Direct Research Journal of Agriculture and Food Science
Vol. 12(1), Pp. 132-137, April 2024
ISSN: 2354-4147
DOI: https://doi.org/10.26765/DRJAFS60638693
Article Number: DRJAFS60638693

https://journals.directresearchpublisher.org/index.php/drjafs

Study of some Genetic Parameters and Harvesting Dates of Flax Genotypes for Yield and its Related Traits

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Received 2 March 2024; Accepted 20 April 2024; Published 30 April 2024

ABSTRACT: Genetics improvement studies in Flax through variability, heritability and correlation were conducted in Ismailia Experimental station, Ismailia Governorate, Egypt during 2020-2021 and 2021-2022 seasons. The analysis of combined data revealed that the two genotypes Giza 11 and Giza 12 recorded the highest means of most studied traits, while Giza 12 and Sakha 3 were the best genotypes for fiber percentage. Data also showed significant and gradually increases in the mean values of the straw and seed yield and its related traits towards the last harvesting date (160 days after sowing), except for the percentage of fiber, preference was given to the middle harvest date (150 days after sowing). The highest phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) values were found for seed yield/plant (62.44% and 61.38%), seed yield/hectare (61.05% and 61.05%), 1000-seed weight (54.21% and 54.18%), straw yield/plant (38.13% and 37.01%), straw yield/hectare (35.11% and 34.76%) and plant height traits (25.29% and 25.22%), respectively. These results showed the highest values of PCV and GCV, also low gap between PCV and GCV values indicated the presence of high genetic variability and the possibility of effective selection for the traits improvement. All the traits studied exhibited high values of heritability which ranged from 99.89% for 1000 – seed weight to 89.33% for number of capsules/plant. Therefore, the studied traits are less influenced by environment in there expression. Thus, the flax breeder makes selection on the basis of phenotypic expression for these traits. Straw yield per hectare and per plant were exhibited positive significant correlation with plant height, technical length, seed yield/plant, number of capsules/plant and fiber percentage, indicating that maximization of straw yield can be obtained by selection for these traits. Positive significant correlation were recorded between seed yield/hectare and seed yield/plant, number of capsules/plant and 1000–seed weight. Thus, these traits considered selection indices for improving flax seed yield.

Keywords: Flax, genetic parameters, phenotypic coefficient of variation, genotypic coefficient of variation, heritability, correlation

Citation: Sabah, M. A. E.K., Abdelmasieh, W.K.L.,& Omar, T.A.. (2024). Study of some Genetic Parameters and Harvesting Dates of Flax Genotypes for Yield and its Related Traits. Direct Res. J. Agric. & Food Sci.. Vol. 12(1), Pp. 132-137. https://doi.org/10.26765/DRJAFS60638693. This article is published under the terms of the Creative Commons Attribution License 4.0.

INTRODUCTION

Flax is annual winter multi-purpose crop in Egypt grown for commercially production of strong stem fiber and seed oil (Singh *et al*., 2011). Flax is one of the most very important industrial crops of Egypt and its cultivation since more than 5000 years. All parts of the flax plant have extensive and varied uses. There is very important traits in flax oil the high iodine number, thus used this oil in paint and varnish increase capabilities of fast drying comparison with other traditional oils (Bayrak *et al*., 2010). Flax oil is the richest plant source of five major fatty acids palmitic, stearic, oleic, linoleic (omega-6) and linolenic (Omega-3) poly unsaturated fatty acids (Bloedon and Szapary, 2004 and Khan *et al*., 2010). The Fatty acids linolenic (Omega-3) is essential fatty acid as it cannot be synthesized in the human body and may be supplemented directly from foods. Omega-3 very important for lower blood cholesterol level and cardiovascular disorders in human if used in diet successfully (Singh and Marker, 2006). Seed of flax is a good source of lignans that have anticancer properties (Westcott and Muir, 2003). Flax seed is a very important oil seed crop which is the only species in linaceae family with economic values (Tadesse *et al*., 2010). The strong stem fiber of flax provides for linens, textiles, twine and paper. The short fiber is used for pulp to produce special paper for cigarettes, currency notes and art work. The fiber also used for the manufacture of rough textiles like blankets, carpets, mats and material for suits and dresses. Harvest date influence the yield and quality of flax genotypes. Hence, there is an urgent need to increase the productivity of fiber and seed yield by choosing the right time for flax harvesting, (Mohamed *et al*., 1998 and El-Sweify *et al*., 2003) reported that harvesting date governs yield and quality of flax.

The success of any Flax breeding program depending on selection high yield of fiber and oil but, direct selection for yield improvement is not available. Thus it is rather more successful to improve yield through indirect selection of yield genetic parameters. Knowledge about genetic yield potential and genetic variability of different traits is very important for improving flax yield. The traits which have higher range of genetic variability and high heritability may be an effective to improve economic yield (Aytac and Kinaci, 2009). According to Kumar *et al.* (2019) and Upadhyay *et al.* (2019), genetic parameters such the phenotypic coefficient of variability (PCV) and genotypic coefficient of variability (GCV) are crucial for determining the level of variability seen in germplasm. High heritability values demonstrate that the environment has less of an impact on the traits under study when it comes to expression hence, breeders would base selection on phenotypic expression. Prior to developing a breeding strategy for genetic improvement, the estimation of variability for yield and other traits is crucial (Kumar *et al*., 2019). The objectives of the present investigation were to assessment genetic variability and relationship among traits of flax genotypes and the suitable harvesting date to improve flax yield.

MATERIAL AND METHODS

This study was carried out in Ismailia Experimental Station. Ismailia Governorate (Sandy Soil, Organic matter of 0.049 and 0.053 % available nitrogen 6.67 and 6.85 p.p.m, Ec. 0.14 and 0.17 and pH value of 7.51 and 7.42) during 2020/2021 and 2021/2022 seasons, respectively. The assessment will focus on evaluating the variability and harvesting dates of ten different flax genotypes as described in (Table 1). This will involve analyzing the differences in characteristics and growth patterns among the genotypes, as well as determining the optimal time for harvesting each genotype. Field experiments were arranged in a split-plot design with three replications, where harvesting dates in the main-plots and genotypes in sub-plots. The planting date was during the 3rd week of November in the both seasons. The fiber types of flax were planted with 60 kg/fed (fed=feddan= 4200 m^2) at a rate of 8 g/row, and the dual types of flax were planted with 70 kg/fed (10 g/row). Each plot consisted of ten rows, row length of 3m with row to row distance was 20cm. Normal cultural practices for growing flax were applied as recommended. Data at harvest was recorded on ten randomly selected plant for the traits; straw yield/plant (g), plant height (cm) technical length (cm), seed yield/plant (g), number of capsules/plant, number of seeds/capsule and 1000-seed weight. Data of straw yield/hectare (ton), seed yield/hectare (ton) and fiber percentage (%) was recorded on plot basis. The harvesting dates (three dates) 1- 140 days after sowing, 2- 150 days after sowing and 3- 160 days after sowing.

Analysis of variance

The data collected were subjected to analysis of variance, and homogeneity test (Bartlett test) was performed, therefore. The combined analysis of variance for the mean data of two years was performed as per the statistical procedure given by Gomez and Gomez (1984).

Genetic parameters

The variability of genotypes was estimated as follows:

$$\delta^2 g = \frac{\delta^2 v - \delta^2 e}{r}$$

Where, $\delta^2 g$ = genotypic variance, $\delta^2 v$ = mean square of varieties and $\delta^2 e$ = Mean square of error and r = number of replication.

$$\delta^2 ph = \delta^2 g + \delta^2 e$$

Where, $\delta^2 ph$ = phenotypic variance According to Singh and Chaudhary (1999),

Phenotypic coefficient of variance (PCV) % $= \frac{\sqrt{\delta^2 ph}}{x} x100$

Genotypic coefficient of variance (GCV) % $= \frac{\sqrt{\delta^2 g}}{x} x100$

Where, X = mean value of the trait

Heritability in broad sense H^2%

$H^2\% = \frac{\delta^2 g}{\delta^2 ph} x100$

Table 1: Identification and described of the studied flax genotypes.

Genotypes	Pedigree	Type
Sakha I	I. Bombay (USA) X I.148/61 (USA)	Dual
Sakha 2	I. 2348 X Hera	Dual
Sakha 3	I. Belinka X I. 2569	Fiber
Sakha 4	I. Belinka X I. 2069	Fiber
Sakha 5	I. 370 X I. 2561	Oil
Sakha 6	Giza 8 x S.2419/1	Dual
Giza 9	S. 420/140/5/10 X Bombay	Fiber
Giza 10	S. 420/140/5/10 X Bombay	Fiber
Giza 11	Giza 8 x S. 2419/1	Dual
Giza 12	S. 2419/1 x S. 148/6/1	Dual

Table 2: Mean values of straw and seed yields and its components for ten flax genotypes (combined analysis over 2020/2021 and 2021/2022 seasons).

Genotypes	Straw yield/ hectare (ton)	Seed yield/ hectare (ton)	Straw yield/ plant (g)	Plant height (cm)	Technical length (cm)	Seed yield/plant (g)	Number of capsules / plant	Number of seed/ capsules	1000-seed weight (g)	Fiber percentage %
Sakha I	4.854	0.791	2.35	68.28	52.42	0.93	17.04	7.22	8.59	15.39
Sakha 2	4.911	0.821	2.12	68.57	50.24	0.80	15.47	7.43	7.35	15.95
Sakha 3	5.790	0.540	2.44	79.54	59.43	0.72	16.83	8.09	6.13	18.02
Sakha 4	5.423	0.556	2.49	79.83	59.30	0.81	17.48	8.56	6.23	17.79
Sakha 5	4.844	0.962	1.76	60.76	47.60	0.67	18.01	7.28	6.99	13.83
Sakha 6	5.815	0.968	2.56	68.94	50.96	0.93	16.63	7.35	8.35	15.81
Giza 9	6.401	0.613	2.13	76.97	57.01	0.84	17.55	8.05	6.26	17.33
Giza 10	6.274	0.656	2.22	76.46	57.64	0.80	16.64	8.18	6.29	17.46
Giza 11	6.875	1.023	2.74	83.10	61.98	1.23	20.32	7.19	9.89	15.57
Giza 12	7.111	1.048	3.08	84.63	62.74	1.41	21.82	7.38	10.44	18.35
Mean	5.830	0.798	2.39	74.71	55.93	0.91	17.78	7.67	7.55	16.55
L.S.D at 5%	0.190	0.012	0.144	0.911	0.856	0.071	1.038	0.227	0.091	0.161

RESULTS AND DISCUSSION

Effect of different genotypes

Mean values of straw; seed yields and its components for ten flax genotypes are showed in (Table 2). The two genotypes Giza 12 and Giza 11 recorded the highest means for straw yield/ hectare (7.111 and 6.875 ton), seed yield/hectare (1.048 and 1.023 ton), straw yield/plant (3.08 and 2.74(g)), plant height trait (84.63 and 83.10 cm), technical length (62.74 and 61.98 cm), seed yield /plant (1.41 and 1.23 (g)), number of capsules/plant (21.82 and 20.32) and 1000 – seed weight (10.44 and 9.89(g)) respectively. The two genotypes Sakha 3 and Sakha 4 also recorded high values of plant height (79.54 and 79.83 cm), technical length (59.43 and 59.30 cm) and fiber percentage (18.02 and 17.79%), respectively. The two genotypes Giza 9 and Giza 10 recorded high values of straw yield/hectare (6.401 and 6.274 ton) respectively, but Sakha 5 and Sakha 6 recorded high values of seed yield/hectare (0.962 and 0.968 ton) respectively. These results illustrated that Giza 12 and Giza 11 were the best genotypes for most of the studied traits, and the two genotypes Giza 12 and Sakha 3 were the best for fiber percentage. Thus the differences between genotypes may be due to variability in genetic and potentiality. Similar conclusion reported by Mohamed *et al*. (1998) and El-Sweify *et al*. (2003).

Effect of harvesting dates

Estimates of traits mean values under different harvesting dates of flax are presented in (Table 3). The results showed significant and gradually increase in the mean values of the straw and seed yields and its related traits towards the last harvesting date (160 days after sowing). With regard to straw yield trait the increase in straw yield/hectare and straw yield/plant attributed to an increase in metabolites synthesized by plant height, technical length.

Regarding seed yield trait, the results revealed that the increase in seed yield/hectare and seed yield/plant attributed to the increase in dry matter accumulation in capsules and seeds also to the increase in number of capsules and seeds per capsules. The percentage of fibers increased significantly with the middle harvest date (150 days after sowing) and then decreased after that with the delay in the harvest date. This could be attributed to the fact that the more the harvest date was delayed, the more cellulose in the secondary walls of the fibrous cells converted into lignin and thus, the percentage of fibers decreases and also produces

Table 3: Effect of different harvesting dates on flax yield and its components (combined analysis over 2020/2021 and 2021/2022 seasons).

Traits	Harvesting Date			Mean	L.S.D at 5%	L.S.D. at 1%
	140 days	150 days	160 days			
Straw yield/ hectare (ton)	5.000	5.964	6.525	5.830	0.104	0.140
Seed yield/ hectare (ton)	0.729	0.814	0.850	0.798	0.007	0.009
Straw yield/ plant (g)	1.832	2.391	2.939	2.388	0.079	0.106
Plant height (cm)	69.54	75.32	79.27	74.71	0.499	0.671
Technical length (cm)	50.94	56.22	60.64	55.93	0.469	0.630
Seed yield/ plant (g)	0.62	0.91	1.21	0.91	0.039	0.052
Number of capsules/ plant	13.23	18.49	21.62	17.78	0.569	0.764
Number of seeds/ capsule	6.94	7.74	8.34	7.67	0.124	0.167
1000 – seed weight (g)	7.30	7.56	7.80	7.55	0.049	0.066
Fiber percentage %	15.77	17.46	16.42	16.55	0.088	1.185

Table (4): The interaction effects among genotypes (G) and harvesting dates (D) on yield and its components of flax (combined analysis of 2020/2021 and 2021/2022 seasons).

Genotypes (G)	Straw yield /hectare (ton)			Seed yield /hectare (ton)			Straw yield /plant (g)			Plant height (cm)			Technical length (cm)		
	D1	D2	D3	D1	D2	D3	D1	D2	D3	D1	D2	D3	D1	D2	D3
Sakha 1	4.119	4.975	5.468	0.732	0.806	0.835	1.84	2.35	2.87	63.7	68.5	72.7	47.3	52.7	57.3
Sakha 2	4.115	5.266	5.353	0.759	0.838	0.867	1.67	2.20	2.50	63.1	69.5	73.1	46.4	50.2	54.1
Sakha 3	4.845	5.950	6.575	0.506	0.551	0.564	1.80	2.45	3.06	74.4	80.7	83.6	54.1	59.8	64.4
Sakha 4	4.468	5.494	6.308	0.514	0.566	0.587	1.85	2.44	3.17	76.1	80.3	83.1	54.4	59.8	63.7
Sakha 5	3.802	4.956	5.774	0.879	0.973	1.033	1.34	1.75	2.19	57.2	60.6	64.4	43.8	47.9	51.2
Sakha 6	4.774	6.159	6.511	0.883	0.990	1.030	2.11	2.49	3.07	64.1	69.4	73.4	46.5	50.0	56.5
Giza 9	5.702	6.460	7.040	0.577	0.613	0.651	1.39	2.09	2.89	70.0	78.8	82.1	50.9	57.8	62.4
Giza 10	5.476	6.363	6.984	0.605	0.654	0.709	1.81	2.18	2.66	69.4	76.3	83.7	52.2	58.4	62.4
Giza 11	6.226	6.827	7.571	0.914	1.060	1.093	2.06	2.80	3.35	78.3	83.5	87.5	56.4	62.2	67.4
Giza 12	6.476	7.187	7.671	0.926	1.092	1.127	2.44	3.15	3.64	79.2	85.5	89.2	57.7	63.4	67.1
LS. DGD	5%=0.329 1%=0.434			5%=0.021 1%=0.028			5%=0.249 1%=ns			5%=1.578 1%=2.081			5%=1.483,1%=1.955		

Table 4: Contd.

Genotypes (G)	Seed yield/plant (g)			Number of capsules/plant			Number of seed/capsules			1000-seed weight (g)			Fiber %		
	D1	D2	D3	D1	D2	D3	D1	D2	D3	D1	D2	D3	D1	D2	D3
Sakha 1	0.64	0.91	1.24	12.32	17.95	20.86	6.27	7.40	8.00	8.46	8.61	8.72	14.30	16.56	15.31
Sakha 2	0.52	0.83	1.06	11.22	15.00	20.18	6.78	7.43	8.07	7.21	7.36	7.48	14.43	17.27	16.15
Sakha 3	0.50	0.74	0.92	12.27	17.65	20.57	7.33	8.22	8.72	5.87	6.19	6.34	17.41	19.18	17.46
Sakha 4	0.52	0.78	1.13	12.13	17.98	22.33	8.23	8.60	8.83	5.95	6.28	6.45	17.40	18.24	17.72
Sakha 5	0.47	0.68	0.88	13.38	19.05	21.58	6.57	7.20	8.08	5.68	6.03	6.25	13.45	14.48	13.57
Sakha 6	0.63	0.93	1.22	11.47	17.82	20.62	6.45	7.45	8.15	8.07	8.35	8.64	15.17	16.65	15.62
Giza 9	0.55	0.80	1.16	13.05	18.32	21.28	7.33	8.12	8.70	6.03	6.22	6.52	16.52	18.25	17.23
Giza 10	0.48	0.82	1.08	11.65	17.53	20.73	7.53	8.22	8.78	6.09	6.28	6.49	16.77	18.39	17.21
Giza 11	0.92	1.20	1.56	16.58	21.33	23.03	6.18	7.30	8.10	9.65	9.88	10.16	14.68	16.44	15.59
Giza 12	0.97	1.42	1.83	18.23	22.25	24.97	6.72	7.47	7.95	9.99	10.38	10.96	17.52	19.12	18.40
LS. DGD	5%=0.122 1%=0.161			5%=ns 1%=ns			5%=0.394 1%=ns			5%=0.157 1%=0.207			5%=0.278 1%=0.367		

coarser fibers. These results are in agreement with those reported by Mohamed *et al*. (1998) and El-Seweify *et al*. (2003).

Interaction effect

The interaction between the genotypes and harvesting dates are presented in (Table 4). From the analysis of combined data genotypes X harvesting dates interaction showed significant effect on all studied traits. The highest values of straw yield/hectare, seed yield/hectare, straw yield/plant, plant height, technical length, seed yield/plant, number of capsules/plant and 1000 – seed weight obtained from the two genotypes Giza 11 and Giza 12 when harvested at all harvesting dates. The two genotypes Sakha 5 and Sakha 6 also recorded high values of seed yield/hectare (1.033 and 1.030 ton/ hectare) when harvested at the late date (after 160 days from sowing), respectively. With respect to the traits plant height and technical length the two genotypes Sakha 3 and Sakha 4 recorded high values after Giza 11 and Giza 12 under the three harvesting dates. Regarding fiber percentage Sakha 3 and Giza 12 recorded the highest percentage of fiber (19.18% and 19.12%), respectively when harvested at the middle harvest date (after 150 days from sowing).

Genetic parameters

Breeders can increase the desired features in successful breeding by using genetic variation analysis. High levels of genetic variability are indicated by traits with the highest PCV and GCV values, whereas low levels of variability are seen in traits with the lowest PCV and GCV

Table 5: Estimates of genetic parameters and heritability of ten traits for ten genotypes of flax..

Traits	M.S of genotypes	M.S. of error	$\delta^2 g$	$\delta^2 ph$	$\delta^2 e$	PCV%	GCV%	H^2%
Straw yield / hectare (ton)	12.385**	0.083	4.107	4.190	0.083	35.11	34.76	98.02
Seed yield/ hectare (ton)	0.697**	0.0003	0.232	0.232	0.0003	61.05	61.05	99.87
Straw yield/ plant (g)	2.390**	0.048	0.781	0.829	0.048	38.13	37.01	94.21
Plant height (cm)	1067**	1.908	355.031	356.939	1.908	25.29	25.22	99.46
Technical length (cm)	498.912**	1.684	165.743	167.427	1.684	23.13	23.02	98.99
Seed yield / plant (g)	0.952**	0.011	0.314	0.325	0.011	62.44	61.38	96.61
Number of capsules/plant	64.675**	2.476	20.730	23.206	2.476	27.10	25.61	89.33
Number of seeds/ capsules	4.369**	0.119	1.417	1.536	0.119	15.18	15.51	92.25
1000-seed weight (g)	50.256**	0.019	16.746	16.765	0.019	54.21	54.18	99.89
Fiber percentage %	37.892	0.059	12.611	12.67	0.059	21.51	21.46	99.53

values. High genetic variability suggests that there may be a chance for successful selection to improve the qualities. Furthermore, the characteristics with high heritability values showed that the environment had less of an impact on the expression of the characteristics under investigation. Thus, the flax breeder may select on the basis of phenotypic expression. Variance components estimates, phenotypic (PCV) and genotypic (GCV) coefficient of variability and heritability (H^2%) for ten traits of flax genotypes are showed in (Table 5). The results indicated that genotypic $\delta^2 g$ variance and phenotypic $\delta^2 ph$ variance gave almost nearly similar values, which means that the phenotype expression of genotype and increase the chance of selection.

The highest PCV and GCV values were recorded for seed yield/plant (62.44% and 61.38%) followed by seed yield/hectare (61.05% and 61.05%), 1000 – seed weight (54.21 % and 54.18%), straw yield/plant (38.13% and 37.01%), straw yield/hectare (35.11% and 34.76%), number of capsules/plant (27.10% and 25.61%) and plant height trait (25.29% and 25.22%) respectively. Similar result was reported by Kumar *et al*. (2019) and Upadhyay *et al*. (2019) for seed yield/plant and number of capsules/plant. High estimates of PCV and GCV for seed yield trait in linseed have also been previously reported by Tadesse *et al*. (2010) and Mizra *et al*. (2011). The observed low range between PCV and GCV for all traits, which gave almost nearly similar values, revealed possibility of effective selection for the traits improvement. Many investigators studied PCV, GCV and heritability Mirza *et al*. (2011), Abdul Nizar and Mulani (2015), Gemechu and Gudeta (2020) and Mengistu *et al*. (2022). The results in (Table 5) indicated that all traits studied exhibited high values of heritability which ranged from 99.89% for 1000-seed weight trait to 89.33% for number of capsules/plant. Therefore, high heritability helps in the effective selection of traits studied. Also, these high values of heritability and the low gap between PCV and GCV means that the studied traits are less influenced by environment in their expression. Therefore, the flax plant breeder makes selection on the basis of phenotypic expression for these traits. Abo-kaied *et al*. (2006), Abo El-Komsan *et al*. (2017) and singh *et al*. (2019) found high heritability for the studied traits of flax.

Correlation studied

Improvement for target traits may be achieved by indirect selection via other traits which are more related with straw and seed yields. The trait which showed high and positive correlation with straw and seed yield of flax considered selection indices for improving these traits. The results presented in (Table 6) revealed that straw yield/hectare exhibited significant and positive correlation with straw yield/plant, plant height, technical length, seed yield/plant, number of capsules/plant and fiber percentage, these results revealed that maximization of straw yield/hectare can be obtained by selection for these traits. These results are in agreement with Abo-Kaied *et al*. (2006) and Abo El-Komsan *et al*. (2017).

Also, significant and positive association were recorded between seed yield/hectare and seed yield/plant, number of capsules/plant and 1000-seed weight. Straw yield/plant showed positive and significant correlation with plant height, technical length, seed yield/plant, number of capsules/plant, 1000-seed weight and fiber percentage. The plant height trait had positive significant correlation with technical length, seed yield/plant, number of capsules/plant and fiber percentage. Seed yield/ plant exhibited positive and highly significant correlation with number of capsules/ plant and 1000-seed weight. These results revealed that number of capsules and 1000-seed weight are the main components and the selection indices for improving seed yield/ plant. Fiber percentage was from the main traits of flax, this trait showed positive and significant association with straw yield/hectare, straw yield/plant, plant height, technical length. Therefore, selection for plant height, technical length and straw yield/plant will improve both straw yield/hectare and fiber percentage. Also, selection for number of capsules/plant and 1000- seed weight will improve seed yield/plant and

Table 6: Correlation coefficients for ten traits of flax.

Traits	Straw yield/ hectare	Seed yield/ hectare	Straw yield/ plant	Plant height	Technical length	Seed yield/ plant	Number of capsules/ plant	Number of seeds/ capsules	1000 seed weight
Straw yield/hectare (ton)	1.000								
Seed yield/hectare (ton)	0.216	1.000							
Straw yield/plant (g)	0.687**	0.318	1.000						
Plant height (cm)	0.818**	-0.157	0.761**	1.000					
Technical length (cm)	0.810**	-0.152	0.738**	0.988**	1.000				
Seed yield/plant (g)	0.718**	0.636**	0.855**	0.595**	0.590**	1.000			
Number of capsules/plant	0.705**	0.564**	0.665**	0.572**	0.622**	0.847**	1.000		
Number of seeds/capsules	0.065	-0.876	-0.108	0.381	0.369	-0.436	-0.303	1.000	
1000-seed weight (g)	0.493	0.751**	0.782**	0.357	0.347	0.934**	0.686**	-0.666	1.000
Fiber percentage %	0.548**	-0.505	0.529**	0.793**	0.753**	0.229	0.173	0.678**	-0.018

per hectare. Singh *et al*. (2015) and Abdul Nizar and Mulani (2015) found positive correlation of number of capsules/plant, plant height with seed yield of linseed. Also, Dabalo (2020) found positive association between seed yield/plant, plant height and seed yield/fed.

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