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Genetic Variability and Path Analysis for Yield and Associated Traits in Linseed Genotypes

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

An experiment was conducted to study the nature and magnitude of genetic variability with yield and related traits and characters association in linseed. Twelve diverse linseed (*Linum usitatissimum* L.) genotypes were evaluated in randomized block design withthree replications during*rabi*season 2020-21 in the experiment field of AICRP on oilseeds in the college of agriculture Tikamgarh. The higher phenotypic coefficient values than corresponding genotypic coefficient values depicted influence of environment in the expression of traits. The data were recorded for days to flowering initiation, days to 50 % flowering, plant stand per hectare, plant height, primary branches per plant, capsules per plant, number of seeds per capsule, biological yield per plant, days to maturity,1000 seed weight, yield per plant, yield per ha., protein and oil content.High to

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moderate magnitude of PCV and GCV were observed for the traits viz., 1000 seed weight, yield per plant, plant height, biological yield per plant, days to flower initiation indicating the presence of significant variability in the existing collection and in path coefficient analysis revealed the positive direct effect at both genotypic and phenotypic levels for the characters for days to 50% flower, plant height, number of capsule per plant, 1000 seed weight and primary branches per plant respectively.

Keywords: GCV; PCV; path coefficient analysis; direct effect; indirect effect.

1. INTRODUCTION

Linseed (*Linum usitatissimum* L.) is an important self pollinated annual oilseed crop and belongs to family linaceae having diploid chromosome number 30 and attains height between 30-90 cm. Linseed is growing in geographical area having annual precipitation between 480-760 mm. It is a cool season crop and requires moderate to cool temperature during the growing season. High rainfall and cloudy weather during growing period is very harmful for the crop. The major linseed growing states in the country are Madhya Pradesh, Chhattisgarh, Maharashtra, Uttar Pradesh, West Bengal, Karnataka, Assam, Orissa and Jharkhand which all together contribute more than 83 percent of total linseed area under production. Seed contains lignans, antioxidants, fiber, protein and poly unsaturated acid fatty acid especially alpha linolenic acid and omega-3 and omega-6 fatty acid [1] with 35-45% oil. Seed are consumed as dietary supplement against high cholesterol (heart disease), cancer, diabetes, and its oil is being used as pigment binder in oil paints.

India produced 120.7 thousand tons linseed from 179.9 thousand ha. area in 2019-2020 with average productivity 671 kg/ha. While Madhya Pradesh harnessed 45 thousands ton from 5 thousand ha. area with average productivity 867 kg/ha. in 2019-2020 [2] (Anonymous, Ministry of Agriculture and Farmer Welfare, 2019). Genetic variability is a key of any crop improvement programme and it is utmost important for desirable swift improvement in the trait. The inter-relationship between seed yield and its important components is effectively predicted by path coefficient analysis which tells about the relationship of cause and effect of yield contributing traits on seed yield. The purpose of this research is to estimate the variability for various characters and also determined that variability is due to the environmentally or genetically controlled for further improvement. Path analysis is used to estimate the yield contributing characters which are directly affects to yield or via other yield contributing traits, for improving the yield.

2. MATERIALS AND METHODS

The experimental materials consisted of 12 genotypes of linseed and the experiment is conducted in randomized block design with three replications at experimental field of AICRP on oil seed, college of agriculture Tikamgarh, Madhya Pradesh during *rabi*2021-22. The plot size were taken in 3×3m and row to row and plant to plant distance was maintained 30 cm and 10 cm, respectively. The recommended agronomic practices were followed for good crop of linseed. The observations were recorded on ten randomly selected plants from each genotype in each replication on fourteen agro-morphological characters viz;days to flowering initiation, days to 50 % flowering, plant stand per hectare, plant height, primary branches per plant, capsules per plant, number of seeds per capsule, biological yield per plant, days to maturity,1000 seed weight, yield per plant, yield per ha., protein and oil content.The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were computed using the formula as suggested by Burton [3]. In the process of calculating the GCV which is the ratio of square root of genotypic variance to the sample mean and PCV is the ratio of square root of phenotypic variance to the sample mean. path coefficient analysis were estimated by using formula suggested by Wright [4] and elaborated by Dewey and Lu [5]. It is a standardized partial regression coefficient, which splits the correlation coefficients into the measures of direct and indirect effects. Correlation gives only the relation between two variables whereas path coefficient analysis allows separation of the direct effect and their indirect effects through other attributes by partitioning the correlation [4].

3. RESULTS AND DISCUSSION

According to estimates of genotypic and phenotypic variation, phenotypic variance was

Table 1. Status of genetic variability parameters for seed yield and its contributing characters in linseed genotypes

Sr. No.	Characters	Genetic parameters				
		Mean	Range		PCV (%)	GCV (%)
			Minimum	Maximum		
1	Days to flowering initiation	53.0	41.0	61.00	11.32	11.14
2	Days to 50 % flowering	60.0	50.0	68.0	8.83	8.65
3	Plant Stand (Numbers)	390.	340	424.0	6.47	6.16
4	Plant height (cm)	65.0	51.0	77.0	12.76	12.56
5	PrimaryBranches/ plant	2.88	2.7	2.90	3.25	2.06
6	Capsules/plant	58.8	51.2	68.40	10.15	8.39
7	seeds/Capsule	8.50	8.20	8.80	2.81	2.75
8	Biological yield (g)	17.1	13.4	20.2	12.46	12.06
9	Days to maturity	114.7	109.3	118.7	2.43	2.25
10	1000 seed weight (g)	7.20	5.1	8.50	16.80	16.08
11	yield /plant (g)	3.30	2.50	4.20	15.75	15.28
12	Yield/ha(kg)	1621.3	1174.0	1759	10.78	9.93
13	Protein content (%)	23.50	21.3	25.7	6.12	6.12
14	Oil content (%)	38.0	35.5	40.4	4.57	4.13

Table 2. Direct (diagonal) and indirect effects of yield components on seed yield per plant at genotypic level in linseed genotypes

S. No.	Character	Days to flowering initiation	Days to 50 % Flowering	Plant Stand (Number)	Plant height (cm)	Primary Branches /Plant	Capsules /Plant	Seeds/ Capsule	Biological yield (g)	Days to maturity	1000 seed weight	Yield/ ha(kg)	Protein content (%)	Oil content (%)	Seed yield /plant
1	Days to flowering initiation	-6.347	-6.290	0.850	-2.399	-1.173	-3.41	2.616	-2.441	-6.253	4.874	-0.258	-0.656	0.800	-0.719
2	Days to 50% flowering	2.249	2.269	-0.197	0.938	0.477	1.332	-0.789	0.941	2.271	-1.916	0.191	0.481	-0.348	-0.706
3	Plant Stand (Numbers)	-0.034	-0.022	0.254	-0.022	-0.023	0.086	0.118	-0.018	-0.056	0.004	0.115	-0.032	-0.100	0.159
4	Plant height (cm)	0.298	0.326	-0.068	0.790	-0.287	-0.025	0.193	0.798	0.291	-0.391	0.337	0.250	-0.171	-0.660
5	Primary Branches /Plant	0.044	0.050	-0.021	-0.865	0.238	0.021	0.075	-0.093	0.052	-0.043	-0.098	-0.002	0.068	0.074
6	Capsules/Plant	-0.346	-0.378	-0.219	0.021	-0.059	0.645	0.273	0.014	-0.374	0.350	-0.430	-0.016	0.249	0.0254
7	Seeds/ Capsule	0.448	0.378	-0.506	-0.265	-0.346	0.461	-1.087	-0.238	0.421	-0.045	-0.227	-0.280	0.191	0.122
8	Biological yield (g)	-0.319	-0.344	0.061	-0.839	0.325	0.018	-0.182	-0.831	-0.319	0.407	-0.355	-0.266	0.186	-0.677
9	Days to maturity	0.764	0.775	-0.172	0.285	0.170	0.449	-0.300	0.298	0.775	-0.672	0.059	0.213	-0.211	-0.693
10	1000 seed weight	2.748	3.022	-0.059	1.774	0.647	1.942	-0.150	1.755	3.103	3.579	1.185	2.333	-0.757	0.605
11	Yield/ ha(kg)	-0.015	-0.032	-0.175	-0.165	0.1604	-0.257	-0.080	-0.165	-0.029	0.128	-0.386	-0.048	0.203	-0.014
12	Protein content (%)	-0.245	-0.504	0.300	-0.754	0.026	-0.059	-0.614	-0.762	-0.653	1.551	-0.297	-2.379	0.274	-0.369
13	Oil content(%)	0.036	0.044	0.113	0.062	-0.082	0.111	0.050	0.006	0.078	-0.061	0.151	0.033	-0.288	0.098

, = Significant at 5 % and 1 % levels,,*Significant at p = 0.05, ** Significant at p = 0.01*

Table 3. Direct (diagonal) and indirect effects of yield components on seed yield per plant at phenotypic level in linseed genotypes

S. No.	Character	Days to flowering initiation	Days to 50 % Flowering	Plant Stand (Numbers)	Plant height (cm)	Primary Branches /Plant	Capsules /Plant	Seeds/ Capsule	Biological yield (g)	Days to maturity	1000 seed weight	Yield/ ha(kg)	Protein content (%)	Oil content (%)	Seed yield /plant
1	Days to flowering initiation	-1.656	-1.617	0.245	-0.613	-0.308	-0.713	0.677	-0.623	-1.474	1.169	-0.114	-0.170	0.151	-0.681
2	Days to 50% flowering	0.803	0.823	-0.081	0.318	0.171	0.377	-0.280	0.338	0.744	-0.647	0.091	0.169	-0.104	-0.662
3	Plant Stand (Numbers)	0.026	0.017	-0.178	0.015	0.016	-0.034	-0.079	0.017	0.033	-0.006	-0.069	0.021	0.067	0.151
4	Plant height (cm)	0.244	0.255	-0.058	0.660	-0.156	-0.007	0.156	0.643	0.213	-0.300	0.243	0.206	-0.105	-0.624
5	Primary Branches /Plant	0.041	0.046	-0.020	-0.052	0.223	-0.036	0.027	-0.046	0.046	-0.023	-0.035	0.000	0.048	0.879
6	Capsules/Plant	0.177	0.188	0.078	-0.004	-0.066	0.410	-0.141	0.002	0.168	-0.190	0.186	0.007	-0.096	0.044
7	Seeds/ Capsule	-0.018	-0.015	0.020	0.010	0.005	-0.015	0.046	0.009	-0.017	0.001	0.008	0.011	-0.007	0.104
8	Biological yield (g)	-0.350	-0.382	0.090	-0.906	0.193	-0.005	-0.196	-0.930	-0.296	0.435	-0.358	-0.286	0.155	-0.637
9	Days to maturity	0.036	0.037	-0.007	0.013	0.008	0.016	-0.015	0.013	0.041	-0.032	0.002	0.010	-0.007	-0.579
10	1000 seed weight	0.051	0.057	-0.002	0.033	0.007	0.033	-0.002	0.033	0.057	-0.072	0.019	0.044	-0.014	0.554
11	Yield/ ha(kg)	0.004	0.006	0.024	0.022	-0.010	0.028	0.011	0.023	0.003	-0.016	0.062	0.007	-0.028	-0.015
12	Protein content (%)	-0.039	-0.078	0.045	-0.119	0.000	-0.007	-0.096	-0.117	-0.096	0.234	-0.044	-0.381	0.039	-0.360
13	Oil content(%)	-0.001	-0.001	-0.004	-0.001	0.002	-0.002	-0.001	-0.001	-0.002	0.002	-0.005	-0.001	0.010	0.109

**, ** = Significant at 5 % and 1 % levels, respectively ,*Significant at p = 0.05, ** Significant at p = 0.01*

typically higher than genotypic variance, showing the influence of environmental factors on the manifestation of characters (Table 1). Moderately higher magnitude of PCV and GCV were observed for the traits viz., 1000 seed weight (16.80, 16.08), yield per plant (15.75, 15.28), plant height (12.76, 12.56), biological yield per plant (12.46, 12.06), days to flower initiation (11.32, 11.14) respectively while moderate PCV recorded with yield per hectare (10.78). Moreover, lower measure of PCV and GCV recorded with capsule per plant (10.15, 8.39), days to 50% flower (8.83, 8.65), plant stand (6.47, 6.16), protein content in per cent (6.12, 6.12), oil content in per cent (4.57,4.13), primary branch per plant (3.25, 2.06), seed per capsule (2.81,2.75), days to maturity (2.43, 2.25)respectively whereas, low GCV recorded for yield per hectare(9.93). In prior art of research, similar trends of results for genotypic and phenotypic coefficient of variation were observed by Bibi et al. [6], Pali and Mehta (2013), Kanwar et al. [7] and Upadhyay et al. [8].

The genetic architecture of seed yield is a result of overall net effect created by interaction of different yield attributing traits and their components. It is important to reveal the causes of the effects of yield attributing characters towards yield. Path analysis provides a route map and magnitude of yield attributing characters that decides final seed yield; it divides correlation into direct and indirect effects. Path coefficient analysis was calculated for fourteen agro-morphological traits which revealed positive direct effect of genetic level on seed yield per plant with 1000 seed weight, days to 50% flowering [9], plant height [10-14] days to maturity [15,16], plant stand, number of capsule per plant [17-24], number of primary branches per plant [13]. Whereas negative direct effect on seed yield per plant with, number of seed per capsule, seed yield per hectare, oil content [25] was observed under present investigation. on the other hand thepositive direct effect of days to 50% flowering [26,27], plant height, number of capsule per plant [26] number of primary branches per plant [27], oil content, days to maturity [27], number of seed per capsule, yield per hectare, on seed yield per plant at phenotypic level. Whereas, days to flower initiation, biological yield per plant, protein content in per cent, plant stand, 1000 seed weight [24] had negative direct effect on seed yield per plant at phenotypic level. Path coefficient analysis revealed the positive direct effect at both genotypic and phenotypic levels for the characters *viz*. Days to 50% flower, number of capsule per plant, 1000 seed weight, primary branches per plant which were supported by Dash et al. [26] and Ankit et al. [27].

4. CONCLUSION

High to moderate magnitude of PCV and GCV were observed for the traitsviz., 1000 seed weight, yield per plant, plant height, biological yield per plant, days to flower initiation indicating the presence of significant variability in the existing collection which can be exploited for further improvement by suitable breeding methods. In path analysis traits like days to 50% flowering, plant height, number of capsule per plant, number of primary branches per plant, yield per hectare, number of seed per capsule, days to maturity, oil content exerted positive direct effect on seed yield per plant at phenotypic level whereas at genotypic level, traits like days to 50% flowering, plant height, days to maturity, plant stand, number of primary branches per plant exerted positive direct effect on seed yield per plant. Hence, these traits should be considered for yield enhancement. Path coefficient analysis revealed the positive direct effect at both genotypic and phenotypic levels for the characters *viz*. Days to 50% flower, plant height, number of capsule per plant, 1000 seed weight and primary branches per plant.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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