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Estimation of genetic variability, heritability and genetic advance among the genotypes/lines for seed yield and other economic traits in linseed (*Linum usitatissimum* L.)

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Abstract
Linseed (*Linum usitatissimum* L.) is an important *rabi* oilseed crop which is having diploid chromosome number 2n=30. A wide range of variability was noted for yield and yield components viz., days to 50 per cent flowering, days to maturity, plant height, number of primary branches per plant, number of secondary branches per plant, number of capsules per plant, number of seeds per capsule, biological yield per plant, seed yield per plant, harvest index and 1000 seed weight. High heritability estimates were recorded for four traits (1000 seed weight, days to 50% flowering, number of primary branches per plant and number of capsules per plant) out of eleven studied traits; these could be growing to greater contribution of genetic components in inheritance of these attributes. High estimates of genetic advance as percentage of means were noted for capsules per plant, seed yield per plant, 1000 seed weight, biological yield per plant, number of primary branches per plant and number of secondary branches per plant. Moderate genetic advance as percentage of means were noted for plant height, harvest index and days to 50% flowering. Low genetic advance as percentage of means were noted for seeds per capsule and days to maturity.

Keywords: variability, high heritability, genetic advance, traits

Introduction
Linseed (*Linum usitatissimum* L.) is an important rabi oilseed crop which is having diploid chromosome number 2n=30. Among different species of *Linaceae* family *L. usitatissimum* is the only species which has economic values. The genus *Linum* comprising over 200 species belong to the family *linaceae*. Linseed is an annual plant that grows to a height of 12-36 inches. Linseed is normally self-pollinated but insects cause 1-2 per cent of natural crossing. The growing period of common flax is in between 90-120 days. It is a cool season crop and requires moderate to cool temperature during the growing season. It is fairly resistant to drought and grows well in areas receiving an annual rainfall of about 48-76 cm. High rainfall and cloudy weather during growing period is very harmful for the crop. It requires high temperature, low moisture and fairly dry weather during its maturity. Linseed contain 33-45% oil, and its major important use in agro-based industries in the manufacturing of paint and varnish and other products. It has high unsaturated fatty acids, especially linoleic acid (Khan *et al.*, 2010) [13]. Linseed or flax crop produces seed and fibre (from stem). Flax fibres are being used in various textile and carpet industries. Linseed oil is the oldest vegetable oil in the world. It is distinctive from other oils as it contains a large amount of (52-63%) α-linolenic acid, a form of omega-3 fatty acids which makes its use in medicinal purpose also. Linseed is highly nutritious. It is a source of protein, high order of linolenic acid (an essential poly unsaturated Omega -3 fatty acid), complex carbohydrates, vitamins and minerals. Recent advances in medical research have found linseed as best herbal source of Omega-3 and the other essential fatty acid that is linolenic acid which is an omega-6 or n-6 fatty acid which has immense nutritional/medicinal effects on human body system. (Erasmes, 1997 & Simopolulos, 1999) [8, 27]. Linseed has an important position in Indian economy due to its wide industrial utility. But, the national average productivity of linseed is quite low. As per FAOSTAT (2016) [9], However, in terms of productivity, India (4266 kg/ha) is far below than Switzerland (21185 kg/ha) and France (19405 kg/ha). In any crop most of the economic characters, including yield, are metric in nature and being polygenically controlled. These are highly influenced by environmental factors.

The progress in breeding for such characters is determined by the magnitude and nature of interactions between their genotypic and phenotypic variability under varying conditions of soil and climate. Hence partitioning of overall variability into its heritable and non-heritable components with the help of genetic parameters such as genetic co-efficient of variation, heritability and genetic advance constitutes an important step in plant breeding programme. It enables selection of genotypes on a sound genetic basis. Genetic variability plays an important key role in plant breeding programme for crop improvement programme and lack of variability limits selection for plant improvement. Yield, complex polygenic traits is influenced by a large number of factors. The genetic architecture of economic yield must be resolved with the genetic condition of all other characters influencing it directly or indirectly. So the study of genetic variability with the help of suitable genetic parameters such as genotypic coefficient of variation, phenotypic coefficient of variation, heritability estimates and genetic advance percent of mean are necessary to start efficient breeding programme. Moreover, estimates of heritability can also be used to predict genetic advance under selection, so that the plant breeder can anticipate genetic gain from single generation of selection.

Material and Methods

The experimental material comprised of forty diverse genotypes of linseed, was obtained from Project Coordinating Unit (Linseed), CSAUA&T, Kanpur. The present experiment was carried out during *rabi* 2016-17, at Crop Research Centre SVPUA&T Meerut (UP). The site of experiment is at an elevation of about 297 meter above mean sea level with 29º 01'N latitude and 77 º 75' E longitudes, representing the North Western Plain Zone.

Results & Discussion

The present study entitled "Estimation of genetic variability, heritability and genetic advance among the genotypes/lines for seed yield and other economic traits in linseed (*Linum usitatissimum* L.) was carried out with forty diverse genotypes of linseed. The data was recorded on eleven characters viz., days to 50% flowering, days to maturity, plant height (cm), primary branches per plant, secondary branches per plant, number of capsules per plant, number of seeds per capsule, biological yield per plant, grain yield per plant, harvest index (%) and 1000 seed weight (g) and were subjected to various statistical and biometrical analysis (Table 2).

A wide range of variability was noted for yield and yield components viz., days to 50 per cent flowering (70.000-84.333), days to maturity (123.333-137.000), plant height (40.733-70.666), number of primary branches per plant (2.000-4.766), number of secondary branches per plant (9.333-17.850), number of capsules per plant (42.000-141,933), number of seeds per capsule (7.666-9.766), biological yield per plant (8.783g- 23.562g), seed yield per plant (3.113g- 9.643g), harvest index (23.973%- 42.374%) and 1000 seed weight (4,460g- 9.766g). A wide range in the mean performance of yield and yield components was also reported by Awasthi and Rao (2005) [4] for number of seeds per plant, Nagaraja *et al.* (2009) [16] for number of branches per plant, number of capsules per plant. Ram Jeet *et al.* (2010) [20] for seed yield, capsules per plant, plant height, number of primary branches per plant, Dandigadasar *et al.* (2012) [6] for number of capsules per plant, number of seeds per capsule and seed yield per plant. Kandil *et al.* (2012) [12] for seed yield per plant, number of capsules plant-1, fruiting zone length, main stem diameter and seed index, Chauhan *et al.* (2012) for number of primary branches per plant and seed yield per plant, Sivaraj *et al.* (2012) [29], Vardhan and Rao (2012) [31], Reddy *et al*. (2013) [22], Rafiq *et al.* (2014) [18] for all traits, Tyagi *et al.* (2014) [30] for seed yield per plant, followed by harvest index, biological yield per plant, capsules per plant, secondary branches per plant and primary branches per plant, Patel *et al.* (2015) [17] for all traits, Kumar *et al.* (2015) [14] for seed yield per plant and harvest index. The above mentioned variation supported by highly significant variation among the genotypes in respect of every traits studied suggested that the genotypes taken for study were genetically divergent. The genotypes showing highest mean values for respective trait (s) such as LCK-1044 for days to 50% flowering, LCK-1044 for days to maturity, LCK-8682 for plant height, LCK-38 for primary branches per plant, GAURAV for secondary branches per plant, LCK-38 for capsules per plant, LM-820 for seeds per capsule, LCK-283 for biological yield per plant, LCK-283 for seed yield per plant, LHCK-59 for harvest index, LHCK-69 for 1000 seed weight and early maturing genotype, could be involved in multiple crossing programme under a suitable mating design to estimate their gca and for their further exploitation in breeding programme. The phenotypic coefficient of variance (PCV) was higher than genotypic coefficient of variance (GCV) for all characters under study. Generally genotypic and phenotypic coefficient of variance for most of character studied revealed a relatively similar contribution of the genotypic variation in determining the phenotypic variation. However, there was not much difference between the values of GCV & PCV which indicated that there was not much effect of environment in expression of the traits. Moderate percentage of PCV was shown in capsules per plant (28.939) followed by seed yield per plant (28.731), biological yield per plant (26.074) and secondary branches per plant (23.394). This result indicated that the improvement in the genotypes might be made by considering these traits in selection breeding programme. The same trend was also observed in GCV of the aforesaid traits. The above result was also in conformity of the findings earlier obtained by Nagaraja *et al.* (2009) [16] for number of branches plant-1, number of capsules plant-1; Dandigadasar *et al.* (2012) [6] for number of capsules per plant, number of seeds per capsule and seed yield per plant; Kandil *et al.* (2012) [12] for seed yield per plant, number of capsules plant-1, fruiting zone length, main stem diameter and seed index; Chauhan *et al.* (2012) for number of primary branches per plant and seed yield per plant, Rafiq *et al*. (2014) [18] for all traits; Tyagi *et al.* (2014) [30] for seed yield per plant, followed by harvest index, biological yield per plant, capsules per plant, secondary branches per plant and primary branches per plant; Kumar *et al.* (2015) [14] for seed yield per plant and harvest index.

High heritability estimates were recorded for four traits (1000 seed weight, days to 50% flowering, number of primary branches per plant and number of capsules per plant) out of eleven studied traits, these could be growing to greater contribution of genetic components in inheritance of these attributes. This indicated that if these traits are considered in mass or progeny or family selection scheme or any other selection scheme aimed at exploiting the genetic variance, widely adopted genotypes possessing good productivity would be developed. High estimates of heritability were reported by Ram Jeet *et al.* (2010) [20] for plant height, Kandil *et al.* (2012) [12] for all characters, Vardhan and Rao (2012) [31] for days to maturity, 100-seed weight, Rafiq *et al.* (2014) [18] days to maturity, 1000 seed weight, seed yield/plot and days to flower completion, Rajanna *et al.* (2014) [19] for 1000 seed weight and seed yield, Tyagi *et al.* (2014) [30] for plant height, primary branches per plant, secondary branches per plant, capsules per plant, days to maturity, biological yield per plant, seed yield per plant, 1000- seed weight, harvest index, Fida *et al.* (2015) [10] for seed yield, plant height as well as days to 50 percent flowering. Kumar *et al.* (2015) [14] for seed yield per plant, biological yield per plant and harvest index, Sahu *et al.* (2016) [25] for seed yield per plant, followed by harvest index, seed weight, days to maturity, biological yield. Moderate heritability was recorded for biological yield per plant, seed yield per plant, number of seeds per capsule, and plant height. This result indicated the role of non-fixable genetic variance, which may be due to dominance and epistasis.

High estimates of genetic advance as percentage of means were noted for capsules per plant, seed yield per plant, 1000 seed weight, biological yield per plant, number of primary branches per plant and number of secondary branches per plant. Moderate genetic advance as percentage of means were noted for plant height, harvest index and days to 50% flowering. Low genetic advance as percentage of means were noted for seeds per capsule and days to maturity. Similar types of findings were also reported by Awasthi and Rao (2005) [4], Nagaraja *et al.* (2009) [16], Ram Jeet *et al.* (2010) [20], Dandigadasar *et al.* (2012) [6], Vardhan and Rao (2012) [31], Shalini *et al.* (2016) [26], Fida *et al.* (2015) [10] and Sahu *et al.* (2016) [25]. High heritability coupled with high genetic advance in percent of mean was observed for the traits, capsules per plant, seed yield per plant, biological yield per plant and 1000 seed weight, while high heritability with moderate genetic advance was observed for days to 50% flowering, plant height and harvest index. These traits may be considered directly in selection programme for the improvement in productivity of linseed crop. Similar type of findings were also reported by Awasthi and Rao (2005) [4], Nagaraja *et al.* (2009) [16], Vardhan and Rao (2012) [31], Rajanna *et al.* (2014) [19], Kumar *et al.* (2015) [14], Siddiqui *et al.* (2016), Shalini *et al.* (2016) [26], Dash *et al.* (2016) [7] and Kumar *et al.* (2017).

Summary & Conclusion

The present investigation entitled "Estimation of genetic variability, heritability and genetic advance among the genotypes/lines for seed yield and other economic traits in linseed (*Linum usitatissimum* L.)" was carried out with forty genotypes of linseed to analyze the analysis of variance revealed highly significant differences among the genotypes for all the characters viz., days to 50% flowering, days to maturity, plant height (cm), number of primary branches per plant, number of secondary branches per plant, number of capsules per plant, number of seeds per capsule, biological yield per plant (g), seed yield per plant (g), harvest index (%) and 1000 seed weight which indicated wide spectrum of variability among the genotypes (Table 1).

The present investigation of the genetic variability, heritability and genetic advance for eleven quantitative traits in a randomized complete block design with three replications during the *rabi* season of 2016-17 (Table 2).

In present study of genetic variability, the percentage of PCV was observed for capsules per plant (28.939) followed by seed yield per plant (28.731), biological yield per plant (26.074), secondary branches per plant (23.394), 1000 seed weight (20.532), primary branches per plant (18.940), plant height (13.857), harvest index (10.868), seeds per capsules (5.780), days to 50% flowering (5.436), and days to maturity (3.352). GCV was observed for capsules per plant (26.242) followed by seed yield per plant (25.144), biological yield per plant (22.961), 1000 seed weight (20.410), primary branches per plant (17.172), secondary branches per plant (15.485), plant height (11.133), harvest index (7.645), days to 50% flowering (5.154), seeds per capsules (4.997) and days to maturity (2.350).

The estimates of heritability (in broad sense) were arbitrarily categorized in three major groups, i.e. high heritability (above 80 %), moderate heritability (60 to 80 %) and low heritability (Less than 60 %). The perusal of data revealed that highest heritability was recorded for 1000 seed weight (98.80) followed by days to 50% flowering (89.90), primary branches per plant (82.20) and capsules per plant (82.20). Moderate heritability was recorded for biological yield per plant (77.50) followed by grain yield per plant (76.60), seeds per capsule (74.80) and plant height (64.50). However low heritability was recorded in harvest index (49.50) followed by days to maturity (49.20) and secondary branches per plant (43.80).

The expected genetic advance expressed as per cent of mean varied from days to maturity (3.395) to capsules per plant (49.020). High genetic advance in percentage of mean (> 20%) was observed for the characters, capsules per plant (49.020) followed by seed yield per plant (45.332), 1000 seed weight (41.794), biological yield per plant (41.651), primary branches per plant (32.071) and secondary branches per plant (21.114). Moderate genetic advance in percentage of mean (10- 20%) was recorded for plant height (18.424), harvest index (11.077) and days to 50% flowering (10.068). However low (<10%) genetic advance in percentage of mean was recorded for seeds per capsule (8.901) and days to maturity (3.395).

Table 1: Analysis of variance (ANOVA) for eleven characters of forty genotypes in linseed (*Linum usitatissimum* L.)

Source of variations	d.f.	Days to 50% flowering	Days to maturity	Plant height (cm)	Primary branches per plant	Secondary branches per plant	Capsules per plant	Seeds per capsule	Biological yield per plant (g)	Seed yield per plant (g)	Harvest index (%)	1000 seed weight (g)
Replication	2	2.033	1.408	27.673	0.012	3.572	207.909	0.039	3.779	0.912	16.987	0.038
Treatments	39	51.845**	38.413**	131.295**	1.044**	16.121**	1502.926**	0.612**	35.562**	4.945**	27.152**	5.932**
Error	78	1.870	9.844	20.321	0.070	4.827	101.005	0.061	3.130	0.457	6.894	0.023

** Significant at 1% level

Table 2: Estimates of general mean, range, S.E., C.D., GCV, PCV, ECV, heritability h^2 % (BS), genetic advance and genetic advance as percentage of mean for eleven characters in linseed (*Linum usitatissimum* L.).

Parameters/Characters	General Mean	Range		S.E.±	C.D. 5%	GCV (%)	PCV (%)	ECV (%)	Heritability h^2 % (BS)	Genetic Advance (GA)	GA as % of mean
		Lowest	highest								
Days to 50% flowering	79.183	70.000	84.333	0.789	2.223	5.154	5.436	1.727	0.899	7.972	10.068
Days to maturity	131.292	123.333	137.000	1.811	5.100	2.350	3.352	2.390	0.492	4.458	3.395
Plant height (cm)	54.633	40.733	70.666	2.602	7.327	11.133	13.857	8.251	0.645	10.066	18.424
Primary branches per plant	3.319	2.000	4.766	0.153	0.431	17.172	18.940	7.992	0.822	1.064	32.071
Secondary branches per plant	12.530	9.333	17.850	1.268	3.571	15.485	23.394	17.536	0.438	2.646	21.114
Capsules per plant	82.377	42.000	141.933	5.802	16.336	26.242	28.939	12.200	0.822	40.381	49.020
Seeds per capsule	8.569	7.666	9.766	0.143	0.404	4.997	5.780	2.903	0.748	0.763	8.901
Biological yield per plant (g)	14.320	8.783	23.562	1.021	2.876	22.961	26.074	12.356	0.775	5.964	41.651
Seed yield per plant (g)	4.864	3.113	9.643	0.390	1.099	25.144	28.731	13.901	0.766	2.205	45.332
Harvest index (%)	33.993	23.973	42.373	1.516	4.268	7.645	10.868	7.725	0.495	3.765	11.077
1000 seed weight (g)	6.877	4.460	9.766	0.088	0.250	20.410	20.532	2.237	0.988	2.874	41.794

References

1. Allard RW. Principles of plant breeding. John Willy and Sons, Inc., New York, 1960.
2. Allard RW. Relationship between genetic diversity and consistency of performance in different environment. Crop Sci. 1961; 1:127-133.
3. Anonymous. Area, production and productivity of linseed. Directorate of Economics and Statistics, Ministry of Agriculture and farmers Welfare, 2015, 211-212.
4. Awasthi SK, Rao SS. Selection parameters for yield and its components in linseed (*Linum usitatissimum* L.). I. J Gen. Pb. 2005; 65(4):323-324.
5. Chuhan MP, Kumar R, Shekhar R, Rahul VP, Ozha GC. Variability Parameters for Yield and its Components in Linseed (*Linum usitatissimum* L.) Environ. & Eco. 2012; 30(2):368-370.
6. Dandigadasar B, Tattimani M, Danaraddi CS, Biradar SB, Dandagi MR. Genetic variability, correlation and path analysis in linseed (*Linum usitatissimum* L.). Asian J Bio Sci. 2012; 6(2):218-222.
7. Dash J, Naik BS, Mohapatra UB. Variability, correlation and path coefficient analysis in linseed (*Linum usitatissimum* L.) under late sown conditions in the north central plateau zone of Odisha in India. Int. J Ad. Res. 2016; 4(1):799-811.
8. Erasmes U. Fats that heal, fats that kill. 2nd edition, Canada, Alive Books, 1997.
9. Faostat. Area, production and productivity of linseed in the world, 2018.
10. Fida H, Javed I, Muhammad R, Zahid M, Muhammad A, Muhammad A *et al*. Genetic improvement in linseed (*Linum usitatissimum* L.) through variability heritability and genetic advance. Directorate of Agricultural Information, Ayub Agricultural Research Institute, Faisalabad. Pak. J Agri. Res. (Lahore). 2015; 53(4):507-512.
11. Johansson HW, Robinson HF, Comstock RE. Estimates of genetics and environmental variability in soybean. Agron. J. 1955; 47:314-318.
12. Kandil AA, Shareif AE, Zaied TAA, Moussa AGT. Multivariate Analysis of Some Economic Characters in Flax. Pakistan J Biological Sci. 2012; 15:85-91.
13. Khan ML, Sharif M, Sarwar M, Sameea, Ameen M. Chemical composition of different varieties of linseed. Pak. Vet. J. 2010; 30(2):79-82.
14. Kumar N, Paul S, Patial R. Assessment of genetic variability, heritability and genetic advance for seed yield and its attributes in linseed (*Linum usitatissimum* L.) Plant Arch., 2015; 15:863-867.
15. Lush JL. Heritability of quantitative characters in farm animals. Hereditas. 1949; 35:356-375.
16. Nagaraja TE, Ajit KR, Golasangi BS. Genetic variability, correlation and path analysis in linseed. Journal of Maharashtra Agricultural Universities, College of Agriculture, Pune, India, J Mah. Agri. Uni. 2009; 34(3):282-285.
17. Patel DD, Mishra SP, Moitra PK. Genetic studies for seed yield and its components in linseed (*Linum usitatissimum* L.).Green Farming. 2015; 6(4):696-699.
18. Rafiq A, Danish I, Mirza MY, Talat M, Khan MA, Iqbal MS *et al*. Genetic variability, heritability and genetic advance in some genotypes of linseed (*Linum usitatissimum* L).Directorate of Agricultural Information, Ayub Agricultural Research Institute, Faisalabad. Pak. J Agric. Res. (Lahore). 2014; 52(1):43-52.
19. Rajanna B, Biradar SA, Ajithkumar K. Correlation and path coefficient analysis in linseed (*Linum usitatissimum* L). National Environmentalists Association, Jharkhand, India, The Bioscan. 2014; 9(4):1625-1628.
20. Ram Jeet, Singh PK, Dubey SD, Ashok Kumar, Gautam CPN. Genetic variability, heritability and genetic advance in linseed (*Linum usitatissimum* L). C S Azad University of Agriculture and Technology, Kanpur, India, Current Ad. Agri. Sci. 2010; 2(1):45-46.
21. Rao CR. Advance statistical methods in biometrical research edt. I. J. Willey and Sons, New York, 1952.
22. Reddy MP, Reddy BN, Arsul BT, Maheshwari JJ. Genetic variability, heritability and genetic advance of growth and yield components of linseed (*Linum usitatissimum* L.). Int. J Curr. Microbiol. App. Sci. 2013; 2(9):231237.
23. Robinson HF, Comstock RE, Hrvey PH. Estimates of heritability and degree of dominance in corn. J Agro. 1949; 41:353-359.
24. Robinson HF. Quantitative genetics in relation to breeding of the centennial of mendalism. Ind. J Gene. 1966; 26:171-187.
25. Sahu D, Sahu M. Selection parameters for seed yield and related traits in linseed (*Linum usitatissimum* L). Bangladesh Botanical Society, Dhaka, Bangladesh J Bot. 2016; 45(3):621-629.
26. Shalini S, Ram S, Bhushan S, Ahmad E. Genetic variability, heritability and genetic advance of yield and quality traits in linseed (*Linum usitatissimum* L.). Int. J Plant Sci. 2016; 11(2):270-274.

27. Simopolulos AP. Essential fatty acids in health and chronic disease. Am. J Clin, Nutr. 1999; 70:560S-9S.
28. Singh SP. Variability in linseed under rainfed condition. Madras Agri. J. 1984; 71(4):255-256.
29. Sivaraj N, Sunil N, Pandravada SR, Kamala V, Abraham B, Kumar A *et al*. Variability in linseed (*Linum usitatissimum* L.) germplasm collections from peninsular India with special reference to seed traits and fatty acid composition. Ind. J Agric. Sci. 2012; 82(2):102-105.
30. Tyagi AK, Sharma MK, Mishra SK, Kerkhi SK, Chand P. Estimates of genetic variability, heritability and genetic advance in Linseed (*Linum usitatissimum* L.) germplasm. Society Recent Dev. Agri. 2014; 14(1):37-48.
31. Vardhan KMV, Rao SS. Genetic variability for seed yield and its components in linseed (*Linum usitatissimum* L.) Int. J App. Bio. Pharma. Tech. 2012; 3(4):0976-4550.
32. Vavilov NI. Studies on the origin of cultivated plant Bull Bot. and Pl. Breed. 1926; 16:39-145.