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Genetic variability for quantitative trait in linseed (*Linum usitatissimum* L.)

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Abstract
The present investigation was conducted to estimate the extent of genetic variability, heritability and genetic advance. The experimental material comprising of 31 genotypes were evaluated at Experimental farm Department of Agril. Botany, College of Agriculture, Latur during *Rabi*- 2021- 2022. The material was sown in randomized block design with two replications, on 29th of October, 2021 with the spacing of 30 cm x 5 cm. Observations were recorded for ten characters *viz.*, days to 50% flowering, days to maturity, plant height (cm), number of primary branches, number of secondary branches, number of capsule per plant, number of seed per capsule, 1000-seed weight, oil content (%) and seed yield per plant. Substantial amount of genetic variability had been found for all the characters, which was indicated by significant difference among and between treatments. The mean performance of the genotypes confirmed higher seed yield per plant for EC- 41741, JLS- 395, ES- 1445, EI-5511 and FR- 111. The genotype EC-41741 recorded best mean values in desirable direction for seed yield per plant, 1000 seed weight, number of primary branches per plant and number of capsule per plant. Genotypes like JLS- 395 and ES-1445 were also seen promising for the characters like days to 50% flowering, days to maturity, plant height, number of primary branches per plant, capsule per plant, 1000 seed weight and oil content in the desired direction. The estimates of GCV and PCV were recorded high for seed yield per plant, number of primary branches, number of capsule per plant, number of secondary branches and 1000 seed weight. Higher heritability estimates were observed for all the traits under the study. However, high genetic advance as percent of mean was noted for number of capsule per plant, plant height (cm), days to maturity, and number of secondary branches. Whereas moderate for days to 50% flowering, oil content, seed yield per plant and number of primary branches, were the characters number of seed per capsule, and 1000- seed weight is low.

Keywords: Linseed, variability, heritability, genetic advance, GCV, PCV

Introduction
Linseed (*Linum usitatissimum* L.) is one of the most significant *Rabi* oilseed crops after rapeseed and mustard. Its origins can be traced back to the Mediterranean and southwest Asian regions (Vavilov, 1935) [10]. Linseed is a self- pollinated annual herbaceous crop. It belongs to the Malpighiales order, the genus Linum, and the Linaceae family. Linnaeus gave the botanical name *Linum usitatissimum* in his book "Species Plantarum." Usitatissimum is a Latin word that means "most beneficial." (Linnaeus, 1857) [5]. There are 290 species in the Linum genus, however only a few are edible "*Linum usitatissimum* L" is economically significant. Linseed has a somatic chromosomal number of 2n = 30 and comes in a variety of colours "Other species range from 16 to 86" in length.
Linum usitatissimum is the only economically important species in the Linum genus having semi-dehiscent and non-dehiscent capsules. (Savita *et al.* 2011) [7]. Linseed is a valuable oil and fibre crop. The seed has a high amount of oil, ranging from 33 to 45 percent, and a crude protein content of 24% in different kinds. Its medicinal and nutritional characteristics have paved the way for a wide range of applications and value additions. Higher order linolenic acid (an essential poly unsaturated omega-3 fatty acid) is the greatest in the plant kingdom, and its seed contains complete protein (rich in eight essential amino acids). Linseed is the best source of omega-3 fatty acids, which are necessary because they cannot be manufactured by the body and must be obtained through food.

Materials and Methods
The experiment material comprised of 31 germplasm lines of linseed collected from P.C. unit Kanpur (Uttar Pradesh) and AICRP Linseed PDKV, Nagpur (Maharashtra), were used to study genetic variability among the genotypes for quantitative characters.

The details of the experimental materials used are given in Table 1.

The field experiment was conducted on the field of Department of Agriculture Botany, College of Agriculture, Latur. Experimental materials comprising 31 germplasm lines (including check) with wider variability for different characters.

Table 1: List of germplasm lines and their sources

Sr. No.	Genotypes	Source
1.	ES- 1445	P.C. Unit, Kanpur.
2.	EC- 1066	P.C. Unit, Kanpur.
3.	EC- 1463	P.C. Unit, Kanpur.
4.	EC- 41623	P.C. Unit, Kanpur.
5.	EC- 41741	P.C. Unit, Kanpur.
6.	EC- 16381	P.C. Unit, Kanpur.
7.	EC- 15888	P.C. Unit, Kanpur.
8.	EC- 99001	P.C. Unit, Kanpur.
9.	GS- 66	P.C. Unit, Kanpur.
10.	GS- 68	P.C. Unit, Kanpur.
11.	GS- 82	P.C. Unit, Kanpur.
12.	GS- 15	P.C. Unit, Kanpur.
13.	GS- 09	P.C. Unit, Kanpur.
14.	GS- 30	P.C. Unit, Kanpur.
15.	GS- 40	P.C. Unit, Kanpur.
16.	FR- 111	P.C. Unit, Kanpur.
17.	GS- 20	AICRP Linseed PDKV, Nagpur.
18.	GS- 109	AICRP Linseed PDKV, Nagpur.
19.	GS- 61	AICRP Linseed PDKV, Nagpur.
20.	GS- 64	AICRP Linseed PDKV, Nagpur.
21.	EI- 511	AICRP Linseed PDKV, Nagpur.
22.	ES- 14230t	AICRP Linseed PDKV, Nagpur.
23.	ES- 1462	AICRP Linseed PDKV, Nagpur.
24.	ES- 1476	AICRP Linseed PDKV, Nagpur.
25.	ES- 1534	AICRP Linseed PDKV, Nagpur.
26.	TL- 99	AICRP Linseed PDKV, Nagpur.
27.	JLS- 395	AICRP Linseed PDKV, Nagpur.
28.	NL- 356	AICRP Linseed PDKV, Nagpur.
29.	Ruchi	AICRP Linseed PDKV, Nagpur.
30.	Mutant- 05	AICRP Linseed PDKV, Nagpur.
31.	NL- 97	AICRP Linseed PDKV, Nagpur. (Check)

Table 2: Analysis of variance (ANOVA) for different characters in Linseed

Sources of Variation	D.F.	Mean sum of squares									
		Days to 50% flowering	Days to maturity	Plant height (cm)	No. of Primary branches per plant	No. of Secondary branches per plant	Number of capsules per plant	Number of seeds per capsule	Test weight (g)	Oil content (%)	Yield per plant (g)
Replications	1	0.25	0.25	1.48	0.19	0.74	2.64	0.07	0.35	0.15	0.14
Genotypes	30	32.15**	49.46**	71.10**	2.60**	30.94**	610.53**	0.85**	2.78**	3.98**	2.69**
Error	30	0.95	1.42	0.80	0.05	0.34	3.48	0.01	0.15	0.06	0.05

*and **, indicates significance at 5% and 1% respectively

Table 3: Estimates of variability parameters for ten quantitative characters in linseed

Sr. No.	Name of the Character	Range	Mean	GV (σ^2g)	PV (σ^2p)	EV (σ^2e)	GCV	PCV	ECV	Heritability (%)	Genetic advance (1%)	Genetic advance % mean
1	Days to 50% flowering	49.00-64.50	52.50	15.59	16.55	0.95	7.13	7.35	1.76	94.00	10.12	18.29
2	Days to maturity	98.50-17.50	107.2 2	24.01	25.44	1.42	4.57	4.70	1.11	94.00	12.57	11.72
3	Plant height(cm)	34.50-67.00	57.39	35.15	35.95	0.80	10.33	10.44	1.56	97.00	15.47	26.96
4	No. of Primary Branches per plant	0.10-5.10	3.06	1.27	1.33	0.05	36.77	37.59	7.77	95.00	2.91	94.99
5	No. of Secondary Branches per plant	9.60-25.80	16.64	15.29	15.64	0.34	23.50	23.76	3.54	97.00	10.21	61.35
6	No. of Capsules per plant	20.30-97.10	48.96	303.52	307.00	3.48	35.58	35.78	3.81	98.00	45.73	93.40
7	No. of Seed per capsule	6.60-9.50	8.09	0.41	0.43	0.01	7.97	8.13	1.61	96.00	1.67	20.63
8	1000 seed wt (g)	5.23-9.64	7.03	1.31	1.46	0.15	16.29	17.20	5.51	89.00	2.86	40.75
9	Oil content (%)	31.40-36.93	33.97	2.96	2.02	0.06	4.12	4.18	0.73	97.00	3.64	10.71
10	Seed yield per plant (g)	1.03-5.13	2.76	1.32	1.37	0.05	41.53	42.38	8.46	96.00	2.97	107.43

Results and Discussion

Analysis of variance showed significant differences among the genotypes for all characters *viz*. days to 50 percent flowering, days to maturity, plant height, primary branches, secondary branches, number of capsule per plant, number of seed capsule per capsules, 1000 seed weight and oil content which is shown in Table 2. Which indicates the presence of wide range of variability among genotypes for yield and its contributing characters and selection can be effective for another trait in respect of genotypes studied. Similar result also reported by Gudmewad *et al*. (2016) [3], Choudhary *et al*. (2017). The analysis of variance showed that there were significant differences among the genotypes for all the traits. This indicates the existence of considerable genetic variability for selection and breeding in the existing material. Similar results reported by Paul *et al*. (2017) [6], Kumar *et al*. (2017) [4], Choudhary *et al*. (2017).

High heritability coupled with high genetic advance as a percent of means would give a more reliable index of selection value. It was observed for days to 50% flowering (94.00%, 17.69% respectively), number of primary branches per plant (95.00%, 77.73% respectively), number of secondary branches per plant (97.00, 35.43%) number of capsules per plant (98.00%, 38.12% respectively), number of seed per capsule (96.00%, 16.17%), 1000 seed weight (89.00, 55.17% respectively) and seed yield per plant (96.00%, 84.67% respectively) indicating that simple selection could be effective for improving these characters. Similar, results observed by Singh *et al.* (2014) Tyagi *et al*. (2014) [9]. The importance of non-additive gene action is indicated by high heritability and poor genetic progress for days to maturity, plant height, number of seeds per capsule, and oil content, suggesting that direct selection for these traits may not be effective.

On the basis of mean, higher estimates of genetic advance were observed in number of capsules per plant (45.73) followed by plant height (15.47) and days to maturity (12.57). Estimated values for genetic advance were least for 1000 seed weight (2.86) among all other characters. On the basis of mean, genetic advance as percent of mean showed higher values for seed yield per plant (107.71%) followed by number of branches per plant (94.99%) and number of capsules plant (93.40%) and showed lower values for oil content (10.71%).

Conclusion

The broad sense heritability estimates were high for days to 50% flowering, days to maturity, plant height, number of primary branches, number of secondary branches, number of capsules per plant, number of seed per capsules, 1000 seed weight, oil content and seed yield per plant whereas, moderate estimates of heritability were observed for number of seeds per capsules. High heritability coupled with high genetic advance as percent of mean for days to 50% flowering, plant height, number of primary branches, number of capsules per plant, 1000 seed weight and seed yield per plant indicating simple selection could be effective for improving these characters.

The genotypic and phenotypic coefficients of variation were observed to be high for seed yield per plant (41.53 and 42.53 respectively) followed by number of primary branches per plant per (36.77 and 37.59 respectively), number of capsules per plant (35.58 and 35.78 respectively) there by indicate the good scope for genetic improvement of these characters by selection.

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