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Research Note

Assessment of genetic diversity in linseed (*Linum usitatissimum* L.) genotypes

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Abstract

An investigation was carried out to assess the nature and magnitude of genetic diversity in 36 genotypes of linseed using Mahalanobis D^2 statistics. Presences of diversity pave way for exploitation of genotypes in breeding programmes which intended to improve the yield and yield attributing traits. The cluster analysis grouped 36 linseed genotypes into 12 distinct clusters. Clusters II and V were the largest containing eight genotypes each followed by cluster I with seven and cluster VII with five genotypes. The pattern of distribution of genotypes within different clusters was random and independent of geographical origin or region of adaptation. The maximum inter cluster distance was observed between cluster VII and XI (227.97) followed by cluster III and VII (207.29). The greater the distance between the two clusters, wider the genetic diversity between genotypes. The intra cluster distance was maximum in cluster VII (48.85) followed by cluster V (41.30) indicating hybridization involving genotypes within the same clusters might result in good cross combinations. On the basis of cluster mean value, genotypes in cluster VI, VII and IV deserve consideration for their direct use as parents in hybridization programs to develop high yielding linseed varieties.

Key words

Genetic diversity, Cluster analysis, D^2 statistics, Inter and Intra cluster distance

Linseed (*Linum usitatissimum* L.) is one of the most important *Rabi* season oilseed crops after rapeseed and mustard. It originated in the Mediterranean and the southwest Asian regions (Vavilov, 1935). Linseed is an annual herbaceous self-pollinated crop. It belongs to the order Malpighiales and family Linaceae. It is one of the richest source of vegetarian Omega-3 fatty acid and a good source of protein, dietary fiber, lignin, flax-fiber and essential micronutrients. Although India ranks third in the world in terms of area and production of linseed, productivity is low as the crop is generally grown as rainfed and the area under linseed cultivation is continuously declining in the country. In India it occupies an area of 0.32 m.ha with a production of 0.17 m.t and productivity of 535 kg/ha (DAC & FW, 2018). In Rajasthan, it is cultivated on 0.04 m.ha area with a production of 0.05

m.t and productivity of 1012 kg/ha. In the Kota region, it occupies an area of 1,544 ha with a production of 1,537 t and productivity of 760 kg/ha (Annual Report of AICRP on Linseed, 2017-18). Studies on variation in germplasm are very useful for developing high yielding, disease and pest resistant cultivars. Genetic divergence among the genotypes plays an important role in selection of parents having wider variability for different yield and quality characters which may be useful for breeding programmes. Selection of suitable divergent parents for hybridization is required because the cross involving diverse parents offers a great possibility of obtaining desirable segregants in segregating generations (Moll and Robinson, 1962). Therefore, this study on genetic divergence was taken up to assess the genetic variability present in 36 linseed genotypes.

Thirty six linseed genotypes were raised at Research Farm of College of Agriculture, Kota during the *Rabi* 2019-2020 to assess the genetic diversity. The experiment was laid out in Randomized Block Design with three replications. Each genotype was grown in plots of 3 m² with a spacing of 30×10 cm. The genotypes were randomly allotted to each plot in each replication. All the recommended agronomic package of practices was followed for raising of a healthy crop. Observations were recorded on ten randomly selected plants per replication for 11 traits viz., plant height (cm), the number of primary branches per plant, the number of capsules per plant, the number of seeds per capsule, harvest index (%), 1000 seed weight (g), protein content (%), oil content (%), seed yield per plant (g) except days to 50 % flowering and days to maturity which were recorded on a plot basis. Genetic diversity was studied following Mahalanobis's (1936) generalized distance (D^2) extended by Tocher's method (Rao, 1952) for grouping the 36 genotypes into 12 different clusters.

The result of the genotypes grouping into clusters is presented in **Table 1**. As per the D^2 values, the 36 genotypes of linseed were grouped into 12 clusters. Cluster II and V had maximum number of genotypes (8), followed by cluster I (7) and cluster VII (5). Clusters viz., III, IV, VI, VIII, IX, X, XI and XII were mono-genotypic. Similar findings were also observed by Diederichsen et al. (2001), Adugna and Labuschagne (2004), Khan et al. (2013), Nizar and Mulani (2015) and Kumar and Kumar (2021). The evaluation of estimates of within and among cluster heterogeneity conferred by intra and inter cluster values admitted that the genotypes within a cluster had little heterogeneity from each other as regards the cumulative effect of 11 parameters under investigation. The greater the distance between two clusters, the wider is the expected genetic diversity between them. Inter and intra-cluster distances among 12 clusters are presented in **Table 2** and relative disposition of clusters showing average intra and inter distance in genetic divergence are presented in **Fig 1**.

Table 1. Grouping of 36 linseed genotypes into 12 clusters

Cluster No.	Name of genotypes	Number of genotypes
I	180616, 180617, 180618, 180619, RL-15594, RL-15583, RL-15580	7
II	180513, 180514, RL-15596, KB-3, RL-15593, RL-15592, RL-15553, KB-4	8
III	180512	1
IV	PA-1	1
V	180101, 180102, 180103, 180104, 180107, RL-13161, RL-15554, RL-13165	8
VI	RL-15581	1
VII	180203, 180204, 180205, 180206, 180216	5
VIII	RL-15597	1
IX	RL-15595	1
X	RL-15559	1
XI	RL-15590	1
XII	RL-15582	1

Table 2. Average intra and inter-cluster distance based on corresponding D^2 values

Cluster	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
I	21.02	74.03	145.82	89.49	108.27	86.90	59.13	68.36	181.25	61.40	174.10	191.22
II		34.85	45.79	45.81	93.34	49.80	113.01	54.83	74.38	77.71	71.14	76.93
III			0.00	41.87	131.85	59.48	207.29	101.90	58.60	121.09	31.50	59.57
IV				0.00	75.39	45.25	116.90	37.99	66.30	83.82	36.90	65.60
V					41.30	93.28	93.11	67.76	71.69	142.03	132.66	98.85
VI						0.00	114.94	71.34	104.48	58.42	56.64	59.11
VII							48.85	80.99	178.31	92.71	227.97	177.94
VIII								0.00	77.09	120.06	84.57	98.64
IX									0.00	199.30	73.37	34.23
X										0.00	155.00	149.97
XI											0.00	59.70
XII												0.00

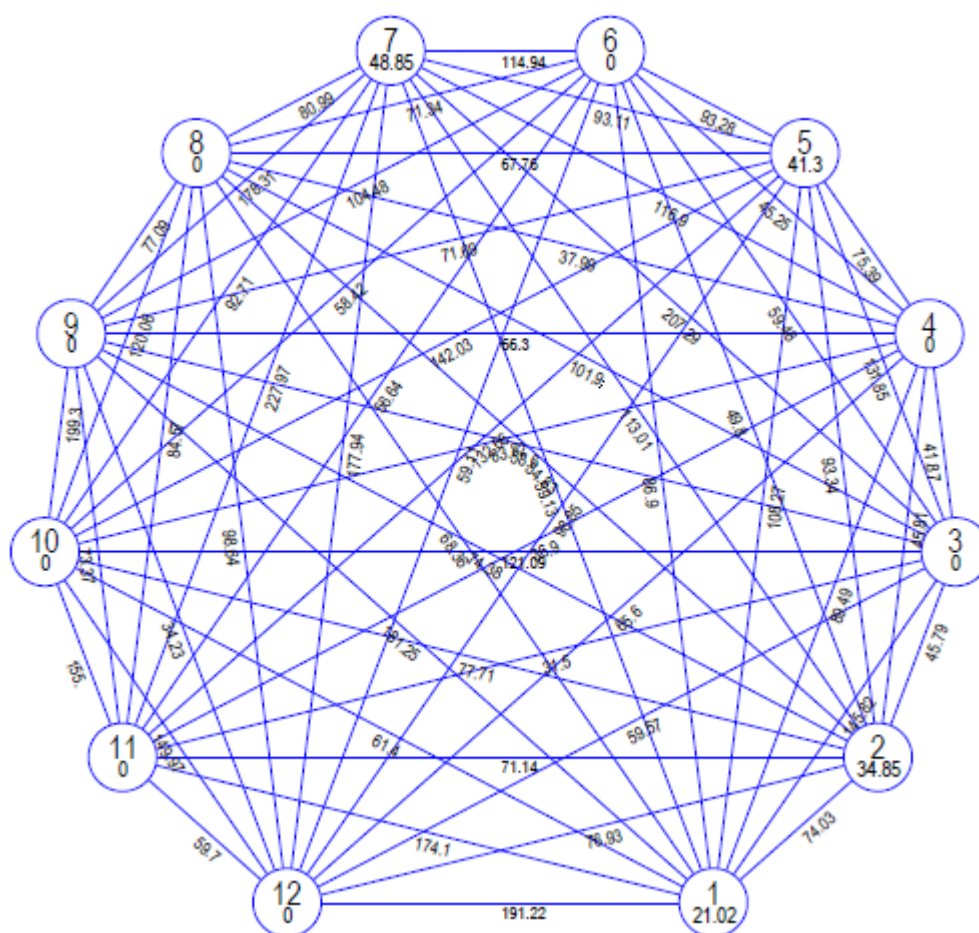


Fig.1. Relative disposition of clusters showing average intra and inter distance in genetic divergence

The intra cluster distance ranged from 0.00 (clusters III, IV, VI, VIII, IX, X, XI, XII) to 48.85 (cluster VII). Cluster VII had the highest intra cluster distance (48.85), followed by cluster V (41.30), cluster II (34.85) and cluster I (21.02). The highest inter-cluster distance (227.97) was found between cluster VII and XI followed by cluster III and VII (207.29), cluster IX and X (199.30), cluster I and XII (191.22) and cluster I and cluster IX (181.25). The smallest inter-cluster distance (31.50) was observed between III and XI followed by clusters IX and XII (34.23) and cluster IV and XI (36.90). Similar results were also reported by Khan et al. (2013), Tadesse et al. (2009) and Nizar and Mulani (2015).

The cluster mean for different quantitative characters of different clusters are presented in **Table 3**. The days to 50 % flowering was earliest in cluster VII (64.53) followed by cluster X (65.33), and cluster XII (66.00) whereas, the highest value for days to 50 % flowering was observed in cluster XI (77.00), followed by cluster VIII (73.00) and cluster VI and IV (71.33).

Early maturity was observed in cluster XII and VII (127.00

days) followed by cluster XI (128.00 days), whereas the late maturity was recorded in cluster III (133.00 days) followed by cluster I (130.14 days). Cluster X has the highest plant height (76.30 cm), followed by cluster IV (70.00 cm). The lowest plant height (42.53 cm) was observed in cluster IX. The maximum number of primary branches per plant was observed in cluster V (7.14) followed by cluster IX (6.13) and cluster IV (4.83). However, the minimum number of primary branches per plant was observed in cluster X (3.27) followed by cluster VI (3.77). Cluster VII has the highest number of capsules per plant (147.47) followed by cluster V (122.29) whereas, cluster III has the lowest number of capsules per plant (50.67) followed by cluster XI (55.67). The maximum number of seeds per capsule was observed in cluster III (8.90) followed by cluster IV (8.63) and cluster IX (8.20), whereas the lowest number of seeds per capsule was reported in cluster VI (6.33). The highest 1000-grain weight (g) was recorded in cluster I (8.40), followed by cluster X (8.00) and cluster VII (7.94); whereas, the minimum 1000-grain weight was reported in cluster IX (5.80). The maximum harvest index (%) was recorded in cluster X (38.57) followed by cluster VIII (37.35) and cluster VII (35.75), whereas the minimum

Table 3. Mean values of different characters for 36 linseed genotypes grouped in different clusters.

Characters Clusters	Days to 50 % flowering	Days to maturity	Plant height (cm)	Number of primary branches per plant	Number of capsules per plant	Number of seeds per capsule	1000 Seed weight (g)	Harvest index (%)	Protein content (%)	Oil content (%)	Seed yield per plant (g)
I	67.57	130.14	62.06	4.50	92.24	8.05	8.40	32.87	20.04	39.04	6.35
II	67.50	129.25	52.60	4.20	73.17	7.60	7.11	33.53	20.21	39.29	5.60
III	68.00	133.00	51.32	4.20	50.67	8.90	6.43	30.61	20.73	39.03	4.68
IV	71.33	130.00	70.00	4.83	93.00	8.63	6.70	34.45	20.89	41.34	6.00
V	69.88	129.50	57.12	7.14	122.29	6.87	6.98	33.41	20.26	37.33	5.87
VI	71.33	130.00	58.96	3.77	111.00	6.33	7.23	28.56	20.68	36.21	6.61
VII	64.53	127.00	65.14	4.94	147.47	7.32	7.94	35.75	20.40	38.83	6.79
VIII	73.00	129.00	54.17	4.63	118.00	7.40	7.00	37.35	20.22	43.14	7.44
IX	67.00	130.00	42.53	6.13	97.00	8.20	5.80	34.50	20.98	39.58	5.90
X	65.33	129.33	76.30	3.27	85.67	7.27	8.00	38.57	20.45	34.79	5.73
XI	77.00	128.00	61.33	4.70	55.67	6.80	6.27	31.03	20.81	40.31	6.46
XII	66.00	127.00	55.47	4.63	112.00	7.07	5.83	33.12	20.55	37.03	7.97

was observed in cluster VI (28.56). The maximum protein content was estimated in cluster IX (20.98 %) followed by cluster IV (20.89 %) and minimum protein content registered in cluster I (20.04 %). The maximum oil content was recorded in cluster VIII (43.14 %) and the minimum oil content found in cluster X (34.79 %). The maximum seed yield per plant was observed in cluster XII (7.97 g) followed by cluster VIII (7.44 g) and the minimum seed yield per plant registered in cluster III (4.68 g). Similar findings were also observed by Fulkar *et al.* (2007); Kumari and Rao (2008); Khan *et al.* (2013); (2018), Ranjana *et al.* (2019) and Kumar and Kumar (2021).

In conclusion, an appreciable extent of genetic divergence was observed among 36 genotypes of linseed. On the basis of the above analysis it can be concluded that the selection of parental material for hybridization programme must be carried out from the farthestmost clusters showing superior mean performance for obtaining transgressive segregants, which may helps in increasing the seed yield instead of those based on geographic diversity, which might not be a fruitful exercise for the finding of useful divergent parents.

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