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

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Abstract

One hundred linseed (*Linum usitatissimum* L.) genotypes and four checks were evaluated during *rabi*, 2017-18 for fifteen traits to examine the nature and magnitude of variability, heritability (h^2 =broad sense) and genetic advance. Analysis of variance revealed that the differences among genotypes were significant for all the characters studied. Knowledge of selection effect on positive or negative changes of a character under improvement is of paramount importance for the success of any plant breeding programme and helps the selection of desirable breeding methods. Heritability and genetic advance are important selection parameters and selection success is a reflectance of selection response. High PCV and GCV values exhibited for number of branches per plant, number of capsules per plant, yield per plant, palmitic acid and linoleic acid indicating wide range of variability with substantial environmental influence on the expression of these traits and provide better opportunity for improvement of these traits through selection. Small differences between GCV and PCV were recorded for all the characters studied which indicated less influence of environment on these characters. High heritability coupled with high Genetic advance as per cent of Mean (GAM >20%) observed for plant height, technical plant height, number of branches per plant, number of capsules per plant, yield per plant, palmitic acid, stearic acid, oleic acid, linoleic acid and linolenic acid indicated that these characters are highly heritable.

Keywords: Genetic variability, genetic advance, *Linum usitatissimum*

Introduction

Linseed [*Linum usitatissimum* L.), (2n=2X=30)] is a self-pollinated crop and commonly known as *Alsi* in Hindi, *Agase* in Kannada. It is an important oilseed and fibre crop of the tropical as well as temperate regions of the world. Linseed is one of the most important industrial oilseed crops of India and its cultivation goes back to more than 5000 years. The genus *Linum* belongs to family *Linaceae* and orders *Geraniale* and is the only species in the family which is of economic importance. In western temperate countries, linseed is more commonly known as "Flax", where it is exclusively cultivated for the fiber called linen. Based on the diversity of plant types, linseed has two centres of origin *i.e.*, Central Asia and the Mediterranean area of Europe (Darlington, 1963) [5].

Linseed is rich in fat, protein and dietary fiber, it contains about 41 per cent fat, 28 per cent dietary fiber, 21 per cent protein, three per cent carbohydrate and also an important source of magnesium, potassium, zinc and B vitamins, soluble fibers (25%) and insoluble fiber (75%). Every part of the linseed plant is utilized commercially either directly or after processing. The linseed oil is also used in industries for the manufacture of paints, varnish, oilcloth, linoleum and pad ink (Walsh, 1965) [20]. The oil cake is a good feed for milch cattle and also used as organic manure to maintain soil fertility as well as to prevent the unwanted microbes with its germicidal properties. The stem yields fiber of good quality having high strength and durability.

Linseed encompasses the potential health suiting nutritional profile in it. The oil possesses a very healthy fatty acid profile and it contains the richest source of omega-3 fatty acid or ALA (Alpha-Linolenic Acid) 58 per cent and it is essential fatty acid as it cannot be synthesized in the human body and must be supplemented directly from foods. Omega-3 fatty acid provides beneficial effects in numerous clinical conditions such as cardiovascular disease, blood

pressure, heart beat rate, blood clotting and inflammatory disorders. Further it also improves digestibility, bioactive peptides, antimicrobial, anti-Parkinson's, anti-proliferative, antihypertensive, immune-enhancing, antiulcer and antioxidant activities. Both fish source of omega-3 fatty acids are EPA (Eicosa Pentaenoic Acid), DHA (Docosa Hexaenoic Acid) and plant based omega-3 fatty acid (Alpha Linolenic Acid) which are rich in linseed crop.

Variability in a crop species is of utmost importance as it provides the basis for effective selection. Variability in a population is measured by phenotypic and genotypic coefficients of variation. The information on the nature and magnitude of genetic variability present in a population is a prerequisite to start any crop improvement programme. Yield being a complex character is dependent on many quantitatively inherited component characters and wider range of genetic variability helps in selecting desired genotypes. In addition to the genetic variability, knowledge on heritability and expected genetic advance helps the breeder to employ the suitable breeding strategy. Therefore, it is necessary to have knowledge of genetic variability, heritability and genetic advance in the available genetic material.

Material and Methods

The experimental material for this study consisted of hundred germplasm lines along with four checks (NL-115, PCL-57, T-397 and Padmini) which were obtained from AICRP on Linseed, MARS, Raichur and Project co-ordinating unit (Linseed), Kanpur. These lines were selected based on their wider adaptability to different agro-climatic regions as well as diverse growing conditions. These includes of released varieties, local land races, mutants and advanced breeding lines.

One hundred linseed germplasm and four checks were planted in augmented design (Federer, 1956) [6]. The entire experimental plot was divided into five blocks, checks were repeated in each block and each line has a single row of three meter length with the spacing of 30 x 5 cm. All the material along with four checks was sown on 31.10.2016 in the experimental blocks of Main Agricultural Research Station, University of Agricultural Sciences, Raichur, Karnataka. All the recommended crop production and protection practices were followed to raise a healthy crop.

Observations on five randomly selected plants in each genotype and checks were recorded for morphological and yield characters. The average values were computed as genotype mean and check means in each block. Oil content was estimated with the help of Nuclear Magnetic Resonance (NMR) at Main Agricultural Research Station, Raichur and expressed as per cent. This instrument gave a direct value of oil percentage in seeds that were previously oven dried.

Fatty acids content was estimated with the help of Gas Chromatographer at Project Coordinating Unit (Linseed), Kanpur.

The mean data after computing for each character was subjected to standard method of analysis of variance following Panse and Sukhatme (1961), genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV), heritability in broad sense (h_b^2) and genetic advance as per cent of mean were estimated by the formula as suggested by Burton (1953) [4] and Johanson *et al.*, (1955) [9].

Results and Discussion

The genetic variability parameters *viz.*, mean, range, phenotypic coefficient of variation (PCV), genotypic

coefficient of variation (GCV), heritability (broad sense) and genetic advance as per cent mean (GAM) for all the fifteen characters are presented in the (Table 1). All the fifteen traits under study showed wide range of variation indicating an enormous opportunity for bringing about improvement in essential direction.

The analysis of variance revealed significant differences among the genotypes for all characters, indicating a high degree of variability in the material studied. This had been exemplified by highly significant mean sum of squares for these traits, which indicated that, the genotypes under study were genetically diverse.

Phenotypic coefficient of variation (PCV) ranged between 5.51 per cent (Days to maturity) to 41.08 per cent (Linoleic acid). Genotypic co-efficient of variation (GCV) ranged between 5.49 per cent (Days to maturity) to 41.07 per cent (Linoleic acid). Broad-sense heritability ranged from 80.48 per cent (Yield per plant) to 99.97 per cent (Linolenic acid). Genetic advance as per cent of mean ranged between 11.26 per cent (Days to maturity) to 84.58 per cent (Linoleic acid).

Moderate PCV and GCV observed for traits like plant height (16.33 and 16.25), technical plant height (19.50 and 19.39), stearic acid (16.18 and 15.98), oleic acid (12.28 and 12.26) and linolenic acid (11.30 and 11.28) indicating that these traits should be given due importance while selecting high yielding genotypes. These results are in accordance with reports of other workers in linseed by Shipra *et al.* (2016) [15], Frank *et al.* (2017) [7] and Amith *et al.* (2017) [1].

High PCV and GCV values exhibited for number of branches per plant, number of capsules per plant, yield per plant, palmitic acid and linoleic acid indicating wide range of variability with substantial environmental influence on the expression of these traits and provide better opportunity for improvement of these traits through selection. Similar results of high PCV and GCV values for above said traits were also reported by Bibi *et al.* (2013) [3], Ranjana *et al.* (2018) [14], Vipin *et al.* (2019) [18] and Ankit *et al.* (2019) [2]. Coefficients of variation studies indicated that the estimates of PCV were slightly higher than the corresponding GCV estimates for all the traits studied indicating that the characters were less influenced by the environment. Therefore, selection on the basis of phenotype alone can be effective for the improvement of these traits.

Genetic variability, heritability and genetic advance are of great importance in improving the yield of a genotype (Gupta and Verma *et al.*, 2000) [8]. With the help of GCV alone it may not be feasible to determine the amount of heritable variation and the relative degree to which a character is transmitted from parent to offspring is indicated by the estimate of heritability. Heritability estimates along with genetic advance are normally helpful in predicting the gain under selection than heritability estimate alone. Hence, both heritability and genetic advance were determined to get a clear picture of the scope of improvement in various characters through selection. Heritability is classified as low (below 30%), medium (30-60%) and high (above 60%). The characters studied in the present investigation expressed high heritability estimates ranging from 80.48 to 99.97 per cent. The genetic advance is a useful indicator of the progress that can be expected as result of exercising selection on the pertinent population. Heritability in conjunction with genetic advance would give a more reliable index of selection value (Johnson *et al.*, 1955) [9].

High heritability coupled with high Genetic Advance as per cent of Mean (GAM >20%) observed for plant height, technical plant height, number of branches per plant, number

of capsules per plant, yield per plant, palmitic acid, stearic acid, oleic acid, linoleic acid and linolenic acid indicated that these characters are highly heritable. Panse and Shukhatme (1978) [12] have expressed that if a character is governed by additive gene action, directional phenotypic selection of these traits could be more effective for desired genetic improvement, heritability and genetic advance both would be high. The findings of higher heritability and expected genetic advance are in line with the findings of Vishnuvardhan and Rao (2012) [19], Kumar *et al.* (2012) [10], Pali and Mehta (2013) [11], Amith *et al.* (2017) [1], Frank *et al.* (2017) [7] and Ranjana *et al.* (2018) [14]. High heritability is suggestive of the scope for higher genetic gain in seed yield through selection (Todorovic *et al.*, 2011) [16].

High heritability coupled with moderate genetic advance as per cent of mean was observed indicating the role of both additive and non-additive gene action governing the inheritance of days to 50 per cent flowering, days to maturity, number of seeds per capsule and 1000 seed weight. These results are in broad agreement with the reports of Vikas and Nandan (2014) [17].

Paul (1978) [13] also reported that, if heritability in broad sense is mainly due to additive gene effects then only it associates with high genetic gain. If the heritability in broad sense is mainly due to non-additive effects (dominance and / or epistasis), the genetic gain will be low as observed in the case of days to 50 per cent flowering, days to maturity, number of seeds per capsule and 1000 seed weight.

Table 1: Genetic variability parameters for yield and oil quality parameters in linseed (*Linum usitatissimum* L.)

Sl. No.	Characters	Mean	Range		Coefficient of variation (%)		h ² _{bs} (%)	GA (%)	GAM (%)
			Minimum	Maximum	PCV	GCV			
1	Days to 50% flowering	55.08	32.00	62.00	7.03	6.96	98.17	7.83	14.21
2	Days to maturity	108.17	89.00	125.00	5.51	5.49	99.15	12.18	11.26
3	Plant height (cm)	50.18	30.00	71.00	16.33	16.25	98.91	16.53	33.29
4	Technical plant height (cm)	35.52	20.00	60.00	19.50	19.39	98.88	13.55	39.72
5	Number of branches per plant	4.92	3.00	8.00	35.47	33.90	91.44	3.27	66.79
6	Number of capsules per plant	53.43	33.00	86.00	25.55	25.23	97.53	28.30	51.34
7	Number of seeds per capsule	6.75	5.00	8.00	9.58	8.99	88.03	1.17	17.39
8	1000 seed weight (g)	6.07	4.58	7.25	8.66	8.42	94.38	1.00	16.85
9	Yield per plant (g)	2.19	1.11	3.87	30.09	27.00	80.48	1.10	49.89
10	Oil content (%)	32.69	26.93	38.35	6.81	6.79	99.52	4.48	13.96
11	Palmitic acid (%)	7.30	5.68	11.05	34.80	34.78	99.90	5.46	71.67
12	Stearic acid (%)	5.81	3.356	7.56	16.18	15.98	97.62	1.85	32.54
13	Oleic acid (%)	31.95	17.21	41.72	12.28	12.26	99.72	7.96	25.23
14	Linoleic acid (%)	12.93	8.06	53.34	41.08	41.07	99.90	10.97	84.58
15	Linolenic acid (%)	41.30	12.64	50.12	11.30	11.28	99.97	9.60	23.22

Where,

PCV= Phenotypic coefficient of variation

h²_{bs}=Heritability in broad

GA=Genetic advance

GCV=Genotypic coefficient of variation

GAM=Genetic advance as per cent mean

Summary and conclusion

Analysis of variance revealed the presence of adequate variability among the germplasm lines for all the fifteen characters. A close correspondence between PCV and GCV was noticed for most of the characters indicated the fact that the environmental influence is very low and hence selection for characters would be made based on their phenotypic performance. High heritability coupled with high GAM observed for plant height, technical plant height, number of branches per plant, number of capsules per plant, yield per plant, palmitic acid, stearic acid, oleic acid, linoleic acid and linolenic acid suggested that these characters are highly heritable and these traits could be improved by simple selection procedures.

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