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GENETIC VARIABILITY AND INTERRELATIONSHIPS OF SEED YIELD AND YIELD COMPONENTS IN LINSEED (*Linum usitatissimum* L.)

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SUMMARY

In this study, we investigated the correlations among seed yield and yield components and direct and indirect effects of the yield components on seed yield in linseed, *Linum usitatissimum* L. We conducted replicated experiments during 2 consecutive years of rabi seasons, 2010-11 (S-I) and 2011-12 (S-II) involving 18 dual-purpose type linseed genotypes to assess genetic variation for seed yield and yield components, quantify interrelationships among them, and determine direct and indirect effects of yield components on seed yield through path coefficient analysis to identify traits for indirect selection of seed yield. Highly significant ($P \leq 0.01$) genotype × environment interaction was observed for seed yield/plot and the seed yield components capsules/plant, 1000-seed weight, biological yield/plot, straw yield/plot, days to flower initiation, days to maturity, plant height, technical height, number of primary branches/plant and number of secondary branches/plant, indicating substantial environmental influence on these traits for these genotypes. Data for these traits were analyzed separately for each year revealing significant ($P \leq 0.01$) differences among genotypes at both years for each of these traits. Highly significant and positive phenotypic correlations with seed yield/plot were found for biological yield/plot and straw yield/plot in both the seasons. Path coefficient analyses revealed that biological yield/plot had the greatest positive direct effect on seed yield/plot in both the seasons. Ample genetic variability was present among the linseed genotypes studied to allow breeding improvement of seed yield. Selection for biological yield/plot followed by capsules/plant and seeds/capsule would be the most effective means of indirectly selecting for higher seed yield within these genotypes.

Key words: Linseed, genetic variability, path coefficient, seed yield, indirect selection, *Linum usitatissimum* L.

Key findings: The results from this experiment demonstrate the wide variability for the characters with strong effects upon productivity. Selection for biological yield/plot followed by capsules/plant and seeds/capsule would be the most effective means of indirectly selecting for higher seed yield within these genotypes. Correlation and path coefficient analyses among biomass yield and seed yield, indicated that, at least within the linseed genotype studied it would be possible to breed linseed genotypes with enhanced biomass yielding ability and sufficient seed production capability for their commercial cultivation.

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INTRODUCTION

Linseed, also known as flax/Alsi (*Linum usitatissimum* L., 2n = 2x = 30) is a member of the genus *Linum* in the family Linaceae. It is an annual self-pollinated crop that is commercially grown as a source of stem fibre and seed oil. The species is believed to have originated in either the Middle East or Indian regions (Vavilov, 1951) and spread throughout Asia and Europe, prior to its introduction into the New World (Soto-Cerda *et al*., 2013). Divergent selection applied over thousands of years has resulted in fibre and linseed types which are the same species but differ considerably in morphology, anatomy, physiology and agronomic performance (Diederichsen and Ulrich, 2009). Fibre flax cultivars are taller and less branched and are grown in the cool-temperate regions of China, the Russian Federation and Western Europe (Soto-Cerda *et al.*, 2013). Oilseed type flax plants (linseed) are more branched and shorter than the fibre type and are grown over a wider area in continental climate regions of Canada, India, China, the United States and Argentina (Soto-Cerda *et al*., 2013). Every part of the linseed plant is utilized commercially either directly or after processing. Oil content in seeds generally varies from 33-45%, 24% crude protein, containing high levels of dietary fibers and micronutrients. Flax seeds contain relatively large amounts of α-linolenic acid, an omega-3 fatty acid, which is considered essential for human health. Flax seed oil is utilized for the fabrication of various biodegradable products such as high quality drying oil, paints, varnishes and linoleum flooring. The residue cake remaining after the oil extraction contains about 3% oil and 36% protein, which is a very rich proteinaceous feed for livestocks and quick growing animals. Flax is an important crop worldwide, with Canada leading the world in production and export of its oil. The current worldwide acreage is only 2.2 M ha, whereby the European Union (EU) member countries contributed 10% of the total production of 1.9 M t seed (Anonymous, 2012). India is an important linseed growing country in the world ranking second in area (16%) after Canada, Whereas, in terms of productivity India (317.4 kg/ha) is far behind to USA (3389.2 kg/ha), Egypt (1333.3 kg/ha), Canada (1197.3 kg/ha), China (1029.4 kg/ha) and Russia (786.8 kg/ha) (Anonymous, 2012). In Himachal Pradesh total area under linseed is 0.0018 M ha with a total production of 0.0004 M t with 225.0 kg/ha average productivity (Anonymous, 2010-11).

The key for success of any genetic breeding program lies in the availability of genetic variability for desired traits. Genetic resource through global exploration, introduction, characterization and evaluation will provide strong base for development of elite varieties by various improvement methods. Knowledge of the nature of genetic variability and interrelationships among seed yield and yield components would facilitate breeding improvement for these traits. Correlation analysis can be used to measure the relationships among traits. Correlations provide only limited information because they disregard complex interrelationships among traits. Accordingly, they must be used with caution in making decisions regarding indirect selection criteria (Kang, 1994; Board *et al*., 1997). A path coefficient is a standardized, partial regression coefficient that measures the direct influence of one trait upon another trait and permits the separation of a correlation coefficient into components of direct and indirect effects for a set of a priori cause-and-effect interrelationships (Dewey and Lu, 1959). To determine the direct and indirect effects of seed yield components on seed yield, it is essential to compute correlations of the yield components among themselves and with seed yield. Several studies including perennial grasses (Dewey and Lu, 1959; Das *et al*., 2004; Wu *et al*., 2006) have demonstrated that partitioning correlation coefficients into direct and indirect effects provides more useful information. However, limited information exists on correlation coefficients among seed yield and yield components and the relative importance of direct and indirect effects of seed yield components on seed yield in linseed. The objectives of this study were to (1) assess genetic variability of seed yield and yield components, and (2) determine phenotypic correlation coefficients among seed yield and yield components, (3) partition the correlation through path coefficient analysis to determine the relative importance of direct and indirect effects of the yield components on seed yield in linseed.

MATERIALS AND METHODS

Plant material and experimental site

A total of 18 genotypes of linseed were used in the present study (Table 1). All the 18 genotypes, including 3 checks, Nagarkot, Jeewan and Him Alsi-2, of linseed were raised at the experimental farm of the Department of Crop Improvement, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur (H.P.), India, during 2 consecutive years of *rabi* seasons, 2010-11 (S-I) and 2011-12 (S-II), for recording yield, yield components and various morphological characters. The experimental site is located at 1290.8 m amsl and at 32^{o}8' N latitude and 76^{o}3' E longitude. Agro-climatically, the location represents the mid-hill zone of Himachal Pradesh (Zone-II) and is characterized by humid sub-temperate climate with high rainfall (2,693 mm). The soils are clay loam to silty clay loam in texture. The reaction of soil is acidic with pH ranging from 5.0 to 5.6. The records of environmental parameters like temperature, rainfall and humidity were diverse in the 2 years under study.

Experimental design and layout

At 2 seasons, experimental layout was a randomized complete block design with 2 replications. Plot size was 2.5 m^2 (4 rows, 2.5 m long and 25 cm row spacing). A pre-sowing irrigation was given to ensure proper germination. The experimental field was well prepared and FYM was added before sowing. The recommended dose of fertilizer (50 kg N, 40 kg P_2O_5 and 20 kg K_2O/ha) was applied. Half dose of nitrogen and full dose of phosphorous and potash was applied as basal and the remaining half nitrogen was top dressed after 2 months of sowing. Irrigation was given whenever required and regular weeding was done to keep the trial free from weeds.

Table 1. List of linseed genotypes and their parentage used in the study.

No.	Genotype	Parentage
1.	KL-225	K2 × EC-23239
2.	KL-226	Aoyagi × JRF-2
3.	KL-227	Flak-1 × Janaki (DP)
4.	KL-228	Polf-22 × KL-31
5.	KL-229	Polf-16 × KL-31
6.	KL-230	Aoyagi × RL-33-4
7.	KL-231	Polf-16 × KL-1
8.	KL-232	Polf-38 × Janaki
9.	KL-233	Flax purple × Gaurav
10.	KL-234	Polf-22 × Jeewan
11.	KL-235	Polf-22 × Aoyagi
12.	KL-236	Jeewan × Janaki
13.	KL-237	Aoyagi × Jeewan
14.	KL-238	Aoyagi × Nagarkot
15.	KL-239	Polf-27 × RL-33-4
16.	Nagarkot	New River × LC-216
17.	Jeewan	Sumit × LC-216
18.	Him Alsi-2	EC-21741 × LC-216

Recording of observations

Data on seed yield and yield components were collected during both the years from 5 randomly selected plants from the middle 2 rows of each plot excluding the 2 end plants from each row. Observations were recorded on: (1) flowering (days to flower initiation) (2) maturity (days to 75%) (3) plant height (4) technical height (5) number of primary branches/plant (6) number of secondary branches/plant (7) capsules/plant (8) seeds/capsule (9) 1000-seed weight (10) biological yield/plot (11) straw yield/plot (12) harvest index (13) seed yield per plant. Days to flower initiation, days to 75% maturity, seed yield/plot, biological yield/plot and straw yield/plot, which were recorded on plot basis. Thousand-seed weight was measured from a random sample of 1000-seeds from the total amount of seed obtained from each of the 5 selected plants per plot. Harvest index was calculated by dividing seed yield/plot by biological yield/plot.

Statistical analysis

Plot mean values were determined for all traits and these mean values were used in the analysis of variance (ANOVA) to test genotypic differences and the significance of genotype × environment interaction effects. Separate ANOVA's were obtained for each year for traits with significant genotype × environment interactions. Correlation and path coefficient analyses among the seed yield and yield components were done using standard methods (Dewey and Lu, 1959; Kang, 1994). Because seed yield is the complex outcome of different traits, it was considered as the effect (response) variable or trait, while all other traits were considered as causal (predictor) variables in the cause-and-effect relationship required for path coefficient analysis. The statistical analysis was performed by statistical software WINDOWSTAT 8.0 version.

RESULTS AND DISCUSSION

Analysis of Variance

Highly significant genotypic differences were found for all the traits studied in both the seasons except for seeds per capsule and harvest index in S-I and number of primary branches/plant and number of secondary branches/plant in S-II. Significant variation for all the characters was also observed by earlier workers (Payasi *et al*., 2000; Diederichsen and Fu, 2008). The genotype × environment interaction was highly significant ($P \leq 0.01$) for all traits except for seeds per capsule and harvest index, suggesting that the relative genotypic values for these traits changed significantly over the years. Therefore, no pooled analysis was possible. Moreover, genotypes responded differently to change in the environmental conditions at the 2 seasons, as genotype × environment interaction mean squares were highly significant ($P \leq 0.01$) for all the traits (Table 2). This indicates that experiments at several environments are required for evaluating the diversity in linseed germplasm.

Correlation between characters

Correlations for seed yield/plot and yield components from the S-I and S-II are given in Table 3. Highly significant and positive correlations with seed yield/plot were found for biological yield/plot [r = 0.68** (S-I) and 0.62**(S-II)] and straw yield/plot [r = 0.65** (S-I) and 0.61** (S-II)] in both the seasons. Correlation of seed yield/plot with plant height (r = 0.29*) was positive and significant only in S-I, while correlations of seed yield/plot with harvest index (r = 0.55**) and capsules/plant (r = 0.36**) were positive and significant only in S-II. Significant positive correlation of capsules per plant with seed yield per plot has been reported earlier by different workers (Dewan *et al*., 1992; Muduli and Patnaik 1994; Rashid *et al*., 1998; Muhammad Akbar *et al*., 2001).

Table 2. Univariate analysis of variance (ANOVA) for tests of significance of differences among genotypes, environments and their interaction, for 13 traits in a collection of 18 linseed genotypes evaluated in 2 seasons during 2010-2012.

No.	Characters	S-I		S-II		Pooled over the seasons			
		Mean Squares							
	Source	Genotypes	Error	Genotypes	Error	Genotypes	Environments	Genotype x Environment (g x e)	Pooled error
	df	17	34	17	34	17	1	17	68
1.	Days to flower initiation	8.35**	0.34	19.50**	1.11	15.21	4988.48	12.64**	0.73
2.	Days to 75% maturity	7.56**	0.96	17.49**	0.001	8.80	9222.26	16.26**	0.48
3.	Plant height (cm)	31.82**	5.88	77.09**	15.97	74.60	9270.37	34.32**	10.92
4.	Technical height (cm)	29.16**	9.02	49.06**	11.10	42.15	4620.38	36.08**	10.06
5.	No. of primary branches/plant	0.27**	0.09	0.08	0.08	0.17	8.78	0.18**	0.08
6.	No. of secondary branches/plant	0.81**	0.27	0.12	0.11	0.41	0.23	0.52**	0.19
7.	Capsules/plant	14.58**	3.87	9.49**	1.58	9.02	1838.51	15.06**	2.73
8.	Seeds/capsule	0.24	0.23	0.30**	0.10	0.26	8.73	0.29	0.17
9.	1000-seed weight (g)	0.78**	0.001	1.55**	0.0003	1.98**	0.0012	0.36**	0.0007
10.	Seed yield/plot (g)	6853.40**	528.73	16198.26**	1953.49	12492.72	882918.75	10558.95**	1241.11
11.	Biological yield/plot (g)	98137.25**	25490.19	166190.09**	13011.98	148905.50	8732445.37	115421.84**	19251.09
12.	Straw yield/plot (g)	28860.68**	7129.30	75765.69**	4214.38	62115.47	1521781.48	42510.89**	5671.84
13.	Harvest index (%)	32.49	20.56	41.82**	10.74	47.42	70.29	26.90	15.65

* & ** indicate significant at *P* value of 0.05 and 0.01 levels, respectively.

Table 3. Phenotypic correlation coefficients among seed yield and yield components of 18 linseed genotypes grown at both the seasons.

Characters		Days to 75% maturity	Plant height	Technical height	No. of primary branches/plant	No. of secondary branches/plant	Capsules/ plant	Seeds/ capsule	1000-seed weight	Biological yield/ plot	Straw yield/ plot	Harvest index	Correlation with seed yield /plot
Days to flower initiation	S-I	-0.20	0.38**	0.20	-0.32*	-0.45**	-0.11	-0.20	-0.34*	0.00	-0.13	-0.10	-0.15
	S-II	0.52**	0.05	0.06	0.12	0.12	0.33*	0.13	-0.14	-0.02	0.08	-0.09	-0.07
Days to 75% maturity	S-I		-0.25	-0.22	-0.06	0.18	0.03	0.02	0.06	-0.28*	-0.13	0.10	-0.25
	S-II		0.07	-0.00	-0.11	-0.07	-0.21	-0.13	0.37**	-0.32*	-0.30*	-0.28*	-0.53**
Plant height	S-I			0.52**	-0.19	-0.002	-0.09	0.05	0.32*	0.45**	0.31*	-0.25	0.29*
	S-II			0.76**	-0.03	0.14	0.06	0.19	0.08	0.35**	0.46**	-0.07	0.21
Technical height	S-I				-0.07	-0.26	-0.27*	-0.11	0.30*	0.13	0.32*	0.02	0.16
	S-II				-0.11	-0.03	0.02	0.20	-0.03	0.25	0.42**	0.08	0.24
No. of primary branches/ plant	S-I					0.17	0.46**	-0.03	-0.04	-0.14	-0.10	0.08	-0.09
	S-II					0.16	0.25	0.04	0.10	-0.08	-0.13	0.16	0.04
No. of secondary branches/ plant	S-I						0.53**	0.15	0.07	0.02	-0.10	-0.07	-0.05
	S-II						0.56**	0.05	-0.09	0.12	0.07	0.06	0.15
Capsules/ plant	S-I							0.07	-0.13	-0.17	-0.33*	-0.10	-0.28*
	S-II							0.23	-0.26	0.18	0.26	0.23	0.36**
Seeds/ capsule	S-I								0.04	0.29*	0.11	-0.12	0.27
	S-II								-0.07	0.32*	0.37**	-0.05	0.22
1000- seed weight	S-I									0.05	0.07	0.11	0.15
	S-II									-0.13	-0.13	-0.18	-0.28*
Biological yield/ plot	S-I										0.74**	-0.60**	0.68**
	S-II										0.88**	-0.30*	0.62**
Straw yield/ plot	S-I											-0.23	0.65**
	S-II											-0.20	0.61**
Harvest index	S-I												0.16
	S-II												0.55**

* Significance at 0.05 level of probability; ** Significance at 0.01 level of probability
S-I: Seasons-1 (rabi 2010-11) & S-II: Seasons-2 (rabi 2011-12)

On the other hand, correlation of seed yield/plot with capsules/plant (*r* = -0.28*) was negative and significant only in S-I, while correlations of seed yield/plot with days to 75% maturity (*r* = -0.53**) and 1000- seed weight (*r* = -0.28*) were negative and significant only in S-II.). Muduli and Patnaik (1994) reported that 1000-seed weight was negatively correlated with seed yield which is in confirmation with the results of this study.

Among the yield components, significant positive correlations between biological yield/plot and straw yield/plot were found in both the seasons, on the other hand, biological yield/plot revealed significant negative correlations with harvest index in both the seasons. Significant positive correlation of plant height with 1000- seed weight, biological yield/plot and straw yield/plot was found only in S-I, while a significant negative correlation between capsules/plant and straw yield/plot was also found in S-I. On the other hand, days to 75% maturity had significant positive correlation with 1000-seed weight, whereas it had significant negative association with biological yield/plot, straw yield/plot and harvest index only in S-II. Significant positive correlations among different characters have also been reported earlier by different workers such as for number of branches/plant and capsules/plant (Pal *et al.*, 2000; Chimurkar *et al*., 2001).

Path coefficient analysis

Correlation were analyzed further by path coefficient technique, which involves partitioning correlation coefficient into direct and indirect effects via other traits. Results of the path coefficient analyses for both the seasons are given in Table 4. Biological yield/plot had the greatest positive direct effect on seed yield/plot in both the seasons. This trait also had significant positive correlation with seed yield in both the seasons indicating that selection for biological yield/plot would indirectly select for higher seed yield. Harvest index had the second highest positive direct effect on seed yield at both the seasons, however, the correlation coefficient of this trait with seed yield was positive and significant only at S-II. Therefore, harvest index cannot be generalized as a trait for indirect selection for higher yield. Nagaraja *et al*. (2009) also revealed that 1000-seed weight exhibited direct effect on seed yield/plant followed by harvest index and days to flowering which is in confirmation with the results of present study. Muhammad Akbar *et al.* (2003) in a similar study on path coefficient analysis revealed that the number of capsules per plant had highest direct effect followed by plant height, 1000-seed weight and number of branches/plant on seed yield. Gauraha and Rao (2011) revealed that number of capsules/plant showed the higher and positive direct effect on seed yield. In order to identify a trait as an indirect selection criterion for seed yield through path coefficient, the trait should have positive direct effect on seed yield as well as significant positive correlation with seed yield. Identifying a trait as an indirect selection criterion based solely on positive direct effect and disregarding the nature and magnitude of correlation of that trait with seed yield would be misleading. Straw yield/plot had a negative direct effect in S-I and a positive direct effect in S-II on seed yield. However, straw yield/plot had high positive indirect effect on seed yield through biological yield/plot in both the seasons. In S-I significant positive correlation of plant height with seed yield/plot was mainly due to high positive indirect effects via biological yield/plot. Significant correlations of capsules/plant in S-I and 1000-seed weight in S-II with seed yield/plot, in spite of their low positive direct effects were negative, which were mainly due to their high negative indirect effects via biological yield/plot and harvest index. In S-II, significant negative association of days to 75% maturity with seed yield/plot in spite of its low negative direct effect was mainly, due to its negative indirect effects via biological yield/plot and harvest index. Significant positive correlation of plant height with seed yield/plot was mainly due to high positive indirect effects via biological yield/plot only in the S-II.

In conclusion, ample genetic variability exists in the linseed germplasm studied for improvement of seed yield and the yield components. Results from correlation and path coefficient analyses indicated that seeds/capsule showed significant correlations with biological yield and high indirect effects for both the years through biological yield/plot.

Table 4. Direct and indirect effects of component traits on seed yield per plot over the 2 seasons.

Characters		Days to flower initiation	Days to 75% maturity	Plant height	Technical height	No. of primary branches/plant	No. of secondary branches/plant	Capsule/ plant	Seeds/ capsule	1000- seed weight	Biological yield/plot	Straw yield/ plot	Harvest index
Days to flower initiation	S-I	-0.178	0.035	-0.067	-0.038	0.057	0.080	0.019	0.036	0.060	-0.0001	0.023	0.018
	S-II	0.064	0.033	0.003	0.004	0.007	0.008	0.021	0.008	-0.009	-0.001	0.005	-0.006
Days to 75% maturity	S-I	-0.002	0.010	-0.003	-0.002	-0.001	0.002	0.0004	0.0002	0.001	-0.003	-0.001	0.001
	S-II	-0.040	-0.078	-0.005	0.0003	0.008	0.006	0.016	0.010	-0.029	0.025	0.023	0.022
Plant height	S-I	0.014	-0.009	0.037	0.019	-0.007	-0.0001	-0.003	0.002	0.012	0.017	0.011	-0.009
	S-II	0.0002	0.0003	0.004	0.003	-0.0001	0.001	0.0002	0.001	0.0003	0.002	0.002	-0.0003
Technical height	S-I	0.006	-0.006	0.015	0.029	-0.002	-0.008	-0.008	-0.003	0.009	0.004	0.009	0.001
	S-II	-0.003	0.0002	-0.033	-0.043	0.005	0.002	-0.001	-0.009	0.001	-0.011	-0.018	-0.003
No. of primary branches/plant	S-I	0.013	0.002	0.008	0.003	-0.041	-0.007	-0.019	0.001	0.001	0.006	0.004	-0.003
	S-II	-0.004	0.004	0.001	0.004	-0.037	-0.006	-0.009	-0.001	-0.004	0.003	0.005	-0.006
No. of secondary branches/plant	S-I	0.044	-0.017	0.0002	0.026	-0.016	-0.098	-0.051	-0.015	-0.006	-0.001	0.010	0.007
	S-II	0.0002	-0.0001	0.0003	-0.0001	0.0003	0.002	0.001	0.0001	-0.0002	0.0002	0.0001	0.0001
Capsule/plant	S-I	-0.004	0.001	-0.003	-0.010	0.017	0.019	0.038	0.003	-0.005	-0.006	-0.012	-0.004
	S-II	-0.002	0.001	-0.0003	-0.0001	-0.001	-0.003	-0.005	-0.001	0.001	-0.001	-0.001	-0.001
Seeds/capsule	S-I	0.002	-0.0002	-0.0004	0.001	0.0002	-0.001	-0.001	-0.008	-0.0003	-0.002	-0.001	0.001
	S-II	-0.003	0.003	-0.005	-0.005	-0.001	-0.001	-0.006	-0.026	0.002	-0.008	-0.009	0.001
1000- seed weight	S-I	0.024	-0.004	-0.023	-0.022	0.003	-0.005	0.009	-0.003	-0.072	-0.004	-0.005	-0.008
	S-II	-0.001	0.002	0.0003	-0.0001	0.0004	-0.0003	-0.001	-0.0003	0.004	-0.001	-0.001	-0.001
Biological yield/plot	S-I	0.0004	-0.364	0.590	0.177	-0.184	0.019	-0.219	0.379	0.066	1.319	0.972	-0.789
	S-II	-0.014	-0.264	0.292	0.204	-0.063	0.099	0.150	0.270	-0.105	0.832	0.733	-0.252
Straw yield/plot	S-I	0.019	0.019	-0.045	-0.047	0.015	0.015	0.048	-0.017	-0.011	-0.107	-0.146	0.034
	S-II	0.002	-0.007	0.011	0.009	-0.003	0.002	0.006	0.009	-0.003	0.021	0.024	-0.005
Harvest index	S-I	-0.092	0.089	-0.223	0.021	0.071	-0.067	-0.095	-0.109	0.097	-0.546	-0.212	0.913
	S-II	-0.074	-0.226	-0.055	0.063	0.125	0.047	0.188	-0.037	-0.142	-0.243	-0.157	0.803
Correlation with seed yield/plot	S-I	-0.154	-0.245	0.286*	0.159	-0.089	-0.049	-0.281*	0.267	0.151	0.675**	0.652*	0.162
	S-II	-0.074	-0.531**	0.214	0.239	0.040	0.154	0.360**	0.224	-0.283*	0.618**	0.605**	0.553**

Residual effects; S-I = 0.178; S-II = 0.106; * Significance at $P \leq 0.05$ & ** significance at $P \leq 0.01$; the bold values indicate direct effects.

Capsules/plant also showed significant negative correlation in one season and positive in other with seed yield/plot. Considering this it will be prudent to base selection for seed yield on biological yield/plot giving emphasis on capsules/plant and seeds/capsule. Both these are simple traits and easy for making selections. Therefore, biological yield/plot followed by capsules/plant and seeds/capsule will be most effective selection criteria for seed yield in linseed.

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