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Genetic variability analysis for plant selection in linseed (*Linum usitatissimum* L.)

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Abstract
The experiment was conducted in *rabi* 2015-2016 at the center of the Department of Genetics and Plant Breeding, Sam Higginbottom University of Agricultural, Technology and Sciences, Allahabad Uttar Pradesh (U.P). The evaluate fourteen genotypes of linseed in randomized block design with three replications. The objective of this work was to assess the magnitude of genetic variability parameters for different quantitative traits in linseed. The genetic variability analysis for plant selection in linseed for ten characters under study *viz.*, seedling vigour, days to 50 percent flowering, plant height, number of branches, number of capsules per plant, days to maturity, number of seeds per capsules, 1000 seed weight, seed yield per plant and seed yield per plot. The mean sum of squares due to genotypes showed significant differences for all the characters suggesting that the genotypes were genetically variable and considerable amount of variability existed among them. The present investigation can be concluded that best genotype was identified as a desirable genotype with highest seed yield, seeds per capsule and capsules per plant. All PCV values were greater than GCV for all traits. Thus, indicating selection based on these characters would be rewarding for yield improvement in linseed.

Keywords: *Linum usitatissimum*, genetic variability, GCV, PCV

Introduction

In India, Linseed (*Linum usitatissimum* L.) is an important oilseed self-pollinated crop grown in *rabi* season. Linseed originated from wild flax *Linum angustifolium Huds.* (N=15) native of Mediterranean region (Tadesse *et al*., 2009) [21]. The genus *Linum* is the type genus for the comprising 22 genera and about 300 species distributed worldwide (Hickey 1988; McDill *et al*. 2009) [12, 16]. Flax is not found as a wild plant; *L.angustifolium* (*L. bienne*), with which is shares the same chromosome number (2n=30) and is inter fertile, is considered its progenitor (Diederichsen and Hammer 1995; Fu *et al.* 2002a; Gill and Yermanos 1967 [5, 9, 10]. The genus '*Linum'* to order '*Geraniale'* and is the only species in the family, which is of economic importance. The word '*Linum'* means 'many' and '*usitatissimum'* means 'uses'. Every part of linseed is used in various things directly or indirectly. The two major user types are connected to morphotypes, broadly designed as oil (linseed; convar. mediterraneum), fiber (flax; convar. elongatum), and intermediate (Convar. usitatissimum) varieties, although this infra-specific grouping is not unified (Diederichsen and Fu 2006) [6].

In India, Madhya Pradesh leads in yield and acreage, followed by Uttar Pradesh and Maharashtra, Bihar, Rajasthan, Karnataka and West Bengal. In Uttar Pradesh the area of linseed is 121.5 thousand hectare, Production is 52.6 thousand tonnes, productivity is 433 kg/ha. India ranks first in terms of area and third in terms of production of linseed globally. In India, area under cultivation is approximately 292.1 million per hectare, Average yield is 484 kg/ ha which is comparably low with world average yield that is 943 kg/ ha and annual production of linseed is 141.2 tonnes per hectares. In U.P, this crop is grown in an area of about 26 million hectares with annual production of 10 tonnes per hectare and productivity of 385 kg/ha. (Annual Report, AICRP 2014-15).

Industrial oil production, linseed ranks first in the country. The main flaxseed producing countries are Argentina, Canada, China, India, Poland, Romania, Russia, Uruguay and the USA (Gill, 1987) [11]. The largest production of fiber flax occurs presently in China, Russia, Belarus and Ukraine, while oilseed production is important in India, Canada, China, United States, Germany, Argentina, United Kingdom and Spain (FAOSTAT data, 2006) [7]. Canada has the highest productivity of about 7 quintal per hectare. Linseed occupies about 4.9 million hectare on world map of its cultivation. India accounts for about 1.9 million hectares with a seed production of 4.98 lakhs of tones and occupies the third rank among the linseed producing countries. India is the second largest producer of linseed, next to Canada in the world with an area of 525.5 thousand hectares, a production of 211.9 thousand tons per annum

annum and productivity of 403 kg/ha. India has 18.8% of worlds recorded linseed area but produces less than 10% of total world production. In Karnataka, it is grown over an area of thirteen thousand hectares with the production of 1.0 thousand tons per annum, with the very low productivity of 77 kg/ha. In Uttar Pradesh 78.7 hectare area, productions 39.9 tones and yield 507 Kg per hectare. According to Indian oilseed production in 2003-04 production of linseed is 0.23 million tones, 0.2 million tonnes in 2004-05, 0.2 million tonnes in 2005-06, 0.19 million tonnes in 2006-2007, 0.18 million tonnes in 2007-08, 0.13 million tonnes in 2008-09, 0.16 million tonnes in 2009-10, 0.16 million tonnes in 2010-11(Appendix- 3). Flax cultivation has been steadily declining in favor of cotton, with linseed currently occupying about 2.4 million ha and fiber flax is about 0.4 million ha (FAOSTAT data 2010) [8].

Variability refers to the presence of differences among the individuals of plant population. Genetic variability is a measure of the tendency of individual genotypes in a population to vary from one another. The estimates of variability help the plant breeder in selection of elite genotypes from diverse genetic population. Selection is also effective there is significant amount of genetic variability among the individuals in the population. (Singh and Narayanam, 2007) [20]. Higher the genetic variability more will be the opportunities for improvement through appropriate selection procedure because uniform varieties have narrow genetic base, poor adaptability. Selection for yield has many complexities because it is end product of various yield components or yield contributing characters, which are naturally polygenic inherited and majorly influenced by environment. So due to less impression of direct selection for yield, more efforts should be over indirect selection for yield components (changing yield through yield components). Proper understanding of association of different traits, provide more reliable selection criterion to achieve a high seed yield (Akbar *et al*., 2001) [1]. The yield of flax is related to its components as number of plant per unit area, number of capsules per plant and weight of seeds per capsule and so on. The main target of improvement programs is achieving varieties having high yield and quality. Obtaining high yielding and high quality linseed varieties depend upon applying fertilizers like nitrogen. Historical (successive/evolutionary) increases in cereal yield have depended on large inputs of nitrogen fertilizer .Genetic traits such as genotypic co-efficient of variability, heritability and genetic advance provide precise estimate of genetic variation of quantitative traits (Yadav and Dalal, 1972., Khorgade and Pillai, 1994., Khan *et al*., 2000) [23, 14, 15]. In many crops most of the economic characters, including yield, are metric are polygenic in nature. 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 the 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.

Material and Methods

An experiment comprised of 14 genotype accessions (Table-1) was conducted at at the Field Experimentation Center of the Department of Genetics & Plant Breeding, Sam Higginbottom University of Agricultural, Technology and Sciences, Allahabad Uttar Pradesh (U.P). The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications recommended package of practices were applied to raise the normal crop. Observations were recorded on one randomly selected competitive plants from each genotype, in each replication on 10 characters *viz.*, Seedling vigour, Days of 50% flowering, Plant height (cm), Number of Branches per plant, Number of Capsules per plant, Days of maturity. Number of Seeds per capsule, 1000 seed weight, Seed yield per plant and Seed yield per plot. The statistical analysis for genetic variability was done as per the method given by Burton (1952). Heritability in broad sense and genetic advance (Johnson *et al.,* 1955) were calculated.

Results and Discussion

Analysis of variance

The Analysis of variance (ANOVA) worked out for quantitative traits with respect to seed yield and its components in linseed indicated that the mean sum of squares due to genotypes were highly significant for all the characters. This is an indication of existence of sufficient variability for the traits (Table-2).

Genetic variability parameters

The analysis of variance for different characters is presented in (Table-3). Mean performance of 10 characters *viz* ., seedling vigour, days to 50 percent flowering, plant height, number of branches, number of capsules per plant, days to maturity, number of seeds per capsules, 1000 seed weight, seed yield per plant, seed yield per plot, were subjected to analysis of variance for experimental design. Analysis of variance was carried out for 10 characters to partitioning the total variation. The mean sum of squares due to genotypes showed significant differences for all the characters revealed that mean sum of squares due to genotypes were significant for the all the characters under study at 1% level of significance suggesting that the genotypes were genetically variable and considerable amount of variability existed among them. Thus, indicating selection for different quantitative character for linseed improvement.

Genetic parameter

The quantitative measurement of individual character provides the basis for an interpretation of different variability parameter. The estimate of genetic parameters includes coefficient of variation, heritability and genetic advance for all quantitative character studies .These parameter 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 environment conditions. Environmental is non-heritable variation, which is slowly due to environmental effects and varies under different environmental conditions. Estimation of phenotypic and genotypic coefficient of variation for the ten characters studied is presented in Table-3.

Coefficient of variation

The variance measures the variation with in a particular character. But it does not provide any real measure for comparison of variance between different traits. The term “coefficient of variation (cv.)” truly provides a relative measure of variance among different characters. In general, estimates of phenotypic coefficient of variation (PCV) were found to be higher than their corresponding genotypic coefficient of variation (GCV), this was due to environmental component, which was being added to GCV. The estimates of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) for all the ten characters were presented in Table -3.

Genotypic variance ($\sigma^2 g$)

The value of genotypic variance ($\sigma^2 g$) and phenotypic variance ($\sigma^2 p$) are presented in table -3. The genotypic variance was found to be highest for seed yield per plot (20428.11), followed by capsules per plant (583.40), plant height (86.04) and seedling vigour (42.60), while low value was observed in seeds per capsule (0.38).

Phenotypic variance ($\sigma^2 p$)

Phenotypic variance range from 0.86 to 27454.24 and character like seed yield per plot (27454.24) showed high value of phenotypic variance, followed by capsules per plant (667.212), plant height (104.22) and seedling vigour (99.78), while low value was observed in seeds per capsule (0.86).

Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV)

The estimation of genotypic coefficient of variation (GCV) were lower than respective phenotypic coefficient of variation (PCV) indicating less or no influence of environmental factor on the expression of these traits. Seed yield per plant had maximum estimates of both the coefficient of variation, while days to maturity had minimum estimate of both the coefficient of variation.

Genotypic coefficient of variation (GCV)

The genetic coefficient of variation (GCV) was recorded highest for seed yield per plant (34.30), followed by number of capsules per plant (26.16) and seed yield per plot (21.96), while the lowest genetic coefficient of variation was recorded in days to maturity (2.49).

Phenotypic coefficient of variation (PCV)

The phenotypic coefficient of variation (PCV) was recorded highest for seed yield per plant (37.55), followed by number of capsules per plant (27.98) and seed yield per plot (25.45), while low phenotypic coefficient of variation was seen in days to maturity (3.35).

The experimental material exhibited a wide range of variation for all the characters studied, thereby providing a better chance of selecting the desired traits. The PCV and GCV estimates revealed that the differences in magnitude of both the estimates in case of seed yield per plant, number of capsules per plant, seed yield per plot, number of branches per plant, were relatively higher, indicating higher degree of influence of environment. The above results were well supported by similar finding by Nagaraja *et al.* (2009) [17], Vardhan and Rao (2012) [22], Rajanna *et al.* (2014) [18], Singh *et al.* (2015) [19] and Dash *et al.* (2016) [4] who observed wide range of PCV and GCV for seed yield per plant and number of capsules per plant.

Table 1: List of genotypes used in present investigation.

S. No.	Designation	Pedigree	Decoding
1.	IVT (R) 150101	T- 491×T 1193-1	LR 150101 (National check)
2.	IVT (R) 150113	Laxmi-27×EC1387	LR 150113 (Zonal check)
3.	IVT (R) 150102	Bengal-64×Laxmi-27	LR 150102
4.	IVT (R) 150103	SLS- 36×Padmani	LR 150103
5.	IVT (R) 150104	T-397×NDL-2004-05	LR 150104
6.	IVT (R) 150105	LMS-350×EC-4117	LR 150105
7.	IVT (R) 150106	Neelam×CI-1843	LR 150106
8.	IVT (R) 150107	Meera×RLC-32	LR 150107
9.	IVT (R) 150108	RLC-100×T-397	LR 150108
10.	IVT (R) 150109	LCK88062×R-552	LR 150109
11.	IVT (R) 150110	LCK88062×EC-1424	LR 150110
12.	IVT (R) 150111	RL-906×Triveni	LR 150111
13.	IVT (R) 150112	Shubhra × Parvati	LR 150112
14.	IVT (R) 150114	(RLC-29×Laxmi-27) ×R-1871	LR 150114

Table 2: Analysis of variance for different quantitative traits in linseed.

S. No.	Characters	Mean sum squares		
		Replications (d.f. = 2)	Genotypes (d.f.=13)	Error (d.f.= 26)
1	Seedling vigour	24.93	185.00**	57.19
2	Days of 50%flowering	5.36	78.52**	3.20
3	Plant height (cm)	1.41	276.31**	18.18
4	Number of branches per plant	2.61	5.68**	1.36
5	Number of capsules per plant	258.38	1834.03**	83.80
6	Days of maturity	2.45	38.26**	8.12
7	Number of seeds per capsule	0.26	1.61**	0.49
8	1000 seed weight (g)	0.35	4.08**	0.27
9	Number of Seeds per plant	0.70	4.64**	0.29
10	Seed yield per plot(g)	180.96	6831.04**	702.61

** Significant at 1% and * Significant at 5%

Table 3: Genetic parameters for different traits in Linseed

S. No.	Characters	Variance			
		$\sigma^2 g$	$\sigma^2 p$	GCV%	PCV%
1	Seedling vigour	42.60	99.79	7.93	12.13
2	Days of 50% flowering	25.11	28.31	6.35	6.74
3	Plant height (g)	86.04	104.22	14.06	15.47
4	Number of branches per plant	1.44	2.80	18.16	25.34
5	Number of capsules per plant	583.41	667.21	26.16	27.98
6	Days of maturity	10.05	18.16	2.49	3.35
7	Number of seeds per capsule	0.38	0.86	6.99	10.58
8	1000 seed weight (g)	1.27	1.54	16.75	18.45
9	Number of Seeds per plant	1.45	1.74	34.30	37.55
10	Seed yield per plot (g)	20428.11	27454.24	21.96	25.45

GCV = Genotypic coefficient of variation, PCV = Phenotypic correlation Coffiecient, $\sigma^2 g$ & $\sigma^2 p$ genotypic & Phenotypic variance.

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