Environment and Ecology 40 (1) : 93—98, January—March 2022
ISSN 0970-0420

Principal Component and Correlation Studies in Linseed under Sub Tropical Region of Rajasthan India

Sandhya, Manoj Kumar, Mukul, Pawan Kumar

Received 23 June 2021, Accepted 8 December 2021, Published on 9 January 2022

ABSTRACT

A study was undertaken to evaluate fifty linseed genotype during *rabi* 2019. Principal component analysis (PCA) and correlation analysis were used for understanding the traits relations that showed that the individual contribution of PC1, PC2 and PC3 were 29%, 12.7% and 11 %, respectively.The first PCA was more related to total dry matter and days to maturity. The second factor was indicated the importance of the total dry matter, number of seeds per capsule and number of capsules per plant.Therefore, the selection may be done accordingly and helpful for a designing good breeding program.The correlation coefficient between two traits is approximated by the cosine of the angle between their vectors in the plot of the first two PCAs and the most prominent relations were found between to most of the yield contribution traits with the seed yield per plant.

Keywords Principle component analysis, Correlation,Grain yield, Linseed.

Sandhya[1]*, Manoj Kumar[2],
[1,2]Assistant Professor, Department of Plant Breeding and Genetics, Agricultural Research Station, Ummedganj, Agriculture University, Kota, Rajasthan 324001, India

Mukul
Seed Officer, Krishi Pant Bhavan Jaipur, Rajasthan, India

Pawan Kumar
Scientist, Central Institute for Arid Horticulture, Bikaner Rajasthan, India
Email:sandhyakulhari1990@gmail
*Corresponding author

INTRODUCTION

Linseed (*Linum usitatissimum* L., 2n = 30) is an important self-pollinated oilseed and fiber crop which belongs to the family Linaceae and genus linum. *Linumusitatissimum* is the only economically significant species of the family with semi-dehiscent and non-dehiscent capsules type (Savita 2011). It is believed that this crop species were originated from *Linum angustifolium* Huds native to the Mediterranean region (Burako 2010). Linseed is the richest source of vegetarian omega-3 fatty acid and good source of protein, dietary fiber, lignin, flax-fiber and essential micronutrients. Linseed contains EPA and DHA that has medicinal and nutraceutical properties have paved the way for its diversified used and value addition forms. Drying property of linseed oil is responsible for its extensive use in manufacturing paints, varnishes, oilcloths, printers' ink, linoleum flooring and imitation in leather industry. Linseed contains about 36 to 48% oil content which is high in unsaturated fatty acids, especially alpha linolenic acid (ALA) an essential omega-3 fatty acid and lignin oligomers which constitute about 57 % of total fatty acids in linseed (Reddy *et al.* 2013). Linseed cake contains 3% oil and 36% protein and serves as nutritious feed and better quality supplement for cattle. Linseed is also a good source of phosphorus (370 mg/100g), manganese, calcium (170 mg/100g), potassium (Mirza *et al*. 2011).

The success of crop improvement program is mainly dependent on the efficient estimation of genetic distance, correlation between parental selections during hybridization and transgressive segregation. A successful selection depends upon the information on the association of morpho-agronomic traits that acts directly or indirectly on seed yield (Kumar *et al.* 2013).Germplasm serves as the most valuable reservoir in providing needed attributes for developing superior varieties. Characterization involves estimating existing variability across the population of individuals (Singh and Tewari 2016, Singh *et al.* 2017). So, there is an urgent need to characterize and evaluate linseed genotypes to identify donor(s) for different traits and utilizing these genotypes in different breeding programes. Statistical process of categorization is generally by multivariate methods as it has wide use in summarizing and describing the innate discrepancy among the genotypes. Principal-component analysis has been widely used in plant sciences for a reduction of variables and grouping of genotypes and designed to identify unknown trends in a multi-dimensional data set and reduced the data into two dimensions.The main objective of this study was to assess the potential genetic diversity and correlation by using cluster analysis-PCA-based methods for selection of parents in hybridization programe to obtain desirable segregants in advanced generation.

Table 1. List of linseed genotype collected from different region of India.

Sl. No.	Genotype/Code	Sl. No.	Genotype/Code
1	RLC-109	26	BAU 06-5
2	NL-126	27	BAU 06-8
3	NL-157	28	BAU 06-17
4	NL-165	29	LCK-6028
5	SLS-61	30	NDL 2005-24
6	JLT-206	31	NDL 2005-26
7	KL-215	32	NDL 2005-29
8	LCK-6010	33	NDL 2005-34
9	LMS-149-4	34	PCL-1-106
10	NL-119	35	PCL-12-3-06
11	NDL-2005-16	36	PCL-35-06
12	NDL-2005-17	37	RL-26016
13	PKDL-64	38	26018
14	RLC-113	39	LMS-3
15	SLS-68	40	LMS-23-6
16	RRN-1	41	LMSP-5
17	RRN-2	42	SLS-67
18	RRN-3	43	SLS-68
19	RRN-4	44	SLS-71
20	RRN-5	45	SLS-72
21	RRN-6	46	SLS-73
22	RRN-7	47	PKDL-62
23	KL-219	48	PKDL-65
24	LCP-146	49	PKDL-71
25	LC-2279-4	50	PKDL-72

MATERIALS AND METHODS

The experiment was conducted using fifty linseed germplasm (Table 1) collected from various regions of India to estimate genetic diversity and correlation during *rabi* 2019–20 at Research Farm, Agricultural Research Station, Ummedganj, Kota. The site of experiment is at an elevation of about 271 meter (889 ft) above mean sea level with 25.18°N latitude and 75.83°E longitude . The experiment was performed in

Table 1. (Continued). Simple statistics for yield and related traits in linseed.

	50 % days to flowering	Days to maturity	Plant height	No. of primary branches par plant	No. of capsules per plant	Plant stand	No. of seeds per capsule	Test weight	Total dry matter	Seed yield (kg/ ha)
Mean	62.45	126.02	59.84	3.74	130.88	63.93	7.50	5.60	0.36	1164.81
Minimum	60.00	120.33	45.00	2.00	54.00	54.00	5.00	4.00	0.22	462.96
Maximum	65.00	131.67	73.46	8.00	194.00	85.50	9.00	7.10	0.40	2025.45

Table 2. Eigen vectors and eigen values of 10 principal components for 10 characters of linseed genotypes.

Statistics	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10
Standard deviation	1.691	1.301	1.058	0.969	0.931	0.877	0.834	0.770	0.519	0.434
Proportion of variance	28.62	16.94	11.20	9.40	8.67	7.70	6.96	5.94	2.70	1.89
Cumulative proportion	28.62	45.55	56.75	66.15	74.82	82.52	89.48	95.41	98.11	10.00
Eigen value	2.861	1.693	1.119	0.939	0.867	0.769	0.696	0.593	0.269	0.188

a complete Randomized Block Design with three replicates. Each replication was made up of four rows of each genotype with a gap of 30 cm and 10 cm respectively for row to row and plant to plant and preserved by thinning. As suggested for linseed, normal cultural practices were performed. Non-experimental rows were planted all around the experiment to eliminate the border effects, if any. Observations were recorded from five randomly selected competitive plants for plant height, no. of primary branches per plant, no. of capsule per plant, plant stand, no. of seeds per capsule, test weight, total dry matter and seed yield except for days to 50% flowering and days to maturity that were recorded on a plot basis.Statistical analysis: The recorded data was subjected to analysis of genotypic correlation coefficients as per the standard formula given by Al-Jibouri *et al.* (1598), Dewey and Lu (1959). Principal component analysis (PCA) analysis was performed using XLSTAT software.

RESULTS AND DISCUSSION

In the present investigation simple statistics of the studied wheat characteristics are presented in Table 2 sowing the mean value, minimum and maximum value for each character under study.The main objective of crop enhancement is to increase seed yield and to consider the correlation between different yield-contributing traits in the germplasm. The correlation coefficients between the different characters are shown in Table 3. The results of the experiment showed that the characteristics of days to 50 % flowering, plant height, number of primary branches, number of capsules per plant, plant stand, number of seeds per capsule and test weight were positively correlated with the seed yield per plant at genotypic level. The genotypic and phenotypic correlation coefficients were similar in directions, while in magnitude, genotypic correlations were higher than corresponding phenotypic correlations for most of the traits. Similar findings were reported by (Paul *et al.* 2017, Joshi PK 2004) and it can be concluded that the selection based on traits viz., 50% flowering, plant height, number of primary branches, number of capsules per plant, plant stand, number of seeds per capsule and test weight can provide better result for improvement of seed yield in linseed, as earlier reported by Tariq *et al*. (2014), Yadav (2001),

Table 3. Estimates of correlation coefficients among different traits of linseed.

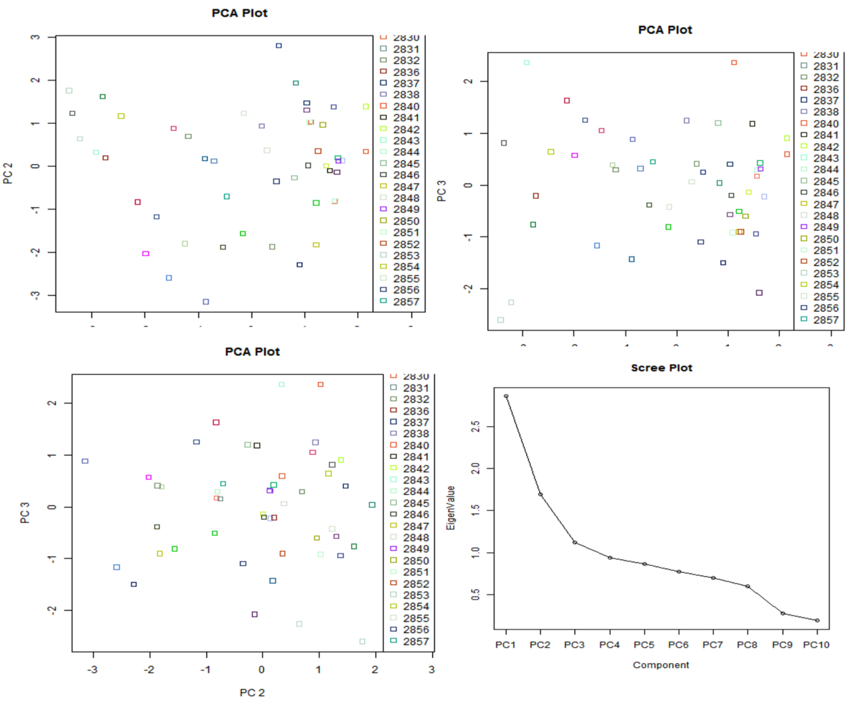
	50% days to flowering	Days to maturity	Plant heigh	No. of primary branches par plant	No. of capsules per plant	Plant stand	No. of seeds per capsule	Test weight	Total dry matter	Seed yield (kg/ ha)
50 % days to flowering	1	0.1330	-0.0778	-0.1142	-0.0876	0.0330	-0.2600	0.0525	-02122	0.0909
Days to maturity	0.1330	1	-0.1226	-0.0353	-0.1030	-0.1028	-0.1632	-0.0454	-0.1039	-0.1258
Plant height	-0.0778	-0.1226	1	-0.0572	0.1551	0.2470	0.1280	0.1506	-0.0281	0.1643
No. of primary branches par plant	-0.1142	-0.0353	-0.0572	1	0.0958	0.1070	0.2117	0.1821	0.0753	0.2352
No. of capsules per plant	-0.0876	-0.1030	0.1551	0.0958	1	-0.0203	0.1515	-0.0371	0.166	0.0457
Plant stand	0.0330	-0.1028	0.2470	0.1069	-0.0202	1	0.3075	0.7195	-0.1170	0.7809
No. of seeds per capsule	-0.2600	-0.1632	0.1280	0.2116	0.1515	0.3075	1	0.3057	0.1388	0.03122
Test weight	0.0525	-0.0454	0.1505	0.1820	-0.0371	0.7195	0.3057	1	-0.2669	0.7373
Total dry matter	-0.2198	-0.1038	-0.0280	0.0753	0.1675	-01170	0.1388	-0.2660	1	-0.2145
Seed yield (kg/ ha.)	0.0909	-0.1258	0.1643	0.2352	0.0457	0.7809	0.3122	0.7373	-0.2145	1

Table 4. Eigen values and cumulative variability in different PCs for yield and related traits in linseed.

Variables	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10
50 % days to flowering	0.0048	-0.4943	0.0935	-0.4268	0.4218	-0.3207	0.2146	-0.4829	-0.0446	0.0516
Days to maturity	0.1140	-0.3155	-0.2919	-0.3646	-0.7934	-0.1859	0.0055	0.0130	0.0577	-0.0422
Plant height	-0.1854	0.1456	0.6671	-0.0866	-0.3483	0.2511	0.5130	-0.1916	-0.0476	-0.0732
No. of primary branches par plant	-0.1745	0.2260	-0.6037	-0.2954	0.1305	0.4683	0.4595	-0.0711	0.0206	0.1171
No. of capsules per plant	-0.0406	0.3822	0.2334	-0.7521	0.0912	0.0229	-0.4162	0.2083	-0.0239	0.0782
Plant stand	-0.5191	-0.0797	0.0594	0.0695	-0.0413	-0.2521	0.0816	0.2306	0.3786	0.6690
No. of seeds per capsule	-0.2962	0.3915	-0.1421	0.1220	-0.1785	-0.1498	-0.3321	-0.7459	0.0519	0.0175
Test weight	-0.5127	-0.1515	-0.0726	0.0286	-0.0472	-0.0451	-0.0779	0.1402	-0.8235	-0.0051
Total dry matter	0.1303	0.4954	-0.1034	-0.0065	0.0275	-0.6962	0.4282	0.1570	-0.1398	-0.1178
Seed yield (kg/ ha)	-0.5324	-0.0989	-0.0482	-0.0624	0.0973	-0.0833	-0.0095	0.1661	0.3844	-0.7132

Akbar *et al*. (2001).

PCA was performed using phonological and yield component on linseed germplasm. Out of ten, eight principal components exhibited more than 0.5 eigen values and showed about 90 % total variability among the characters were studied. Maximum variation was observed in PC1 in comparison to other ten PCs. So selection of lines from this PC will be useful. Those principal components having more than one eigen value that showed more variation among the linseed genotypes for the selection of the diverse parents. Sharma (1998) explained that principal component analysis reflects the importance of the largest contributor to the total variation at each axis of differentiation. It is a well- known multivariate statistical technique which is used to identify the minimum number of components, which can explain



Figs. 1. (1.1-1.3). Principal components displaying contribution of variability to the total variance of linseed.

maximum variability out of the total variability (Gour *et al.* 2017). In this analysis the first factor retains the information contained in 2.861 of the original variables. PCA for the first three principal components of these data are given in Table 4. Out of ten principal components, PC1 to PC3, which extracted from the original data and having latent roots greater than one, accounts nearly 57%of the total variationas earlier reported byWorku *et al.* (2015), Kaur et al. (2018). Suggesting these principal component scores might be used to summarize the original ten variables in any further analysis of the data. Out of the total principal components retained, PC1, PC2 and PC3 with values of 28.6%, 16.9% (Figs. 1-3) and 11.2% respectively contributed more to the total variation. Zero influences the clustering less than those with largest absolute value closer to unity within the first principal component.

The present study revealed differentiation of the genotypes into different clusters was because of relatively contribution from each trait. Accordingly, the first principal component had positive component loading from days to 50% flowering, days to maturity, total dry matter and negative loading from plant height, number of primary branches per plant, number of capsules per plant, plant stand, number of seeds per capsule, test weight and seed yield. The traits which load positively or negatively contributed more to the diversity and they were the ones that most differentiated the clusters. PC2 contributed 12.7% of the total variation and traits that positively contributed to variation include total dry matter followed by number of seeds per capsule, number of capsules per plant, number of primary branches per plant and plant height whereas traits like plant height, number of capsules per plant, similarly days to 50% flowering and plant stand; number of capsules per plant, plant stand and test weight were major contributing traits for the diversity in the third principal component (PC3). It contributed 11% of the total variation, whereas, plant stand; number of capsules per plant, plant stand and test weight were positively contributing traits in the forth principal component (PC4). Similar finding also reported by Paul *et al.* (2017), Patial *et al.* (2019).

Therefore, in the present study, differentiation of the genotypes into different clusters was because of relatively high contribution of few characters rather than small contribution from each character. These findings revealed that seed yield had maximum genotypic and phenotypic correlation with plant height, capsules per plant and seeds per capsule so direct selection of plants based on these three would be effective to increase seed yield. First three principal components were related to various traits in linseed mostly associated with high seed yielding genotypes and also these traits can identify the diverse genotypes which could be employed in hybridization program for improvement of linseed.

ACKNOWLEDGEMENT

Authors gratefully acknowledge the Indian Institute of Pulses Research- Kanpur for providing germplasm used in the present study and for research support received from All India Coordinated Research Project on Linseed.

REFERENCES

Akbar M, Khan NL,Sabir KM (2001) Correlation and path coefficient studies in linseed. *Online J Biol Sci* 1(6): 446–447.

Al-Jibouri HA, Miller PA, Robinson HP (1958) Genotypic and environmental variance and covariance in upland cotton cross of inter-specific origin. *Agron J* 50: 633–636.

Burako L (2010) Genetic Diversity Study of Linseed Genotypes on Acidic Soil at Bedi Trial Site, Central Highland of Ethiopia. MSc thesis. Addis Ababa University, Addis Ababa.

Dewey DR, Lu KH (1959) A correlation and path coefficient analysis of components of crested wheat grass and seed production. *Agron J* 51: 515–518.

Gour L, Maurya SB, Koutu GK, Singh SK, Shukla SS, Mishra DK (2017) Characterization of rice (*Oryza sativa* L.) genotypes using principal component analysis including scree plot and rotated component matrix. *Int J Chem Stud* 5(4): 975–983.

Joshi PK (2004) Breeding behavior and association analysis for yield and yield component in linseed (*Linum usitatissimum* L.). PhD thesis. Indira Gandhi KrishiVishwavidyalaya, Raipur, (CG).

Kaur V, Kumar S, Yadav R, Wankhede DP, Aravind J, Radhamani J, Rana JC, Kumar A (2018) Analysis of genetic diversity in Indian and exotic linseed germplasm and identification of trait specific superior accessions. *J Environ Biol* 39: 702–709.

Kumar B, Singh CM, Jaiswal KK (2013) Genetic variability, association and diversity studies in bread wheat. The Bioscan 8 (1): 143–147.

Mirza MY, Khan MA, Akmal M, Mohmand AS, Nawaz MS, Nawaz N (2011) Estimation of genetic parameters to formulate selection strategy for increased yield in linseed. Pak *JAgric Res* 24 (1–4): 19–24.

Patial R, Paul S, Sharma D, Sood VK, Kumar N (2019) Morphological characterization and genetic diversity of linseed (*Linum usitatissimum* L.). *J Oilseeds Res* 36(1): 8–16.

Paul S, Kumar N, Chopra P (2017) Correlation and genetic diversity of linseed (*Linum usitatissimum* L.) genotypes based on prin cipal component analysis in Mid-Hills of North-West Himalayas. *Int J Pharmacogn Phytochem* 6 (1): 287–290.

Reddy MP, Arsul BT, Shaik NR,Maheshwari JJ (2013) Estimation of heterosis for some traits in linseed (*Linum usitatissimum* L.). *J Agric Vet Sci* 2 (5): 11–17.

Savita SG (2011) Correlation and path coefficient analysis for yield and yield components in linseed (*Linumusitatissimum* L.) germplasm. *Karnataka J Agric Sci* 24: 382-386.

Sharma JR (1998) Statistical and biometrical techniques in plant breeding. New Age International, New Delhi.

Singh A,Tewari N (2016) Combining ability analysis for yield and yield contributing attributes in linseed (*Linum usitatissimum* L.). *J Oilseeds Res* 33 (1): 75–78.

Singh A, Tewari N,Dubey SD (2017) Study of gene action for seed yield, oil and quality components in linseed (*Linum usitatissimum* L.). *J Oilseeds Res* 34 (2): 109–112.

Tariq MA, Hussain T, Ahmad I, Saghir M, Batool M,Safdar M (2014) Association analysis in linseed (*Linumu sitatissimum* L.). J *Biol Agric Healthcare* 4 (6): 60–62.

Worku N, Heslop-Harrison JS, Adugna W (2015) Diversity in 198 Ethiopian linseed (*Linum usitatissimum* L.) accessions based onmorphological characterization and seed oil char acters. *Genet Resour Crop Evol* 62: 1037–1053.

Yadav RK (2001) Association studies over locations in linseed characters and its variability in different environments. *J Agric Sci* 140(3): 283–296.