Variation in Growth of 3-Year Old Provenance Trial of *Albizia lebbek* (L.) BENTH. in Arid India

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Summary

Twelve provenances of *Albizia lebbek* (L.) BENTH., a multipurpose tree were collected from 9°N to 32°N latitude, 72°E to 85°E longtitude and 40 cm to 400 cm rainfall zones in India. The plantations were raised at Hisar, in north-western India (29°N, 75°E, 215 m alt., 60 cm rainfall). In 3-year old trees significant variations ($P<0.05$) in height, diameter (DBH), branch number and biomass were observed among most of the provenances. Wide ranges in the means were exhibited by height (3.4 m to 5.6 m), DBH (3.3 cm to 6.3 cm) and biomass (2.7 kg/tree to 9.4 kg/tree). Provenances from north-western and central India, in general, were superior to those from south India. There were significant correlations between height or DBH with the latitude of seed source origin ($r = 0.644$, $r = 0.803$, respectively; $P<0.05$). The heritability estimates were: 23.6% for height, 20.3% for DBH, 24% for crown spread and 17.3% for bole biomass. The variations are useful for breeding work on this important multipurpose tree of semi-arid and arid regions.

Key words: India, *Albizia lebbek,* 12 provenances, 3-year age, height, DBH, biomass.

FDC: 232.12; 165.53; 176.1 *Albizia lebbek;* (540).

Table 1. – Seed collection sites.

Provenance	Latitude (N°)	Longitude (E°)	Rainfall zone (cm)
Cochin	9° 58'	76° 17'	200–400
Madurai	9° 58'	78° 10'	40–100
Bangalore	12° 58'	77° 38'	40–100
Madras	13° 04'	80° 17'	100–200
Anantpur	14° 41'	77° 39'	40–100
Bhubaneshwar	20° 15'	85° 52'	100–200
Jabalpur	23° 10'	79° 59'	40–100
Mahesana	23° 42'	72° 37'	40–100
Raniganj	25° 52'	85° 52'	100–200
Hisar	29° 10'	75° 46'	40–100
Dehradun	30° 19'	78° 04'	100–200
Jammu	32° 43'	74° 54'	100–200

Introduction

Albizia lebbek (L.) BENTH. (family leguminosae, sub-family mimosoideae), commonly called "black siris", is a robust tree. It is a fast growing species and widely used in arid and semi-arid regions for production of fuelwood, timber and forage in agroforestry systems or energy plantations (National Academy of Sciences, 1983; BISHT and TOKY, 1993). It is an excellent tree for reforestation of dry alkaline soils. It is native to the Indian sub-continent and has been cultivated in tropical and subtropical regions in North America, South America, South-East Asia and the West Indies.

Collection and evaluation of the germplasm of native multipurpose/agroforestry species is desirable for future breeding work (BURLEY and STYLES, 1976; NAMKOONG *et al.,* 1980). Considerable work has been done on provenance trials of temperate trees but comparatively less work has been done on subtropical arid and semi-arid regions, particularly on multipurpose agroforestry species.

The present paper reports variation in growth of 3-year old trees of *A. lebbek* from 12 provenances collected from the entire distribution range of this species in India.

Materials and Methods

Seeds of 12 Indian provenances from latitudes ranging from 9°58'N to 32°43'N, longitudes from 72°37'E to 85°52'E and rainfall zones from 40 cm to 400 cm were collected (*Table 1*). For each provenance seeds were collected from 20 healthy trees during December, 1988 from south India, and during February to March 1989 from north India. Seeds of the 20 trees of each provenance were mixed.

The study was conducted at Hisar (29°10'N, 75°46'E, 215 m a.s.l., 60 cm rainfall) in north-western India, which is classified as an arid sub-tropical region. The minimum and maximum temperatures vary from 3 °C during winter to 48 °C during summer. In April 1989, 600 seeds of each provenance were sown in polythene bags (32 cm x 60 cm) containing a mixture of soil, sand and manure in equal proportions. The bags were kept in a nethouse.

In October 1989, 6 month old seedlings were transplanted into a rectangular field of about 1 ha with uniform spacing of 3 m x 3 m. Planting was done following a randomized block design (RBD). There were 75 plants of each provenance distributed into 3 blocks. Fertilizers were not added to the soil. The plants were not watered except during the first year.

After 3 years (in October, 1992) plant height, dbh (diameter at breast height), number of branches and crown spread of 15 randomly selected trees of each provenance (5 from each block), were measured.

These trees were harvested at ground level. The bole and branches were cut into 3 to 4 pieces. Sub-samples were taken from cut ends of the segments and the fresh weight was measured. The sub-samples of bole and branches were oven dried. All biomass estimates were based on oven dry weight at 80 °C ± 2 °C. The data were analysed by the analysis of variance. The correlations between various growth parameters were computed following the methods of PANSE and SUKHATME (1978).

The genotypic co-efficient of variation (GCV), phenotypic co-efficient of variation (PCV) and broad sense heretibility (h^2) was calculated by the formula suggested by BURTON and DEVANE (1953).

$$GCV\ (\%) = \frac{V_g}{\bar{X}} \times 100$$

$$PCV\ (\%) = \frac{V_p}{\bar{X}} \times 100$$

$$\underset{(\%)}{\text{Heretibility}}\ (h^2) = \frac{V_g}{V_p} \times 100$$

where, V_g = genotypic variance
V_p = Phenotypic variance
$\bar{X}$ = Population mean

The genetic gain (%) was calculated by the following method suggested by JOHNSON et al. (1955):

$$\text{Genetic gain}\ (\%) = \frac{\text{Genetic advance}}{\text{General mean}} \times 100$$

where, Genetic advance = $h^2 \times \sqrt{V_p \times K}$

K = selection intensity

In the present study, the value of K was given to 2.06 which is its expectation in the case of 5% selection in large samples from a normally distributed population.

Results and Discussion

After 3 years, the survival percentage varied from 76% in the Madurai provenance to 97% in the Bangalore provenance. Plant growth varied significantly among most of the provenances. The plant height and dbh ranged from 3.4 m to 5 m and 3.3 cm to 6.3 cm, respectively. The Jammu provenance showed the greatest height and diameter. Branch number and crown spread also differed significantly among provenances (P<0.05). The values were highest in the Raniganj provenance and least in the Madurai provenance (*Table 2*).

Table 2. – Survival percentage and growth of 3-year old trees.

Provenance	Survival (%)	Height (m)	DBH (cm)	Branch number	Crown spread (m^2)	Biomass (kg/plant) Bole	Branch	Total
Cochin	80	3.4	4.0	7.7	6.2	3.1	1.3	4.4
Madurai	76	4.0	3.3	6.7	4.6	1.7	0.7	2.7
Bangalore	97	4.5	4.8	9.1	5.5	3.0	1.3	4.3
Madras	78	3.9	3.8	6.9	5.6	2.2	1.0	3.2
Anantapur	84	4.1	4.7	8.0	5.1	2.5	1.3	3.8
Bhubaneshwar	87	3.8	4.0	7.3	8.0	1.8	1.2	2.8
Jabalpur	87	3.9	5.5	8.2	6.0	3.9	1.7	5.6
Mahesana	87	4.7	5.1	7.5	6.7	4.1	2.1	6.2
Raniganj	88	4.4	5.6	11.7	8.3	1.9	1.0	2.9
Hisar	89	4.9	5.3	8.6	6.4	2.9	1.3	4.2
Dehradun	92	4.0	5.8	9.9	8.2	5.5	2.7	7.2
Jammu	93	5.6	6.3	9.3	6.7	6.4	3.0	9.4
LSD (at 5% level)	13.46	0.73	0.61	2.35	1.41	2.04	1.20	
Standard error of the treatment mean		0.37	0.56	1.20	0.72	1.03	0.58	

Stem biomass ranged from 1.7 kg to 6.4 kg and branch biomass from 0.7 kg to 3.0 kg per plant. The highest plant biomass was recorded in the Jammu provenance from north India, and least in the Madurai a provenance from south India (*Table 2*).

Table 3 shows the analysis of variance for different characters. Variations in growth parameters among trees of different blocks, provenances and interactions of the provenances and blocks, were mostly highly significant (P<0.01).

Table 3. – F. value from ananlysis of variance for different characters (traits).

Source	D.F.	F.Value Height	DBH	Branch number	Crown spread	Bole weight	Branch weight
Provenances	11	9.43**	6.30**	3.29**	7.60**	5.30**	4.01**
Block	2	4.76**	5.68**	0.15	15.10**	3.21**	3.09**
Provenance X Block	22	5.51**	3.09**	1.72*	3.10**	2.86**	2.78**
Error	140						

*) $p < 0.05$
**) $p < 0.01$

The correlation matrix showed positive and significant correlations among plant height, diameter and biomass (*Table 4*). Significant correlations were observed between height or diameter with the latitude of seed source (r = 0.644, P<0.05; r = 0.8093, P<0.05, respectively). Similarly, positive and significant correlations were also observed for stem and branch biomass (r = 0.648 and r = 0.725, P<0.05, respectively).

Table 4. – Correlation co-efficients among different growth parameters of 3-year old trees.

	Height	Collar diameter	DBH	Bole biomass	Branch biomass
Height	1.000				
Collar diameter	0.490*	1.000			
DBH	0.548*	0.961*	1.000		
Bole biomass	0.509*	0.724*	0.773*	1.000	
Branch biomass	0.511*	0.742*	0.760*	0.070	1.000

*) $p < 0.05$

The genotypic and phenotypic coefficient of variation ranged from 12.8% to 40%, and 26.5% to 111%, respectively (*Table 5*). The plant biomass showed comparatively higher genotypic and phenotypic variation. The broad sense heretibility ranged from 12% for branch number to 24% for crown spread. The genetic gain was the highest (34.2%) for bole biomass and least (10.4%) for branch number.

Table 5. – Estimates of broad sense heritability (h^2%), genotypic co-efficient of variation (GCV), phenotypic co-efficient of variation (PCV), and expected genetic advance (GA) in % of mean for different characters (traits).

Parameter	G CV (%)	P CV (%)	h^2(%)	G A (%)
Height	12.8	26.5	23.6	12.9
DBH	15.7	34.7	20.3	14.6
Branch number	14.5	42.0	12.0	10.4
Crown spread	17.2	35.2	24.0	17.4
Bole biomass	40.0	96.0	17.3	34.2
Branch biomass	40.0	111.0	12.6	29.0

Thus, in the present study, provenances from the north showed comparatively better growth than the southern provenances. It is interesting to mention here that southern provenances showed better seed germination and seedling growth (up to 1 year) in the nursery (KUMAR, 1993). In another study (KUMAR and TOKY, 1993) we reported that 3-year old trees of these 12 provenances also differed significantly in leaf chemical composition. Thus, the variation observed in the present study are mainly genetical in nature as all the plants were growing in a similar environment. The large variations in *A. lebbek* may be due to its cross pollination behaviour and also due to its natural occurrence in highly varied agro-climatic conditions.

We did not come across any other provenance study on *A. lebbek* for comparison. However, some studies conducted on *Eucalyptus* (TOKY and BISHT, 1991), *Acacia nilotica* (KRISHAN, 1992) and *Populus deltoides* and *P. X. euramericana* (TOKY *et al.,* 1995a and b) growing in arid and semi-arid environmental conditions in India also reported wide variations in plant growth of different provenances. In the present study the provenances from north-western particularly that of Jammu, were superior in growth than rest of the provenances. Thus, selection of superior seed source is possible for future breeding programme.

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Allozyme Variation among European Beech (*Fagus sylvatica* L.) Stands in Piedmont, North-Western Italy

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Summary

The genetic diversity and the genetic differentiation of 11 native populations of European beech from Piedmont (north-western Italy) were studied by means of the allozyme variation at 10 *loci.* Data obtained also contributed to the identification of the most valuable stands for the production of high quality seed.

Horizontal electrophoresis on starch gel was employed to separate the variants of 7 enzyme systems: Got, G3pdh, Idh, Mdh, Mnr, 6Pgdh and Pgi.

The expected heterozygosity ranged from 0.177 to 0.278 with an average of 0.232; the mean number of alleles per *locus* was 2.12 and 68.18% of *loci* were polymorphic.

Only 4.3% of the total genetic diversity was due to differentiation among populations and the mean value of NEI's genetic distance was 0.013. The sharing of one gene pool among the studied beechwoods suggests a lack of barriers to gene flow.

It was possible to score a significant correlation between the frequency of the allele 6Pgdh-B1 and the altitude where the samples were collected, while the north exposure was related to a higher mean heterozygosity.

Although no correlation between genotype and geographical distance could be found, the stands from the same province showed a certain degree of similarity. On the basis of the genetic distances, the very old stand of Palanfrè was clearly distinguishable from the others. Moreover, it displayed the highest level of expected heterozygosity.

Key words: allozyme variation, *Fagus sylvatica,* genetic diversity, population differentiation.

FDC: 165.3; 165.5; 176.1 *Fagus sylvatica;* (450).

Introduction

European beech (*Fagus sylvatica* L.) grows in Europe under very different ecological conditions, particularly in the southern part, close to the Mediterranean sea (COMPS *et al.,* 1990). This environmental diversity, together with natural selection and genetic isolation, accounts for the genetic