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STUDY OF GENETIC DIVERSITY IN SOME LOCAL AND EXOTIC LENTIL (*LENS CULINARIS* MEDIK) GENOTYPES

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Abstract

Genetic diversity was studied in 30 lentil genotypes (including 15 hybrids, 8 mutants and 7 exotic accessions) originating from Pakistan, Argentina and ICARDA (Syria) by using Metroglyph analysis. The objectives were to classify the lentil germplasm into distinct groups and to identify the most desirable genotype(s) for hybridization programme for the evolution of high yielding varieties. A desirability index was constructed to assess the worth of a particular genotype for different traits. Metroglyph analysis distributed the genotypes into 10 distinct groups. Maximum mean index score was observed for group-V followed by group-VI and group-VII. Mean index score of exotic accessions (14.3) was found greater than those of hybrids (13.9) and mutants (13.8). Genotypes like TCL 85-1, ILL 6821, Precoz and Masoor 93 were found to be the desirable genotypes. TCL 85-1 appeared as most prominent one with a high desirability index and maximum index score (17) followed by an exotic accession, viz., Precoz (15). Metroglyph technique was found useful in identifying groups of genotypes with yield enhancing traits and in the selection of superior genotypes.

Introduction

Lentil seed is referred as poor man's meat because of its rich protein (25%), carbohydrates, nitrogen and fiber contents, high proportion of vitamin-A, vitamin-B, potassium and iron and low sodium and fat that regulates growth and development (Anon., 2003). It has both food and medicinal value. The major lentil producing regions are Asia and West Asia-North Africa region. In Pakistan, lentil is grown as an important winter pulse crop after chickpea on an area of 39.0 thousand hectares with an annual production of 21.1 thousand tones having an average seed yield of 541 kg per hectare (Anon., 2008) which is low and cannot meet the demand of increasing population. Area under lentil crop has decreased because of the attack of various diseases and infestation of weeds. Lentil seed has rich protein content (Rachie & Roberts, 1974) and meets the protein requirements of the people of Pakistan. There is a dire need to increase the seed yield per hectare of lentil to meet day to day requirement.

The success of any plant breeding programme aimed at the evolution of high yielding, better quality and disease resistant varieties depends upon the selection of suitable genotypes to be utilized in breeding programme. The study of genetic diversity among genotypes is helpful in formulating effective crop breeding strategy. Genetic divergence has been studied in lentil (Rajput & Sarwar, 1989; and Sultana *et al*., 2005) and various other crops like sugarcane (Kashif & Khan, 2007), wheat (Ashraf *et al*., 2003), oilseeds (Arshad *et al*., 2003) and legumes (Ghafoor & Ahmad, 2005; Sharma *et al*., 1996). In the present study local and exotic genotypes were used and an attempt was made to generate information for the selection of best mutants/hybrids to broaden the genetic base for the evolution of high yielding and disease resistant varieties. The major objectives of this study were, 1-to classify the available lentil genotypes into distinct groups on the basis of their genetic diversity by using Metroglyph analysis and to identify most desirable genotypes to be utilized in hybridization programme for the evolution of high yielding varieties with improved plant traits.

Materials and Methods

Experiment was conducted at Nuclear Institute for Agriculture and Biology (NIAB), Faisalabad, Pakistan during winter 2007-08. The experimental material consisted of 30 lentil genotypes comprising of 15 hybrids, 8 mutants and seven exotic accessions (Table 1) originating from Pakistan, Argentina and ICARDA (Syria). The experiment was laid out in a triplicated Randomized Complete Block Design (RCBD) having a plot size of 3.6 m^2 keeping row to row distance of 30 cm and plant to plant distance of 10 cm. Three plant rows per entry were sown and normal agronomic practices were followed. At maturity 10 guarded plants from the central row were selected at random from every genotype in each replication and data were recorded on different traits viz., days to flower, days to mature, plant height, primary branches per plant, pods per plant, 100-seed weight and seed yield per plant.

Data were subjected to the analysis of variance (Steel *et al*., 1997) followed by Anderson's Metroglyph technique (Anderson, 1957) to study the patterns of morphological variations in different genotypes. Chandra *et al*., (1997) suggested metroglyph technique to be more suitable for preliminary grouping prior to undertaking D^2 analysis. Two most variable traits (pods per plant and seed yield per plant) were drawn on X-axis and Y-axis, respectively. Except these traits other traits were represented as rays on the glyph, where each glyph represented a genotype thus forming a scatter diagram. The traits were represented by different length of rays. The length of ray assigned to each trait was according to the index value of genotypes set for that trait (1 for lower value, 2 for medium and 3 for highest value). The performance of a genotype was judged by its total index score, which was the sum of the index values with regard to all characters. The index values 1, 2, 3 meant lower to higher value of worth of a genotype/variety. All the genotypes were divided into different groups in the scatter diagram and the genotypes aggregating closely were kept in one group. For days to flower and days to mature, desirability was in lower magnitude; therefore higher index value (3) was given to the genotypes showing early flowering and maturity. For all other traits desirability was linked with higher magnitude, so high index value was given to the genotypes exhibiting greater mean values of these traits (Table 2).

A desirability index of lentil genotypes was constructed to assess the worth of a particular genotype for different traits. Three levels of desirability were set for different traits viz., Level A for index score 3, level B for index score 2 and level C for index score 1 (Table 3). An ideal genotype was proposed as one with desirability index AAAAAAA resulting in total index score of 21 and linked with maximum mean phenotypic values for all traits. Accordingly, the least desirable was proposed as one with desirability index CCCCCCC resulting in total index score of 7.

Table 1. Origin thirty of lentil genotypes and mean phenotypic values of different traits contributing to genetic divergence.

Sr. No.	Genotype	Origin	Nature of genotype	Days to flower	Days to maturity	Plant height (cm)	Number of primary branches	Number of pods per plant	100-seed weight (g)	Seed yield/ plant (g)
1.	NL 30-50-2	Pakistan	Hybrid	94.33	136.33	37.27	3.56	206.11	2.63	6.31
2.	NL 96	//	Mutant	100.67	137.33	34.40	2.44	137.11	2.81	4.87
3.	NL 96700	//	Mutant	94.33	138.33	36.91	2.44	178.78	2.99	5.84
4.	NL 9725	//	Hybrid	100.67	138.67	28.42	2.44	179.67	2.02	5.36
5.	NL 9723	//	Hybrid	94.33	139.33	33.13	2.56	165.89	3.11	6.87
6.	NL 96505	//	Mutant	99.33	140.67	34.64	2.22	96.67	2.62	3.35
7.	NL 9820	//	Hybrid	93.33	139.33	27.09	2.00	100.44	3.04	5.13
8.	TCL 85-1	//	Mutant	100.33	140.67	45.63	3.67	241.44	2.47	9.15
9.	NL 9681	//	Hybrid	94.33	138.33	35.19	3.00	149.89	2.88	5.13
10.	NL 0205	//	Mutant	99.67	137.67	41.66	3.11	179.78	2.59	4.66
11.	ILL 11136	Syria	Accession	99.33	137.33	41.41	3.44	178.44	2.54	4.33
12.	NL 96353	Pakistan	Hybrid	94.33	140.00	36.91	3.11	209.78	2.00	6.89
13.	NL 9726	//	Hybrid	95.33	140.00	34.81	3.89	187.78	2.80	8.08
14.	Masoor 93 G	//	Hybrid	100.67	141.67	40.78	4.44	156.44	2.64	4.72
15.	Precoz	Argentina	Accession	90.33	131.00	23.56	2.33	127.00	3.90	4.98
16.	NL 9810	Pakistan	Hybrid	95.67	139.67	31.89	3.33	157.33	2.55	5.69
17.	NL 2106	//	Mutant	99.00	140.33	35.10	2.44	129.89	2.52	4.57
18.	NL 23124	//	Hybrid	99.67	141.67	33.89	2.89	166.56	2.17	7.96
19.	NL 30-33-1	//	Hybrid	100.33	139.33	32.81	3.44	146.11	2.65	6.33
20.	NL 55-1B	//	Hybrid	100.67	139.00	32.86	3.22	158.56	3.02	6.74
21.	NL 96102	//	Hybrid	100.00	139.67	31.32	3.00	136.44	2.94	6.34
22.	ILL 11125	Syria	Accession	97.67	135.67	32.84	3.22	145.89	3.19	6.73
23.	NL 96697	Pakistan	Mutant	94.33	138.33	32.94	2.56	120.78	2.88	6.36
24.	ILL 6024	Syria	Accession	100.67	141.00	33.43	2.44	118.00	2.00	5.49
25.	ILL 6821	//	Accession	88.33	134.33	33.12	2.78	125.44	3.05	5.73
26.	66121	PGRI Line	Accession	94.67	139.67	40.41	3.11	172.89	2.76	6.66
27.	NL 20-24	Pakistan	Mutant	102.00	142.67	41.57	3.56	221.11	1.74	8.54
28.	ILL 6463	Syria	Accession	95.67	139.33	32.32	3.56	166.44	2.29	5.75
29.	NL 2151	Pakistan	Hybrid	93.67	139.00	42.77	3.11	211.56	2.65	7.13
30.	NL 96476	//	Hybrid	99.33	139.33	33.30	3.44	170.89	2.42	7.43
Grand Mean ± Standard deviation				97.10 ± 3.55	138.86 ± 2.38	35.08 ± 4.87	3.03 ± 0.67	161.44 ± 35.92	2.66 ± 0.45	6.10 ± 1.51

Table 2. Coefficients of variation, range of means and index scores for different quantitative traits of thirty lentil genotypes.

Traits	GCV%	PCV %	Range of means	Score 1		Score 2		Score 3	
				Value more than	Sign	Value from to	Sign	Value less than	Sign
Days to flower	3.58	3.61	88.33-102.0	100.33		93.67-100.33		93.33	
Days to mature	1.63	1.67	131.0-142.67	141.0		137.33-141.0		137.33	
				Score I		Score II		Score III	
				Value less than	Sign	Value from to	Sign	Value more than	Sign
Plant height (cm)	13.63	13.77	23.56-45.63	31.32		31.32-37.27		37.27	
Number of primary branches	16.50	18.54	2.00-4.44	2.44		2.44-3.67		3.67	
Number of pods per plant	21.43	21.78	96.67-241.44	-		-		-	
100-Seed weight (g)	15.86	16.27	1.74-3.90	2.29		2.29-3.11		3.11	
Seed yield/plant (g)	19.96	21.75	3.35-9.15	-		-		-	

Table 3. Mean squares from the analysis of variance of some plant traits of thirty lentil genotypes.

SOV	df	Days to flower	Days to mature	Plant height (cm)	Primary branches/plant	Pods/plant	100-Seed weight (g)	Seed yield/ plant (g)
Replications	2	4.433	1.378	2.880	0.322	147.291	0.002	0.335
Genotypes	29	36.900**	16.039**	69.986**	0.944**	3709.550**	0.563**	5.290**
Error	58	0.709	0.608	1.359	0.196	119.451	0.028	0.834
Total	89							

*, ** = Significant at 0.05 and 0.01 probability levels, respectively.

Results and Discussion

All the traits studied exhibited the presence of considerable genetic variation as evident from highly significant mean squares (Table 3). Genotypic and phenotypic coefficients of variation were greater for number of pods per plant and seed yield per plant (Table 2) which shows the presence of sufficient amount of genetic variability and hence these traits were drawn on X and Y axis, respectively to form Metroglyph Scatter Diagram.

Metroglyph analysis distributed 30 lentil genotypes into 10 distinct groups on the basis of relative dispositioning of genotypes on the graph (Fig. 1). Groups I, II and V, each consisted of one genotype viz., NL 96505, NL 9820 and NL 9726, respectively. Group I comprises of a single mutant genotype that separates it from other two groups each comprising single hybrid genotypes. Group-I and group-II showed close genetic relationship in respect of number of pods and seed yield as evident from total index scores of 11 and 12, respectively. However, Group-V had greater index score of 16 and is different from group-I and group-II. Group-III includes 6 genotypes, 4 of which are hybrids, 1 mutant and 1 exotic accession. Group-IV and group-X each included 5 genotypes. Group-IV comprised of 4 hybrids and 1 accession whereas Group-X comprised of 2 hybrids, 1 mutant and 1 accession. Likewise Group-VI and group-VIII consisted of 2 genotypes each and Group-VII and group-IX each had 3 and 4 genotypes, respectively. Group-VI totally comprised of mutants and Group-VII totally comprised of hybrids. However, Group-VIII had 1 mutant genotype and 1 exotic accession. Similarly, Group-IX had 2 hybrids, 1 mutant and one accession (Fig. 1).

The index scores of the genotypes ranged from 11 to 17 (Table 4). Least index score of 11 was attained by 3 genotypes, viz., NL 9725 (hybrid), NL 96505 (mutant) and ILL 6024 (hybrid), respectively. First genotype belongs to Group IX and the remaining two genotypes belong to Group-I and group-III, respectively. Maximum index score of 17 was exhibited by a mutant TCL 85-1 belonging to group-VI.

Local germplasm scattered among different clusters, ranging from low to high yielders. Only two exotic genotypes belonging to medium yield groups have larger seed size. All other genotypes had less seed weight. Generally, the genotypes within a group showed little divergence from each other than from the genotypes of different groups as has been observed by Sultana *et al*., (2005). Hybridization among the genotypes of same group may not be fruitful. Variation within the group may be due to different genetic make up of the genotypes and different sources of collection as reported by Bharawadraj *et al*., (2001), Ibrahim *et al*., (1990) and Kotaiah *et al*., (1986).

The mean performance of each group for different plant traits is presented in Table 5. The range of total mean index score varied from 11.0 to 16.0. Maximum mean index scores were obtained for group-V, VI and VII. In all the three groups, primary branches per plant, pods per plant and seed yield per plant contributed more to index scores. However, the contribution of pods per plant and seed yield per plant towards mean index score was greater in group-VI and group-VII, thus separating them from group-V. The desirability index allotted to each individual trait (Table 4) indicates the worth of a genotype for that particular trait. Genotypes included in Group-VI seem to be better with large number of pods per plant and greater seed yield per plant. Whereas group-V can be characterized by genotypes having large number of primary branches per plant and high seed yield per plant. However, genotypes of Group-VI were having medium yield but greater pods. Hybridization may be attempted between the genotypes of different groups with high index scores to produce new genetic recombinants with desirable traits.

Table 4. Desirability index of lentil genotypes, mean index score of hybrids, mutants and exotic accessions and the most desirable genotypes for different traits.

Hybrids	Desirability index	Mutants	Desirability index	Exotic accessions	Desirability index
	FMHBPWY[†] (Traits)		FMHBPWY (Traits)		FMHBPWY (Traits)
NL 30-50-2	BABBABB[*] (16)[§]	NL 96700	BBBBBBB (14)	ILL 11136	BBABBBC (14)
NL 9725	CBCBBCB (11)	NL 96505	BBBCCBC (11)	**Precoz**	**AACCBAB (15)**
NL 9723	BBBBBBB (14)	**TCL 85-1**	**BBABABA (17)**	ILL 11125	BABBBAB (16)
NL 9820	ABCCCBB (12)	NL 0205	BBABBBB (15)	66121	BBABBBB (15)
NL 9681	BBBBBBB (14)	NL 2106	BBBBBBC (13)	ILL 6463	BBBBBBB (14)
NL 96353	BBBBACB (14)	NL 96697	BBBBCBB (13)	ILL 6024	CBBBCCB (11)
NL 9726	BBBABBA (16)	NL 20-24	CCABACA (14)	**ILL 6821**	**AABBCBB (15)**
Masoor 93 G	**CCAABBB (14)**	NL 96	CBBBBBB (13)		
NL 9810	BBBBBBB (14)				
NL 23124	BCBBBCA (13)				
NL 30-33-1	BBBBBBB (14)				
NL 55-1B	CBBBBBB (13)				
NL 96102	BBBBBBB (14)				
NL 2151	BBABABB (16)				
NL 96476	BBBBBBB (14)				
Total:	15		08		07
Mean index score:	13.9		13.8		14.3

Most desirable genotypes for different traits:

- ILL 6821 (Genotype No.25) [Early flowering (Mean = 88.3 days)]
- Precoz (Genotype No. 15) [Early maturity (Mean = 131.0 days), Bold seeds (Mean = 3.9g)]
- TCL 85-1 (Genotype No. 8) [More height (Mean = 45.6cm), Maximum pods per plant (Mean = 241.4) and high seed yield (Mean = 9.2g per plant)]
- Masoor 93 (Genotype No. 14) [Maximum primary branches per plant (Mean = 4.4)]

* = Desirability index for plant traits. Letters A, B and C represent index scores of 3, 2 and 1 for individual traits, respectively. (First letter corresponds to F, second to M, third to H, fourth to B, fifth to P, sixth to W and seventh to Y).

† = F = days to flower, M = days to mature, H = plant height, B = primary branches per plant, P = pods per plant, W = 100-seed weight and Y = seed yield per plant.

§ = Total index score of the genotype.

Table 5. Group means for different traits along with their mean index scores of thirty lentil genotypes following metroglyph technique.

Group	Genotypes included	Days to flower	Days to maturity	Plant height (cm)	Number of primary branches	Number of pods per plant	100-seed weight (g)	Seed yield/ plant (g)	Total mean index score
I	6	99.33 (2.0)*	140.67 (2.0)	34.64 (2.0)	2.22 (1.0)	99.67 (1.0)	2.62 (2.0)	3.35 (1.0)	11.0
II	7	93.33 (3.0)	139.33 (2.0)	27.09 (1.0)	2.00 (1.0)	100.44 (1.0)	3.04 (2.0)	5.13 (2.0)	12.0
III	19, 21, 22, 23, 24, 25	96.89 (2.0)	138.06 (2.3)	32.75 (2.0)	2.91 (2.0)	132.11 (1.5)	2.78 (2.0)	6.16 (2.0)	13.8
IV	5, 18, 20, 26, 30	97.73 (1.8)	139.80 (1.8)	34.72 (2.2)	3.04 (2.0)	166.96 (2.0)	2.70 (1.8)	7.13 (2.2)	13.8
V	13	95.33 (2.0)	140.00 (2.0)	34.81 (2.0)	3.89 (3.0)	187.78 (2.0)	2.80 (2.0)	8.08 (3.0)	16.0
VI	8, 27	101.17 (1.5)	141.67 (1.5)	43.60 (3.0)	3.61 (2.0)	231.28 (3.0)	2.10 (1.5)	8.84 (3.0)	15.5
VII	1, 12, 29	94.11 (2.0)	138.44 (2.3)	38.98 (2.3)	3.26 (2.0)	209.15 (3.0)	2.43 (1.7)	6.78 (2.0)	15.3
VIII	10, 11	99.50 (2.0)	137.50 (2.0)	41.53 (3.0)	3.28 (2.0)	179.11 (2.0)	2.57 (2.0)	4.50 (1.5)	14.5
IX	3, 4, 16, 28	96.58 (1.8)	139.00 (2.0)	32.39 (1.8)	2.94 (2.0)	170.56 (2.0)	2.46 (1.8)	5.66 (2.0)	13.4
X	2, 9, 14, 15, 17	97.00 (1.8)	137.73 (2.0)	33.80 (2.0)	2.93 (2.0)	140.07 (2.0)	2.95 (2.2)	4.85 (1.8)	13.8

*In parenthesis are index scones of mean phenotypic values of individual traits.

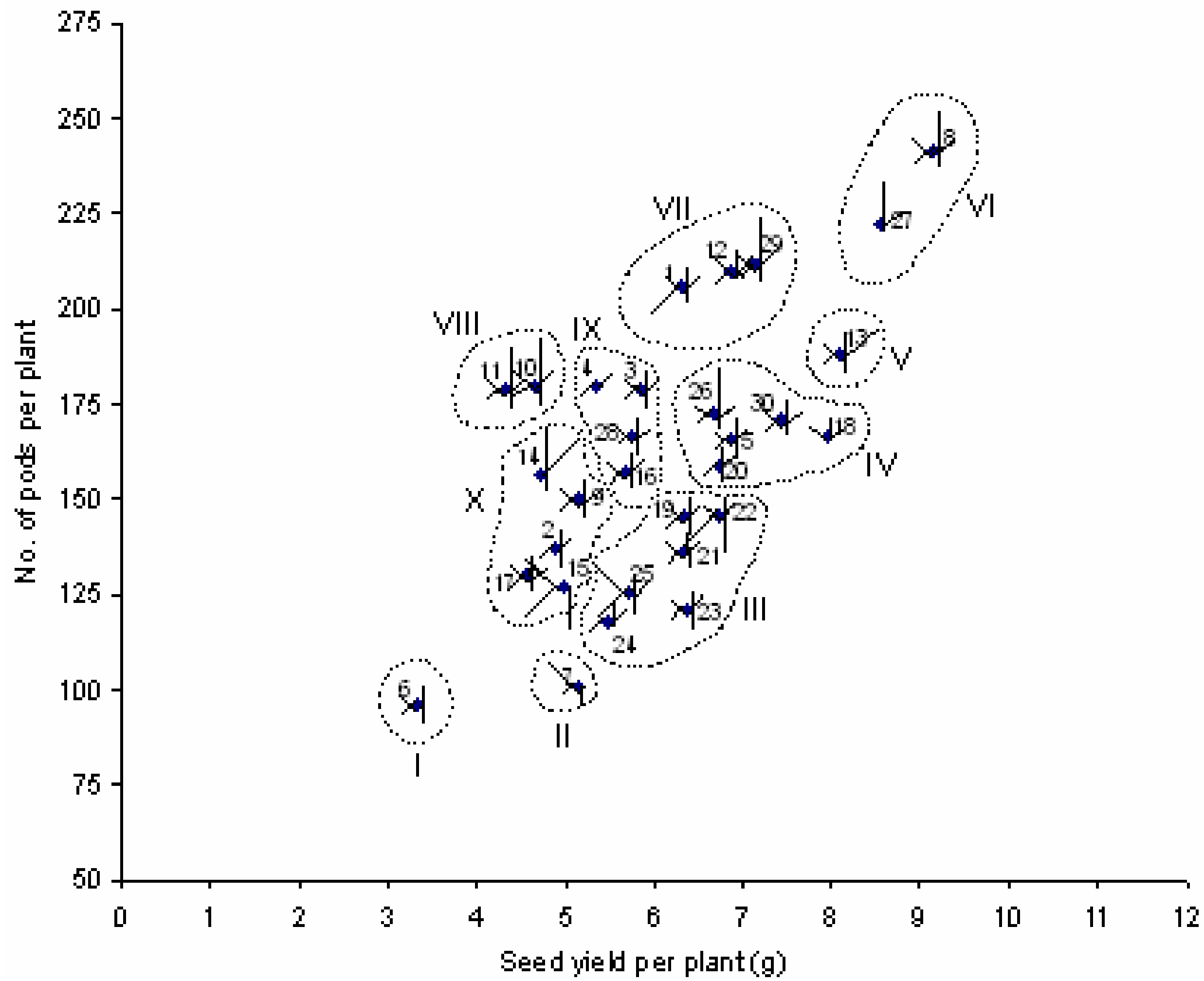

Fig. 1. Metroglyph scatter diagram showing different groups formed from lentil genotypes.

The desirability index along with total index score of all hybrids, mutants and accessions for different traits is presented in Table 4. The mean index score of exotic accessions was greater (14.3) than those of hybrids (13.9) and mutants (13.8), which indicated the presence of desirable genetic potential in exotic germplasm. Whereas the score of mutants was close to that of hybrids thus implying that both kind of genotypes have almost similar patterns of genetic diversity among themselves. It can be concluded that use of exotic accessions as parents in lentil breeding program or mutation breeding program would be fruitful.

It is evident from Table 4 that with desirability level ‘A’, three genotypes may be used for improving early flowering, three for early maturity, seven for height, two for primary branches, four for pods per plant, two for 100-seed weight and four for seed yield per plant. This suggests that for improving a specific trait, true genotypes may be picked up with great success. Genotypes like TCL 85-1, ILL 6821, Precoz and Masoor 93 were found to be the desirable genotypes. Desirability index of TCL 85-1 was high (level A) for plant height, pods per plant and seed yield per plant. Similarly, desirability index of precoz was high (level A) for maturity days and seed size, whereas those of ILL 6821 and Masoor 93 were high (level A) for flowering days and primary branches. TCL 85-1 was identified as the most superior genotype with maximum desirability index (17). This genotype may be efficiently used in hybridization and mutation breeding programs.

In present study metroglyph technique was found useful in identifying groups (clusters) of genotypes with yield enhancing traits among the collection of diverse genotypes and thus suggesting its potential value in lentil improvement. An effective hybridization program must include the genotypes of group-V, VI, VII and VIII to yield better segregants that may result in the evolution of high yielding lentil varieties. TCL 85-1 was identified as the most important genotype with maximum seed yield, large number of primary branches, and moderate seed weight. Likewise, Precoz an accession from Argentina with higher seed weight and early maturity was also found superior among exotic germplasm for hybridization programme. From these results one can foresee which genotype is undesirable or otherwise weak in some traits and can identify the desirable cross combinations. The information furnished here will be helpful to the breeder in the selection of superior genotypes which may be directly improved or utilized as parents in hybridization program for the development of future varieties as depicted by Sultana *et al*., (2005).

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