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RESEARCH PAPER

Association studies for morphological and biomass traits of *Bauhinia variegata* Linn.

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Abstract : *Bauhinia variegata* (Kachnar) is an important tree species of India which produces nutritive and palatable leaf fodder. It is generally preferred by the farmers of Himachal Pradesh and Uttrakhand for livestock feeding at the time of fodder scarcity. Keeping its importance, 48 plus trees were selected from different parts of Himachal Pradesh. Seeds were collected from these trees and sown in nursery under randomized block design to assess the association among different morphological and biomass traits. After 16 month growth, data were recorded and statistically analyzed for association studies. A strong simple, genotypic and phenotypic correlation was observed between biomass traits and some morphological traits especially collar diameter, plant height and leaf area. The phenotypic correlation coefficients were lower than their corresponding genotypic values, which revealed that magnitude of correlation coefficient at genotypic level was higher than their corresponding phenotypic coefficient of correlations. Present study indicates that collar diameter, plant height and leaf area are the common causal factor that influences biomass productivity of *Bauhinia variegata* genotypes. Therefore, these characters may be given proper emphasis during selection programme of a fodder tree species where the amount of leaf and biomass production is of immense importance.

Key Words : *Bauhinia variegata*, Association, Genetic correlation, Leaf fodder, Morphological traits

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INTRODUCTION

Livestock rearing plays a significant role in the economy of the people of hilly regions of India. Natural grasslands and fodder trees are the primary source of fodder for livestock in Himalayan region (Katoch *et al.*, 2012). There are so many fodder trees found in the Himalayan tract, *Bauhinia variegata* (Kachnar) is one of them on which farmers bank up during the long winter lean period when the grasses are dry, less digestible and unpalatable. It is a small to medium sized deciduous tree with elongated spreading crown and green foliage commonly grows in the sub-Himalayan tract and also in dry forests of east central and south India (Anonymous, 1983). It has lush green foliage and excels to other tree fodder in a comprehensive nutritive value and collates with cultivated green leguminous fodder. A large scale variation is found in the nutritive value and biomass productivity of its leaves. Therefore, the artificial regeneration/plantation of this species requires a quality genetic material which can give better quality and quantity of leaf fodder. The use of quantitative characters has been and remains the essential basis for phenotypic selection in any breeding programme (Gupta *et al.*, 2012).

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 for helping this is ‘correlation’, which gives the nature and degree of association between various traits. So, the knowledge of association for different characters among themselves is of utmost importance for any improvement programme. Based on the estimation of genotypic and phenotypic correlations the breeder decides the breeding methodology to be followed so that the useful correlations can be exploited and the undesirable ones

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modified by generating fresh variability to obtain new recombinants. Therefore, present study was undertaken to analyse the simple, genotypic and phenotypic correlation among different morphological and biomass traits.

MATERIAL AND METHODS

Present study was undertaken to find out the relationships between different morphological and biomass traits at genotypic and phenotypic levels and magnitude of association of different traits in 48 plus tree families/ genotypes of *Bauhinia variegata.* First of all, fourty eight (48) phenotypically superior (plus) trees were selected on the basis of the criteria of height, diameter, crown length, crown width, leaf size and disease and pest resistance as per the Zobel and Talbert (1984). Seeds from well mature pods of these phenotypically superior trees were collected during March, April and uniform healthy seeds graded to constitute the lot of each tree family for experimental purposes. Then the seeds were sown in a Randomized Complete Block Design in three replications during the last week of with 20 cm distance from seed to seed and 45 cm from row to row at a depth of 1.0 to 1.5 cm. Regular irrigation, weeding and hoeing were done as and when required. In all the 48 plus tree progenies plant per cent was recorded above 80 per cent at the time of morphological and biomass data taken. After the 16 month growth, sixteen seedlings of each plus tree family per plot / replication (48 seedlings per treatment) were randomly selected and tagged, excluding the border ones and data on morphological and biomass traits *viz*., seedling height, collar diameter, intermodal length, number of nodes per plant, total number of leaves per seedling, leaf area, number of branches per seedling, fresh shoot weight, dry shoot weight, fresh root weight and dry root weight were recorded and the data were subjected to statistical analysis to find out the relationship between the traits. Karl Pearson's (simple) correlation coefficient was worked out as per Panse and Sukhatme (1967), whereas, phenotypic and genotypic correlation coefficients were estimated as per the methodology suggested by Searle (1961) and Chavan *et al.* (2011).

RESULTS AND DISCUSSION

The information on the nature and magnitude of variability and correlation in a population owing to genetic and non-genetic factor is one of the prerequisites in any hybridization programme for selecting parents with desirable characters (Majumder *et al.*, 2012). According to Falconer (1989), the study of correlation is required to obtain the response of various traits to the characters interesting for selection. Based on the estimation of genotypic and phenotypic correlations the breeder decides the breeding methodology to be followed so that the useful correlations

Table 1 : Estimates of simple correlation coefficients among morphological and biomass traits of *Bauhinia variegata* Linn.

Characters	Seedling height	Collar diameter	Internodal length	No of nodes/ seedling	No of leaves/ seedling	Leaf area	No of branches/ seedling	Fresh shoot weight	Dry shoot weight	Fresh root weight	Dry root weight
Seedling height	1.0000										
Collar diameter	0.5581	1.0000									
Internodal length	0.2762	0.4028	1.0000								
No. of nodes/ seedling	0.5595	0.6481*	0.2396	1.0000							
No. of leaves/ seedling	0.4044	0.6581*	0.1632	0.4712	1.0000						
Leaf area	0.5976	0.7241*	0.3313	0.6255*	0.4115	1.0000					
No. of branches/seedling	-0.2078	-0.2872	-0.2171	-0.2523	-0.2438	-0.3680	1.0000				
Fresh shoot weight	0.5174	0.7351**	0.3088	0.5413	0.7253*	0.6028*	-0.3484	1.0000			
Dry shoot weight	0.5573	0.7821**	0.2754	0.6473*	0.6772*	0.7130*	-0.3135	0.8580**	1.0000		
Fresh root weight	0.3042	0.2982	0.2674	0.3533	0.1910	0.4445	-0.2754	0.4674	0.5119	1.0000	
Dry root weight	0.3428	0.5430	0.2923	0.5538	0.3793	0.5265	-0.2940	0.6177*	0.6348*	0.7291*	1.0000

* and ** indicate significance of values at P=0.05 and 0.01, respectively

can be exploited and the undesirable ones modified by generating fresh variability to obtain new recombinants. Therefore, simple, genotypic and phenotypic correlation coefficients were worked out to find out the direction and magnitude of association between different traits. Out of 55 simple correlation coefficients among morphological and biomass traits three were found positive and highly significant (1% level of significance) and twelve positive and significant (5% level of significance), ten negative and non-significant and the remaining positive and non-significant. An appraisal of Table 1 revealed that a positive and highly significant correlation existed between collar diameter and fresh shoot weight (0.7351), collar diameter and dry shoot weight (0.7821), fresh shoot weight and dry shoot weight (0.8580). Significant and positive correlation was also observed between collar diameter and number of nodes (0.6481), collar diameter and number of leaves (0.6581), collar diameter and leaf area (0.7241). The significant and positive correlation among various morphological and biomass traits suggests and emphasize their utilization in indirect selection. The above results support the findings of Veerendra and Sharma (1990) in *Santalum album,* Hosalli (1997) in *Leucaena* species, Manga and Sen (1998) in *Prosopis cineraria*, Jha (2001) in *Dalbergia sissoo*. Number of branches showed negative correlation with all other traits which may be due to distribution of food, nutrients, salts and water to different branches instead of available to the main shoot/ axis.

The phenotypic correlation coefficients are presented in Table 2. The appraisal of this table revealed that seedling height was positively and significantly correlated at phenotypic level with shoot fresh weight (0.651) whereas, collar diameter with fresh shoot weight (0.612) gave positive and significant correlated response. Fresh shoot weight exhibited highly significant and positive correlation with dry shoot weight (0.904), significant with fresh root weight (0.673), seedling height (0.651), collar diameter (0.612) and non-significant with rest of the traits. A significant and positive correlation was observed between dry shoot weight and fresh root weight (0.624), whereas, all other combinations showed non-significant correlation. Fresh root weight showed non-significant correlation with all the morphological and biomass traits. Similar trend was observed for dry root weight with all the morphological and biomass traits.

The Table 3 shows estimates of genotypic correlation coefficients among different traits. It is evident from the data that most of the morphological and biomass traits showed highly significant correlation among themselves. Seedling height showed highly significant and positive correlation with number of leaves (0.912), leaf area (0.997), fresh root weight (0.815) and dry root weight (0.858). A highly significant and positive correlation was projected by collar diameter with number of leaves (0.939), leaf area (0.959) fresh shoot weight (0.973), dry shoot weight (0.994), and fresh root weight (0.812). Highly significant and positive association of number of nodes was observed with number of leaves (0.894) and leaf area (0.921). Number of leaves was found highly significant and positively correlated with fresh shoot weight (0.833) and dry shoot weight (0.870). Leaf area depicted highly significant and positive correlation with fresh shoot weight (0.853), dry shoot weight (0.848), fresh root weight (0.737) and dry root weight (0.760). Number of branches demonstrated negative and significant association with dry shoot weight (-0.651) and dry root weight (-0.661). Highly significant and positive correlation was observed between fresh shoot weight and dry shoot weight (0.968). Dry shoot weight showed significant and positive correlation with fresh root weight (0.665) and dry root weight (0.644). Fresh root weight depicted highly significant and positive correlation with seedling height (0.815), collar diameter (0.812), leaf area, (0.737) and root dry weight (0.845); significant and positive with number of nodes (0.638), fresh shoot weight (0.650) and dry shoot weight (0.665). Dry root weight was found positively and highly significantly correlated with seedling height (0.858), leaf area (0.760), and fresh root weight (0.845); significantly and positively with collar diameter (0.678), number of nodes (0.685), fresh shoot weight (0.613) and dry shoot weight (0.644).

It is clear from the Table 2 and 3 that phenotypic correlation coefficients were lower than their corresponding genotypic values, which revealed that magnitude of correlation coefficient at genotypic level was higher than their corresponding phenotypic coefficient of correlations. This could be either due to the modifying effect of environment or the strong inherent association of characters at genetic level. It supports the finding of Aabd *et al.* (2011) for Argon tree.

Fresh shoot weight was positively and significantly correlated at phenotypic and genotypic level with seedling height, collar diameter, dry shoot weight and fresh root weight, this association suggests that selection for any one of these traits would be a reliable measure of other also. Number of leaves, leaf area and fresh shoot weight, fresh root weight and dry root weight exhibited positive and highly significant to significant genotypic correlations with dry shoot weight suggesting the simultaneous inheritance of these traits most probably due to linkage and/ or pliotropic effects of genes. Thus it can be said that an increase in the collar diameter, plant height, lead area and number of leaves accompanies increase in the biomass production of *Bauhinia variegata* tree. Therefore, these characters may be given proper emphasis during selection programmes of a fodder tree species where the amount of leaf and biomass production is of immense importance. The findings of

Table 2 : Estimates of phenotypic correlation coefficients among morphological and biomass traits of *Bauhinia variegata* Linn.

Characters	Seedling height	Collar diameter	Internodal length	No. of nodes/ seedling	No. of leaves/ seedling	Leaf area	No. of branches/ seedling	Fresh shoot weight	Dry shoot weight	Fresh root weight	Dry root weight
Seedling height	1.000	0.530	0.222	0.455	0.398	0.573	-0.094	0.651*	0.600	0.371	0.207
Collar diameter		1.000	0.358	0.432	0.450	0.508	-0.084	0.612*	0.589	0.413	0.322
Internodal length			1.000	0.135	0.119	0.213	-0.094	0.284	0.211	0.298	0.087
No. of nodes/seedling				1.000	0.250	0.460	-0.038	0.431	0.389	0.307	0.186
No. of leaves/ seedling					1.000	0.255	-0.211	0.485	0.501	0.319	0.247
Leaf area						1.000	-0.144	0.569	0.560	0.373	0.286
No. of branches/seedling							1.000	-0.125	-0.125	-0.157	0.032
Fresh shoot weight								1.000	0.904**	0.673*	0.339
Dry shoot weight									1.000	0.624*	0.355
Fresh root weight										1.000	0.459
Dry root weight											1.000

* and ** indicate significance of values at P=0.05 and 0.01, respectively

Table 3 : Estimates of genotypic correlation coefficients among morphological and biomass traits of *Bauhinia variegata* Linn.

Characters	Seedling height	Collar diameter	Internodal length	No of nodes/ seedling	No. of leaves/ seedling	Leaf area	No. of branches/ seedling	Fresh shoot weight	Dry shoot weight	Fresh root weight	Dry root weight
Seedling height	1.000	0.632*	0.410	0.658*	0.912**	0.997**	-0.527	0.611*	0.721*	0.815**	0.858**
Collar diameter		1.000	0.462	0.673*	0.939**	0.959**	-0.698*	0.973**	0.994**	0.812**	0.678*
Internodal length			1.000	0.435	0.243	0.473	-0.483	0.440	0.354	0.507	0.198
No. of nodes/seedling				1.000	0.894**	0.921**	-0.829**	0.710*	0.715*	0.638*	0.685*
No. of leaves/ seedling					1.000	0.586	-0.313	0.833**	0.870**	0.568	0.323
Leaf area						1.000	-0.769**	0.853**	0.848**	0.737**	0.760**
No. of branches/seedling							1.000	-0.494	-0.651*	-0.537	-0.661*
Fresh shoot weight								1.000	0.968**	0.658*	0.613*
Dry shoot weight									1.000	0.665*	0.644*
Fresh root weight										1.000	0.845**
Dry root weight											1.000

* and ** indicate significance of values at P=0.05 and 0.01, respectively

present study is in conformity with that of Chavan *et al.* (2011) for *Casurina* species who reported that in correlation study, bole height, stem diameter and number of branches per tree emerged as most important traits for production of biomass.

These findings area also in confirmation with Gupta *et al.* (2012), Gera and Gera (2006) in *Acacia catechu*, Jha (2009) in *Populus deltoids*, Chauhan and Verma (1993) in *Acacia catechu*. Thakur *et al.* (2000) in *Alnus nitida*, Srivastava *et al.* (1999) in *Terminalia arjuna*, Reddy and Subramanian (1998) in *Santalum album*, Patil *et al.* (1997) in *Eucalyptus* and Subramanian *et al.* (1995) in *Eucalyptus grandis*.

Therefore, on the basis of overall observation of simple, genotypic and phenotypic correlation studies it can be concluded that collar diameter, plant height and leaf area are the common causal factor that influences biomass productivity of *Bauhinia variegata* genotypes which indicated that there might be several genes responsible in the expression of phenotype and genotype which influence the tree biomass yield. So, these traits must be given proper emphasis in indirect selection for improved tree fodder production.

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