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SELECTION PARAMETERS FOR SEED YIELD AND RELATED TRAITS IN LINSEED (*LINUM USITATISSIMUM* L.)

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Abstract

The experiment was conducted to study the association analysis for yield and its characters in 35 linseed accessions for 12 agro morphological characters. It was revealed that high heritability with high genetic advance were recorded for the characters *viz.*, seed yield/ plant, followed by harvest index, seed weight, days to maturity, biological yield. Selection for these traits is likely to accumulate more additive genes leading to further improvement of performance of genotypes. Significant positive correlation with depending character seed yield/plant height and biological yield. Biological yield showed positive direct effect and significant positively correlation with seed yield/ plant.

Introduction

Linseed is an annual plant belonging to the genus *Linum* of Linaceae (Sultana 1992). It contains 35 to 45% oil with the alpha linolenic acid (ALA) making up about 57% of the total fatty acids. It is a very important medicinal supplement for controlling the cholesterol in human body. High content of linolenic acid (45 - 60%) in its oil is beneficial for industrial purpose while low linoenic acid content is necessary for its human consumption. The oil linseed is extensively used for many purposes like mainstay of paints, varnishes, lacquers and linoleum industries. In India, Russia and some other countries, the oil extracted from unheated seed is used for food purposes. On global scenario linseed is an important crop grown over 27.29 lakh hectare with the production of 25.2 lakh tons and productivity of 923 kg/ha (Anon. 2013). India is the second largest producer of linseed, followed by Canada, China, USA whereas, in production stands third position. India has 18.8% of world's recorded linseed area but produces less than 10% of total world production The acreage of linseed in India is about 3.22 lakh hectares with production of 1.52 lakh tones and national productivity is about 473 kg/ha (Anon. 2013). Yield of any agricultural crop is dependent on the performance of many different traits and their relationship. Hence, it is too much important to identify interrelationship of traits and their direct as well as indirect contribution towards seed yield. There are several reports on correlation and path coefficient analysis in linseed, Kumar *et al.* (2012), Reddy *et al*. (2013) and Bibi *et al*. (2013). A better and accurate breeding scheme can be devised when a breeder is known to all aspects of the traits under study. The objective of current study was to determine variability parameters and trait association of seed yield and its components while studying 35 linseed genotypes.

Materials and Methods

The materials of present study were collected from Research cum Instructional Farm under AICRP on Linseed, Department of Genetics and Plant Breeding, IGKV, Raipur, Chhattisgarh, India (altitude of 289.60 m above mean sea level, and 24°45'N and 84°15' E). Experiment was conducted in medium black soils under rainfed conditions. The experiment material for present study was comprised of 35 linseed germplasm accessions and three checks T-397 (NC), Padmini

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(ZC) and Indira Alsi-32 (ZC) and the work was carried out during *Rabi* 2014-2015. The experiment was laid out in an randomize block design with three replications, and all the three checks. The spacing between row to row was 30 cm and plant to plant 25 cm with accommodating 35 number of plant in each plot of 3 m × 4 m. Fertilizer was applied @ 40 kg N, 20 kg P_2O_5 per hectare. Observations were recorded on five randomly selected plants in each genotype for 12 agromorphological characters.

The data collected were used to calculate the genotypic and phenotypic correlation coefficient (GCV and PCV), respectively, correlation estimates at both GCV and PCV level were calculated by following Snedecor and Cochran (1989). Direct and indirect effects of traits on grain yield were calculated using genotypic correlation coefficient of various traits as suggested by Wright (1921), elaborated by Dewey and Lu (1959). Therefore, the GCV of any attribute with grain yield was dividing into direct and indirect effects of independent variable, on the dependent variable (yield) adopting the standard formula.

Results and Discussion

All the characters under study exhibited existence of variable significance at 1% significant level, whereas plant height had significant at 5% probability level. It was not significant for seed size (Table 1). This indicated existence of sufficient variability among the genotypes for the characters and sufficient scope for development of genotypes. Mean performance of different characters recorded from the population of linseed were presented in Table 2. Different parameters of genetic variability have been estimated and are described in Table 3. The PCV values were higher than the GCV. The high PCV (55.81%) and GCV (54.78%) were recorded for seed yield/plant followed by number of primary branches/plant (18.27 and 15.33%), harvest index (16.12 and 14.52%) and number of capsules/plant (14.22 and 9.00%). The GCV and PCV values indicated that lot of variability exists among the genotypes at genotypic and phenotypic level and better chances of improvement is possible by selection.

The present investigation revealed that high heritability with high genetic advance were recorded for the characters *viz.*, seed yield/plant, followed by harvest index, seed weight, days to maturity, biological yield, number of primary branches/plant, days to 50% flowering, capsule size, number of capsules/plant, plant height, number of seeds/capsule and seed size. Selection for these traits is likely to accumulate more additive genes leading to further improvement of performance of genotypes. These findings are in conformity to the finding of previous workers Tadesse *et al.* (2010), Vardhan and Rao (2012), Bibi *et al.* (2013), Pali and Mehta (2013).

The PCV and GCV were determined among yield components in all possible character combinations and are presented in Table 4. For most of the characters genotypic correlation was higher in magnitude than the phenotypic correlation. Days to 50% flowering showed positive significant correlation with number of primary branches/plant (0.37*) and seed weight (0.42**) whereas negative significant correlation with capsule size (–0.32*) and seed yield/ plant (–0.42*). Plant height exhibited significant positive correlation with capsule size (0.56*), number of seeds/ capsule (0.54**), days to maturity (0.31*) and seed yield/plant (0.45**), whereas it showed negative significant correlation with number of capsules/plant (–0.39*). Number of primary branches/plant had positive significant correlation with 1000-seed weight (0.43**), days to maturity (0.51**) whereas negative correlation with capsule size (–0.31*) and seed yield/plant (–0.44*). Number of capsules/plant exhibited positive correlation with days to maturity (0.30*) and biological yield (0.50**), whereas negative correlation with seed size (–0.33*). These findings are in conformity with those of the previous workers (Reddy *et al.* 2013, Pali and Mehta 2013).

Table 1. Analysis of variance for yield and its attributing traits in linseed.

Source of variation	Degree of freedom	Mean sum of squares											
		Days to 50% Flowering	Plant height (cm)	No. of primary branches/ plant	No. of capsules/ plant	Capsule size (mm)	No. of seeds/ capsule	Seed size (mm)	Seed weight (g)	Days to maturity	Biologi-cal yield (g)	Harvest index (%)	Seed yield/ plant (g)
Replications	2	7.65	0.40	0.01	18.03	0.11	0.19	0.03	0.55	62.35	0.07	3.95	0.01
Treatments	34	58.84**	26.15*	0.70**	21.52**	0.43**	1.34**	0.03	0.65**	19.03**	0.33**	121.06**	1.21**
Error	68	11.42	14.22	0.08	10.09	0.09	0.08	0.02	0.05	9.52	0.06	8.71	0.02

**,*Significant at 1 and 5 % probability level, respectively.

Table 2. Mean performance of linseed genotypes for yield and yield attributing characters.

Genotypes	Days to 50% flowering	Plant height (cm)	No. of primary branches/ plant	No. of capsules/ plant	Capsule size (mm)	No. of seeds / capsule	Seed size (mm)	Seed weight (g)	Days to maturity	Biological yield (g)	Harvest index (%)	Seed yield/ plant (g)
C I-1924	62.33	45.22	3.36	23.11	5.45	8.71	4.09	5.32	118.89	4.20	34.83	1.52
C I-2006	50.67	46.00	3.11	28.00	6.50	9.41	4.04	5.58	115.67	3.80	52.32	1.96
C I-2204	51.44	47.67	2.00	23.30	5.56	9.45	4.08	4.21	116.67	3.36	37.48	2.45
C I-2260	56.00	47.22	2.32	21.11	5.45	8.33	4.07	4.37	116.56	3.59	36.13	1.23
E C-511	64.11	48.67	2.45	22.41	5.89	8.33	4.26	4.54	122.33	3.57	36.73	2.43
E C-704	54.67	47.22	2.41	22.67	5.56	8.44	4.03	4.29	113.67	3.42	42.43	2.43
E C-1066	51.22	48.44	2.11	26.11	6.22	8.45	4.37	4.60	115.44	3.49	56.73	1.47
E C-1386	62.89	46.44	2.25	31.15	5.13	8.33	4.01	5.40	120.22	3.68	44.99	1.63
E C-1645	63.00	41.56	3.00	31.30	5.50	8.33	4.04	5.34	121.78	4.50	31.31	1.66
E C-41623	61.56	44.67	3.11	27.11	5.06	8.44	5.19	5.35	121.11	3.77	39.93	0.95
E C-41628	51.56	46.33	3.22	28.22	5.24	8.33	4.14	4.25	114.67	3.70	34.61	0.54
E C-41659	63.56	53.11	3.56	32.77	5.45	8.56	4.15	4.27	120.44	3.68	38.81	1.76
E C-41741	63.11	55.56	3.00	23.11	5.56	9.45	4.19	5.07	121.22	3.74	33.27	0.81
E C-51904	55.56	44.78	3.22	23.11	5.33	8.22	4.02	4.42	117.11	3.56	43.76	0.63
E C-98994	60.00	42.56	3.25	24.26	5.18	7.22	4.04	4.62	117.89	3.50	44.20	0.65
E C-99001	53.67	45.44	3.51	27.00	5.33	6.22	4.08	5.09	117.00	3.69	36.13	1.16
EX-313-23	61.33	49.33	3.22	26.33	5.67	8.22	4.12	5.44	122.00	3.53	46.95	1.49
Fatehpur	65.00	43.11	3.55	25.11	5.09	8.70	4.04	5.38	121.22	3.59	44.35	0.75
FR-11	63.22	43.00	3.23	26.11	5.11	8.03	4.06	5.48	120.22	3.73	47.68	0.48
FRW-9	59.89	46.89	3.38	25.56	5.33	8.30	4.02	5.10	121.00	3.52	35.65	1.72
FRW-12	64.44	44.33	3.00	26.67	5.00	8.22	4.01	4.13	122.33	3.28	54.97	0.71
FX-16	62.67	47.22	2.85	24.22	6.45	8.33	4.02	5.39	122.00	3.51	52.48	0.97
Gewargi-1-2	63.33	47.22	2.66	25.63	6.45	8.33	4.27	5.02	122.44	3.32	42.77	0.65
GIF-white	62.33	47.44	3.23	27.78	5.41	9.37	4.07	5.28	121.44	3.32	46.09	1.28
GlC-11-1	61.67	43.44	3.66	26.89	5.00	8.33	4.06	5.22	120.89	3.61	37.32	0.63
GS-27	60.56	43.44	2.60	27.55	5.44	8.33	4.04	4.64	117.11	3.58	45.58	0.62
GS_61	62.56	42.89	3.46	23.33	5.45	8.33	4.44	5.62	119.22	3.19	35.59	0.55
GS-64	62.44	48.00	3.33	26.33	5.56	8.37	4.07	4.61	121.67	3.13	44.29	1.30
GS-85	61.11	47.67	3.11	25.00	5.33	8.44	4.08	5.42	121.44	3.22	46.41	0.54
GS-129	65.22	48.78	3.33	24.33	5.45	9.56	4.06	5.33	120.89	3.20	36.04	0.54
NL-97(ZC)	61.56	48.67	2.29	25.00	5.47	9.11	4.07	5.32	121.00	3.23	43.96	0.49
JLS-9(ZC)	65.11	43.78	2.25	27.89	5.45	9.45	4.67	4.62	121.00	3.43	45.91	0.82
T-397(NC)	54.56	46.89	2.18	28.63	5.33	7.72	4.03	4.54	116.00	4.71	43.99	2.48
Padmini(ZC)	58.22	45.22	3.37	27.11	5.33	7.33	4.05	4.65	120.44	3.56	45.43	0.80
IA-32(ZC)	61.89	46.00	3.22	29.81	5.33	8.33	4.04	5.24	120.44	3.63	36.05	0.54

*Data are average of 3 replications.

Table 3. Genetic variability parameters for yield and its attributing traits in linseed.

Characters	Range		Grand mean ($\overline{X}$)	PCV (%)	GCV (%)	h^2 (%)	GA (% of mean)
	Minimum	Maximum					
Days to 50 % flowering	51	65	60.70	8.68	6.61	58.05	10.38
Plant height (cm)	41	55	46.28	9.26	7.07	21.06	4.02
No. of primary branches/plant	2	4	2.96	18.27	15.33	70.29	26.46
No. of capsules/plant	21	33	26.11	14.22	9.00	27.40	8.06
Capsule size (mm)	5	6	5.46	8.40	4.25	53.84	9.31
No. of seeds/capsule	6	9	8.42	8.41	6.16	83.91	14.54
Seed size (mm)	4	5	4.09	3.89	1.48	8.75	0.70
Seed weight (g)	4.13	5.62	4.94	10.26	7.47	76.97	16.27
Days to maturity	113	122	119.52	2.98	1.15	24.85	1.52
Biological yield (g)	3.13	4.71	3.57	11.02	8.32	56.93	12.94
Harvest index (%)	31.31	56.73	42.14	16.12	14.52	81.13	26.94
Seed yield/plant (g)	0.48	2.48	1.16	55.81	54.28	94.59	108.76

Table 4. Genotypic and phenotypic correlation analysis for yield and its attributing traits in linseed.

Character		Plant height (cm)	No. of primary branches/ plant	No. of capsules/ plant	Capsule size (mm)	No. of seeds /capsule	Seed size (mm)	1000-seed weight (g)	Days to maturity	Biological yield (g)	Harvest index (%)	Seed yield/ plant (g)
Days to 50 % flowering	G	–0.16	0.37*	0.12	-0.32*	0.23	-0.09	0.42**	1.16	–0.26	–0.1	–0.42**
	P	0.04	0.16	0.07	-0.20	0.12	0.02	0.29*	0.67**	–0.14	–0.07	–0.30*
Plant height (cm)	G		–0.34*	–0.39*	0.56*	0.54**	0.22	–0.17	0.31*	–0.17	–0.14	0.45**
	P		–0.06	–0.01	0.11	0.21	0.23	–0.18	–0.04	–0.21	0.01	0.19
No. of primary branches/plant	G			0.14	–0.31*	–0.27	–0.18	0.43**	0.51**	–0.07	–0.26	–0.44**
	P			0.14	–0.18	–0.19	–0.009	0.24	0.13	–0.06	–0.19	–0.37*
No. of capsules/ plant	G				0.03	–0.12	–0.33*	0.15	0.30*	0.50**	0.09	0.04
	P				–0.16	–0.08	–0.13	0.03	0.04	0.28	0.07	0.03
Capsule size (mm)	G					0.27	0.69**	0.14	–0.15	–0.04	0.38*	0.19
	P					0.19	0.10	0.12	–0.11	–0.07	0.31*	0.14
No. of seeds/ capsule	G						0.12	0.14	0.23	–0.27*	–0.01	0.07
	P						0.02	0.09	0.09	–0.19	0.01	0.04
Seed size (mm)	G							0.09	0.11	–0.45**	–0.23	–0.28*
	P							0.05	–0.02	–0.11	–0.07	–0.04
1000-seed weight (g)	G								0.55**	0.02	–0.04	0.28*
	P								0.33*	0.02	–0.01	0.24
Days to maturity	G									–0.34*	–0.01	–0.27*
	P									–0.17	–0.01	–0.22
Biological yield (g)	G										–0.27*	0.47**
	P										–0.20	0.35**
Harvest index (%)	G											–0.06
	P											–0.06

**,*Significant at 1 and 5 % probability level, respectively.

Table 5. Path coefficient analysis matrix of direct and indirect effects when seed yield is taken as dependent character.

Characters	Days to 50% flowering	Plant height (cm)	No. of primary branches/ plant	No. of capsules /plant	Capsule size (mm)	No. of seeds/ capsule	Seed size (mm)	1000-seed weight (g)	Days to maturity	Biological yield (g)	Harvest index (%)	Seed yield/ plant (g) (correlation at genotypic level)
Days to 50 % flowering	**0.02**	-0.03	–0.13	–0.005	–0.15	–0.03	0.04	–0.03	–0.08	–0.04	0.04	–0.42
Plant height (cm)	–0.004	**0.22**	0.12	0.01	0.26	–0.08	–0.10	0.01	–0.02	–0.02	0.05	0.45
No. of primary branches/ plant	0.01	–0.07	**–0.36**	–0.006	–0.14	0.04	0.08	–0.03	–0.03	–0.01	0.09	–0.44
No. of capsules/plant	0.003	–0.08	–0.05	**–0.04**	0.01	0.02	0.17	–0.01	–0.02	0.08	–0.03	0.04
Capsule size (mm)	–0.009	0.12	0.11	–0.001	**0.47**	–0.04	–0.31	–0.01	0.01	–0.007	–0.14	0.19
No. of seeds /capsule	0.006	0.12	0.09	0.005	0.12	**–0.16**	–0.05	–0.01	–0.01	–0.04	0.004	0.07
Seed size (mm)	–0.002	0.05	0.06	0.01	0.32	–0.02	**–0.45**	–0.007	–0.008	–0.07	0.08	–0.28
1000-seed weight (g)	0.01	–0.03	–0.15	–0.007	0.06	–0.02	–0.04	**–0.08**	–0.03	0.004	0.01	–0.28
Days to maturity	0.03	0.07	–0.18	–0.01	–0.07	–0.03	–0.05	–0.04	**–0.07**	–0.05	0.004	–0.27
Biological yield (g)	–0.007	–0.04	0.02	–0.02	–0.02	0.04	0.20	–0.002	0.02	**0.16**	0.10	0.47
Harvest index (%)	–0.003	–0.03	0.09	–0.004	0.18	0.001	0.10	0.003	0.009	–0.04	**–0.36**	–0.06

Residual effect = 0.00340. Diagonal values showed direct effect on seed yield/plant (g).

The present investigation showed significant positive correlation of depending character seed yield/plant with plant height (0.45**) and biological yield (0.47**). Whereas seed yield/plant showed negative correlation an order 1000-seed weight, number of primary branches/plant, followed by days to 50% flowering, seed size and days to maturity. The genotypic path coefficient (direct and indirect effects *via* other characters) has been presented in Table 5. Seed yield as dependent trait, maximum positive direct effect was obtained for capsule size (0.47) followed by plant height (0.22), biological yield (0.16), days to 50% flowering (0.02), whereas negative direct effect were obtained *via*, seed size (–0.45) followed by harvest index (–0.36) number of primary branches/plant (–0.36). Days to 50% flowering showed positive indirect effect on seed size (0.04) and harvest index (0.04) and negative correlation with seed yield/plant (g) (–0.42). Plant height showed positive indirect effect on number of primary branches/plant (0.12), number of capsules/ plant (0.01), capsule size (0.26), seed weight (0.01) and harvest index (0.05) and positive correlation with seed yield/ plant (g) (0.45). Number of primary branches/plant indicated positive indirect effect on days to 50% flowering (0.01), number of seeds/capsule (0.04), seed size (0.08) and harvest index (0.09) and negative correlation with seed yield/plant (g) (–0.44). Capsule size showed positive indirect effect on plant height (0.12), number of primary branches/plant (0.11) and days to maturity (0.01) and positive correlation with seed yield/plant (g) (0.19). Number of seeds/capsule showed positive indirect effect on days to 50% flowering (0.006), plant height (0.12), number of primary branches/plant (0.09), number of capsules/plant (0.005), capsule size (0.12) and harvest index (0.004) and positive correlation with seed yield/plant (g) (0.07).

Seed size exhibited positive indirect effect on plant height (0.05), number of primary branches/plant (0.06), number of capsules/plant (0.01), capsule size (0.32) and harvest index (0.08) and negative correlation with seed yield/plant (g) (–0.28). Seed weight showed positive indirect effect on days to 50% flowering (0.01), capsule size (0.06), biological yield (0.004) and harvest index (0.01) and negative correlation with seed yield/plant (g) (–0.28). Days to maturity showed positive indirect effect on days to 50% flowering (0.03), plant height (0.07) and harvest index (0.004) and negative correlation with seed yield/ plant (g) (–0.27). Biological yield showed positive indirect effect on number of primary branches/plant (0.02), number of seeds/capsule (0.04), seed size (0.20), days to maturity (0.02) and harvest index (0.10) and positive correlation with seed yield/plant (g) (0.47). Harvest index indicated positive indirect effect on number of primary branches/plant (0.09), capsule size (0.18), number of seeds/capsule (0.001), seed size (0.10), seed weight (0.003) and days to maturity (0.009) negative correlation with seed yield/plant (g) (–0.06). These finding are in conformity to the finding of previous workers Khan and Gupta (1995), Mirza *et al.* (1996), Yadav (2001), Akbar *et al*. (2003), Pali and Mehta (2013), Tariq *et al.* (2014). In the present investigation seed size showed high negative direct effect and significant negative correlation with seed yield/plant, indicating a true relationship. Therefore, the plants with increasing seed size should be considered in selection criterion for increasing seed yield/plant. Biological yield showed positive direct effect and significant positively correlation with seed yield/plant, indicating a true relationship. Therefore, plant with high biological yield should be considered in selection criterion for enhancing seed yield/ plant.

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