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RESEARCH ARTICLE

Genetic diversity in linseed (*Linum usitatissimum* L.)

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SUMMARY

A study conducted, at RARS, Raichur during 2006 *Rabi* to know the genetic divergence in 79 linseed genotypes. The experiment was laid out in complete randomized block design with three replications. Observations were recorded on 12 different characters. Following Mahalanobis D^2 statistics genotypes were grouped into 13 clusters using Tocher's method. The higher inter cluster D^2 values were recorded between cluster XI and XIII. Days to maturity, plant height, capsules per plant, days to flowering and harvest index were identified as potential variability which can be used as parameters while selecting diverse parents in the hybridization programme for yield further improvement.

Key Words **:** Genetic, Diversity, Lentil

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Linseed or flax (*Linum usitatissimum* L.) is one of the oldest crops cultivated by man.It is important crop of tropical as well as temperate zone of the world. Based on diversity of plant types, linseed has two centers of origin *i.e.,* South West Asia and the Mediterranean region of Europe (Darlington, 1963).

Linseed oil is unsuitable for nutritional purpose but it is an unparalleled source for paints, varnishes, oil, cloths, lenolinum and lubricants. It has a significant position with about 32 per cent share in total technical oil pool which is having industrial importance. The oil cake is a most valuable feeding cake to both milch and flattering animals. The cake is also used as manure and is a very good source of nitrogen to soil.

Fibres obtained from the stem are known for their length, strength and beauty. They are spun into linen yarns which are used in making the best quality textiles. They are also used for the manufacture of rough textiles such as blankets, carpets, galicha, mattresses, etc. The remaining material after fibre extraction can successfully be utilized as pulp for manufacturing straw boards, writing papers and parchment paper. The stalks are used as fuel.

Crop improvement depends on the magnitude of genetic variability and extent to which the desired characters are heritable. This has inturn attracted the attention of biometrician to study the genetic aspects of economically important characters, such as yield, its components.

MATERIALS AND METHODS

The material for the present study comprised of 79 linseed genotypes. These genotypes were evaluated in the regional agricultural research station, Raichur, UAS, Dharwad, which is situated in North-Eastern Dry Zone (Zone-2) of Karnataka

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at 16^0 12' N latitude and 77^0 12' E longitude and 389 meters above mean sea level with average annual rainfall of 660 mm. The genotypes were grown in randomized block design in three replications. Data on 12 characters were recorded from 5 plants per replication and the average was taken for analysis. Observations were recorded on days to flowering, plant height, number of branches per plant, number of capsules per plant, number of seeds per capsule, seed length, seed breadth, 1000-seed weight, harvest index, days to maturity, oil content and seed yield per plant were recorded. Data were analyzed as per standard procedures.

The genetic divergence among genotypes was computed by means of Mahalanobis D^2 technique and genotypes were grouped into clusters by following Tocher's method as described by Rao (1952). The statistical analysis was carried out using computer software SPAR (Indian agricultural statistical research institute, Delhi) and Indostat (Indo stat services, Hyderabad).

RESULTS AND DISCUSSION

The analysis of variance revealed that the highly significant differences for characters among the genotypes. The genetic divergence was estimated by Mahalanobis D^2 statistic and the genotypes were grouped into 13 clusters using Tocher's method each clusters having 40, 15, 5, 5, 4, 1, 1, 3, 1, 1, 1, 1 and 1 genotypes respectively (Table 1). Cluster I consisted of maximum number of genotypes (40). Cluster II is next which had 15 genotypes. Cluster VI, VII, from IX and XIII were solitary clusters each represented by single genotypes. The intra-cluster D^2 values ranged from 0.00 to 7.960. The intra cluster D^2 values among 13 clusters revealed (Table 2) that maximum genetic diversity has been observed with Cluster-V (7.960) followed by in descending order cluster I (7.382), III (7.044), II (7.018), VIII (6.332) and IV (5.297). The results of the intra-cluster distance indicating that, the maximum amount of heterosis is expected in cross combination involving the genotypes of most divergent cluster. The inter cluster D^2 values varied from 6.291 to 33.948. It indicates that the genotypes in the cluster V were more diverse than the genotypes in the above clusters. The maximum inter- cluster distance between cluster IV and XIII (33.948). The minimum inter cluster distance was observed between cluster IX and X (6.291). Genotypes present in this cluster may be used as parents in hybridization programme to obtain heterotic combinations. The cluster XI and cluster XIII were strictly more diverse from the rest of the clusters. The criteria used for selection of varieties as parents for hybridization using D^2 analysis is the inter cluster distance. Those genotypes included in clusters with maximum inter cluster distance are obviously genetically more divergent. Hence, it would be logical to incorporate genotypes from these clusters in further breeding programmes. The mean values for different characters of 13 clusters indicated that the superior expression of some characters in different clusters (Table 3). The genotype

Table 1 : Composition of genotypes in different cluster

Clusters	Number of genotypes	Name of genotypes
I	40	RLC 106, LC– 2279– 4, RLC– 93, PKDL– 50, LMS– 153– 03, RLC– 101, PKDL– 42, PADMINI, NL97, RLC– 92, JLS– 9, SLS– 62, RLC– 102, PKDL– 21, PKDL– 41, LMS– 125– 4, T397, LMS– 153– 03, RLC 99, RLC– 110, RLC– 100, SWETA, SLS– 63, NL– 165, OLC– 99– 57, PADMINI, SLS– 66, RLC 88, RLC 81, RLC 89, JLT– 62, PKDL– 44, NL 155, RLC– 94, LC– 2221, JLT– 188, KIRAN, PKDL– 47, RLC– 109
II	15	NDL– 2004– 1, S– 36, RLC– 96, LCK– 5002, LCK– 4012, LCK– 4036, R– 552, PCL 2001, SLS– 61, GARIMA, J– 23, LMS– 166– 03, PKDL– 52, LC– 2246, OLC 38
III	05	SHEELA, NDL– 2004– 5, RL– 24109, RL– 24106, RL– 2206
IV	05	LMS4– 21, RLC– 95, SLS 60, SLS 34, T– 397
V	04	SLS 39, LCK– 4004, LMS– 9– 2K, SLS37
VI	01	SHEKAR
VII	01	JLT – 119
VIII	03	SHUBRA, PARVATI, LCK – 4028
IX	01	SLS – 65
X	01	SLS – 64
XI	01	SLS38
XII	01	RL – 2202
XIII	01	LC 54

Table 2 : Averate inter cluster (above diagonal) and intra cluster (diagonal) D^2 and D values for 13 clusters in linseed

Cluster number		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
I	D^2	7.382	13.636	22.907	11.158	11.944	15.118	10.174	16.576	11.628	11.954	14.306	24.258	26.005
	D	2.716	3.692	4.786	3.340	3.456	3.897	3.189	4.071	3.409	3.457	3.782	4.925	5.099
II	D^2		7.018	13.124	21.671	18.220	9.968	15.738	10.640	15.992	17.317	24.239	15.825	17.705
	D		2.649	3.622	4.655	4.268	3.157	3.967	3.261	3.998	4.161	4.923	3.978	4.207
III	D^2			7.044	31.456	26.216	17.902	25.151	13.895	25.715	27.910	32.226	12.607	11.366
	D			2.654	5.608	5.021	4.231	5.015	3.727	5.070	5.282	5.676	3.550	3.371
IV	D^2				5.297	13.012	22.025	12.032	23.712	13.497	12.783	9.851	31.854	33.948
	D				2.301	3.607	4.693	3.468	4.869	3.673	3.575	3.138	5.643	5.826
V	D^2					7.960	20.206	10.638	16.768	13.917	17.495	10.917	23.826	25.495
	D					2.821	4.495	3.261	4.094	3.730	4.182	3.304	4.881	5.049
VI	D^2						0.000	13.552	15.500	12.241	13.393	26.342	16.458	21.626
	D						0.000	3.681	3.391	3.498	3.659	5.132	4.056	4.650
VII	D^2							0.000	14.866	6.563	10.420	14.920	22.173	26.000
	D							0.000	3.855	2.561	3.228	3.862	4.708	5.099
VIII	D^2								6.332	15.318	19.473	24.925	10.061	14.979
	D								2.516	3.913	4.412	4.992	3.171	3.870
IX	D^2									0.000	6.291	18.708	23.292	28.479
	D									0.000	2.508	4.325	4.826	5.336
X	D^2										0.000	20.046	27.443	32.005
	D										0.000	4.477	5.238	5.657
XI	D^2											0.000	32.253	32.679
	D											0.000	5.679	5.716
XII	D^2												0.000	9.502
	D												0.000	3.082
XIII	D^2													0.000
	D													0.000

Table 3: Cluster mean values for different character in linseed

Sr. No.	Characters	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
1.	Days to flowering	36.46	44.2	48.72	30	33.78	43.73	35.6	43.69	35.87	35.53	30	47	50
2.	Plant height (cm)	34.05	34.8	39.93	33.16	42.93	32.2	37.6	41.89	34.27	28.27	40.53	46.07	48.33
3.	Number of branches per plant	3.85	4.11	3.76	3.59	4.17	4.87	5.2	4.71	5.2	5.2	4.4	5.4	4.93
4.	Number of capsules per plant	22.13	23.4	20.32	22.28	22.12	31.13	29.6	27.07	30	S28.93	18.73	29.87	23.67
5.	Number of seeds per capsule	8.22	8.47	8.07	7.76	8.15	8	8.4	8.73	8.13	7.67	8.47	8.4	7.47
6.	Seed length (mm)	4.43	4.43	4.52	4.49	4.57	4.73	4.13	4.31	4.43	4.53	4.3	4.6	4.37
7.	Seed breadth (mm)	2.23	2.24	2.31	2.27	2.33	2.53	2.1	2.17	2.43	2.53	2.23	2.13	2.53
8.	1000-seed weight (g)	5.42	5.38	5.43	5.38	5.42	5.37	5.53	5.44	5.35	5.29	5.3	5.47	5.38
9.	Harvest index (%)	30.74	31.23	30.9	31.06	32.02	33.03	31.57	34.73	37.05	36.02	28.03	32.3	26.3
10.	Days to maturity	104.51	113.13	121.6	98	102.75	112	103	113.33	104	103	96	120	120
11.	Oil content (%)	39.73	39.21	40.26	39.19	39.85	41.17	39.8	39.46	39.77	39.9	41.3	40.17	39.8
12.	Seed yield per plant (g)	1.06	1.08	1.13	0.99	1.22	1.58	1.24	1.5	1.81	1.73	1.06	1.24	0.72

Table 4 : Per cent contribution of characters towards divergence in linseed

Sr. No	Characters	Contribution (%)	Cumulative effect (%)
1.	Days to maturity	39.37	39.37
2.	Plant height	21.45	60.82
3.	Capsule per plant	20.42	81.24
4.	Days to flowering	13.66	94.90
5.	Harvest index	4.54	99.45
6.	Oil content	0.55	100.0
7.	Branches per plant	0.00	100.0
8.	Seeds per capsule	0.00	100.0
9.	Seed length	0.00	100.0
10.	Seed breadth	0.00	100.0
11.	1000 seed weight	0.00	100.0
12.	Seed yield per plant	0.00	100.0

in the cluster IX can be chosen for hybridization programme, as it recorded highest cluster mean values for 1000 seed weight, harvest index and seed yield per plant. However for earliness, genotypes from cluster IV and XI and for seeds per capsule genotypes from VIII may be included in hybridization programme. The genotype from cluster VI was included for breeding programme as it recorded higher mean values for capsules per plant and oil content. The genotype from solitary cluster XIII which had highest number of days to flowering and plant height can also be considered as parent in hybridization programme. It is suggested that the crosses should be effected among the genotypes of above said clusters for improving more than one economic characters to develop potential segregants and future selection needs to be made in above, to develop high yielding cultivars of linseed.

Among the twelve characters studied, the most important character contributing to the divergence was days to maturity followed by plant height, capsules per plant, days to flowering and harvest index (Table 4). While low contribution was from oil content. These observations are also in accordance with Ajit (2006), for days to maturity (Mahto and Verma, 1998; Haque *et al.,* 1994; Mahto and Singh 1996), for plant height and number of capsules per plant (Mahto and Singh, 1996 and Mahto and Verma, 1998), for days to flowering and plant height (Asthana and Pandey, 1980), for capsules per plant and days to flowering (Verma, 1996), for plant height (Chandra, 1977), for number of capsules per plant (Mahto, 1999).

The above results imply that in order to select genetically diverse genotypes for hybridization the material should be screened for important traits like days to maturity, plant height, capsules per plant, days to flowering, harvest index and oil content.

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