Environment & Ecology 36 (1) : 127—132, January—March 2018
Website: environmentandecology.com ISSN 0970-0420

Assessment of Variability and Heritability in Linseed (*Linum usitatissimum* L.) Germplasm under Rainfed Conditions

Mitali Mishra, Shailesh Marker

Received 17 August 2017 ; Accepted 19 September 2017 ; Published on 9 October 2017

Abstract The present investigation consists of 16 genotypes of linseed including one check grown during *rabi* 2014-2015 following RBD with three replications. The datas were recorded on 9 characters. Based on the mean performance RLC-156 and PKDL-162, were identified as best genotype for grain yield per plant. Highly significant variation was obtained for all characters studied. The difference between PCV and GCV was low for most of the characters indicating little influence of environment. Whereas, high genetic advance was observed for seed yield per plot. High heritability was observed for all characters. High heritability show scope of genetic improvement of these characters through selection. Similar results owing to greater contribution of additive genetic component in the inheritance of these attributes. This indicates that, if these traits 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 could be developed, possessing good quality and productivity.

Keywords Linseed (*Linum usitatissimum* L.), Genetic variability, Genetic advance, GCV (Genotypic coefficient of variation), PCV (Phenotypic coefficient of variation).

Mitali Mishra*, Shailesh Marker
Department of Genetics and Plant Breeding, Sam Higginbotton University of Agriculture, Technology & Sciences Allahabad 211007, India
e-mail: mishra.mitali1992@gmail.com
*Correspondence

Introduction

Linseed (*Linum usitatissimum* L., $2n = 30$) is a diploid and self-pollinated species of *Linaceae* family. This genus comprises mostly herbs and shrubs in tropical and subtropical region. It is an important oilseed crop grown both for seed oil and stem fiber. It is an industrial oilseed crop and its each and every part has commercial and medicinal importance. It is native to the region extending from the eastern Mediterranean to sub-continent and was probably first domesticated in the Fertile Crescent. Linseed was extensively cultivated in ancient Ethiopia and ancient Egypt.

The seed contains 33 to 47% oil and 24% crude protein. Richest source of omega–3 fatty oil which is thought to be helpful in decreasing cholesterol level when included in the diet chain [1]. The oil is edible with lower cholesterol, contains of linoleic and Alfa linoleilic acid, short chain poly unsaturated fatty acid, soluble and insoluble fibers, proteins and array of antioxidants [2]. Due to its quick drying property it is used for the preparation of paints, varnishes, printing ink, oil cloth, soap, patent leather and waterproof fabrics. The oil cake is a most valuable feeding cake which is good in taste and contains 36% protein. Important flaxseed growing countries are Canada, China, US, India and Ethiopia. Canada is the world's largest producer with 0.42 million tones accounts for nearly 80% of world trade in flaxseed [5]. India ranks 4th with 0.15 million tones of total flaxseed production [4].

India ranks first in terms of area under linseed cultivation and third in production in the world. In India, Madhya Pradesh leads in yield and acre age, followed by Orissa, Jharkhand, Chhattisgarh, Uttar Pradesh, Bihar, Maharashtra, Rajasthan, Karnataka and West Bengal. The area under cultivation is approximately 292.1 ha in India. Average yield of linseed in India 484 kg/ha which is comparably very low in comparison with world average yield that is 943 kg/ha. Annual production of linseed is 141.2 ton in India. In U. P., the crop grown in an area about 26 ha, annual production is 10 ton and productivity is 385 kg/ha [5].

Linseed oil contains three times as much Omega-3-fatty acid than Omega-6-fatty acid. Growing popularity of linseed is due to health benefits in reducing cardio vascular diseases, decreased risk of cancer, anti-inflammatory activity and laxative effect.

The progress in breeding for yield and its contributing characters of any crop is polygenically controlled, environmentally influenced and determined by the magnitude and nature of their genetic variability. It is very difficult to judge whether observed variability is highly heritable or not. Moreover, knowledge of heritability is essential for selection based improvement, as it indicates the extent of transmissibility of a character into future generations [6]. Genetic variability for agronomic traits is the key component of breeding programs for broadening the gene pool. The genetic coefficient of variation together with heritability estimate would give the best picture of the amount of advance to be expected from selection. The amount of genetic advance under selection depends mainly on the amount of genetic variability. The phenotype of an individual is affected both by genotype (G) and environment (E). Most agronomically significant characters are inherited quantitatively and are known to be affected by environmental factors. In breeding programs, it is often difficult to manipulate such traits, since several inter-componential characters indirectly control them.

Keeping in view of increasing demand of linseed, there is consistent need to increase genetic seed yield potential. To achieve this goal, knowledge about extent of genetic variability of different traits and their correlation is very important, as the success of breeding program mostly hinge on the presence of genetic variability in the breeding material. The present investigation was, therefore, undertaken in linseed to generate information on phenotypic and genotypic variances as well as heritability, genetic advance and interrelationships of yield and yield related quantitative traits in the crop like linseed, where comparatively little information is available.

Materials and Methods

The experiment was conducted during *rabi*, 2014-2015 at the Field Experimentation Center of Department of Genetics and Plant Breeding, Sam Higginbottom University of Agricultural, Technology & Sciences, Allahabad.

Experimental materials for the present study consists of 16 genotypes of linseed, which were obtained from Initial Varietal Trial (Rainfed) of All India Co-ordinated Research Project on Linseed, Kanpur (UP). The 16 genotypes will be grown in randomized block design (RBD) with three replications during *rabi* 2014-2015. Treatments were randomly arranged in each replication divided into 48 plots.

Observations on days to 50% flowering, plant height (cm), number of primary branches per plant, number of capsules per cluster, days to maturity, plant stand / plot, number of seeds per capsule, test weight (g), seed yield per plot (g). The datas were recorded on five randomly selected plants of each genotype for all characters except for days to 50% flowering and days to maturity, where the observations were recorded on plot basis.

Results and Discussion

The results pertaining to variability studies, among the 16 genotypes and associations among yield and yield related traits in linseed are presented here. The important implications of these observations in breeding linseed for high grain yield discussed as follows.

Table 1. Mean performance of 16 linseed genotypes on the basis of different quantitative characters.

Sl. No.	Characters/ Genotypes	Days to flow-ering	Days to matu-rity	Pri-mary bran-ches/ plant	Plant hei-ght (cm)	Plant stand/ plot at har-vest	Seeds/ cap-sule	Capsu-les plant	Test wei-ght (g)	Seed yield plot (kg/ha)
1	PKDL-162	70.33	108.67	4.57	56.37	1218.67	8.13	94.53	5.52	766.67
2	LMS-2014-103	70.00	108.67	5.13	59.07	513.33	6.53	123.27	7.05	405.00
3	LMS-2014-107	61.33	107.00	4.27	83.73	507.33	6.60	124.08	6.97	391.67
4	NDL-2014-01	72.67	107.67	3.53	80.33	1315.00	8.87	53.13	7.52	716.67
5	SLS-103	72.00	111.00	4.27	78.20	1321.67	7.80	62.70	8.07	700.00
6	SLS-104	70.33	111.67	3.47	84.33	1349.33	6.93	102.38	6.05	650.00
7	OL-98-15-2	70.67	111.00	4.87	70.57	1246.00	7.40	99.36	6.55	708.33
8	LCK-1529	65.67	101.00	3.73	73.20	1065.00	5.47	46.70	7.08	475.00
9	RL-1007	71.33	110.67	3.77	78.23	1143.33	8.07	68.80	6.87	600.00
10	RLC-155	73.00	111.67	4.07	81.30	1342.33	8.13	76.33	6.67	741.67
11	RLC-156	73.00	110.67	4.07	86.43	1418.33	8.87	63.93	7.63	791.67
12	BAU-14-9	73.67	102.00	3.67	81.87	1404.33	7.73	57.80	8.06	516.67
13	T-397 (NC)	65.67	110.33	4.00	85.73	1397.33	8.60	88.47	5.97	725.00
14	Sheela	68.67	111.67	3.60	79.47	1297.67	8.53	97.53	7.22	726.00
15	Shekhar	64.33	108.33	4.00	87.80	1299.33	6.27	53.73	7.94	425.00
16	Kota Barani Alsi-4	71.33	110.67	4.30	86.47	1031.33	7.60	121.60	7.03	700.00
	Mean	69.63	108.92	4.08	78.32	1179.40	7.60	83.40	7.01	646.21
	CV	1.96	1.22	7.43	2.29	1.38	4.18	14.36	1.92	4.42
	SE	0.79	0.77	0.18	1.04	9.38	0.18	6.91	0.08	16.48
	CD 5%	2.28	2.21	0.51	3.00	27.08	0.53	19.97	0.22	47.59

Mean performance

The variability exploited in breeding program is desired from the naturally occurring variants and wild relative of main crop species as well as from strains and genetic stock artificially developed by human efforts. Through this study, an attempt was made to assess the mean performance and extent of variability in 16 genotypes. The mean values, range, grand mean (GM), standard error of mean (SEm), critical difference (CD) of 9 traits are presented in the Table 1.

Genetic variability parameters

One of the important considerations in any crop improvement is the detailed study of genetic variability. Variability is a measure by estimation of phenotypic and genotypic variance, genotypic and phenotypic coefficient variation, heritability, genetic advance and genetic gain for different quantitative traits.

These parameters deserve attention in selection for improvement in the concerned characters. The phenotypic variability, which is observable, includes both genotypic and environmental variation. It changes under different environmental conditions. Environmental variation is the non-heritable variation, which is slowly due to environmental effects and varies under different conditions. The estimates of variance, coefficient of variation, heritability and genetic advance for all the 9 characters studies have been boxed in Table 2 and explained here as under.

Estimates of phenotypic and *genotypic variances*

The estimates of coefficient of variation, heritability and genetic advance for all the 9 traits studied have been boxed in Table 2 and explained here as under: Data revealed the presence of phenotypic variation in the experimental material for all the traits studied. The highest phenotypic variance were recorded for days to maturity (81189.84) followed by seed yield per plot (29208.99), number of seeds per capsule (798.04), number of capsules per plant (89.37) days to 50% flowering (13.98), plant height (11.76). While

Table 2. Estimates of genetic parameters for 9 quantitative traits in linseed.

Sl. No.	Traits	Vg	Vp	Coefficient of variation Geno-typic	Pheno-typic	h^2 (bs) %	GA	GA as % of mean
1	Days to 50% flowering	12.12	13.98	5.00	5.37	0.87	6.68	9.59
2	Plant height	10.00	11.76	2.90	3.15	0.85	6.01	5.52
3	Number of branches/ plant	0.20	0.29	10.83	13.13	0.68	0.75	18.41
4	Number of capsules / plant	86.14	89.37	11.85	12.07	0.96	18.77	23.97
5	Days to maturity	80926.04	81189.84	24.12	24.16	0.87	585.07	49.61
6	plant stand	0.96	1.06	12.89	13.55	0.90	1.92	25.25
7	Number of seeds / capsule	654.69	798.04	30.68	33.87	0.82	47.74	57.25
8	Test weight	0.55	0.57	10.58	10.75	0.97	1.50	21.45
9	Seed yield/plot	28394.55	29208.99	26.08	26.45	0.97	342.25	52.96

moderate value for plant stand (1.06) and other all traits showed low phenotypic variation.

Genotypic variation was observed in the experimental material for all the traits studied. The highest genotypic variance were recorded for days to maturity (80926.04) followed by seed yield per plot (28394.55), number of seeds per capsule (654.69), number of capsules per plant (86.14) days to 50% flowering (12.12), plant height (10.00).

Less difference in the estimates of Vg and Vp and higher genotypic values compared to environmental variances for all the traits suggested that the variability present among the genotypes were mainly due to genetic reason with minimum influence of environment and hence heritable. The genotypic estimates of variability (Vg and GCV) being the most important and helps in the measurement of contribution of the genotype to the expression of particular trait and gives clue to compare the genetic variability for different traits.

High phenotypic variations were high genetic variability for different traits and less influence of environment [7]. Therefore, selection on the basis of phenotype alone can be effective for the improvement of these traits.

Phenotypic and *genotypic coefficient of variation*

Table 2 the values of phenotypic coefficient of variation (PCV) were higher than that of genotypic coefficient of variation (GCV) for all the traits, it means that the apparent variation is not only due to genotype but also due to the little influence of environment on the expression of these traits.

The estimates of GCV revealed that it ranged from 2.90% (plant height) to 30.68% (number of seeds per capsule). GCV estimates were highest for number of seeds per capsule (30.68) followed by seed yield per plot (26.08), days to maturity (24.12). Moderate GCV was observed for number of capsules per plant (11.85) and no. of branches per plant (10.83), while the low GCV observed for test weight (10.58) followed by days to 50% flowering (5.00%) and plant height (2.90%).

The estimates of PCV ranged from 3.15% (plant height) to 33.87% (number of seeds per capsule). PCV estimates were highest for number of seeds per capsule (33.87) followed by seed yield per plot (26.45), days to maturity (24.16). Moderate PCV was observed for number of capsules per plant (12.07) and no. of branches per plant (13.13), while the low PCV observed for test weight (10.75) followed by days to 50% flowering (5.37%) and plant height (3.15%).

Coefficients of variation studies indicated that the estimates of PCV were slightly higher than the corresponding GCV estimates for all the traits studied. Further, the difference between two was low, indicating that the characters were less influenced by the environment. Therefore, selection on the basis of phenotype alone can be effective for seed yield improvement in linseed based on these characters [8].

Heritability and genetic advance

The estimates of heritability in broad sense were workout using Burton and Devane (1953) statistical analysis, presented in Table 3 and discussed herewith: Results of estimates of heritability (broad sense) revealed that it was high (>60%) for the all the characters studied. Highest heritability was recorded by test weight and seed yield per plot (97.00) followed by number of capsules per plant (96.00), plant stand (90.00), days to 50% flowering (87.00), plant height (85.00) and number of seeds per capsule (82.00).

High heritability values indicate that the characters under study are less influenced by environment in their expression. High heritability show scope of genetic improvement of these characters through selection. This indicates that, if these traits 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 could be developed, possessing good quality and productivity. The genetic advance in a trait is a product of the heritability and selection differential expressed in terms of phenotypic standard deviation of the trait concerned. For comparison of the different attributes, it is better to express it as a percentage of mean. Heritability values in conjunction with selection differential are more effective as they indicate the expected genetic gain resulting from selection [9].

High genetic advance as percent of mean was observed for number of seeds per capsule (57.25), seed yield per plot (52.96), days to maturity (49.61), plant stand (25.25) and number of capsules per plant (23.97). Low genetic advance as percent of mean was observed for plant height (5.52), days to 50% flowering (9.59) and number of branches per plant (18.41).

Selection for the traits having high heritability coupled with high genetic advance is likely to accumulate more additive genes leading to further improvement of their performance. In the present study, high heritability along with high genetic advance was noticed for the traits. Other characters showed high heritability along with moderate or low genetic advance which can be improved by intermating superior genotypes of segregating population developed from combination breeding [10]. These genotypes 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 productivity [11].

Conclusion

The results from the present investigation indicated that considerable amount of genetic variability was present in studied genotypes. Wide range of variation was observed for all the nine characters except for capsules per plant, which shows presence of considerable amount of genetic variation in the experimental materials. Phenotypic coefficient of variation (PCV) was higher than genotypic coefficient of variation (GCV) for all the traits, indicating that the apparent variation is not only due to genotype but also due to the influence of environment. GCV and PCV were recorded highest for number of seeds per capsule (30.68% and 33.87%) heritability was found to be high (> 60%) for all the traits studied indicating good index for transmission of characters from parents to off spring. High heritability associated with high genetic advance was observed for seed yield (97.00% and 342.25), indicating the importance of this character in selection. Genotype RLC-156 was identified as a desirable genotype with the highest seed yield, capsules per plant and seeds per capsule.

References

1. Singh A, Marker S (2015) Study on variability, heritability and correlation coefficient among linseed (*Linum usitatissimum* L.). Adv in Appl Sci Res 6 : 14—17.
2. Narayanan R, Marugan S (2013) Studies on variability and heritability in sesame (*Sesamum indicum* L.). Int J Curr Agric Res 2 : 52—55.

3. Anonymous (2015) Annual report 2014-2015, Directorate of Economics and Statistics, Department of Agriculture, Cooperation and Farmers welfare ministry of Agriculture and Farmers welfare, Government of India.
4. FAO (2012) The state of Food and Agriculture. Food and Agriculture Organization of the United States.
5. AICRP (2015) All India Co-ordinated Research Project on Linseed Annual Report, 2014-2015.
6. Tadesse T, Parven A, Singh H, Weyessa B (2010) Estimates of variability and heritability in linseed germplasm. Int J Sustain Crop Prod 5 : 8—16.
7. Pali V, Mehta N (2013) Genetic variability and correlation coefficient analysis in linseed (*Linum usitatisimum* L.). Ind J Agric 10 (In press).
8. Diederichsen A, Ulrich A (2009) Variability in stem fiber content and its association with other characteristics in 1177 flax (*Linum usitatissimum* L.) gene bank accessions. Ind Crop Prod 30 : 33—39.
9. Reddy MP, Reddy BN, Arsul BT, Maheshwari JJ (2013) Genetic variability, heritability and genetic advance of growth and yield components of linseed (*Linum usitatissimum* L.). Int J Curr Microbiol and Appl Sci 2 : 231—237.
10. Vardhan KMV, Rao SS (2012) Genetic variability for seed yield and its components in linseed (*Linum usitatissimum* L.). Int J Appl Biol and Pharmaceut Technol 3 : 200—202.
11. Tyagi AK, Sharma MK, Mishra SK, Kerkhi SA, Chand P (2014) Estimates of genetic variability, heritability and genetic advance in linseed (*Linum usitatissinum* L.) germplasm. Prog Agric 14 : 37—48.