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RESEARCH ARTICLE

Genetic variability, heritability and genetic advance of yield and quality traits in linseed (*Linum usitatissimum* L.)

■ **SHIPRA SHALINI, SOHAN RAM, SHANTI BHUSHAN AND EKHLAQUE AHMAD**

SUMMARY

The present studies were carried out with a set of eight varieties of linseed and their twenty eight F_1's obtained through diallel crossing excluding reciprocals. The eight parents and their 28 F_1s were grown in a randomised block design during *Rabi* season of 2012 and studied for fifteen quantitative and qualitative characters. The analysis of variance showed highly significant differences among the genotypes for all the characters studied except days to maturity in F_1s. The genetic co-efficient of variance was high in number of capsules per plant, linolenic acid content in F_1s. The highest value of heritability was observed in linoleic acid content among parents whereas among crosses it was the highest in case of linolenic acid. Highest genetic advance was exhibited by number of capsules per plant in case of both parents and crosses. Genetic advance expressed as per cent of mean was the highest in steric acid per cent for parent and seed yield per plant for crosses in F_1s. The traits with high heritability and high genetic advance may be subjected to mass or progeny or family selection or any selection scheme, aimed at exploiting additive (fixable) genetic variance, a widely adapted genotype can be developed, possessing good quality and high productivity.

Key Words : Linseed, Genetic variability, Heritability

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Linseed is second most important oilseed crop of *Rabi* season next to rapeseed mustard in area as well as in production. It is commonly known as flax in western countries. This crop is as old as the history of civilization. It is grown for both oil and fibre purposes. Linseed seed contains 33-47 per cent oil. Linseed is globally important crop and its production is 22.39 lacs tons from an area of 22:70 lacs ha. with an average yield of 986 kg./ha. Major growing countries are UK, USA, Argentina, Canada, Ethiopia, China etc. India is

also an important linseed growing country in the world. India ranks third in area after Canada and Kazakhstan which is almost equivalent to but in production slides to fourth place after Canada, China and Kazakhstan. As far as productivity is concerned our national average of 435 kg/ha is surpassed by almost all major linseed growing countries *viz.*, Canada (1728 kg/ha), USA (1659 kg/ha), UK (1500 kg/ha), China (1000 kg/ha) and Ethiopia (933 kg/ha). Total production of linseed in India is 1.47 lac tons from an area of 3.38 lacs ha. with an average productivity of 435 kg./ha. India contributes about 14.88 and 6.57 per cent to world area and production, respectively (Anonymous, 2015). Linseed occupies an important position in India for its technical grade vegetable oil producing ability and fibre production. About 80 per cent of the oil goes to the industries for the manufacturing of the paints, varnish. The stem yields fibre of good quality having high strength and durability. High content of linolenic acid (45-60%) in it soil is beneficial for industrial purpose while low linoenic acid content is necessary for its human consumption. Linseed oil contains alpha linolenic acid (ALA), a omega -3-fatty acid, is very important medicinal supplement for controlling the cholesterol content in human body therefore, high grain yield with better quality should be the aim of breeding programme which depends upon the choice of suitable diverse parents.

MATERIAL AND METHODS

A set of 8 parents namely Meera, Padmini, LMS-149-4, JLS-9, LMS-153-3, RLC-76, KL-221 and LC-185 and their 28 F'1S obtained through diallel crossing excluding reciprocals along with check as T-397 were sown in a Randomised Block Design with three replications in the experimental field area of Linseed Research Scheme at Birsa Agricultural University, Kanke, Ranchi during *Rabi* season of 2012-13. Each genotype was sown in one row of four meter length with row to row and plant to plant spacing of 30cm and 10cm, respectively. Recommended doses of 40 kg N, 20kg P_2O_5 and 20kg K_2O /ha were applied to raise a healthy crop. Four irrigations were applied and other recommended agronomic practices were followed for raising the crop. Observations on different yield and quality traits namely days to 50 per cent flowering, days to maturity, plant height (cm), technical height (cm), number of capsule / plant, capsule diameter (cm), number of seed / capsule, seed yield (g) / plant, 1000 seed weight (g), oil content (%), palmitic acid content (%), steric acid content (%), oliec acid content (%), linoliec acid content (%) and linolenic acid content (%) were recorded on ten randomly selected plants in parents and F_1s in each replication. Data on various variables were analyzed by analysis of variances (Panse and Sukhatme, 1967). Heritability, in narrow sense, was calculated by the formula suggested by Lush (1949) and Johnson *et al.* (1955). The genetic advance was calculated by the formula given by Lush (1949) and Johnson *et al*. (1955).

RESULTS AND DISCUSSION

The analysis of variance (Table 1) revealed highly significant differences among the genotypes for almost all the characters except days to maturity in F_1s indicating the presence of variability among treatments which is pre-requisite for any crop improvement programme. Thus, it will facilitate to identify promising line/lines from the present gene pool for yield and oil quality traits. The presence of large amount of variability might be due to diverse source of materials. The characters, plant height, technical height, number of capsules per plant, seed yield per plant and 1000-seed weight recorded a wide range in their phenotypic variation, whereas, days to 50 per cent flowering, days to maturity, number of seeds per capsules, oil content, palmitic acid content, stearic acid content, oliec acid content and linoleic acid content had narrow range of variation both in parents and crosses. The present result corroborates with the findings of Patil and Chopde (1981); Khorgade and Pillai (1994) and Kumar *et al*. (2012). In general, the values of phenotypic variance were higher than the genotypic variance for all the characters studied. In F_1s the highest value of phenotypic and genotypic variances was observed in number of capsules per plant followed by linolenic acid per cent, whereas for parents, the highest value of phenotypic and genotypic variances was observed in number of capsules per plant followed by plant height. The lowest value of genotypic as well as phenotypic variance was observed for capsule diameter in case of both parents and crosses Khorgade and Pillai (1994) also reported highest genotypic as well as phenotypic variability in number of capsule per plant. Similar type of results were also obtained by many of the workers in past such as Choudhary *et al.* (1972) and Kumar *et al*. (2012).

The phenotypic co-efficient of variation (PCV) was invariably higher than the corresponding genotypic co-

efficient of variation (GCV). Genotypic co-efficient of variation was high for number of capsules per plant in parents and linoleic acid per cent in F_1s. The lowest value of genotypic as well as phenotypic co-efficient of variance was observed for the character, capsule diameter in case of both parents and crosses. Similar findings were observed by Mirza *et al*. (1996) and Mohammadi *et al.* (2010).

The estimates of heritability for the fifteen characters ranged from 46.15 per cent for days to maturity to 99.90 per cent for linoleic acid per cent among parents, whereas among crosses it varied from 3.54 per cent for days to maturity to 99.98 per cent for linolenic acid per cent (Table 2). Among other characters, high heritability was observed for days to 50 per cent flowering, plant height, technical height, number of capsules per plant, capsule diameter, number of seeds per capsule, 1000-seed weight, seed yield per plant, oil content, palmitic acid per cent, stearic acid per cent and oleic acid per cent. Similar findings were obtained by Kumar *et al*. (2012; Pali and Mehta (2013); Reddy *et al*. (2013) and Ahmad *et al*. (2014).

The estimates of genetic advance showed large differences among all the characters studied within parents as well as crosses. In F1 generation, the highest value was recorded for number of capsule per plant (15.48) followed by linolenic acid per cent (15.27) whereas, in parents it was highest in number of capsule per plant (14.19) followed by technical height (9.16). The lowest value was observed in capsule diameter among parents as well as crosses (0.10 and 0.09), respectively.

Among parents, genetic advance expressed as per cent of mean ranged from 2.48 per cent in days to maturity to 55.41 per cent in steric acid per cent. While, among the crosses it ranged from 0.14 per cent in days to maturity to 54.51 per cent in seed yield per plant. In case of parents, the characters like technical height, number of capsule per plant, number of seeds per capsule, 1000-seed weight, palmitic acid, oleic acid, linolic acid showed higher genetic advance as per cent of mean, whereas, among the crosses also, the characters like technical height, number of capsule per plant, 1000-seed weight, palmitic acid, steric acid, oleic acid, linoleic acid and linolenic acid showed higher genetic advance as per cent of mean.

As indicated in Table 2, characters like number of capsule per plant, palmitic acid content, stearic acid content, oliec acid content, linoleic acid content, linolenic acid content, 1000 seed weight, seed yield per plant and technical height had high genetic advance as per cent of mean and also high to moderately high heritability estimates. It may be concluded then that heritability in

Table 1 : Analysis of variance for yield and yield components in linseed (*Linum usitatissimum* L.)

Source of variance	Degree of freedom	Days to 50 % flowering	Days to maturity	Plant height (cm)	Technical height (cm)	Number of capsule/ plant	Capsule diameter (cm)	Number of seeds / capsule
Replications	2	0.84	5.95	12.76	2.90	16.79	0.00	0.15
Genotypes	35	46.77***	9.84*	74.81**	43.23***	280.85***	0.01***	2.32***
Parents	7	61.09***	19.76**	107.72***	73.07***	165.88***	0.01***	8.67***
Crosses	27	43.53***	6.14	67.29***	37.05***	193.27***	0.01***	0.60***
Parent Vs. Hybrids	1	34.08**	40.35**	47.25	1.07	3450.17***	0.05***	4.23***
Error	70	3.10	5.53	17.32	3.87	6.43	0.01	0.17
Total	107	17.35	6.95	36.04	16.72	96.38	0.00	0.87

Source of variance	Degree of freedom	1000-seed weight (g)	Seed yield per plant	Oil content (%)	Palmitic Acid(%)	Steric Acid(%)	Oliec acid (%)	Linoleic acid (%)	Linolenic acid (%)
Replications	2	0.02	0.03	0.06	0.01	0.01	0.08	0.00	0.00
Genotypes	35	3.61***	3.14***	34.33***	5.05***	21.98***	34.86***	7.03***	139.85***
Parents	7	4.38***	0.29***	13.76***	2.53***	7.97***	27.71***	11.66***	16.90***
Crosses	27	2.54***	3.05***	40.84***	5.82***	18.20***	23.96***	5.86***	164.87***
Parent Vs.Hybrids	1	27.10***	25.46***	2.37**	2.01***	222.06***	379.19***	6.21***	325.15***
Error	70	0.04	0.05	0.22	0.01	0.01	0.48	0.00	0.01
Total	107	1.21	1.06	11.37	1.66	7.19	11.72	2.30	45.75

*, ** and *** indicate significance of values at P≤0.05, 0.01 and 0.001, respectively

Table 2 : Mean, range, genotypic and phenotypic variances, genotypic and phenotypic co-efficient of variation, heritability and genetic advance as per cent of mean for yield and quality traits in linseed (*Linum usitatissimum* L.)

Sr. No.	Characters		Mean	Range	σ^2g	σ^2p	PCV	GCV	h^2 (%) (Broad sense)	Genetic advancement	Gen. adv as % of mean
1.	Days to 50% flowering	P	74.38	75.00-82.33	19.33	22.43	30.16	25.99	86.18	8.41	11.30
		C	73.02	67.33-83.00	13.48	16.58	22.70	18.46	81.30	6.82	9.34
2.	Days to maturity	P	122.96	119.00- 127.00	4.74	10.28	8.36	3.86	46.15	3.05	2.48
		C	124.43	119.67-126.67	0.20	5.74	4.61	0.16	3.54	0.18	0.14
3.	Plant height (cm)	P	56.63	51.59-69.82	30.13	47.45	83.79	53.21	63.50	9.01	15.91
		C	58.22	51.02-72.57	16.66	33.98	58.36	28.62	49.03	5.89	10.11
4.	Technical height (cm)	P	30.68	26.87-41.87	23.07	26.93	87.78	75.19	85.65	9.16	29.85
		C	30.44	26.15-41.17	11.06	14.93	49.03	36.33	74.10	5.90	19.37
5.	Number of capsule/ plant	P	46.42	39.00- 63.00	53.15	59.58	128.34	114.50	89.22	14.19	30.56
		C	60.01	42.67-76.67	62.28	68.71	114.49	103.78	90.65	15.48	25.79
6.	Capsule diameter (cm)	P	0.70	0.58-0.76	0.00	0.00	0.47	0.39	82.56	0.10	13.98
		C	0.75	0.66-0.84	0.00	0.00	0.38	0.30	79.69	0.09	11.67
7.	Number of seeds/ capsule	P	9.00	6.00- 11.00	2.83	3.00	33.34	31.48	94.43	3.37	37.44
		C	9.48	8.67-10.33	0.14	0.31	3.28	1.51	46.16	0.53	5.59
8.	1000-seed weight (g)	P	7.20	5.22-8.59	1.45	1.49	20.69	20.09	97.12	2.44	33.91
		C	8.41	6.54- 10.26	0.83	0.88	10.42	9.91	95.10	1.83	21.81
9.	Yield/plant	P	2.53	1.99-3.04	0.08	0.13	5.00	3.16	63.25	0.46	18.32
		C	3.70	2.45-6.05	1.00	1.05	28.36	27.11	95.57	2.02	54.51
10.	Oil content (%)	P	38.90	34.62-41.70	3.80	4.02	10.32	9.76	94.57	3.90	10.03
		C	39.26	33.53-44.84	12.82	13.04	33.22	32.66	98.33	7.32	18.63
11.	Palmitic acid content (%)	P	6.88	5.21-7.81	0.84	0.85	12.28	12.21	99.39	1.88	27.36
		C	7.21	5.95-10.63	1.94	1.94	26.93	26.86	99.74	2.86	39.71
12.	Stearic acid content (%)	P	6.05	3.80-9.33	2.65	2.65	43.94	43.86	99.81	3.35	55.41
		C	9.50	5.25-13.05	6.06	6.07	63.88	63.83	99.91	5.07	53.37
13.	Oliec acid content (%)	P	28.31	24.62-33.92	9.08	9.56	33.75	32.06	94.99	6.05	21.37
		C	23.80	19.44-31.57	7.83	8.31	34.90	32.83	94.24	5.60	23.51
14.	Linoleic acid content (%)	P	12.32	9.59-15.13	3.89	3.09	31.57	31.54	99.90	4.06	32.95
		C	12.90	10.76-16.49	1.95	1.96	15.17	15.14	99.81	2.88	22.30
15.	Linolenic acid content (%)	P	48.72	45.23-51.74	5.63	5.64	11.58	11.56	99.85	4.89	10.03
		C	52.89	44.33-65.27	54.95	54.96	103.92	103.90	99.98	15.27	28.87

these characters might be due to additive effect of genes. On the other hand, high heritability associated with lower genetic advance shown by days to 50 per cent flowering and oil content in the present study may be because of preponderance of non-additive gene action. Other characters like days to maturity and number of seeds per capsule had low genetic advance as well as heritability estimates. The result obtained corroborates with the findings of Patil and Chopde (1981); Mishra and Yadav (1999); Akbar *et al.* (2003); Bhataria *et al.* (2006); Belate *et al.* (2013) and Sahu *et al.* (2014).

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