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Genetic divergence in *Albizia lebbek* Benth. provenances in Himachal Pradesh

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ABSTRACT: The present investigation was carried out to determine the genetic divergence among morphometric and biomass traits of the progenies of *Albizia lebbek* selected from fifteen different provenances in the state of Himachal Pradesh. The seedling height contributed maximum (51.10 %) followed by collar diameter (24.50 %) and number of leaves (12.60 %) to the total divergence whereas; the least contribution was shown by dry root weight (0.35%). Following Euclidean cluster analysis all the provenances were grouped into four clusters. Cluster II included (8) maximum number of provenances followed by cluster I (4), whereas cluster IV accommodated minimum (1) provenance. The intra cluster distance was maximum (1.442) in cluster II followed by cluster I (1.439). The generalized inter cluster distance was found highest (7.913) between cluster III and IV and lowest (2.725) between cluster I and cluster II.

Key words: *Albizia lebbek,* morphometric and biomass traits and euclidean cluster analysis.

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1. INTRODUCTION

To have a successful promotion of large scale plantation there is a need of carefully planned and well directed provenance research (Sehgal and Chauhan, 1995). Most successful tree improvement programme is that in which proper provenances and seed sources are used. The loss from using the wrong sources can be great and even disastrous (Zobel and Talbert, 1984). The potential and importance of assessing genetic differences associated with place of origin have long been realized on a global scale and several national and international provenance trials have been conducted. The large scale plantation programme going on in India will demand a large amount of planting material and it is necessary to start with superior planting material to make those plantations more productive both qualitatively and quantitatively. This necessitates the effective and planned tree breeding programme to capture maximum genetic gain from the natural population.

Siris *(Albizia lebbek* Benth.) is a member of sub-family mimosoidae of family Fabaceae. It is a multipurpose tree species suitable for afforestation on a wide range of site conditions and also a good fuelwood. The species improves the soil fertility through nodulation and it has been widely planted as avenue tree. It is now found throughout the country except in the temperate Himalayan region. The bark contains tannin and some saponin. The leaves and twigs are widely used as fodder and for manuring purpose (Singh, 1982). It has also been reported to be a good agroforestry tree species (Nair, 1993). Reddish brown gum is obtained from crack in the bark (Parkash, 1991). Seeds are astringent and given in piles and restorative tonic, roots powdered in making strong gums, leaves in night blindness (Singh, 1995). Its wood is used for furniture, carving, cabinet work and paneling, and also for wheel work.

Provenance trials may be used for various purposes *viz*., study of population genetics, site assessment and classification or wood quality evaluation. In provenance trial it is possible to measure many characteristics of nursery plants and subsequently in the field; survival, growth pattern, morphology, chemistry and anatomy of trees. The use of results differs depending on the background knowledge of the species and its evolutionary history. Quantitative estimation of the magnitude of variability in each character would suggest the scope for improving the desirable and economic characters through selection. Further, an investigation into the nature and degree of divergence among populations will be useful in understanding the course of evolution and for classifying the tree population into groups based on the diversity, particularly when they

are overlapping in one or more characteristics (Murthy *et al.*, 1965). Therefore, the present investigations were undertaken to study the genetic divergence among different provenances of the species.

2. MATERIALS AND METHODS

Study area

The study was under taken during the year 2011-12 in the Department of Tree Improvement & Genetic Resources, Dr Y. S. Parmar University of Horticulture and Forestry, Nauni, Solan , Himachal Pradesh. A pilot survey of the population of *Albizia lebbek* in Himachal Pradesh was carried out to identify the sites, where this species occurs. The sampling procedure include delineation of the whole area under the species into number of sites depending upon the altitudes and aspects. This way, fifteen provenances were selected from six districts of Himachal Pradesh (Table 1.) These locations were coded as P1, P2, P3, P4, P5, P6, P7, P8, P9, P10, P11, P12, P13, P14 and P15, respectively. Five mature seed bearing trees having approximately the same crown size and diameter of 15-25 cm were selected within each locality. These trees were marked for the collection of seeds. The seeds from mature pods were collected from these five selected trees each at fifteen locations in the month of January, 2011. The seed sample of each tree was kept separately for each location for further use. The geographical locations of the provenances are given in Table 1. The localities fall under sub-tropical and sub-temperate climate.

Field experiment and observations

The field experiment was laid out in the departmental nursery at Majhgaon in the main campus of the University. The area is situated at 30°50' N latitude and 76°11' E longitude at an elevation of 1100 m above mean sea level on north eastern aspect. On an average the area receives an annual rainfall of 1150 mm most of which is concentrated during monsoon season. Seeds were sown in nursery beds as per standard nursery practices during April, 2011 following Randomized Block Design (RBD) with three replications. The regular watering was provided and weeding/ hoeing was done as and when required.

The observations were recorded (seedlings age 7 months) on the characters *viz.*, seedling height (cm), collar diameter (cm), number of leaves, number of branches, shoot fresh weight (g), shoot dry weight (g), root fresh weight and root dry weight (g). The genetic divergence was calculated by using non-hierarchical Euclidean cluster analysis (Spark, 1973).

3. RESULTS AND DISCUSSION

Growth performance of progenies

The analysis of variance revealed significant differences among all the progeny characters. As far as seedling height (Table 2) is concerned it was found maximum for P12 (35.83 cm) among provenances however, the minimum value was found for P4 (16.36 cm). Maximum collar diameter among provenances was found in P3

Table 1. Location of provenances of *Albizia lebbek* in Himachal Pradesh

Code no	Provenance	District	Latitude (N)	Longitude (E)	Altitude (m)
P1	Bilaspur	Bilaspur	31°20'21.22"	76°45'33.39"	502
P2	Dadhol	Bilaspur	31°30'22.59"	76°29'01.50"	700
P3	Bhota	Hamirpur	31°36'55.08"	76°33'25.38"	805
P4	Rangus	Hamirpur	31°40'52.24"	76°27'31.47"	480
P5	Dehri	Kangra	32°10'33.21"	75°45'56.70"	502
P6	Jachh	Kangra	32°16'57.29"	75°51'13.60"	438
P7	Khatiyad	Kangra	31°59'26.70"	75°56'32.62"	528
P8	Jogipanga	Una	31°28'06.81"	76°16'51.40"	380
P9	Mubarakpur	Una	31°42'26.28"	76°64'54.62"	400
P10	Khatiyadi	Una	31°30'05.47"	76°13'28.31"	340
P11	Dhaulakuna	Sirmaur	30°29'57.23"	77°28'27.43"	345
P12	Shambuwala	Sirmaur	30°26'11.21"	77°36'29.14"	322
P13	Kunihar	Solan	31°04'45.25"	76°56'52.12"	850
P14	Kakkadhatti	Solan	31°00'42.55"	76°56'14.14"	900
P15	Nauni	Solan	30°51'46.04"	77°10'06.87"	1204

Source: Google Earth

Table 2. Growth performance of progenies of provenances of *Albizia lebbek* in nursery

Provenance	Progeny characters							
	Seedling height (cm)	Collar diameter (cm)	No. of leaves	No. of branches	Shoot fresh weight (g)	Shoot dry weight (g)	Root fresh weight (g)	Root dry weight (g)
Bilaspur (P_1)	28.22	6.18	13.31	3.02	21.26	10.69	14.91	7.23
Dadhol (P_2)	27.79	6.12	12.84	2.22	22.05	10.82	15.82	8.04
Bhota (P_3)	30.50	8.48	14.56	2.73	19.65	9.54	14.01	7.13
Rangus (P_4)	16.36	3.92	10.78	4.02	14.77	7.43	10.96	5.51
Dehri (P_5)	18.42	4.53	15.96	4.22	15.96	7.91	10.71	5.81
Jachh (P_6)	22.16	4.53	11.64	2.02	19.39	9.51	13.29	7.33
Khatiyad (P_7)	21.56	5.87	10.47	2.26	22.69	11.19	16.50	8.67
Jogipanga (P_8)	21.16	5.63	10.36	2.82	19.55	9.91	12.89	6.52
Mubarakpur (P_9)	24.09	6.42	10.16	2.49	21.63	10.33	15.86	8.39
Khatiyadi (P_{10})	21.35	5.02	7.89	2.22	20.03	9.63	16.14	7.83
Dhaulakuna (P_{11})	19.89	5.51	10.04	2.42	21.83	10.69	15.67	7.89
Shambuwala (P_{12})	35.83	5.60	12.16	3.69	21.90	10.46	16.06	8.23
Kunihar (P_{13})	22.06	4.54	8.31	3.16	20.39	9.82	14.06	7.39
Kakkadhatti (P_{14})	18.13	4.97	9.42	2.69	19.11	9.41	13.96	7.28
Nauni (P_{15})	24.13	5.52	9.49	1.42	19.34	9.20	13.62	6.97
CD $_{(0.05)}$	1.29	0.15	0.51	0.38	0.77	0.17	0.80	0.14

(8.48 mm) and the minimum value for this trait was observed in P4 (3.92 mm). The highest number of leaves among provenances was observed in P5 (15.96). It was followed by P3 (14.56), P1 (13.31). The minimum value was recorded in P10 (7.89). The highest number of branches (4.22) was found in P5. The highest shoot fresh weight was found in P7 (22.69 g) which was statistically at par with P2 (22.05g) and P11 (21.83g), however the minimum value was observed in P4 (14.77 g). The highest average shoot dry weight among provenances was noticed in P7 (11.19 g) and the lowest value for this trait was found in P4 (7.43 g). The maximum root fresh weight (Table 2) among provenances was observed in P7 (16.5 g) which was statistically at par with P10 (16.14 g), P12 (16.06 g) and P9 (15.86 g). The maximum average dry root weight was observed in P7 (8.67g) and the minimum in P4 (5.51 g).

Genetic divergence

Contribution of different characters to the total divergence indicated that seedling height alone contributed maximum (51.10%) followed by collar diameter (24.50%) and number of leaves (12.60%). The least contribution was by dry root weight (0.35%) (Table 3). Perusal of Table 4 revealed that intra cluster distance was maximum (1.442) in cluster II followed by cluster I (1.439) and cluster III (1.275). The generalized inter cluster distance was found maximum (7.913) between cluster III and IV and minimum (2.725) between cluster I and cluster II which was superseded by cluster I and Cluster IV. On the basis of D^2 analysis, the 15 provenances were grouped in to 4 clusters (Table 5) using Tocher's method. Cluster II included 8 provenances (P6, P7, P9, P10, P11, P13, P14 and P15) , cluster I had 4 provenances (P1, P2, P3, P8) and cluster III (P4 and P5) contained 2 provenances. However, cluster IV has only one (P12) provenance.

The analysis of variance revealed highly significant differences among the provenances for all the characters studied indicating the existence of wide genetic divergence among them. Provenances from same

Table 3. Contributions of progeny traits to total divergence among provenances of *Albizia lebbek*

Trait	Percent contribution
Seedling height (cm)	51.10
Collar diameter (cm)	24.50
No of leaves	12.60
No of branches	5.93
Shoot fresh weight(g)	2.33
Shoot dry weight (g)	2.14
Root fresh weight(g)	1.05
Root dry weight (g)	0.35

Table 4. Average intra and inter cluster distances (D2) among provenances of *Albizia lebbek*

	I	II	III	IV
I	1.439			
II	2.725	1.442		
III	4.696	4.924	1.275	
IV	4.576	4.776	7.913	0.000

Table 5. Clustering pattern of *Albizia lebbek* provenances on the basis of genetic divergence

Cluster	Provenances
I	P1, P2, P3 and P8
II	P6, P7, P9, P10, P11, P13, P14 and P15
III	P4 and P5
IV	P12

geographical areas were placed in separate clusters, indicating that genetic diversity is independent of the geographical diversity. These results are in line with the findings of Mohapatra (1996) in *Acacia catechu,* Bhat (1999) in *Albizia lebbek* and Warpa (2010) in *Bauhinia variegata.*

The 15 provenances of *Albizia lebbek* showed high divergence. All the provenances were grouped into 4 clusters and maximum numbers of provenances were accommodated in cluster II followed by cluster I, III and IV. Theoretically, crossing of provenances belonging to the same cluster will not be expected to yield superior hybrids or segregates. The diverse provenances characterized by maximum inter cluster distance (cluster III and IV) will differ in phenotypic performance and therefore, chances to obtain favorable transgressive segregates are more on the basis of results obtained.

The existence of diversity among the provenances was also assessed by the considerable amount of variation in cluster means for different characters. Cluster II exhibited higher means for shoot fresh weight, shoot dry weight, root fresh weight and root dry weight. Crossing between the trees selected from provenances in cluster III and IV appeared to be most promising to combine the desirable characters. Earlier workers like Mohapatra (1996) in *Acacia catechu*, Chauhan *et al.,* (1997) in *Bauhinia variegata*, Bhat and Chauhan (1999) in *Albizia lebbek*, Jha (2001) in *Dalbergia sissoo* and Warpa (2010) in *Bauhinia variegata* have also indicated the significance of genetic divergence.

4. CONCLUSION

Divergence studies indicated remarkable diversity among the provenances. The present investigations suggest the preponderance of genetic diversity than that of geographical diversity on the basis of clustering pattern of the provenances. The assessment of nature and extent of diversity among different populations is useful for categorizing the provenances into groups. Such a study helps in choosing parents for specific breeding objectives to get the desirable segregates by hybridization besides its taxonomic application. Information on genetic diversity can also be used to identify the promising diverse provenances which may be useful in breeding programmes in future.

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