Association Analysis for Morphological and Biomass Traits in *Albizzia lebbeck* Seedlings

AM Wani[1*], MS Wani[2] and A Bijalwan[3]

[1]*Department of Tree Breeding, School of Forestry and Environment, Allahabad Agricultural Institute Deemed University, Allahabad, Naini-211007, Uttar Pradesh*

[2]*Department of Botany, University of Kashmir, Srinagar, Jammu & Kashmir*

[3]*Indian Institute of Forest Management, Bhopal, Madhya Pradesh*

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Seeds of *Albizzia lebbeck* Benth from 20 different seed sources were collected from different eco-geographic regions of Uttar Pradesh to study of the morphological and biomass traits in the experimental area of the school of Forestry and Environment, green house and natural field conditions. The traits studied were seedling height, collar diameter, internodal length, branches/seedling, leaf area, shoot and root fresh and dry weight, shoot/root ratio and seedling biomass. Out of total 55 correlation combinations in both environments, 26 and 10 were positive and highly significant, 10 and 9 positive and significant. Seedling height showed positive and significant correlation with collar diameter, leaf area, shoot fresh weight and root dry weight. Shoot dry weight and root dry weight showed positive and significant correlation with seedling biomass under both environments. This suggests that there exits a strong inherent association between these characters.

Key Words: *Albizzia lebbeck*, Genotypic correlation, Phenotypic correlation

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Introduction

Albizzia lebbeck Benth. is commonly known as Siris belongs to the family Fabaceae and sub family mimosoideae. *Albizzia* is a large tropical genus containing 150 species, mainly shrubs and trees (Allen and Allen, 1981) and is native to deciduous and semi-deciduous forests of Asia from Eastern Pakistan, throughout India and Sri Lanka to Myanmar (Everist, 1969). It occurs naturally in the sub-Himalayan tract from the Indus eastwards to the Khasi hills throughout the Indian peninsula and Andamans. It grows in the tropical rain forest of Burma and in the Himalayan valleys up to an altitude of 1600 m, with an annual rainfall range of 600-2500 mm and a temperature range 5ºC to 46ºC (Streets, 1962).

A. lebbeck is a well known leguminous fodder tree with very palatable leaves (Negi, 1977). It is extensively grown as a shade tree and which makes it a potentially valuable species for pasture development (Anonymous, 1980). It has soil-binding ability and tolerance to saline soil (Sommen, 1981). Paste of stem bark of *A.lebbeck* has been claimed to be useful in respiratory problem (asthma), snake bite, scorpion sting and malarial/intermittent fever (Chopra and Nayar, 1956). The flowers and leaves of the plant is reported to have antiseptic, anti dysenteric and anti tubercular properties. The bark, leaves, flowers, pods and seeds are employed medically. Bark extracts have documented anti-inflammatory activity (Lowry, 1989).

The ultimate goal of the tree breeder is to improve tree species in terms of the quality and the quantity of wood produced. This can be achieved through the selection of superior genotypes for which an indirect selection is often performed. The expression of a character is sum total of the contribution of so many other characters and therefore, screening/selection should be done on the basis of components contributing towards that character. The biometrical tool used for this is correlation which gives the nature and degree of association between various traits. So, the knowledge of association of different characters is the first hand information for any improvement programme (Searle, 1961). The species, therefore, offers an opportunity to study existing variation and also to select the superior seed sources for adaptability and growth pattern. Due to longer rotation period of the tree, there is very less information available on its genetic improvement (Zobel and Talbert, 1984).

Materials and Methods

The present study was carried out in the nursery of College of Forestry and Environment, Allahabad Agricultural Institute-Deemed University, Allahabad, Uttar Pradesh, India. The area is situated at 28.87º N latitude and 81.15º

**Author for Correspondence: E-mail: afaqtree@gmail.com*

Table 1. Passport data of collections from U.P.

Notation	District	Latitude*	Longitude*
S_1	Meerut	29 º01'N	77º45'E
S_2	Ghaziabad	28 º40'N	77º28'E
S_3	Bulandshahar	28º24'N	77º54'E
S_4	Aligarh	27º53'N	78º05'E
S_5	Bareilly	28º22'N	79º27'E
S_6	Mathura	27º28'N	77º41'E
S_7	Etah	28º20'N	78º11'E
S_8	Hathras	37º36'N	78º06'E
S_9	Agra	27º10'N	78º05'E
S_{10}	Jhansi	25º27'N	78º37'E
S_{11}	Kanpur	26º28'N	80º20'E
S_{12}	Sitapur	27º35'N	79º37'E
S_{13}	Lucknow	26º55'N	80º59'E
S_{14}	Unnao	26º48'N	80º43'E
S_{15}	Fatehpur	27º05'N	77º39'E
S_{16}	Pratapgarh	25º34'N	81º59'E
S_{17}	Allahabad	28º87'N	81º 15'E
S_{18}	Ghazipur	25º35'N	83º34'E
S_{19}	Varanasi	25º20'N	83º03'E
S_{20}	Mirzapur	25º10'N	82 º37'E

* Encarta U.S. geological survey

E longitude at an elevation of 78 m above mean sea level on Northern aspect. Mature pods from different parts of the crown for the present study was procured by selecting, the twenty phenotypically superior trees in the natural distribution zones of Uttar Pradesh on the basis of different morphological characters of fruit and seed character mentioned below: (a) tree height, (b) tree diameter, (c) leaf area, (d) pod length, (e) pod width, (f) number of seeds/pod, (g) seed weight/pod. Five phenotypically superior trees of same size and free from any disease and pest were selected and observations were made. Out of these, the best one was considered as plus tree. Uniform and healthy seeds from mature pods of plus trees from twenty representing stands were collected to constitute the seed lot. The passport data of the plus trees is given in Table 1. For experimental purpose, the seeds were sown in a Complete Randomized Design under green house and Randomized Block Design under field conditions. Seeds of plus trees were sown in three replicates in polybags (10 x 25 cm) filled with a mixture of soil, sand and farm yard manure (1:1:1) at a depth of 0.5 cm. The observations were made for till 12-mo-old seedlings for different morphological and biomass traits *viz*., seedling height, collar diameter, inter-nodal length, branches per seedling, leaf area, shoot fresh weight, root fresh weight, shoot dry weight, root dry weight, shoot: root ratio and seedling biomass. The data were statistically analyzed for each character in a Completely Randomized Design under green house and Randomized Block Design under field condition. Karl Pearson's correlation coefficient was worked out as per Panse and Sukhatme (1967). The significance of correlation coefficients was tested against 'r' values as given by Fisher and Yates (1963).

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Table 2. Progeny mean for morphological and biomass traits of 20 superior trees of *A. lebbeck* in greenhouse environment

Traits → / Sites ↓	Seedling height (cm)	Collar diameter (cm)	Internodal length (cm)	Branches/ seedling	Leaf area (cm^2)	Shoot fresh weight (g)	Root fresh weight (g)	Shoot dry weight (g)	Root dry weight (g)	Shoot/ root ratio	Seedling biomass (g)
S_1	47.05	1.184	3.85	11.23	5.24	8.62	4.21	2.66	1.57	1.69	12.83
S_2	43.25	1.067	4.52	10.57	5.63	8.66	4.71	1.98	1.59	1.25	13.37
S_3	41.04	1.079	3.69	11.01	5.35	10.52	4.99	2.89	1.32	2.19	15.51
S_4	39.15	0.856	3.74	11.46	5.57	7.20	3.05	1.91	1.19	1.61	10.25
S_5	49.12	1.180	5.35	13.23	4.52	12.67	5.01	4.18	1.63	2.56	17.68
S_6	41.51	0.967	4.08	11.12	5.68	11.21	5.01	2.46	1.58	1.56	16.22
S_7	43.68	1.012	3.96	12.12	5.74	10.42	4.24	2.96	1.33	2.23	14.66
S_8	35.35	0.893	4.46	12.79	4.29	8.58	3.35	2.07	1.61	1.29	11.93
S_9	61.37	1.245	5.81	16.12	6.91	14.19	5.28	4.74	1.77	2.68	19.47
S_{10}	46.30	1.079	3.52	10.79	5.52	11.88	4.27	3.20	1.41	2.27	16.15
S_{11}	53.62	1.023	4.31	11.34	5.18	12.94	4.72	3.21	1.54	2.08	17.66
S_{12}	58.95	1.189	4.16	14.68	5.91	12.42	3.64	3.05	1.21	2.52	16.06
S_{13}	52.74	0.901	3.93	12.12	5.41	10.66	3.47	2.55	1.58	1.61	14.13
S_{14}	48.53	0.922	4.62	11.57	5.79	10.73	3.31	3.06	1.34	2.28	14.04
S_{15}	48.06	0.801	4.32	12.34	5.63	9.13	3.29	1.98	1.29	1.53	12.42
S_{16}	40.12	0.656	4.34	10.23	4.63	10.15	4.10	2.30	1.54	1.49	14.25
S_{17}	51.01	0.756	4.03	13.23	5.57	9.13	4.08	1.59	1.42	1.12	13.21
S_{18}	46.23	0.734	4.42	13.91	4.41	10.66	3.24	2.42	1.19	2.03	13.90
S_{19}	55.27	0.856	3.83	11.96	5.85	10.39	3.50	3.10	1.24	2.50	13.89
S_{20}	47.80	0.901	4.37	15.01	4.37	9.39	3.01	1.86	1.18	1.58	12.40
Mean	47.51	0.966	4.27	12.34	5.36	10.48	4.02	2.71	1.77	1.90	14.50
Range	61.37-35.35	0.656-1.245	3.52- 5.81	10.23-16.12	4.29-6.91	7.2-14.19	3.01-5.28	1.59-4.74	1.18-1.77	1.12-2.68	10.25-19.47
S.E. ±	4.27	0.092	0.16	0.22	0.18	2.21	0.72	0.81	0.29	0.31	4.13
C.D. 5%	8.54	0.184	0.32	0.44	0.36	4.41	1.44	1.62	0.58	1.92	8.26

Table 3. Progeny mean for morphological and biomass traits of 20 superior trees of *A. lebbeck* in field

Traits → / Sites ↓	Seedling height (cm)	Collar diameter (cm)	Internodal length (cm)	Branches/ seedling	Leaf area (cm^2)	Shoot fresh weight (g)	Root fresh weight (g)	Shoot dry weight (g)	Root dry weight (g)	Shoot/ root ratio	Seedling biomass (g)
S_1	13.54	0.873	2.4	7.98	4.43	2.46	1.52	0.42	0.44	0.95	3.98
S_2	14.73	0.973	2.51	8.12	4.71	2.90	2.06	0.63	0.84	0.75	4.96
S_3	14.71	0.907	2.66	8.31	4.44	2.44	1.74	0.43	0.52	0.83	4.18
S_4	10.47	0.784	2.12	7.76	4.1	1.53	1.67	0.38	0.54	0.70	3.20
S_5	12.67	0.884	2.32	8.23	4.65	2.73	1.15	0.50	0.73	0.68	3.88
S_6	15.16	0.996	2.48	8.64	5.15	3.38	2.38	0.84	1.03	0.82	5.76
S_7	13.35	0.873	2.65	8.26	4.71	2.8	1.93	0.61	0.81	0.75	4.73
S_8	14.51	0.851	2.39	8.53	5.21	2.74	1.94	0.57	0.78	0.73	4.68
S_9	14.52	0.984	2.63	8.42	4.82	2.76	1.84	0.6	0.72	0.83	4.6
S_{10}	11.89	0.807	2.31	7.03	4.6	2.55	1.71	0.36	0.61	0.59	4.26
S_{11}	24.01	1.029	2.93	9.94	5.66	4.04	2.43	0.89	1.13	0.79	6.47
S_{12}	17.47	0.707	2.27	8.32	4.18	2.24	1.27	0.41	0.45	0.91	3.51
S_{13}	12.9	0.662	1.77	7.23	4.37	1.98	1.24	0.23	0.33	0.70	3.22
S_{14}	18.96	0.707	2.61	8.56	4.54	2.45	1.46	0.47	0.37	1.27	3.91
S_{15}	14.28	0.729	2.24	7.64	4.10	2.36	1.2	0.45	0.38	1.18	3.56
S_{16}	19.17	0.762	2.71	9.23	4.38	3.69	2.22	0.86	1.05	0.82	5.91
S_{17}	20.95	1.016	2.88	9.82	5.54	3.99	2.31	0.77	1.12	0.69	6.30
S_{18}	19.94	0.962	2.86	8.21	4.43	3.57	2.23	0.53	0.91	0.58	5.80
S_{19}	20.27	1.004	2.64	8.42	4.32	3.64	2.26	0.61	0.93	0.66	5.90
S_{20}	13.23	0.718	2.23	8.62	4.6	2.53	1.13	0.35	0.29	1.21	3.66
Mean	15.84	0.861	2.48	8.36	4.65	2.84	1.78	0.55	0.70	0.82	4.62
Range	10.47-24.01	0.662-1.029	1.77-2.93	7.03-9.94	4.1-5.66	1.53-4.04	1.13-2.43	0.23-0.89	0.29-1.13	0.58-1.27	3.20-6.47
S.E.±	1.06	0.043	0.18	0.34	0.11	0.20	0.20	0.06	0.10	0.12	0.38
C.D. 5%	3.14	0.129	0.53	1.00	0.34	0.61	0.58	0.18	0.29	0.35	1.13

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Results and Discussion

The mean, range and variation under green house and field condition of twenty superior tree progeny are presented in Table 2 and 3. Range of seedling height varied between 35.35-61.37 cm under green house condition and 10.47-24.01 cm under field environment; collar diameter 0.656-1.245 cm and 0.662-1.029 cm; inter-nodal length 3.52-5.81 cm and 1.77-2.93 cm; branches/seedling 10.23-16.12 and 7.03-9.94; leaf area 4.29-6.91 cm^2 and 4.1-5.66 cm^2; shoot fresh weight 7.2-14.19 g and 1.53-4.04 g; root fresh weight 3.01-5.28 g and 1.13-2.43 g; shoot dry weight 1.59-4.74 g and 0.23-0.89 g; root dry weight 1.18-1.77 g and 0.29-1.13 g; shoot/root ratio 1.12-2.68 and 0.58-1.27; seedling biomass 10.25-19.47 g and 3.2-6.47 g, respectively. Collar diameter and leaf area recorded similar variation under both the environments and there was not much difference in the range for these traits in all the genotypes. However, seedling height, branches/seedling, shoot fresh weight, shoot dry weight and seedling biomass varied greatly and it was recorded maximum for S_9 collection under green house whereas, under field environment it was found highest for S_{11} followed by S_{17}.

Estimation of phenotypic and genotypic correlation between various traits provide better understanding to the improver/breeder during selection especially when selection is based on two or more characters. The intensity and direction of association between two or more characters may be measured by genotypic and phenotypic coefficients of correlation depending on the type of materials studied. The knowledge of genotypic interrelationship between characters may be either due to pleiotropic action of genes or due to linkage or more likely both. The main genetic cause of such correlation is pleiotropy, which refers to the manifold effects of the gene.

It is clear from the Table 4 and 5 that phenotypic correlation coefficients were lower than the genotypic correlation coefficients. This suggests that it could be either due to the modifying effect of environment or the strong inherent association of characters at genetic level. Seedling height showed positive and significant correlation with collar diameter, leaf area, shoot fresh weight and root dry weight. Collar diameter with branches/seedling. Inter-nodal length showed positive and significant correlation with branches/seedling. Branches/seedling with leaf area and shoot dry weight. Leaf area with shoot dry weight. Shoot fresh weight with root fresh weight, shoot dry weight, root dry weight and seedling biomass. Root fresh weight showed positive and significant correlation with seedling biomass but negative and significant correlation with shoot: root ratio. Shoot dry weight and root dry weight showed positive and significant correlation with seedling biomass under both environments. A positive genetic correlation

Table 4. Phenotypic (r_p) and genotypic (r_g) correlation coefficients between morphological and biomass traits of *A. lebbeck* in Greenhouse

Characters		Seedling height	Collar diameter	Internodal length	Branches/ seedling	Leaf area	Shoot fresh weight	Root fresh weight	Shoot dry weight	Root dry weight	Shoot/ root ratio	Seedling biomass
Seedling height (cm)	r_p	1.000	0.865**	0.385	0.323	0.652*	0.869**	0.658*	0.850**	0.703*	0.323	0.747**
	r_g	1.000	0.883**	0.964**	0.214	0.697*	0.484	0.667*	0.890**	0.850**	0.466	0.851**
Collar diameter (mm)	r_p		1.000	0.417	0.276	0.285	0.787**	0.715*	0.732*	0.779**	0.079	0.846**
	r_g		1.000	0.725*	0.972**	0.843**	0.218	0.793**	0.854**	0.862**	-0.198	0.889**
Internodal length (cm)	r_p			1.000	0.782**	0.717*	0.406	0.263	0.384	0.303	0.343	0.374
	r_g			1.000	0.886**	0.912**	0.183	0.656*	0.401	0.442	0.463	0.536
Branches/seedling	r_p				1.000	0.756*	0.273	0.089	0.367	0.151	0.468	0.340
	r_g				1.000	0.870**	0.329	0.517	0.756*	0.283	0.773*	0.976**
Leaf area (cm^2)	r_p					1.000	0.445	0.118	0.421	0.106	0.435	0.364
	r_g					1.000	0.857**	0.342	0.672*	0.528	0.546	0.627*
Shoot fresh weight (g)	r_p						1.000	0.755*	0.871**	0.724*	0.257	0.935**
	r_g						1.000	0.774*	0.973**	0.756*	0.367	0.973**
Root fresh weight (g)	r_p							1.000	0.434	0.919**	-0.247	0.873**
	r_g							1.000	0.536	0.978**	-0.756*	0.932**
Shoot dry weight (g)	r_p								1.000	0.505	0.456	0.746*
	r_g								1.000	0.619	0.943**	0.852**
Root dry weight (g)	r_p									1.000	0.658*	0.808**
	r_g									1.000	0.715*	0.921**
Shoot/root ratio	r_p										1.000	0.256
	r_g										1.000	0.329
Seedling biomass (g)	r_p											1.000
	r_g											1.000

* Significant at 5% level of significance; ** Significant at 1% level of significance

Table 5. Phenotypic (r_p) and genotypic (r_g) correlation coefficients between morphological and biomass traits of *A. lebbeck* in field

Characters		Seedling height	Collar diameter	Internodal length	Branches/ seedling	Leaf area	Shoot fresh weight	Root fresh weight	Shoot dry weight	Root dry weight	Shoot/ root ratio	Seedling biomass
Seedling height (cm)	r_p	1.000	0.665*	0.245	0.373	0.742*	0.674*	0.374	0.643*	0.453	-0.220	0.578
	r_g	1.000	0.739*	0.351	0.458	0.783*	0.798*	0.426	0.783*	0.521	-0.198	0.431
Collar diameter (mm)	r_p		1.000	0.374	0.473	0.193	0.338	0.225	0.453	0.125	-0.167	0.267
	r_g		1.000	0.532	0.692*	0.284	0.484	0.473	0.578	0.367	-0.045	0.088
Internodal length (cm)	r_p			1.000	0.483	0.327	0.148	0.135	0.367	0.042	0.050	0.092
	r_g			1.000	0.863**	0.439	0.322	-0.389	0.583	0.274	0.250	0.134
Branches/seedling	r_p				1.000	0.594	0.158	-0.197	0.452	-0.257	0.246	-0.029
	r_g				1.000	0.953**	-0.252	-0.280	0.767*	-0.382	0.533	-0.254
Leaf area (cm^2)	r_p					1.000	0.136	-0.182	0.412	0.251	0.279	0.072
	r_g					1.000	0.261	-0.231	0.759*	0.364	0.291	0.053
Shoot fresh weight (g)	r_p						1.000	0.853**	0.653*	0.856**	-0.634*	0.870**
	r_g						1.000	0.932**	0.856**	0.937**	-0.825**	0.902**
Root fresh weight (g)	r_p							1.000	0.635*	0.932**	-0.751*	0.868**
	r_g							1.000	0.743*	0.963**	0.793*	0.974**
Shoot dry weight (g)	r_p								1.000	0.761**	-0.316	0.628*
	r_g								1.000	0.793**	-0.424	0.706*
Root dry weight (g)	r_p									1.000	-0.676	0.646*
	r_g									1.000	-0.843**	0.928**
Shoot/root ratio	r_p										1.000	-0.723*
	r_g										1.000	-0.901**
Seedling biomass (g)	r_p											1.000
	r_g											1.000

*Significant at 5% level of significance; **Significant at 1% level of significance

between two desirable traits makes the job of the plant breeder easy for improving both traits simultaneously because any one of the two characters would be a reliable measure of the other. This also suggests that there exists a strong inherent association between these characters. Therefore, these trait seems to be under strong genetic control and is quite amenable for selection. Root dry weight showed negative but significant correlation with shoot:

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root ratio under both, green house and field environment. These non significant associations between two characters advocate that they are independent of each other and could be selected separately. The above findings support the results of Manga and Sen (1998) in *Prosopis cineraria*, Chauhan and Verma (1993) in *Acacia catechu*, Thakur *et al.* (2000) in *Alnus nitida*, Raj *et al.* (2006) in *Bambusa bambos* and Wani *et al.* (2008) in *Bauhinia variegata.*

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