INFRASPECIFIC VARIATION OF *BAMBUSA NUTANS* SUBSPECIES *NUTANS* FROM SIX DIFFERENT SITES OF CENTRAL NEPAL

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Abstract: *Bambusa nutans* Wallich ex Munro subspecies *nutans* is a valuable economic plant occurring especially on the Terai region and mid hills (Kathmandu valley) in Nepal from sea level to 1700 m. Variation plays major role to compare the populations and to select superior trees for breeding purpose. Infraspecific variation is the study of comparison between plants belonging to the same species but from different populations which could be distinguished in nature. Study on the infraspecific variation of this species has been carried out from six different stands (Kapan, Kirtipur, Sisneri, Naldum, Kafledi and Narayanghat) of Central Nepal ranging in altitude (from 256 m to 1850 m) and climatic conditions. Altogether 10 culms, from 3-4 clumps were selected and 6 morphological characters having utmost importance in bamboo growth has been studied. Those characters were culm height, culm diameter at breast height, culm wall thickness, internode length ,culm sheath length and culm sheath breadth. Statistical analysis was performed for the calculation of correlation coefficient using SPSS software program. Variation within and among population was analyzed using one way ANOVA. All the characters show significant differences with 5% level of significance and ratios of morphological characters also show the significant differences except CH/CD, which was not significant. From the present study it is concluded that significant differences were observed in phenotypic characters. Since genetic differences leads to the variation among the plants, these variations might be of genetic origin .Reciprocal transplant experiment and progeny testing should be conducted for further research. Provided information can be utilized to conserve the genetic resources and to exploit these resources scientifically and economically.

Keywords: *Bambusa nutans* subspecies *nutans*; Infraspecific variation; Correlation; ANOVA; Genetic differences.

INTRODUCTION

Nepal, with its land area of 1, 47,181 square km, lies between the latitudes of 26^0 22' and 30^0 27'N, and longitudes of 80^0 04' and 88^0 12'E in the central part of the main Himalaya encompassing one third of its whole length (2500km). Climatic variations also exist horizontally from east to west (average length of 885km). The western part of the country receives less precipitation and is hotter and drier than the central and eastern parts. Presence of such diverse topography and accompanying diversity in climate has provided a variety of habitat, ecological and bio-geographical zones (from tropical to nival) within the country which are characterized by diverse vegetation types, flora and fauna.

Bambusa nutans Wallich ex Munro subspecies *nutans* is a very common cultivated evergreen bamboo species. It is a multipurpose plant with ecological and economical importance. According to Das (2003), *Bambusa nutans* subspecies *nutans* is found only in Nepal. It is distributed from inner terai to 1500m in mid hills of Central, Midwestern and Western part of Nepal particularly abundant in private lands and protected areas. According to Poudyal (1992) Kathmandu valley possesses large number of *Bambusa nutans* subspecies *nutans* and is the commonest cultivated bamboo in the hills of central and west Nepal.

Infraspecific variation is the study of comparison between plants belonging to the same species but from different populations which could be distinguished in nature whether they were the subspecies or varieties of the taxonomist or local races of the biometrician. There may be considerable difference between populations, between plants of the same population growing in different sites, or even between plants of a single population growing together. Geographic variations are the phenotypic differences among native plants that are growing in different portion of species range. If the differences are largely genetic rather than environmental, the variation is usually specified as racial, ecotypical or clinal (Briggs and Walters 1997).

Since diversity within species is the building block for evolution and speciation, diversity of bamboo opens the door to study morphological and genetic variation. Variation occurs in a species within and among stands, sites and individual trees. Geographic variation is often the most important for characteristics related to survival and adaptability whereas individual tree variability within species is generally of the greatest value for economic characteristics.

Das (2002) studied about the environmental and socioeconomic aspects of bamboos. Similarly, Manandhar and Bhattarai (1998) studied the distribution of bamboos in Kathmandu

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Table 1: Analysis of Variance (one way ANOVA) of Morphological and Ratio of Morphological Characters

Character	df (degree of freedom)	F value	P- value (probability)	CV%(Coefficient of variation)
CH	5	3.815	0.005*	8.10
CD	5	3.671	0.006*	7.39
CWT	5	45.547	<0.001**	10.39
IL	5	47.74	<0.001**	21.11
CSL	5	4.71	0.001*	18.26
CSB	5	20.15	<0.001**	20.48
CH/CD	5	2.361	0.052	3.52
CD/CWT	5	43.89	<0.001**	19.05
CH/IL	5	60.08	<0.001**	21.82
CD/IL	5	58.19	<0.001**	2.09

**Significant at 1% level
*Significant at 5% level

valley. Oli (2003) estimated the biomass of *Bambusa nutans* subspecies *nutans* in the eastern terai.

MATERIALS AND METHODS

Six natural stands of Bambusa nutans subspecies nutans were selected at different places of the Central Nepal from two different zones with different environmental, climatic and ecological factors. Different stands are from different altitudes i.e. from terai to hilly regions and valleys. In Bagmati zone Kathmandu, Lalitpur, Bhaktapur and Kavre districts were selected. In Narayani zone Narayanghat of Chitawan was selected. Population of the species was cultivated and had good stand quality as determined by apparent abiotic and biotic factors.

Bagmati zone lies within $27^0$22'N to 28^0 60'N and 84^0 06'E to 86^0 06'E and covers 10,488 square km. First site for the study in Kathmandu district is at Kirtipur. It is 6-7 km west to Kathmandu city and is at slope. Newars are predominant and it has its importance as an inevitable fort since the eons of history.Another stand in Kathmandu district is Kapan, which is 10-11 km north to core Kathmandu and lies at the base of Shivapuri. It harbors excellent diversity of *Bambusa* and *Dendrocalamus* spp. Two beautiful and heavenly monasteries are there, enhancing the enshrinement and tranquility of this undoubtedly beautiful peak.In Lalitpur district, Sisneri is selected for the study which is 15 km south to Kathmandu city and at the base of Phulchowki and near to Godawari. It is also famous for the bamboos and places about 6 species of bamboo including *Bambusa nutans* supsps *nutans.*Naldum is a place in Bhaktapur district chosen for the study purpose. It is near the famous tourism hob, Nagarkot, famed for beautiful sunrise, situated at an altitude of 2163 m. But our study site is at an altitude of 1850m. It is 30 km east to Kathmandu and 23 km east to Bhaktapur city.In kavre district, a stand of *Bambusa nutans* subspecies *nutans* is selected at Kafledi. It is 48 km east to Kathmandu and 18 km east to Dhulikhel. It is a beautiful, small valley and is at low altitude of 900m with subtropical and tropical climate along with abundant rainfall. Stand in Narayani zone is at Narayanghat of Chitawan district, a major industrial center outside Kathmandu valley. Climate is mainly tropical and shares its border with India and is famous because of Royal Chitwan National Park.

From each stand10 sample culms from 3 clumps were selected for six morphological characters such as culm height (CH), culm diameter (CD), culm wall thickness (CWT), internode length (IL), culm sheath length (CSL) and culm sheath breadth (CSB). Analysis of variance (ANOVA) within and among populations was calculated for each morphological traits and its ratio by using SPSS (version 10) programme. A same program was used to determine the correlation between morphological traits and whether the correlation is significant or non-significant and to calculate the coefficient of variation after complete descriptive analysis for each individual character of 60 sample clumps in each population.

Variation within and between the population has been analyzed with the analysis of variance(one way ANOVA) .The results of ANOVA have been tabulated also for the ratio of phenotypic characters estimated among populations. Similarly, coefficient of correlation (Karl Pearson) has been analyzed for each traits to interpret whether the individual characters are significantly correlated with each other or not.

RESULTS AND DISCUSSIONS

Correlations between morphological characters and between soil character and mean of the morphological characters of

Table 2: Correlation Coefficient(r) between Different Morphological Characters

	CH	CD	CWT	IL	CSL
CD	0.898***				
CWT	0.510***	0.428**			
IL	0.289	0.331**	– 0.286*		
CSL	0.402**	0.560***	– 0.203	0.343**	
CSB	0.711***	0.671***	0.343***	0.445***	0.248

***Correlation is significant at the <0.001 level (2 tailed)
** Correlation is significant at the <0.01 level (2 tailed)
*Correlation is significant at the <0.05 level (2 tailed)

each stand are given in Table 2.

The characters that justify the purpose of the study were average culm height (CH), culm diameter (CD), culm wall thickness (CWT), internode length (IL), culm sheath length (CSL) and culm sheath breadth (CSB) and they show significant variation within and between the populations.

The average culm height (CH) of the bamboo showed significant variation (p=0.05) among the population. The ratio between culm height(CH) and culm diameter(CD) show non significant variation while significant variation was found in the ratio between culm height(CH) and internode length(IL).The culm height was positively correlated with culm diameter(CD), culm wall thickness(CWT), internode length(IL), culm sheath length(CSL) and culm sheath breadth(CSB). Among these characters, correlation of culm height (CH) and culm diameter(CD), culm wall thickness(CWT), culm sheath length(CSL) & culm sheath breadth(CSB) is significant at 0.01 level (2 tailed) while with internode length(IL) is significant at 0.05 level.

Culm diameter (CD) of bamboo show significant differences among population (p< 0.05). Similar to culm height, culm diameter(CD) also show positive correlation with significance at 0.01 level with culm height(CH), internode length(IL), culm wall thickness(CWT), culm sheath length(CSL) and culm sheath breadth(CSB).

Culm wall thickness (CWT) of bamboo show highly significant difference among the population. It means that the samples from different population show variation among them. Culm wall thickness (CWT) was positively correlated with culm diameter (CD), culm height (CH) and culm sheath breadth (CSB) but negatively correlated with internode length (IL) and culm sheath length (CSL). Between these two correlations, with internode length (IL) is significant at 0.01 level.

It showed highly significant variation among population at 5% level. It is positively and significantly (at 0.05 level) correlated with culm diameter(CD), culm sheath length(CSL) and culm sheath breadth(CSB) and has negative correlation with culm wall thickness(CWT) and leaf length(LL) which were significant at (0.05 and 0.01 level).

Culm sheath length (CSL) & culm sheath breadth (CSB) showed highly significant differences (p<0.05). Ratio of culm sheath length (CSL) and culm sheath breadth (CSB) also showed significant differences. Culm sheath length (CSL) is positively correlated with culm wall thickness (CWT) and is positively and significantly correlated with culm height (CH), culm diameter (CD) & internode length (IL) except culm sheath breadth (CSB).

Culm sheath breadth (CSB) is positively correlated with culm sheath length (CSL) without significance and culm height (CH), culm diameter (CD) and culm wall thickness (CWT) with significance.

Among the characters culm height (CH) has lowest CV% value of 8.1 suggesting the variability of this character among the population. Higher the CV higher will be the variability show the most consistent & uniform value of character was that of internode length (IL) with 21.1% CV. Li et al (2002) observed geographic pattern of phenotypic features, similar to that of this research, of *Phyllostachys pubescens*. Diameter at breast height, culm length, and thickness of bamboo culm, leaf width and length were affected by longitude.

CONCLUSION

From the study it can be concluded that there exists variation in the phenotypic traits of *Bambusa nutans* subspecies *nutans* among populations in different geographical region of Central Nepal. All the characters show significant differences with 5% level of significance and ratios of morphological characters also show the significant differences except CH/CD, which was not significant. Most of the characters were significantly correlated with each other reflecting high correlation. Significant differences were observed in phenotypic characters. Since genetic differences leads to the variation among the plants, these are the genetic variation .Reciprocal transplant experiment and progeny testing should be conducted for further research. Molecular markers should be used to check the variations but it can be concluded that the species chosen for the study show genetic variation and it should be exploited positively by using the superior cultivar in different experiments.

Provided information can be utilized to preserve genetic re-

sources of our country and for the management of internal resource, endowed to us as bamboo.

ACKNOWLEDGEMENTS

The authors are indebted to Prof. Dr. PK Jha for providing opportunity and resources while conducting this research. We want to thank Mr. Prakash Deep Rai, Mr. Prakash Kunwar and the persons who helped us during the field visits and also like to thank the locals of the study area, who provided important information.

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