
RESEARCH ARTICLE

Genetic and association studies in Linseed (*Linum utitatissimum* L.)

R.B. Gudmewad, A.M. Misal, M. K. Ghodke and M. V. Dhuppe

Oilseeds Research Station, Latur, VNMKV, Parbhani-431 402, Maharashtra, India.

Corresponding authors email Id: drammisal15@gmail.com

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Abstract

The present investigation is carried out for evaluation of promising germplasm lines for genetic variability, correlation and path analysis for yield and yield contributing characters in linseed. Estimates of genotypic and phenotypic coefficient of variation indicated significant variability for the traits seed yield per plant, 1000 seed weight, number of capsule per plant, number of secondary branches per plant indicating good scope for genetic improvement of these traits. High heritability coupled with high genetic advance for days to 50 percent flowering, plant height, number of primary branches per plant, number of secondary branches per plant, number of capsule per plant, 1000-seed weight indicating prevalence of fixable type of genetic variation for the expression of these characters. Hence direct selection is highly rewarding in the material. Further significant positive correlation of seed yield per plant existed with number of primary branches per plant, secondary branches per plant, number of seed per capsule, 1000-seed weight and negative association with days to maturity allowed selection of the material for the same. Yield contributing characters like number of seed per capsule, number of capsule per plant, 1000-seed weight, number of primary branches per plant, plant height had highest direct positive effect on seed yield followed by number of

secondary branches per plant. Based on the studies of association and path effects it can be suggested that the traits number of capsule per plant, 1000-seed weight, number of secondary branches per plant, number of seed per capsule and plant height are the major determinants of seed yield. The germplasm accession ES-1444, Flate-C-16, ES-1474 may be used as parent's in future breeding programme for improving seed yield in linseed.

Key words: Linseed, correlation, path analysis, heritability, yield

Introduction

Linseed (*Linum utitatissimum* L) is an important oilseed and fiber crop in India. In India its area is limited to 338 thousand hectares and production 147 thousand tons with the productivity of 434.91 kg per hectare, (Anonymous 2013). Development of a variety with desired attribute depends upon the genetic makeup of material available. Selection based on phenotypic expression does not often lead to expected genetic advance mainly due to undesirable association between the component characters at genotypic level. The genetic variability studies provide basic information regarding the genetic properties of population based on which breeding methods are formulated for further improvement of the crop. In linseed on the basis of growth habit, two

types (long stemmed and short stemmed) are recognized. Long stem linseed produces a high quality fiber but the oil content of the seed is relatively low. On the other hand, short-stemmed linseed bears larger seeds with high oil content and has a branching tendency. The measurement of genetic variation and mode of inheritance of quantitative and qualitative traits are of prime importance in planning the breeding programme efficiently and effectively (Shah et al., 2015). Heritability of any trait depends upon genetic properties of breeding material and environmental conditions in which experiments are carried out (Falconer and Mackay, 1996).

Grain yield is a complex character and its appearance mainly depends upon the interaction of numerous traits. A clear picture of contribution of each component in final expression of complex character would emerge through the study of correlations and path coefficient analysis revealing different ways in which component attributes influence the complex trait (Savita et al., 2011). In order to achieve the goal of increased production by increasing the yield potential of the crop, knowledge of direction and magnitude of association between various traits is essential for plant breeders (Iqbal et al., 2013). Hence, keeping all above parameters in mind the current research was carried out to study the variability study and to study the association of grain yield and its related attributes.

Material and methods

The present investigation programme was undertaken at oil seed research station, Latur during rabi 2012. The experimental material utilized for present investigation consisting 100 germplasm lines of linseed collected from Project Coordinating Unit (PCU) Kanpur, and five checks were sown in augmented blocks. single row plot of 3m length consisting five block and all the checks were repeated in all the blocks i.e. 100 plus 5 checks.

Five plants were selected from each treatment randomly for recording observations. Average value of each character was determined from these observation plants for each treatment. The observations were recorded on days to 50 % flowering, days to maturity, plant height (cm), number of primary and secondary branches per plant, number of capsules per plant, number of seeds per capsule, 1000-seed weight (g), oil content (%), and seed yield per plant (g). The main value of all the treatments for the characters under study was worked out. Standard error and critical difference at 1 and 5 per cent level of significance was calculated by using the standard formula (Panse and Sukhatme, 1985). Various parameters of genetic variability were calculated by using the following formula

$$1. \text{ Genotypic variance } (\sigma^2_g) = \frac{\text{Treatment MSS} - \text{Error MSS}}{\text{Number of replications}}$$

$$2. \text{ Phenotypic variance } (\sigma^2_p) = \text{Genotypic variance} + \text{error variance}$$

The genotypic and phenotypic coefficient of variation (GCV and PCV) was calculated (Burton, 1953)

$$3. \text{ Genotypic coefficient of variation (GCV)} = \frac{\sqrt{\sigma^2_g}}{\bar{X}} \times 100$$

$$4. \text{ Phenotypic coefficient of variation (PCV)} = \frac{\sqrt{\sigma^2_p}}{\bar{X}} \times 100$$

Where,

$$\sigma^2_g = \text{genotypic variance}$$

$$\sigma^2_p = \text{phenotypic variance}$$

$$\bar{X} = \text{General mean of character}$$

The expected genetic advance in percentage of mean was calculated as,

$$\text{EGA} = \frac{\text{GA}}{\bar{X}} \times 100$$

Where,

EGA = expected genetic advance

GA = genetic advance

$\bar{X}$ = general mean of character

Heritability (broad sense) was calculated according to the method suggested by Allard (1960). The genetic advance at 5 percent selection intensity was calculated for each character using the formula suggested by Johnson *et al.*, (1955). Covariance was calculated for all the characters to find out correlation among the characters. The inter relationship of different yield contributing characters was worked out according to Johnson *et al.*, (1955). Path coefficient analysis was carried out according to Dewey and Lu (1959).

Results and discussion

The present investigation was undertaken with an object to evaluate the variability, correlation and path coefficient for yield and yield contributing traits in the selected germplasm of linseed in respect of ten quantitative characters. The genetic variability studies provide basic information regarding the genetic properties of population based on which breeding methods are formulated for further improvement of the crop. These studies are also helpful to know about the nature and extent of the crop to environmental influences. In present study wide range of variation was observed for yield and yield component characters based on mean performance (Table not shown). The germplasm accession Flate- C-16 for early flowering, maturity, number of primary branches, seed yield. ES-1444 for number of secondary branches, number of capsule per plant, number of seed capsule and seed yield. ES-14600 for 1000-seed weight and seed yield. ES-1474 for number of primary branches, number of secondary branches and numbers of seed per capsule were promising for seed yield and yield contributing characters.

Analysis of variance (Table1) showed significant differences among the germplasm lines for these characters viz., 1000-seed weight, plant height, number of capsule per plant, days to maturity, seed yield per plant, number of secondary branches per plant, days to 50 percent flowering and number of primary branches per plant, except number of seed per capsule and oil content. Similar result also reported by Dubey *et al.*, (2006) and Tadesse *et al.*, (2010). This indicates the presence of wide range of variability among germplasm lines for yield and its contributing characters and selection can be effective for another traits in respect of germplasm studied.

The genotypic and phenotypic variances (Table 2 and Fig 1) for days to 50 percent flowering, plant height and number of capsule per plant are almost equal and hence environment did not exert masking influence on the expression of genetic variability for these traits. These results are in agreement with earlier reports of Verma and Sinha (1993).

The phenotypic coefficient of variation were of high magnitude for number of primary branches per plant, number of secondary branches per plant, number of capsule per plant and 1000-seed weight. The similar result also reported by Chandrashekhar *et al* (1998). Comparison of relative magnitude of genetic coefficient of variation among germplasm lines revealed that maximum amount of genetic variability was observed for seed yield per plant (12.098%), number of capsule per plant (17.298%), number of primary branches per plant (11.792%), no. of secondary branches per plant (17.673%) and 1000 seed weight (11.195%). This indicates good scope for the genetic improvement of these traits. Similar results were reported by Verma and Sinha (1993) and Chandrashekhar *et al.*, (1998).

High heritability coupled with high genetic advance for days to 50 percent flowering, plant height, number of primary branches per plant,

number of secondary branches per plant, number of capsule per plant, 1000-seed weight indicating prevalence of fixable type of genetic variation for the expression of these characters (Table 2 and Fig 2). Hence, direct selection is highly rewarding in the material. Further significant positive correlation of seed yield per plant existed with number of primary branches per plant, secondary branches per plant, number of seed per capsule, 1000-seed weight, and negative association with days to maturity allowed selection of the material for the same (Table 3). The revealed that significant positive association of seed yield per plant existed with number of primary branches per plant (0.363), number of secondary branches per plant (0.317), number of seed per capsule (0.235) and 1000 seed weight (0.319) where as it was negative with days to 50 percent flowering which allows early flowering. These results are in conformation with Muhammad Akbar *et al.*, (2001), Savita *et al.*, (2011), Tadele Tadesse *et al.*, (2010). Days to 50 percent flowering was positively and significantly associated with days to maturity and plant height, and it has recorded negative significant association with number of secondary branches per plant and 1000-seed weight (Table 3). Plant height was significantly and positively associated with number of capsule per plant. Further number of primary branches per plant was positively and significantly associated with number of secondary branches per plant. Number of capsule per plant exhibited positive and highly significant association with number of seed per capsule. Similar report also reported by Savita *et al.*, (2011). Plant height had positive but non significant correlation with number of secondary branches per plant, number of seed per capsule and yield per plant. Similar result also reported by Muhammad Akbar *et al.*, (2001). Number of seed per capsule was positively and significantly associated with seed yield per plant and oil content positively non significant with seed

yield per plant. Same result was reported by Muhammad Akbar *et al.*, (2001). The result of path coefficient analysis revealed that the character plant height (0.114), number of primary branches per plant (0.267), number of seed per capsule (0.193) and 1000 seed weight (0.282) had highest direct effect on seed yield followed by number of secondary branches per plant (0.050). The above results are confirming with the finding of Singh (1980). Thus, in order to increase seed yield, attributes like number of capsule per plant, number of seed per capsule, number of secondary branches per plant, 1000-seed weight, maturity- plant height seems to be most important traits.

The result of path coefficient analysis (Table 4) revealed that the character plant height (0.114), number of primary branches per plant (0.267), number of seed per capsule (0.193) and 1000 seed weight (0.282) had highest direct effect on seed yield followed by number of secondary branches per plant (0.050), number of capsule per plant (0.084) and oil content (0.072) confirming the positive association and are the major determinants of seed yield. The above results are confirming with the finding Singh (1980). The plant height had positive direct effect on seed yield as well as positive association with seed yield. Their indirect effect via days to 50 percent flowering, number of primary branches per plant, 1000-seed weight and oil content. The similar result was reported by Tadele Tadesse *et al.*, (2010).

In conclusion yield contributing characters like number of seed per capsule, number of capsule per plant, 1000-seed weight, number of primary branches per plant, plant height had highest direct positive effect on seed yield followed by number of secondary branches per plant. Based on the studies of association and path effects it can be suggested that the traits number of capsule per plant, 1000-seed weight, number of secondary branches per plant, number of seed per capsule and plant height are the major

determinants of seed yield. The germplasm accession ES-1444, Flate-C-16, ES-1474 may be used as parent's in future breeding programme for improving seed yield in linseed.

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Table 1: Analysis of variance for yield and yield contributing characters

Source of variation	d. f.	Mean sum of squares									
		Days to 50% flowering	Days to maturity	No. of branches /plant		Plant height (cm)	No. of capsules /plant	No. of seed / capsule	1000-seed weight (g)	Seed yield/ Plant (g)	Oil content (%)
				Primary	Secondary						
		1	2	3	4	5	6	7	8	9	10
Block	4	1.640	4.540**	0.082	0.980	0.340	2.325*	0.400	0.159	1.825	7.344*
Treatment	104	35.851**	28.822**	1.121	14.269**	42.905**	55.814**	1.631*	2.595**	7.769**	3.820**
Error	16	2.890	10.665	0.082	0.830	2.965	2.075	0.450	0.164	1.075	0.164

* and ** indicates significance at 5 and 1 per cent level respectively

Table 2: Parameters of genetic variability for yield and yield contributing characters

Sr. No	Character	Range	General mean	Genotypic variance (σ^2_g)	Phenotypic variance (σ^2_p)	GCV	PCV	Heritability (%)	GA	EGA
1	Days to 50% Flowering	42-67	55.065	6.592	9.482	4.663	5.592	69.5	4.410	8.009
2	Days to maturity	85-113	98.592	3.631	14.296	1.933	3.835	25.4	1.978	2.007
3	Plant height (cm)	28-53	40.440	7.988	10.953	6.989	8.184	72.9	4.972	12.295
4	No. of Primary Branch/pt	2-7	3.990	0.221	0.236	11.792	12.172	93.9	0.939	23.532
5	No. of Secondary Branch/plant	3-20	9.277	2.688	3.518	17.673	20.220	76.4	2.952	31.820
6	No. of capsule / plant	10-34.10	18.952	10.748	12.823	17.298	18.894	83.8	6.183	32.624
7	No. of seed / cap.	5.60-9.20	7.743	0.157	0.607	5.119	10.063	25.9	0.415	5.364
8	1000 seed wt(gm)	4.16-8	6.229	0.486	0.650	11.195	12.946	74.8	1.242	19.943
9	oil content(%)	33.20-41.66	38.032	0.459	1.987	1.781	3.706	23.1	0.670	1.762
10	seed yield/ plant(gm)	4.70-15.30	9.200	1.239	2.314	12.098	16.534	53.5	1.678	18.236

Table 3: Correlation coefficient of yield with yield contributing characters

Sr. no.	Characters	Dy to 50% flowering	Days to maturity	Plant height (cm)	No. of Primary Branch/plant	No. of secondary branch/plant	No. of capsule / plant	No. of seed / capsul	1000-seed weight (g)	Oil content (%)	Seed yield/ plant (g)
1	Days to 50% flowering	1.000	0.576**	0.252*	-0.195	-0.246*	0.024	-0.051	-0.367**	-0.173	-0.231*
2	Days to maturity		1.000	0.033	-0.091	-0.071	0.005	-0.097	-0.311**	-0.044	-0.121
3	Plant height (cm)			1.000	-0.004	0.011	0.323**	0.114	-0.061	-0.024	0.117
4	No. of primary branch/plant				1.000	0.715**	-0.029	-0.004	0.174	-0.010	0.363**
5	No. of secondary branch/ plant					1.000	-0.007	0.109	0.114	-0.010	0.317**
6	No. of capsule / plant						1.000	0.578**	-0.094	0.024	0.197
7	No. of seed / capsule							1.000	-0.115	0.145	0.235*
8	1000 seed weight								1.000	0.055	0.319**
9	Oil content									1.000	0.129
10	Seed yield/ plant										1.000

* and ** indicates significance at 5 and 1 per cent level respectively

Table 4: path analysis of direct and indirect effects of different quantitative characters

Sr. No.	Characters	Days to 50% Flowe-ring	Days to maturity	Plant height (cm)	No. of Primary Branch / plant	No. of Second-ary Branch / plant	No. of capsule / plant	No. of seed / capsule	1000-seed weight (g)	Oil content (%)	Seed yield/ plant
1	Days to 50% flowering	-0.116	0.045	0.029	-0.052	-0.012	0.002	-0.010	-0.104	-0.013	-0.231*
2	Days to maturity	-0.067	0.079	0.004	-0.024	-0.004	0.000	-0.019	-0.088	-0.003	-0.121
3	Plant height (cm)	-0.029	0.003	0.114	-0.001	0.001	0.027	0.022	-0.017	-0.002	0.117
4	No. of Primary Branch/plant	0.023	-0.007	0.000	0.267	0.035	-0.002	-0.001	0.049	-0.001	0.363**
5	No. of Secondary Branch/ plant	0.029	-0.006	0.001	0.191	0.050	-0.001	0.021	0.032	-0.001	0.317**
6	No. of capsule / plant	-0.003	0.000	0.037	-0.008	0.000	0.084	0.112	-0.026	0.002	0.197
7	No. of seed / capsule	0.006	-0.008	0.013	-0.001	0.005	0.048	0.193	-0.032	0.010	0.235*
8	1000 seed wt	0.043	-0.025	-0.007	0.046	0.006	-0.008	-0.022	0.282	0.004	0.319**
9	Oil content	0.020	-0.003	-0.003	-0.003	-0.001	0.002	0.028	0.015	0.072	0.129

Residual effect = 0.834; $R^2 = 0.304558$

* and ** indicates significance at 5 and 1 per cent level respectively

Fig1: Genotypic and phenotypic coefficient of variation

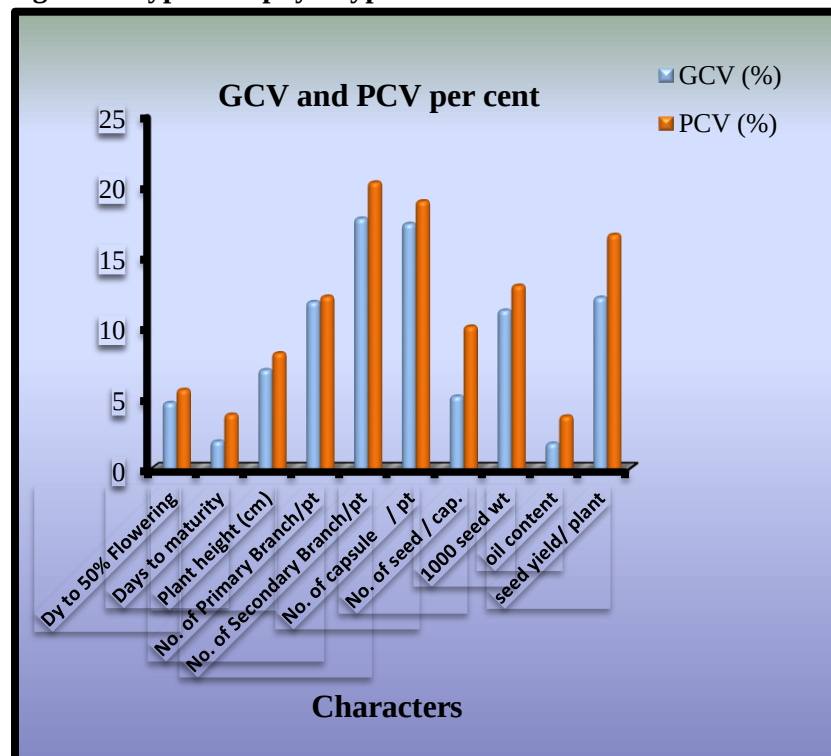


Fig2: Heritability and genetic advance

