Int.J.Curr.Microbiol.App.Sci (2022) *11*(09): 157-164

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 11 Number 09 (2022)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2022.1109.018

Genetic Variability in Bold Seeded genotypes of Linseed (*Linum usitatissimum* L.)

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Keywords

Linum usitatissimum L, L. perenee, L. strictrum, L. mysorence, L. angustifolium

Article Info

Received:
02 August 2022
Accepted:
31 August 2022
Available Online:
10 September 2022

A B S T R A C T

The recent experiment with the title "Genetic variability in bold seeded linseed (*Linum usitatissimum* L.) was conducted in "Research cum instructional farm, Department of Genetics and Plant Breeding, College of Agriculture, IGKV, Raipur, C.G." during *rabi* season 2021-2022, we used total 40 bold seeded (> 6.5 gm of 1000 seed weight) linseed genotypes including 5 checks (RLC-133, RLC-138, RLC-143, RLC-148 & RLC- 153), we used Randomized complete block design with three replications for sowing the seed in field and observations were recorded for different agro morphological traits, listed on linseed descriptors Kanpur (2010) are "days to commencement of flowering, plant height(cm), days to 50 % flowering, days to maturity, number of primary branches per plant, number of secondary branches per plant, total number of branches per plant, number of capsules per plant, number of seeds per plant, 1000 seed weight (g), oil content (%), harvest index (%), and seed yield per plant (g)." All the 40 bold seeded linseed genotypes were gone through D2 analysis for diversity analysis here cluster analysis distributes all the 40 genotypes into 5 clusters. Maximum number of genotypes (31) were grouped in cluster I. According to "intra-cluster distance, the most diverse clusters among all clusters were cluster II and the highest inter cluster D2 values were noted between cluster V and I (1001.96) followed by cluster V and III (852.10), cluster V and IV (607.26), cluster III and II (365.71) and cluster II and I (357.90). In hybridization program highly diverse genotypes are used."

Introduction

Linseed (*Linum usitatissimum* L. 2n = 30) belongs to the Linaceae family and Linum genus, which have around 100 species. There are mainly 5 wild species of linseed *L. usitatissimum* in India. *L. perenee, L. strictrum, L. mysorence, L. angustifolium* and *L. grandiflorum* are the species in the genus. It is mainly cultivated for its fiber and seed for oil purpose. Linseed in India majorly shown in *rabi* season. It is a short plant with high ranges from 30 cm to 120 cm, it has few primary branch and secondary branches coming out of primary branches and the seed colour in brawn which is packed inside the spherical capsules (Chandrawati, *et al.*, 2016; Ankit Singh *et al.*, 2019).

Linseed is a self-pollinated crop which is called Alsi

in India and it is believed that linseed that originated from south west Asia specifically India. Linseed is one of the oldest crops cultivated by humans for its dietary fibre, protein and fat (Payasi, *et al*., 2017; Dhirhi, *et al*., 2019).

A study on brown linseed reveals the nutrient values found in linseed is 41% fat, 20% protein, 28% dietary fiber, 7.7 % moisture and 3.4% ash, which leave mineral rich waste when samples are burnt.

It is noticed when protein content falls the oil content in seed rises, generally the seeds have 33 to 45% oil (Gill 1987), and it also have many omegas fatty acids (Omega 3, omega 6, linolenic acid, EPA, DHA).

Linseed is a valuable crop for seed oil, stem fiber and for various purposes like flour, paints, inks, varnish and other wood treatments, soap, putti and medication (Samantara, *et al*., 2020; Saroha, *et al*., 2022).

The fiber is used as raw material for textiles thread, and packaging materials, whereas, the straw of the plant are used to make special paper such as cigarettes, currency notes and art work and the wooden part of the plant are used as biomass or litter in cattle farming. The linseed generally texts 90 to 120 days for harvesting (Srivastava, *et al*., 2009).

In the global level the linseed crop is cultivated in the area of 285148 million hectares, and produce around 976113 million tonnes of linseed seed. Kazakhstan is the leading exporter of linseed with the productivity of 3410 kg per hectare followed by Russia and Canada (FAOSTAT 2020-21).

In India during 2019-20 total 1.1 lakh tonnes of linseed were harvested which were shown in the area of 1.8 lakh hectare, the average yield was 671 kg per hectare (INDIASTAT 2019-20).

Materials and Methods

To perform this research work Randomized complete block design with 3 replications is used where 40 linseed genotypes including 5 checks (RLC-133, RLC-138, RLC-143, RLC-148 and RLC-153) were shown during *rabi* season 2021-2022 on 10 December 2021.

In plots of 3 rows each of 4-meter length, where the distance between row is 30 cm and the distance between plant is 10 cm and for research and observation work five plants were randomly picked from the middle of each plot.

Results and Discussion

Genetic divergence analysis through Mahalanobis D2 clusters analysis

The existence of genetic divergence among the 40 genotypes of bold seeded linseed was examined by employing Mahalanobis D^2 statistics. The clustering pattern of 40 genotypes on the basis of the D2 statistics analysis has been presented in Table 1. The genotypes were a grouped into five distinct clusters. the highest number of genotypes appeared in cluster I which possessed 31 genotypes namely, GP-2913, RLC-148, GP- 2882, GP-2870, RLC-138, GP-2518, GP-2869, GP-2834, GP-2434, RLC- 143, RLC-133, GP-2087, GP-2123, GP-711, GP-1566, GP-2583, GP-429, GP-880, GP-2872, RLC-153,GP-2831, GP-2336, GP-2832, GP-2873, GP-2871, GP-1894, GP-2405, GP-2894, GP-2861 and GP-2892.

The second highest number of genotypes was found in cluster II which was comprised of 6 genotypes namely. GP-881, GP-2191, GP-68, GP-47, GP-2883 and GP-10. Cluster III comprised of only one genotypes *i.e.*, GP-1973. And cluster V comprised of only one genotypes *i.e*., GP-52.

Intra and inter cluster distance

The intra and inter cluster distance showed by D2 values in Table 2. The maximum intra cluster distance was noted for cluster II (131.17) after that cluster I (90.21). The minimum intra cluster D2 values obtained for cluster III (0.00), cluster IV (0.00) and cluster V (0.00), there was only one genotype present. The highest inter cluster D2

values was noted between cluster I and V (607.26), cluster II and III (365.71) and cluster I and II (357.90). And the lowest inter cluster D2 value was observed between III and IV (89.98).

Mean of inter cluster distance

Cluster I (34.30) showed the highest cluster mean for days to commencement of flowering followed by cluster V (33.33) and cluster III (32.33) and the lowest cluster mean was noted for cluster IV (28.67).

Cluster III (64.00), observed the highest cluster mean for days to 50% flowering after that cluster I (60.95), cluster IV (58.00) and the lowest cluster mean was cluster II (56.83).

Cluster III (131.67), observed the highest cluster mean for days to maturity after that cluster I (122.70), cluster IV (122.33) and the lowest cluster mean was found in cluster II (116.89).

Cluster III (56.30) was observed for plant height at maturity, followed by cluster IV (55.43), cluster I (53.06) and the lowest cluster mean was observed for cluster V (47.04).

Cluster V (3.40) was observed for number of primary branches per plant followed by cluster IV (2.60), cluster II (2.48) and the lowest cluster mean was noted for cluster I (1.44).

Cluster V (25.67) was observed the highest cluster mean for secondary branches per plant followed by cluster II (14.94), cluster III (13.13) and the lowest cluster mean was cluster I (6.56).

Cluster V (116.47) was observed the highest cluster mean for total number of branches per plant which was followed by cluster II (67.99), cluster IV (48.53) and the lowest cluster mean was obtained for cluster I (26.39).

Cluster V (57.80) was observed the highest cluster mean for number of capsules per plant. Which was followed by cluster II (38.72), cluster IV (23.27), and the lowest cluster mean was noted for cluster I (14.76).

Cluster V (334.13) obtained the highest cluster mean for number of seeds per plant which was followed by cluster II (258.60), cluster III (94.13) and the lowest cluster mean was cluster I (88.40).

Cluster III (9.24 g), obtained the highest cluster mean, for 1000 seed weight followed by cluster IV (7.51 g), cluster I (7.50 g), and the lowest cluster mean was noted for cluster V (6.84 g).

Cluster V (33.11) was observed the highest cluster mean for harvest index (%), after that cluster II (31.29) and the lowest mean was noted for cluster IV (23.76).

Cluster V (36.33), showed highest cluster mean for oil content (%) followed by cluster II (35.50), cluster III (33.50) and the lowest cluster mean was noted for cluster IV (31.33).

Cluster V (2.56) was observed the highest cluster mean followed by cluster II (2.29), cluster III (1.76) and the lowest cluster mean for cluster I (1.60), according to Table 3.

Genetic divergence analysis distributes all the 40 genotypes into 5 clusters. where cluster I showed maximum genotypes *i.e.,* 31 genotypes. Highly diverse genotypes can be used in hybridization process.

This study shows about the best bold seeded linseed genotypes with respect to various traits including "1000 seed weight (g) is GP-2006 followed by GP-1894, GP-2405, GP-2832, GP-2871 and GP-2336 whereas, for seed yield per plant (g) GP-10 followed by GP-52, GP-2883, GP-881 and GP-2894 were found out to be the high yielding genotypes of linseed.The highest percent contribution towards divergence are "days to commencement of flowering, plant height at maturity, and seed yield per plant (g)."

Table.1 Genotypes included in different clusters based on D2 analysis in bold seeded linseed

Cluster Group	No. of Genotypes	List of Genotypes	Seed yield/plant (g) (Cluster mean)
I	31	GP 2913, RLC 148A©, GP 1981, GP 2882, GP 2870, RLC 138A©, GP 2518, GP 2869, GP 2834, GP 2434, RLC 143A©, RLC 133A©, GP 2087, GP 2123, GP 711, GP 1566, GP 2583, GP 429, GP 880, GP 2872, RLC 153A©, GP 2831, GP 2336, GP 2832, GP 2873, GP 2871, GP 1894, GP 2405, GP 2894, GP 2861 & GP 2892	1.60
II	6	GP 881, GP 2191, GP 68, GP 47, GP 2883 & GP 10	2.29
III	1	GP 2006	1.76
IV	1	GP 1973	1.62
V	1	GP 52	2.56

Table.2 Average intra and inter cluster distances

Cluster Distances					
Clusters	I	II	III	IV	V
I	90.21	357.90	192.59	178.06	1001.96
II	357.90	131.17	365.71	234.09	316.38
III	192.59	365.71	0.00	89.98	852.10
IV	178.06	234.09	89.98	0.00	607.26
V	1001.96	316.38	852.10	607.26	0.00

Table.3 Cluster means for seed yield and its component of forty bold seeded linseed genotypes

S. No.	Characters	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
1	Days to Commencement of flowering	34.30	32.28	32.33	28.67	33.33
2	Days to 50 % flowering	60.95	56.83	64.00	58.00	57.00
3	Days to maturity	122.70	116.89	131.67	122.33	117.33
4	Plant height at maturity (cm)	53.06	50.37	56.30	55.43	47.04
5	No. of primary branches/plant	1.44	2.48	1.87	2.60	3.40
6	No. of secondary branches/plant	6.56	14.94	13.13	12.53	25.67
7	Total no. of branches/plant	26.39	67.99	46.00	48.53	116.47
8	No. of Capsule/plant	14.76	38.72	17.07	23.27	57.80
9	No. of seeds/plant	88.40	258.60	94.13	90.53	334.13
10	1000 Seed weight (g)	7.50	7.30	9.24	7.51	6.84
11	Harvest Index (%)	27.59	31.29	23.87	23.76	33.11
12	Oil content (%)	35.45	35.50	33.50	31.33	36.33
13	Seed yield/plant(g)	1.60	2.29	1.76	1.62	2.56

Fig.1 Average intra and inter cluster distance with Tocher method

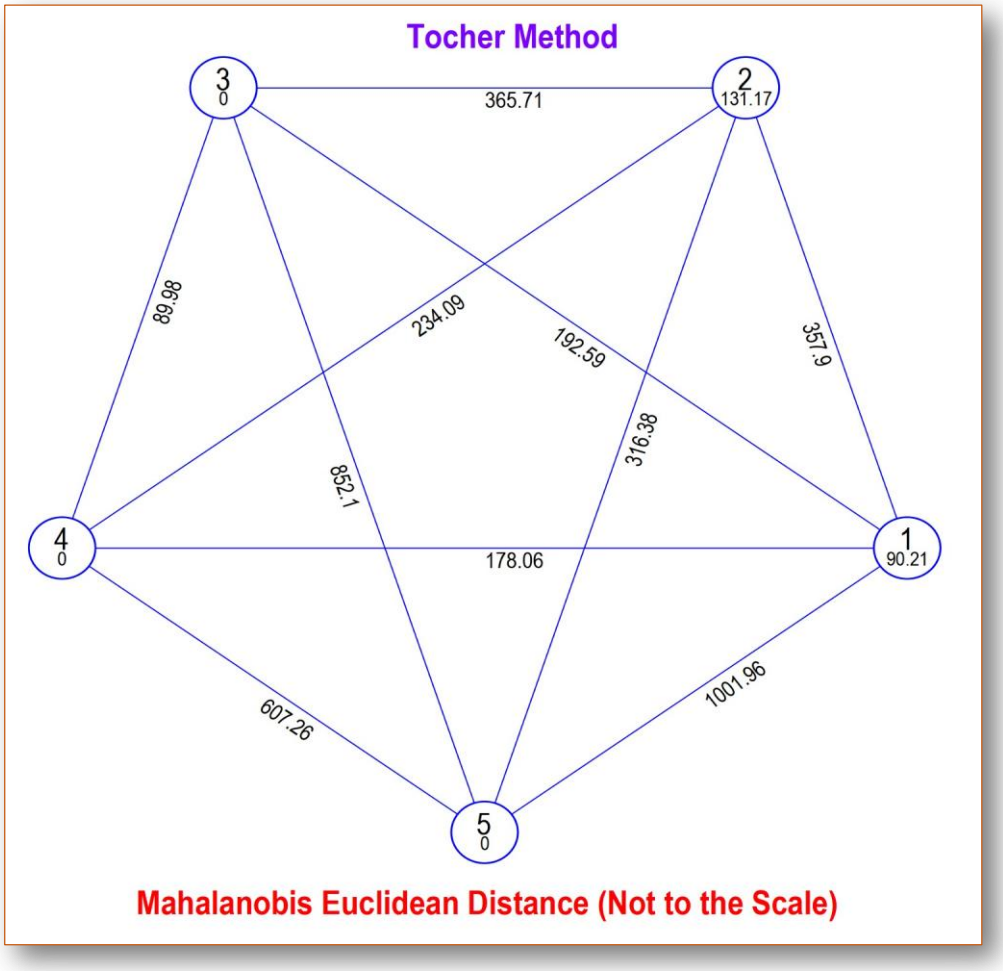
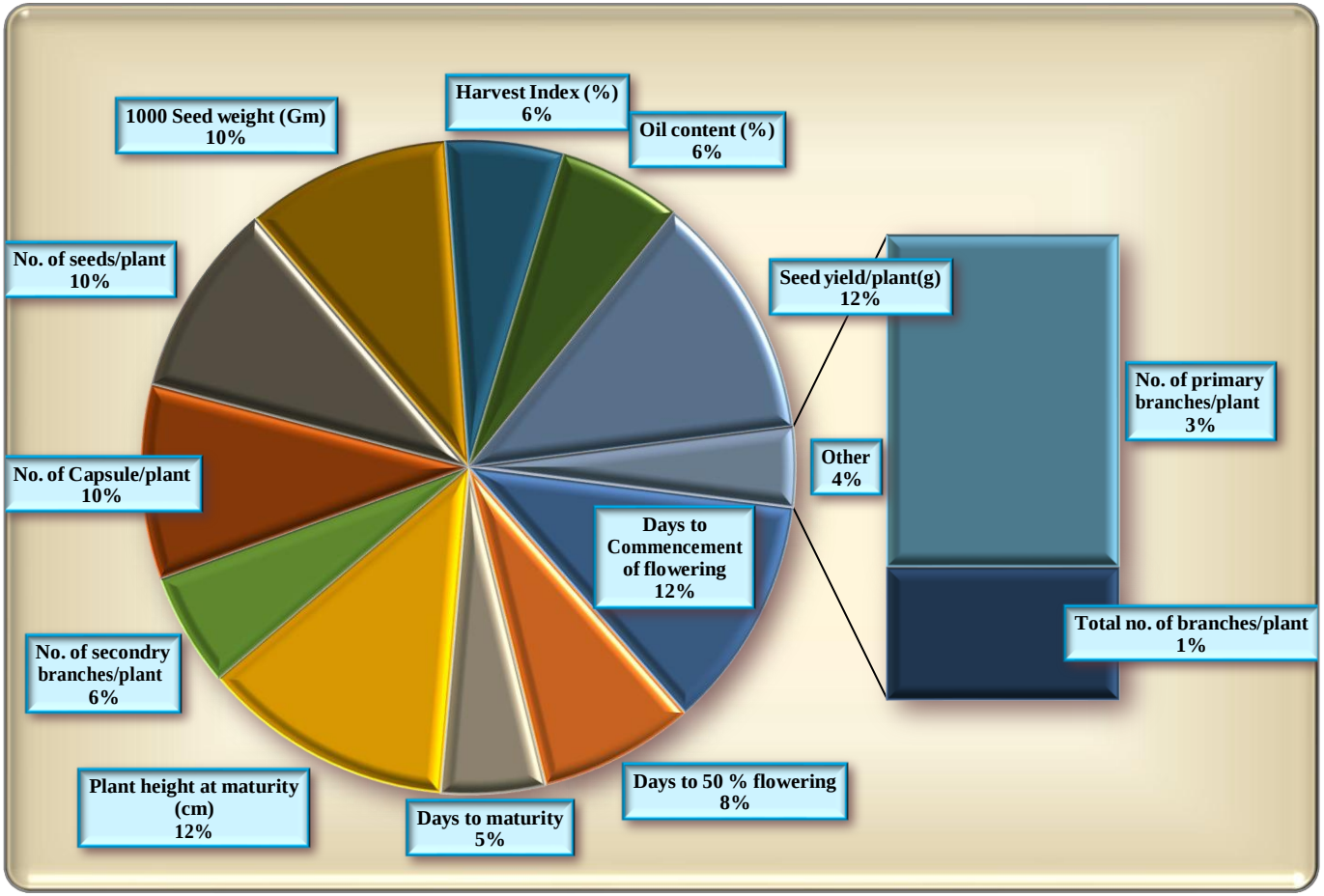


Fig.2 Percent contribution towards divergence



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How to cite this article:

Vidya Markandey, Nandan Mehta, Abhinao Sao, S. B. Verulkar, Ravi R. Saxena and Ritu R. Saxena. 2022. Genetic Variability in Bold Seeded genotypes of Linseed (*Linum usitatissimum* L.). *Int.J.Curr.Microbiol.App.Sci.* 11(09): 157-164. doi: https://doi.org/10.20546/ijcmas.2022.1109.018