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GENERAL AND SPECIFIC COMBINING ABILITY STUDY FOR AGRONOMIC TRAITS IN LINSEED (*LINUM USITATISSIMUM* L.)

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ABSTRACT

The present investigation was carried out at Agricultural Research Institute, Patna Farm of Rajendra Agricultural University, Pusa, Samastipur during rabi, 2007-08 and 2008-09. The six genotypes of linseed, namely, KL 248, LCK 7035, RLC 117, RL 26018, NL 260 and Shekhar were crossed in half-diallel fashion to generate 15 F_1's during rabi, 2007-08. All the 15 F_1's, 06 parents and 02 checks were evaluated in complete randomizedb design with three replications during rabi 2008-09. The analysis of variance revealed that the GCA and SCA variances were highly significant for all the traits studied except 1000-grain weight. The estimates of GCA effects revealed that good general combiner for seed yield per plant and number of capsules per plant was Shekhar. Crosses, KL 248 x LCK7035 showed the highest significant SCA effects in positive direction for seed yield per plant followed by LCK 7035 x NL260.

Key words : *Linseed, diallel, GCA and SCA.*

Linseed (*Linum usitatissimum* L.) is an annual oilseed crop belonging to *Linaceae* family. It is an oldest domesticated and economically important industrial non-edible oilseed crop which is being cultivated for seed and its fiber since centuries. The whole plant has commercial use directly or indirectly and also has capability to substantiate the existing natural demand of oil. Linseed oil is considered to be the richest botanical source of Omega-3 among all the plants. ALA has anti-inflammatory properties and has significant effects on inflammatory and autoimmune diseases including coronary heart disease, major depression, aging, rheumatoid arthritis, Chrohn's disease and cancer (Simopoulos, 2002). Linseed oil also possesses superior drying qualities due to high linolenic acid content which render it as an indispensable ingredient in paint and varnish and other industrial products. However, low linolenic acid containing cultivars of flax have been also developed which are directly used as edible oil (Rowland,1995). The flax stem yields fibre of good quality having high strength, non-elasticity, repeated flexibility, a low density etc which make it very attractive and suitable use in textile industries. (Chauhan *et al*., 2009). Besides oil and fibre, lignin is another major compound obtained through linseed which acts as antioxidant for humans.

The success of hybridization programme depends on combining ability of parents used in crossing programme (Hallauer and Miranda, 1981). Selection of superior segregants followed by the selection of the best ones is the basic tasks of any breeding programme. To initiate an effective breeding programme, combining ability analysis is a powerful tool to identify parents with better potential to transmit desirable characteristics to the progenies and to identify the best specific crosses for yield parameters. The concept of combining ability plays a significant role in crop improvement, as it helps the breeder to study and compare the performance of the new lines in hybrids combination. It provides the base to select good combiners and also to understand the nature of gene action. It was, therefore, essential to evaluate some more lines for their various genetic parameters related to yield and its component traits in linseed. Thus, the present investigation was undertaken to study the general combining ability and mode of gene action for various important traits in linseed.

MATERIALS AND METHODS

The present investigation was carried out at Agricultural Research Institute, Patna Farm of Rajendra Agricultural University, Pusa, Samastipur during rabi, 2007-08 and 2008-09. The materials comprising of six genotypes of linseed, namely, KL 248, LCK 7035, RLC 117, RL 26018, NL 260 and Shekhar were crossed in half diallel fashion to generate 15 F_1's during rabi, 2007-08. All the 15 F_1's, 6 parents and 02 checks, Shekhar and T 397 were evaluated in complete randomized block design with three replications during rabi 2008-09. Each entry was grown in two rows of four five length with row to row spacing of 25 cm and plant to plant spacing of 05 cm, within row.

Table-1 : Analysis of variance for combining ability for eight characters in linseed.

Source of Variation	D.F.	Mean Sum of Squares							
		Days to 50% flowering	Days to 50% maturity	Number of primary branch	Number of capsules per plant	Number of Seeds per capsules	1000-grain weight	Oil percent	Grain yield per plant
GCA	7	21.842**	24.337**	4.533**	278.126**	4.524**	1.640	16.235**	6.403**
SCA	28	5.220**	20.193**	1.839*	685.242**	2.224**	1.026	1.885*	4.8595**
Error	70	0.432	1.888	0.132	25.684	0.053	0.080	0.025	0.098

Table-2 : Estimates of components of variance for combining ability for eight characters in linseed.

Source of Variation	Mean Sum of Squares							
	Days to 50% flowering	Days to 50% maturity	Number of primary branch	Number of capsules per plant	Number of Seeds per capsules	1000-grain weight	Oil percent	Grain yield per plant
ó$_{g}^{2}$	1.825	1.125	0.285	48.15	0.432	0.080	1.489	0.088
ó$_{s}^{2}$	5.594	18.123	1.801	561.05	0.288	0.883	1.022	3.025
ó$_{g}^{2}$/ ó$_{s}^{2}$	0.326	0.062	0.158	0.085	1.500	0.09	1.456	0.029

Table-3 : General combining ability (gca) effects of parental lines for nine characters in linseed.

Sl. No.	Parents	Days to 50% flowering	Days to maturity	Number of primary branch	Number of capsules per plant	Number of Seeds per capsules	1000-grain weight	Oil percent	Grain yield per plant
1.	KL 248	0.933	0.685	0.845	-4.262**	0.365	-0.326	1.586	-0.358
2.	LCK 7035	-1.268	-0.433	0.265	0.033	-0.085	0.298	-0.004	0.172
3.	RLC 117	1.668	-0.45	-0.588	8.128**	0.658	-0.236	-1.095	-0.625
4.	RL 26018	-0.558	-3.183**	-0.122	-0.679	-1.456	-0.658	-1.62	0.258
5.	NL 260	-1.343	1.398	-0.932	-5.387**	0.481	0.624	-0.716	0.118
6.	Shekhar	0.568	1.983	0.532	2.167*	0.038	0.298	1.85	0.442
	SE (gi)	0.182	0.3915	0.098	1.265	0.048	0.056	0.042	0.092

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

The recommended agronomic practices were followed to ensure a good crop. The data were recorded number of primary branches per plant, number of capsules per plant, number of seeds per capsule and grain yield per plant (g) on ten randomly selected plants from each plot of each replication. Days to 50 per cent flowering and days to 50 per cent maturity recorded on the plot basis, while 1000-grainweight (g) and oil content per cent were taken from bulk seeds of each plot of each replication. The oil content in seeds was determined by NMR.

The mean value of the recorded data was subjected to analysis of variance using the statistical analysis procedures of Panse and Sukhatme, 1985. The combining ability analysis for diallel mating design was performed according to Model-I and Method-II proposed by Griffing (1956).

RESULTS AND DISCUSSION

The analyses of variance for combining ability for all the eight characters are presented in Table-1. The analysis of variance revealed that the GCA and SCA variances were highly significant for all the traits studied except 1000-grain weight. Highly significant mean sum of squares due to general and specific combining ability (GCA and SCA) for all the characters indicated that both additive and non additive types of gene action were involved for the expression of these characters. GCA/SCA variance was less than 1.0 for days to 50 per cent flowering, days to maturity, number of primary branch, number of capsules per plant, 1000-grain weight and grain yield per plant indicated preponderance of non-additive gene effects over additive genetic effects. This ratio was greater than 1.0 for number of seeds per capsules and the per cent of oil content in the seeds, indicated preponderance of additive gene action compared to non additive gene action involving in the genetic control of these characters.

General combining ability effects (GCA) : The selection of parents based on *per-se* performance is not always good indicator of superior combining

Table-4 : Specific combining ability (sca) effects of the crosses for eight characters in linseed.

Sl. No.	Hybrids	Days to 50% flowering	Days to maturity	Number of primary branch	Number of capsules per plant	Number of seeds per capsules	1000-grain weight	Oil percent	Grain yield per plant
1.	KL 248 x LCK 7035	0.588	6.689**	2.825**	40.883**	3.474	1.890*	1.264	5.166**
2.	KL 248 x RLC 117	-0.25344	1.222	0.945	23.040**	0.034	0.490	-0.307	0.263
3.	KL 248 x Rl 26018	-0.245	-5.611**	0.125	-5.600**	-1.513	-0.486	-2.688**	0.583
4.	KL 248 x NL 260	-2.611**	-5.888**	-0.728	6.867**	-0.806	0.344	-0.475	-0.980
5.	KL 248 x Shekhar	-0.578	4.322**	-0.575	12.353**	0.480	-0.233	1.733*	1.000
6.	LCK 7035 x RLC 117	0.786	2.822**	0.045	10.433**	1.620	0.677	-0.107	1.280
7.	LCK 7035 x RL 26018	-2.616**	-2.372**	-2.341**	-15.300**	1.037	0.597	0.958	0.430
8.	LCK 7035 x NL 260	1.322	4.754**	1.268	16.100**	2.570**	0.180	1.834*	3.100**
9.	LCK 7035 x Shekhar	-4.544**	-2.834**	-0.701	-5.500**	-1.310	-1.983*	0.653	-1.680
10.	RLC 117 x RL 26018	0.289	-5.776**	-0.888	4.267**	-0.803	0.467	-0.534	-1.271
11.	RLC 117 x NL 260	-3.511**	-9.244**	-2.805**	-4.567**	-0.553	0.680	-0.053	-0.797
12.	RLC 117 x Shekhar	-2.511**	0.622	-1.077	-7.900**	0.684	0.337	0.494	-0.450
13.	RL 26018 x NL 260	-0.471	2.822**	0.882	14.800**	0.990	0.357	-0.493	1.102
14.	RL 26018 x Shekhar	0.256	-0.942	-0.905	-18.335**	-1.516	-1.883*	-1.270	-1.220
15.	NL 260 x Shekhar	-0.543	-1.178	-0.625	1.433	-0.743	0.734	-0.874	0.720
	SE (Sij)	0.581	1.235	0.279	4.520	0.184	0.122	0.103	0.216

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

parents (Allard, 1960). Hence, the GCA analyses serve as an important tool for selection of parents with highest breeding value. The parents with high general combining ability effects may be used for improvement of individual trait *per-se*. The combining ability analysis was performed to obtain information on selection of better parents and crosses for their further use in breeding programme. The estimate of GCA effects among the parents for yield and its component traits help to identify the best parent for subsequent hybrid development programme. The estimates of GCA effects (Table-3) revealed that Shekhar was found to be good general combiner for seed yield per plant and number of capsules per plant. The character wise estimation of GCA effects of parent revealed that the parents RLC 117 and NL 260 were the good general combiner for number of capsules per plant. This result indicates the preponderance of additive and additive x additive gene effects (Griffing, 1956 and Sprague and Tatum, 1942). These genotypes could be used in recombination breeding programme to accumulate their favorable genes responsible for increasing seed yield in promising pure lines (Kumar *et al.* 1994 and Nie *et al*. (1991). High GCA effects are mostly due to additive gene effects or additive x additive interaction effects (Griffing, 1956). Diallel selective mating system (Jensen, 1970) and recurrent selection schemes will be most effective breeding procedures which help in accumulating desirable alleles within the base populations. Singh *et al.* (2004) supported the role of diallel selective mating for multiple crossing which produces an elite population for selection of high yielding lines in advanced generations.

Specific combining ability effect (SCA) : Sprague and Tatum (1942) reported that the SCA effect is due to non-additive genetic proportion. The estimates of specific combining ability (SCA) effects for all the eight traits is presented in Table-4. In general, the SCA effects do not contribute tangibly in the improvement of self fertilizing crops, except where commercial exploitation of heterosis is feasible. The SCA value represents the dominance and epistatic interactions which are non-fixable in nature and related to heterosis (Griffing, 1956). Therefore, if both or one of the parents involved in the crosses with high SCA values they could be successfully exploited in varietal improvement program and expected to give superior transgressive segregants (Kumar *et al*., 1994, Nie *et al*., 1991, Mishra and Rai, 1996). The crosses, KL 248 x LCK7035 (5.166**) showed highest significant SCA effects in positive direction for seed yield per plant followed by LCK 7035 x NL260 (3.100**) The cross KL 248 x LCK7035 also exhibited significant positive SCA effects for days to maturity, number of primary branches per plant, number of capsules per plant and 1000-grain weight, indicating potential for exploiting hybrid vigour in breeding programme. Similarly, LCK 7035 x NL260 also exhibited significant positive SCA effects for days to maturity, number of capsules per plant , number of seeds per capsule and oil per cent. Crosses i.e., KL 248 x NL 260, LCK7035 x RL 26018, LCK 7035 x Shekhar, RLC 117 X NL 260 and RLC 117 x Shekhar showed significant and negative SCA effects for days to 50% flowering indicating that these crosses were the best for earliness character. These divergent crosses producing best hybrid combinations with negative SCA effects may be due to contribution of favorable alleles from their parents. For days to maturity, significant and negative SCA effects were observed in the crosses KL 248 X RL 26018,KL 248 X NL 260, LCK 7035 X RL 26018, LCK 7035 X Shekhar, RLC 117 X RL 26018, RLC 117 X NL 260 . For number of capsules per plant, crosses KL 248 X RLC 117, KL 248 X NL 260,KL 248 X Shekhar, LCK 7035 X RLC 117, LCK 7035 X NL 260, RLC 117 X RL 26018, and RL 26018 X NL 260 showed significant and positive SCA effects, indicating that these crosses were the best combinations for this trait. The cross LCK 7035 X NL 260 showed significant and positive SCA effect for oil content.

CONCLUSIONS

The estimates of GCA effects revealed that good general combiner for seed yield per plant was Shekhar. Cross, KL 248 x LCK7035 showed the highest significant SCA effects in positive direction for seed yield per plant followed by LCK 7035 x NL260. Hence, these crosses would be exploited for isolating transgressive segregants for seed yield and its related traits for genetic improvement in linseed.

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