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Selection parameters (heritability, genetic advance, correlation and path coefficient) analysis in linseed (*Linum usitatissimum* L.)

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Abstract

The maximum value of heritability and genetic advance were found for number of capsules per plant. Grain yield showed highly significant and positive association with capsule size and 1000 seed weight at both genotypic and phenotypic level and highly significant and negative correlation with both number of seeds per capsules. Days to 50% flowering, plant height, days to maturity, seed yield per plant and number of seeds per capsule had negative direct effect on seed yield.

Keywords: Selection parameters, heritability, genetic advance, correlation, path coefficient, linseed *Linum usitatissimum* L.

Introduction

Linseed (*Linum usitatissimum* L.) is one of the oldest crop cultivated for its seeds and fibres. Almost every part of the linseed plant is utilized commercially either directly or after processing. Linseed oil and meal are the two products provided by the seeds on account of its quick drying properties. Linseed oil is extensively used in industry for the manufacturing of high quality paints and varnishes. The oil content of the seed generally varies from 33 to 45 per cent. About 20 per cent of the total linseed oil is used for edible and domestic purposes and 80 per cent goes for industrial utilization. The oil is also utilized for manufacturing paints, varnishes, oilcloth, linoleum, pad-ink, printers ink, soap etc.

The genus *Linum* is primarily known for its species, *Linum usitatissimum* L., which has been under cultivation since pre historic time and has 30 somatic chromosomes. The somatic chromosome number in the other species of the genus *Linum* is reported to vary from 16 to 86. The oil and protein per cent in linseed varies from 37.8 to 43.2 per cent and 20 to 24.8 per cent, respectively. The residue cake remaining after the oil extraction contains about 9.7 per cent oil, 32 per cent carbohydrate and 32 per cent protein also. It is very rich proteinaceous feed for the livestock and quick growing animals.

Materials & Methods

The experiment consisting of one hundred fifty one strains/genotypes of linseed was conducted at Oilseed Research Farm, Nawabganj, Kanpur is a Randomized Block Design (RBD) with two replications during rabi 2014-2015. The experiment was sown on 30th October, 2014. Each strain/genotype was sown in a plot of 5.0 m long and 2 m wide. Within the plot, plant x plant (P x P) and row x row (R x R) distances were kept 5 cm and 25 cm, respectively. Recommended agronomical practices and plant protection measures were adopted to raise the good crop. Ten plants were taken randomly from each plot for recording the observations. Observations were recorded for eleven characters namely; days to 50% flowering, size of corolla (cm), number of primary branches per plant, plant height (cm), capsule size (cm), days to maturity, number of capsules per plant, number of seeds per capsule, 1000-seed weight (g), oil content (%) and seed yield per plant (g). Path-coefficient analysis was carried out according to Dewey and Lu (1959) ^[10].

Results & Discussion

The estimates of heritability in broad sense and genetic advance in per-cent of mean for all the characters are given in the (Table-1). The maximum heritability estimate was found for

number of capsules per plant (88.10%), followed by plant height (80.60%), days to flowering (79.20%), size of corolla (76.90%), 1000-seed weight (67.60%), seed yield per plant (65.00%), oil content (60.30%), days to maturity (58.70%), seeds per capsule (43.00%) and capsule size (33.00%). It is calculated to be minimum for primary branches per plant (22.90). The maximum value of genetic advance in per-cent of mean has been observed for number of capsules per plant (41.75%), followed by plant height (15.68%), days to flowering (13.58%), days to maturity (7.27%), size of corolla (4.45%), oil content (3.68%), seed yield per plant (1.72%), 1000-seed weight (0.54%), capsule size (0.43%) and number of primary branches per plant (0.40%). The minimum value of genetic advance in per-cent of mean has been noted for number of seeds per capsule (0.29%). These findings were also observed by Awasthi and Rao (2005) [5], Ram Jeet *et al.* (2010) [12] Tiwari *et al.* (2012) [16] and Ahmed *et al.* (2014) [3].

The correlation coefficients have been estimated for all the characters with seed yield and among the characters pairs at genotypic and phenotypic levels. The results are presented in Table-2. Grain yield showed highly significant and positive association with 1000-seed weight (0.340), capsule size (0.264) and number of capsules per plant (0.165) and negative correlation with number of seeds per capsule (-0.238), days to maturity (-0.213) and size of corolla (-0.118) at genotypic level. Grain yield showed highly significant and positive association with 1000-seed weight (0.417), capsule size (0.211) and number of capsules per plant (0.094) and negative correlation with number of seeds per capsule (-0.394), days to maturity (-0.091) and size of corolla (-0.074) at phenotype level. Similar results were also observed by Verma & Singh (2006) [17], Ram Jeet *et al.* (2010) [12], Savita *et al.* (2011) [15] and Tiwari *et al.* (2012) [16].

The days to 50% flowering showed negative and non-significant correlation with number of plant height (-0.06), capsule size (-0.04), number of seeds per capsule (-0.07) and oil content (-0.04), while positive and highly significant with days to maturity (0.18 & 0.15) at genotypic and phenotypic level, while negative and highly significant association with number of capsules per plant (-0.16 and -0.13) both at genotypic and phenotypic levels. Size of corolla has positive and highly significant correlation with capsule size (0.16), number of seeds per capsules (0.13) and oil content (0.15) at genotypic level. Positive correlation of days to 50% flowering, plant height, days to maturity, number of capsule per plant and number of seeds per capsule at both phenotypic and genotypic levels. These results are similar to Ram and Kerketta (2007) [13], Rama kant *et al.* (2008) [14], Dandigadasar (2011) [6, 7, 9] and Gauraha *et al.* (2011) [11].

Negative and highly significant correlation with 1000 seeds weight (-0.20 and -0.14) at both genotypic and phenotypic level. Negative and non-significant correlation has been observed with number of primary branches per plant at genotypic level. Number of primary branches has positive correlation with capsule size, number of seeds per capsule and oil content at genotypic level, positive and highly significant correlation with plant height (0.31) and number of capsules per plant (0.23) at genotypic level. Negative but non-significant correlation was found with days to 50% flowering, size of corolla and days to maturity at both genotypic and phenotypic levels. Plant height has positive and significant correlation with size of corolla (0.14), capsule size (0.53), number of capsules per plant (0.46), number of seeds per capsule (0.11) and oil content (0.25) at both genotypic and

phenotypic levels. These results were also similar to Verma & Singh (2006) [17], Ram and Kerketta (2007), Rama kant *et al.* (2008) [14], Ram Jeet *et al.* (2010) [12], Savita *et al.* (2011) [15] and Tiwari *et al.* (2012) [16].

Positive correlation of number of primary branches at genotypic level. Negative and highly significant correlation has been observed with days to maturity (-0.17) and 1000 seeds weight (-0.34) at genotypic level. Capsule size has positive but non-significant correlation with size of corolla and number of primary branches per plant at phenotypic level while it has negative non-significant and negative correlation with days to 50% flowering at phenotypic level respectively. Negative and highly significant correlation has been observed with days to maturity (-0.26) and 1000 seeds weight at genotypic level. Capsule size has positive and significant correlation with plant height (0.26), number of capsules per plant (0.56), number of seeds per capsules (0.17) and oil content (0.29) at genotypic level. Days to maturity has positive significant correlation with days to 50% flowering (0.15) and 1000-seed weight (0.16) at both phenotypic and genotypic levels. Negative and highly significant correlation has been observed with plant height (-0.12) and number of capsules per plant (-0.20) at both phenotypic and genotypic levels. Number of capsule per plant has negative but significant correlation with days to 50% flowering (-0.13), days to maturity (-0.11) and 1000 seeds weight while it has positive non-significant association with size of corolla and number of seeds per capsules at both genotypic and phenotypic levels. Number of capsule per plant has positive and highly significant correlation with number of primary branches (0.18), plant height (0.37), capsule size (0.27) and oil content (0.18) at both genotypic and phenotypic levels. Awasthi and Rao (2005) [5], Dandigadasar (2011) [6, 7, 9], Gauraha *et al.* (2011) [11] and Bibi *et al.* (2013) [8] were also observed similar trends.

Number of seeds per capsule has negative but non-significant correlation with days to 50% flowering at phenotypic level. Number of seeds per capsule has positive significant correlation with number of primary branches (0.16), capsule size (0.11) and number of capsules per plant (0.28) at both genotypic and phenotypic levels. Negative and highly significant correlation has been observed with 1000-seed weight (-0.19) at genotypic level. 1000-seed weight has negative and non-significant correlation with days to 50% flowering, number of primary branches per plant and oil content at both genotypic and phenotypic levels. Negative and highly significant correlation has been observed with size of corolla (-0.14), plant height (-0.25), capsule size (-0.19), number of capsules per plant (-0.54), number of seeds per capsule (-0.16) and oil content (-0.12) at both genotypic and phenotypic levels. Oil content has positive significant correlation with plant height (0.13) and number of capsules per plant (0.17) at both genotypic and phenotypic levels. Positive correlation of size of corolla, number of primary branches per plant, capsule size, number of seeds per capsule at both genotypic and phenotypic levels. These findings were also observed by Adugna *et al.* (2003) [1], Ahmed and Hussanein (2003) [2], Akbar *et al.* (2003) [4], Awasthi and Rao (2005) [5], Bibi *et al.* (2013) [8].

The genotypic correlation of characters with grain yield has been further partitioned into direct and indirect effects and the results are presented in Table-3. Path coefficient analysis revealed that number of primary branches per plant, number of capsules per plant, oil content, size of corolla and 1000-

seed weight had positive direct effects whereas; days to 50% flowering, plant height, days to maturity, seed yield per plant and seeds per capsule had negative direct effect on seed yield. These findings were also observed by Adugna *et al.* (2003) [1],

Ahmed and Hussanein (2003) [2], Akbar *et al.* (2003) [4], Awasthi and Rao (2005) [5], Dandigadasar (2011) [6, 7, 9], Gauraha *et al.* (2011) [11] and Bibi *et al.* (2013) [8].

Table 1: Heritability and genetic advance analysis for eleven characters in Linseed.

character	Heritability (%)	Genetic advance	Genetic advance % over mean
Days to flowering	79.20	13.58	23.43
Size of corolla (mm)	76.90	4.45	20.32
Number of primary branches/Plant	22.90	0.40	10.73
Plant Height (cm)	80.60	15.68	25.97
Capsule size (mm)	33.00	0.43	8.14
Days to Maturity	58.70	7.27	5.37
Number of capsules/plant	88.10	41.75	80.02
Number of seeds/Capsule	43.00	0.29	3.79
1000-Seed weight (g)	67.60	0.54	9.89
Oil content (%)	60.30	3.68	10.04
Seed yield/plant (g)	65.00	1.72	14.91

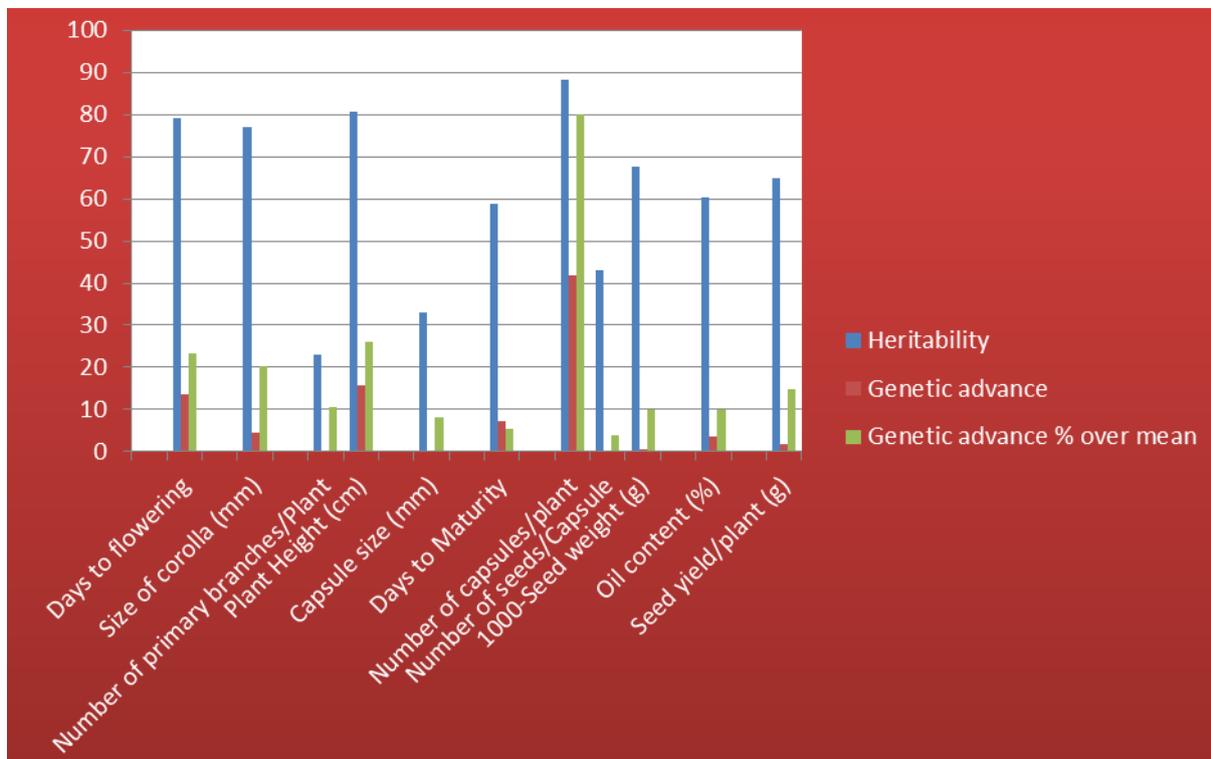


Fig 1.1: Graphical representation of Heritability and genetic advance analysis for eleven characters in Linseed.

Table 2: Genotypic (above diagonal) and phenotypic (below diagonal) correlation coefficient between different character combinations in Linseed.

Character	A	B	C	D	E	F	G	H	I	J	K
A	1.00	0.042	0.041	-0.066	-0.042	0.189**	-0.168**	-0.070	0.085	-0.047	-0.069
B	0.071	1.00	-0.026	0.200**	0.166*	0.103	0.084	0.136*	-0.201**	0.153**	-0.118*
C	-0.033	-0.022	1.00	0.319**	0.117*	-0.041	0.239**	0.043	-0.156**	0.039	0.046
D	-0.050	0.149**	0.081	1.00	0.536**	-0.170**	0.462**	0.114*	-0.348**	0.254**	0.059
E	-0.024	0.051	0.037	0.269**	1.00	-0.267**	0.567**	0.175**	-0.400**	0.290**	0.264**
F	0.152**	0.112	0.022	-0.124*	-0.044	1.00	-0.20	-0.060	0.165**	-0.099	-0.213**
G	-0.133*	0.086	0.189**	0.371**	0.273**	-0.117*	1.00	0.367**	-0.633**	0.183**	0.165**
H	-0.044	0.102	0.167**	0.066	0.116*	0.055	0.285**	1.00	-0.193	0.091	-0.238**
I	0.060	-0.149**	-0.107	-0.253**	-0.192**	0.103	-0.542**	-0.168**	1.00	-0.122*	0.340**
J	-0.029	0.044	0.054	0.132*	0.082	-0.089	0.172**	0.047	-0.112	1.00	0.128*
K	-0.040	-0.074	-0.041	0.032	0.211**	-0.091	0.094	-0.394**	0.417**	0.041	1.00

* Significance at 5% level of significance, ** Significance at 1% level of significance

A = days to 50% flowering, B = size of corolla (cm), C = No. of primary branches per plant, D = Plant height (cm), E = Capsule size, F = Days to maturity, G = No. of capsules per plant, H = No. of seeds/capsule, I = 1000-seed weight, J = Oil content & K = Seed yield/plant.

Table 3: Direct and indirect effects of different characters on yield per plant in Linseed.

Characters	A	B	C	D	E	F	G	H	I	J	K
A	-0.0168	-0.0007	-0.0007	0.0011	0.0007	-0.0032	0.0028	0.0012	-0.0014	0.0008	-0.0697
B	0.0012	0.0285	-0.0008	0.0057	0.0047	0.0029	0.0024	0.0039	-0.0057	0.0044	-0.1182
C	0.0014	-0.0009	0.0338	0.0108	0.0040	-0.0014	0.0081	0.0015	-0.0053	0.0013	0.0467
D	0.0093	-0.0279	-0.0444	-0.1390	-0.0745	0.0237	-0.0643	-0.0159	0.0484	-0.0354	0.0590
E	-0.0118	0.0462	0.0326	0.1491	0.2781	-0.0743	0.1565	0.0488	-0.1113	0.0807	0.2644
F	-0.0334	-0.0182	0.0074	0.0300	0.0471	-0.1763	0.0356	0.0106	-0.0291	0.0175	-0.2139
G	-0.1106	0.0557	0.1571	0.3033	0.3688	-0.1325	0.6554	0.2408	-0.4153	0.1202	0.1659
H	0.0268	-0.0520	-0.0166	-0.0435	-0.0669	0.0229	-0.1401	-0.3813	0.0739	-0.0350	-0.2380
I	0.0676	-0.1598	-0.12243	-0.2766	-0.3182	0.1313	-0.5036	-0.1541	0.7947	-0.0972	0.3401
J	-0.0034	0.0109	0.0028	0.0181	0.0207	-0.0071	0.0131	0.0065	-0.0087	0.0712	0.1285

$R^2 = 0.5814$ Residual effect = 0.6470

A = days to 50% flowering, B = size of corolla (cm), C = No. of primary branches per plant, D = Plant height (cm), E = Capsule size, F = Days to maturity, G = No. of capsules per plant, H = No. of seeds/capsule, I = 1000-seed weight, J = Oil content & K = Seed yield/plant

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