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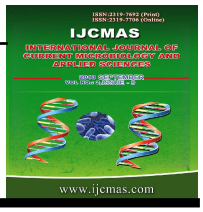

Original Research Article

Genetic variability, heritability and genetic advance of growth and yield components of linseed (*Linum usitatissimum* L.)

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Keywords

Heritability; Genetic advance; GCV; PCV; Secoisolariciresinol diglucoside.

A B S T R A C T

Forty eight linseed (*Linum usitatissimum* L.) genotypes were evaluated during *rabi*, 2010-11 for eleven quantitative 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 forty eight genotypes were significant for all the characters. 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 program, and helps the selection of a desirable breeding method. Heritability and genetic advance are important selection parameters, and selection success is a reflectance of selection response. The characters number of branches per plant, number of capsules per plant, seed yield per plant, seed yield per plot, omega-6-fatty acid and secoisolariciresinol diglucoside (SDG) fatty acid exhibited high genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV). Small differences between GCV and PCV were recorded for all the characters studied which indicated less influence of environment on these characters. The characters plant height, number of branches per plant, number of capsules per plant, 1000 seed weight, yield per plant, omega-6-fatty acid and SDG fatty acid exhibited high heritability coupled with high genetic advance indicating that simple selection could be effective for improving these characters.

Introduction

Linseed (*Linum usitatissimum* L.) is member of the genus *Linum* in the family Linaceae. It is the only agriculturally important species in the family Linaceae, which consists of 13 genera and 300 species (Heywood, 1978). Linseed is unique among oilseeds as it has a high content of Omega-3- fatty acid, alpha linolenic acid (ALA). Linseed contains 35 to 45 % oil with the ALA making up about 57 % of the total fatty acids. Omega-3 fatty acids lower levels of triglycerides in

the blood, thereby reducing heart disease, and also show promise in the battle against inflammatory diseases such as rheumatoid arthritis. Linolenic acid (LA), and Omega-6- essential fatty acid is also found in linseed. Linseed oil contains three times as much Omega -3- fatty acid than Omega-6 -fatty acid. Development of high yielding varieties requires the knowledge of existing genetic variability. The large spectrum of genetic variability in segregating population depends on the amount of the genetic variability among genotypes and offer better scope for selection. The magnitude of heritable variation in the traits studied has immense value in understanding the potential of the genotype for further breeding programme. Assessment of variability for yield and its component characters becomes absolutely essential before planning for an appropriate breeding strategy for genetic improvement. Genetic parameters such as genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) are useful in detecting the amount of variability present in the germplasm. Heritability coupled with high genetic advance would be more useful tool in predicting the resultant effect in selection of the best genotypes for yield and its attributing traits. It helps in determining the influence of environment on the expression of the genotypic and reliability of characters. With the above background information the present investigation was undertaken to study the genetic parameters among the forty eight linseed genotypes.

Materials and Methods

The material for the present study consisted of 48 linseed released varieties including six checks NL-97, PKV NL-260, Padmini, Kartika, Kiran and T-397 obtained from AICRP on Linseed, Kanpur, India. The experiment was laid out in an augmented design with four replications, each replication consisting of 18 blocks including the six checks were repeated in all the blocks. The experiment was conducted in medium black soils under rainfed conditions during *rabi* - 2010 at College of Agriculture, AICRP on Linseed, Nagpur, situated at 305 meters msl and 21° 09′ N latitude and 79° 09′ E longitude, Maharashtra state, India. All recommended agronomic package of practices were followed during the crop growth period for raising good crop. A process for extracting secoisolariciresinol diglucoside (SDG) from de-fatted flax seed will be used as Dobbins *et al.,* (2004), the fatty acid profile will be estimated on HPLC method.

The data were recorded on five randomly selected plants from each line for quantitative traits *viz*., days to 50 per cent flowering, days to maturity, plant height (cm) at maturity, number of branches per plant, number of capsules per plant, 1000 seed weight (g), seed yield per plant, Omega-6- fatty acid, Omega-3- fatty acid, SDG (mg/g) and seed yield per plot.

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^2) and genetic advance as per cent of mean were estimated by the formula as suggested by Burton (1953) and Johanson *et al.,* (1955).

Results and Discussion

Greater variability in the initial breeding material ensures better chances of producing desired forms of a crop plant. Thus, the primary objective of germplasm

conservation is to collect and preserve the genetic variability in indigenous collection of crop species to make it available to present and future generations. The analysis of variance indicated the existence of significant differences among all the hybrids for all the traits studied. Mean performance of forty eight genotypes for all characters are presented in Table 1. The characters studied in the present investigation exhibited low, moderate and high PCV and GCV values (Table 2).

Among the yield characters, highest PCV and GCV values were recorded for number of branches per plant, number of capsules per plant, seed yield per plant, seed yield per plot, Omega- 6- fatty acid and SDG and the lowest PCV and GCV values were recorded for days to 50% flowering, days to maturity and Omega- 3- fatty acid. High phenotypic variations were high genetic variability for different traits and less influence of environment. Therefore, selection on the basis of phenotype alone can be effective for the improvement of these traits. The results are in accordance with the findings of Dayal *et al.* (1975) and Kumar *et al.* (2012). 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.

The estimates of heritability act as predictive instrument in expressing the reliability of phenotypic value. Heritability is a good index of transmission of characters from parents to its progeny. The estimates of heritability help the plant breeder in selection of elite genotypes from diverse genetic population. Therefore, high heritability helps in effective selection for a particular character. Heritability is classified as low (below 30%), medium (30-60%) and high (above 60%). The characters studied in the present investigation expressed medium to high heritability estimates ranging from 57.50 to 100.00 percent. Among the yield characters, broad sense highest heritability was recorded by yield per plot (100.00), number of capsules per plant (99.60), SDG fatty acid (99.22), seed yield per plant (99.10), plant height (98.80), omega- 6- fatty acid (98.50), omega- 3 -fatty acid (94.40), days to 50% flowering (93.00), number of branches per plant (93.00) and 1000 seed weight (85.90) whereas, days to maturity recorded medium heritability value (57.50). High heritability values indicate that the characters under study are less influenced by environment in their expression. The plant breeder, therefore, may make his selection safely on the basis of phenotypic expression of these characters in the individual plant by adopting simple selection methods. High heritability indicates the scope of genetic improvement of these characters through selection. Similar results have been reported by Tewari (1999); Rai *et al.*, (2000); Rama Kant *et al.,* (2005).

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). Genetic advance was high (>20%) for SDG fatty acid (138.80), yield per plot (120.78), omega- 6- fatty acid (61.23), number of

Table.1 Mean performance of genotypes

Character	1	2	3	4	5	6	7	8	9	10	11
Neelam	77.00	120.00	57.35	6.70	77.90	8.39	2.80	249.00	8.09	54.03	6.28
Himalini	82.00	119.00	63.80	9.90	62.35	4.65	2.08	351.00	8.36	54.40	7.49
Chambal	77.50	114.50	62.65	9.30	92.35	6.69	3.55	316.50	13.74	56.84	4.50
LC-54	84.00	118.50	66.80	6.50	59.25	5.45	2.40	379.00	9.87	50.92	4.58
Neela	79.50	111.50	54.45	6.90	60.95	4.41	1.98	533.00	10.96	52.93	9.18
R-552	73.00	110.00	48.95	8.60	106.05	5.68	3.44	361.50	12.83	54.27	10.39
Pusa-2	77.00	116.50	56.00	10.25	80.50	5.72	3.80	434.50	6.93	51.13	19.84
Pusa-3	75.00	116.00	49.10	8.60	96.25	5.65	5.15	501.00	12.85	45.01	7.41
Jawahar-23	68.50	112.00	53.60	4.75	63.05	6.20	2.92	445.50	11.05	51.35	7.52
Garima	72.50	116.00	49.40	7.60	96.00	5.85	3.58	304.50	7.81	57.82	15.10
Padmini	80.00	118.00	61.65	9.60	89.40	6.20	3.85	448.00	8.42	51.49	16.14
Jawahar-1	72.50	116.50	47.90	5.35	59.75	6.74	3.35	280.00	12.50	56.36	18.13
Jawahar-7	73.00	115.00	52.95	4.55	108.8	8.02	5.36	240.50	14.04	55.03	8.18
LC-185	89.00	121.00	47.60	8.60	41.10	3.42	1.13	234.00	11.02	50.60	7.24
Mukta	80.00	118.50	59.15	5.45	63.55	6.63	3.66	610.00	7.86	51.81	3.71
Janki	80.00	114.00	52.50	8.75	106.25	7.30	3.99	432.50	11.90	56.86	6.07
Surbhi	82.50	118.00	51.00	7.30	113.00	4.50	3.82	114.00	11.56	45.78	2.33
JLS-9	64.00	120.00	47.95	9.00	116.95	7.52	4.50	405.50	7.84	51.46	4.17
C-429	82.00	115.500	59.20	11.45	127.75	4.38	5.43	978.00	6.45	55.16	5.12
Sheela	77.00	116.00	58.80	7.70	102.10	5.68	3.80	623.50	9.18	53.97	6.51
Shekhar	70.50	118.50	43.10	6.15	79.20	5.48	2.96	487.00	9.90	56.78	4.26
RL-914	81.00	117.00	67.45	6.25	84.75	5.44	3.11	230.00	8.19	44.63	11.06
Parvati	80.00	122.00	71.40	8.10	103.20	6.20	5.09	521.00	8.51	51.26	8.62
Shubhra	66.00	113.00	44.95	6.00	62.00	6.69	3.02	475.00	15.50	56.30	12.85
Kiran	84.50	116.50	53.65	5.60	52.90	5.63	2.00	108.50	5.58	56.15	4.90
Sharda	66.00	114.00	44.95	6.35	93.35	6.41	5.45	688.50	12.72	57.33	13.27
S-36	82.50	117.00	50.65	7.25	93.10	4.52	2.93	185.00	11.93	51.15	10.31
Gaurav	82.00	121.00	66.65	6.65	67.65	6.52	3.02	233.50	11.16	50.28	3.15
Jeevan	66.50	117.00	49.35	7.45	84.45	5.64	3.88	696.00	12.64	54.03	6.80
Nagarkot	82.00	122.00	59.08	8.35	93.80	4.54	3.69	419.00	9.80	48.64	8.32

Table..1.Contd..

Character	1	2	3	4	5	6	7	8	9	10	11
Shikha	81.50	120.00	62.75	8.35	66.60	5.12	4.36	507.00	10.96	51.01	8.01
Rashmi	82.50	122.00	67.30	9.20	92.80	4.64	4.73	543.00	4.99	44.98	4.36
Suyog	66.50	120.50	46.05	8.30	96.55	6.79	5.65	433.50	6.75	53.80	3.97
Binwa	82.50	120.00	51.30	9.60	82.10	4.55	3.55	177.00	8.88	54.84	13.14
Baner	83.50	122.00	55.65	8.50	112.75	4.40	4.13	326.50	10.18	47.76	11.82
Indira alsi32	77.00	117.00	55.25	8.95	99.10	5.62	6.30	531.00	12.94	53.17	4.98
Laxmi-27	68.00	110.50	49.10	5.60	53.65	7.71	3.70	217.00	11.45	50.59	6.25
Heera	74.00	115.50	61.45	5.85	80.00	5.56	5.70	625.50	9.94	52.22	16.02
Jawahar-1	63.50	117.50	47.70	4.45	79.60	6.56	5.28	452.50	12.50	57.14	17.57
LC-2030	79.50	120.00	60.00	9.70	98.75	5.25	4.60	241.00	8.10	53.58	4.54
Kartika	75.50	114.00	55.52	8.30	132.15	5.09	6.62	738.00	8.33	43.09	4.74
LC-2063	80.00	116.00	64.00	7.25	120.30	5.56	4.65	314.50	8.80	44.98	4.24
RLC-6	78.00	118.00	65.40	6.05	76.30	6.42	2.80	142.50	9.78	52.50	6.43
Him alsi-1	82.50	122.00	57.25	5.95	59.10	5.48	2.74	352.50	12.65	55.96	12.73
Him alsi-2	79.00	122.00	60.75	6.80	74.20	5.74	3.50	142.50	9.46	54.21	3.66
T-397	73.50	114.00	65.45	5.80	81.20	6.02	4.59	641.00	13.87	57.80	14.31
NL-97	78.50	120.00	62.80	6.05	94.20	5.36	3.00	564.50	10.80	53.51	6.53
PKV NL260	73.00	121.5.00	57.20	5.40	85.30	6.70	3.06	741.00	12.74	56.65	9.26
Mean	**76.78**	**117.43**	**56.18**	**7.39**	**85.88**	**5.80**	**3.84**	**416.15**	**10.25**	**52.53**	**8.45**
C.V.	2.14	2.02	1.39	6.07	1.49	6.97	2.98	0.91	2.92	1.76	4.71
F ratio	27.61	3.70	167.66	27.51	528.68	13.14	212.34	5024.50	128.36	34.7	251.61
F Prob.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S.E.	1.16	1.67	0.55	0.31	0.91	0.28	0.08	2.68	0.21	0.65	0.28
C.D. 5%	3.31	4.77	1.57	0.90	2.59	0.81	0.23	7.64	0.60	1.86	0.80
C.D. 1%	4.43	6.37	2.10	1.20	3.45	1.08	0.30	10.20	0.80	2.48	1.07
Range Lowest	63.50	110.00	43.10	4.45	41.10	3.42	1.13	108.50	4.99	43.09	2.33
Range Highest	89.00	122.00	71.40	11.45	132.15	8.39	6.62	978.00	15.50	57.82	19.84

Note: 1=Days to 50% flowering 2=Days to maturity, 3=Plant height, 4=Branches per plant, 5=Capsules per plant, 6=1000 seed weight, 7=Seed yield per plant, 8=Yield per plant, 9=Omega 6 FA, 10=Omega 3 FA, 11=SDG mg/gm

Table.2 Estimation of parameters of variability in linseed for different traits

Character	Range	Mean	GCV	PCV	Heritability	Genetic advance	GAM (%)
Days to 50% flowering	63.50-89.00	76.78	7.84	8.12	93.00	15.32	19.96
Days to maturity	110.0-122.00	117.43	2.35	3.10	57.50	5.53	4.71
Plant height (cm)	43.10-71.41	56.18	12.75	12.83	98.80	18.81	33.48
Branches per plant	4.45-11.45	7.39	22.11	22.92	93.00	4.16	56.28
Capsules per plant	41.10-132.15	85.88	24.35	24.40	99.60	55.12	54.18
1000seed weight	3.41-8.39	5.80	17.18	18.54	85.90	2.44	42.04
Seed yield per plant	1.14-6.62	3.85	30.69	30.83	99.10	3.10	8.64
Yield per plot	108.50-978.00	416.15	45.77	45.77	100.00	502.60	120.78
Omega- 6- fatty acid	4.99-15.50	10.259	23.55	23.55	98.50	6.28	61.23
Omega - 3- fatty acid	43.09-57.82	52.53	7.43	7.43	94.40	9.73	18.53
SDG mg/gm	2.33-19.84	8.46	52.81	53.02	99.22	11.75	138.8

branches per plant (56.28), number of capsules per plant (54.18), 1000 seed weight (42.04), plant height (33.48), genetic advance was moderate (10-20%) for days to 50% flowering and omega- 3- fatty acid and low genetic advance (<20%) for seed yield per plant (8.64) and days to maturity (4.71). The information on genetic variation, heritability and genetic advance helps to predict the genetic gain that could be obtained in later generations, if selection is made for improving the particular trait under study. Almost similar results were reported by Satapathi *et al*. (1987) for capsules per plant and seed yield, Patil *et al*. (1981), Shrivas and Singh (1984), Ingale (1985) and Gupta and Godawat (1984) and Ingale (1985) for 1000 seed weight, Rai *et al*. (1989) for fatty acid profile.

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 (Samadia, 2005).

Thus it is interpreted that the characters *viz*., plant height, number of branches per plant, number of capsules per plant, 1000 seed weight, yield per plot, omega -3- fatty acid and SDG fatty acid were controlled by additive gene action, which could be improved through simple selection methods. The characters showing high heritability with low genetic advance indicated the presence of non-additive gene action. Hence selection could be postponed for these characters or these characters could be improved by

intermating of superior genotypes of segregation population from recombination breeding.

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