of seeds/plant	-22.61	-64.34	97.43**	-110.96**	-40.81	141.29**
100 seed weight (g)	0.07**	0.05**	-0.12**	0.08**	-0.01	-0.06**
Seed yield/ plant	0.35	0.02	-0.36	-0.18	-0.25	0.42*

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

These parents also exhibited significant mean performances for these characters.

The sca effects (Table 3) revealed that cross LCK 9312 x Kiran involving average and high general combiner has high sca effects with high mean performance for days to maturity.

The cross EC596A X R 552 had significant sca effects for plant height. The best cross for number of tillers per plant was found to be LCK 9312 x Kiran involving high general combiner, followed by NL 93 x LCK 9312 and EC596A x Kiran. The cross LCK 9312 x Kiran showed the highest positive significant sca effect. For number of secondary branches per plant, the cross NL 93 x EC596A was found to be promising followed by NL 93 x Kiran. The cross LCK 9312 x Kiran was adjudged as the best cross for number of capsules per plant followed by R 552 x Kiran and EC596A x Kiran involving significant mean performance with average and high general combiner parents. For number of seeds per plant, cross EC596A x Kiran appears to be promising. The cross NL 93 x LCK 9312 observed to be the best combination for seed yield per plant. Other prominent crosses with significant sca effects for number of seeds per plant and seed yield per plant were ICAR 3 x R 552, NL 93 x Kiran and EC596A x Kiran. Though the parents ICAR 3 and R 552 were poor

Table 3. Estimates of sca effects of six half diallel in linseed

Parent combination	Days to flower initiation	Days to maturity	Plant height (cm)	Number of prim-branches plant^{-1}	Number of sec-branches plant^{-1}	Number of capsule plant^{-1}	Number of seed capsule^{-1}	Number of seeds plant^{-1}	100-seed weight(g)	Seed yield plant^{-1}(g)
P1 x P2	1.16	1.23	2.53*	0.77*	5.17*	36.69**	-0.77**	321.08**	0.03	3.42**
P1 x P3	2.17*	0.47	3.48**	0.60*	6.10*	34.05**	-0.17	105.67	-0.04*	0.38
P1 x P4	1.19	0.77	1.13	0.01	0.08	12.64	0.17	90.76	0.0001	0.97
P1 x P5	1.22	0.65	-0.91	0.37	-1.08	7.82	-0.22	53.43	0.001	0.29
P1 x P6	1.88*	2.53**	1.05	0.44	5.76**	28.62**	-0.40*	200.60**	0.04*	1.92**
P2 x P3	-1.36	-0.72	1.50	-0.66	0.83	16.26	-0.31	63.85	0.06*	1.02
P2 x P4	-0.10	-1.95**	-1.44	0.25	2.42	12.84	-0.87**	73.69	0.01	1.20*
P2 x P5	-0.34	-1.79*	1.42	-0.06	1.40	-4.95	-0.22	-59.91	0.04*	-0.40
P2 x P6	-1.70	-1.71*	0.18	0.78**	4.79*	54.07**	-0.19**	199.36*	0.03	1.74**
P3 x P4	0.17	1.24	0.40	0.18	-0.60	9.12	-0.91	140.08	0.001	-0.53
P3 x P5	-0.15	0.48	-3.09**	0.53*	4.13*	42.49	-0.92**	-5.94	0.02	0.22
P3 x P6	-1.64	0.58	3.52**	0.71**	4.72*	35.49**	0.29	436.06**	0.01	2.29**
P4 x P5	0.36	2.25	4.12**	0.63*	5.07*	35.00**	0.21	340.50**	0.01	2.56**
P4 x P6	-0.48	-4.04**	1.18	-0.13	-0.54	-6.23	-0.26	-19.45	0.04*	-0.22
P5 x P6	-0.39	-1.56*	5.89**	0.61*	3.95*	44.08**	-0.47**	122.15	0.01	0.014

*,** Significant at 5% and 1% levels respectively
(P1=NL 93, P2=LCK 9312, P3=EC 596A, P4=ICAR 3, P5=R 552, P6=Kiran)

Table 4. Components of gca and sca and their predictability ratios in linseed

Character	Type of gene action σ^2g	σ^2s	Predictability ratio $2\sigma^2g/2\sigma^2g+\sigma^2s$
Days to flower initiation	2.58	1.50	0.77
Days to maturity	6.58	3.75	0.78
Plant height (cm)	31.07	10.86	0.85
No. of primary branches / plant	0.02	0.42	0.08
No. of secondary branches / plant	2.01	29.87	0.16
No. of capsules / plant	144.73	1876.88	0.18
No. of seeds / capsule	0.06	0.42	0.22
No. of seeds / plant	0.01	0.001	0.92
100 seed weight (g)	17.19	65794.27	0.005
Seed yield / plant(g)	0.583	5.13	0.30

general combiner, but their cross combination proves significant for seed yield per plant. This may be due to complementary genes. Therefore, superior combination may occur even from poor combiners as well. The cross NL 93 x Kiran followed by ICAR 3 x Kiran was observed to be the good cross combination for hundred seed weight.

Thus, it appears worthwhile to exploit these crosses in hybrid breeding programmes and in fixing more number of favourable genes for seed yield and its important attributes. Also, further advancement of such crosses by using diallel selective mating or biparental matings of superior segregants in the early segregating generations would be effective in varietal improvement.

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