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RESEARCH ARTICLE

Responses of vegetative propagation of *Bambusa* sp. under forest management

Siuli Batabyal and Jagatpati Tah*
UGC Centre for Advanced Studies in Botany, The University of Burdwan, Golapbag Campus, Burdwan – 713 104, West Bengal, India
*Corresponding author's E-mail: jt_botbu2012@yahoo.in

ABSTRACT
There are a numbers of *Bambusa* species in India which have been rendering service towards social welfare since ancient times of human civilization. Since then, it plays an immense role not only in building of huts and mansion for the poor and rich men in the modern era, but also it is used as making fancy house-hold furniture and other wood work purposes . It requires certain agronomic as well as propagation factors in specific agro-climatic areas for its large scale population. Now-a-days, the natural regeneration process only can't fulfill the demands of the society. So, the methods other than rhizome propagation are essential for its rapid multiplication. Keeping all these views in mind we have undertaken a venture of vegetative propagation by means of cuttings of different species of *Bambusa* and compared with the seed propagated population. The main aims and objective of this experimentation were to explore the possibilities of rapid multiplication of *Bambusa* sp. in this tropical plain of West Bengal.

Key Words: Agro-climate, immense role, propagation, welfare.
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INTRODUCTION

Bambusa sp. has been serving multi-various roles for the human civilization and their livelihood since ancient time. It is commonly cultivated in North-West and North-East India, Orissa and West Bengal. Bamboo occurs naturally in sub-Himalayan tracts from the Yamuna eastwards to Arunachal Pradesh between 600-1500 m altitudes (Gamble, 1896). There are a few commercial species viz. *Bambusa nutans, B. aurindinacea, B. vulgaris, B. bamboos* etc. cultivated extensively in Thailand (Acantachote, 1987). The people of Thailand are used for various purposes, mainly as poles and carts. Also, *Bambusa nutans* is one amongst commonly used species in Indian paper industry (Krishnamachary *et al*., 1972).

Bambusanutans is known to flower only at long intervals. Gamble (1896) reported no flowering in *Bambusa nutans* for 54 years. However, Bahadur (1980), after analysing the flowering records, concluded that apart from natural /sporadic flowering *Bambusa nutans* seems to flower gregariously after 35 years.

Node of segmented axis of each and every a bamboo plant bears a bud or a branch, and branches, in turn has a bud in their axil. Few studies on its vegetative propagation have aimed at evolving as many as possible of these uncountable buds into planting material (Banik, 1980). The technique of adventitious rooting in culm/ branch cuttings have been successfully adopted for its vegetative propagation of many bamboo species (Pathak, 1966; Hasal, 1980; Kumar, 1989; Agnihotri and Ansari, 2000).

Although, a few species *Bambusa* are very reluctant to root species (Mc-Clure and Kennard, 1955). Certain bindings of adequate adventitious rooting in *Bambusa sp.* is clearly accepted in the scientific community as only some information are available on this specific aspect (Rao *et al*., 1992). Mc-Clure and Kennard (1955) grown 2 year-old culms of *Bambusa nutans* with small branches, severed above the rhizome in alluvial/loamy beds to obtain an overall mean production of only 2.2 roots per plant. Furthermore, Banik (1984) achieved some good results for this propagation using very long (0.5-1.0m) pre-rooted culm segments. Yashoda *et al*. (1997) also experimented for micro-propagation, but exorbitant cost of the technique limits its applicability on a large scale programme.

Keeping in mind of this to explore the alternate solution of inadequate adventitious rhizogenesis in five cultivars of *Bambusa sp.*, the present study was conducted to investigate suitability of culm and culm-branch cuttings and seed propagation under the influence of seasons and forest areas.

MATERIALS AND METHODS

Node cutting and seed propagating techniques out of four cultivars of *Bambusa* sp. viz. (i) *Bambusa aurindinacea,* (ii) *Bambusa ballocia,* (iii) *Bambusa vulgaris*, (iv) *Bambusa bamboos*, were undertaken for the experiments. The local names of each cultivar and considering the techniques over the cultivars, five varieties were considered in our experimentation as shown in the Table 1.

Table 1. Details of studied materials

Variety	Local name	Scientific name	Mode of propagation
V-1	JAWA	*Bambusa aurindinacea*	Node cutting
V-2	VULKI	*Bambusa ballocia*	Node cutting
V-3	BASIN	*Bambusa vulgaris*	Node cutting
V-4	KANTA	*Bambusa bamboos*	Node cutting
V-5	KANTA	*Bambusa bamboos*	Seed propagation

Statistical Models:

The statistical models and calculations were followed as laid down by Singh and Chaudhury (1995). Indeed, there are several ways to determine the varietal performances of any crop plant in any location or various locations. When the performance is assessed and analysed from the metrical traits of the crop plants then it is called location trial performance of the cultivars. But, in this case, four bamboo varieties have grown in a single location of 10 hectares of land area in the forest division. Hardly, it may be considered that the micro-environmental variances may occur out of soil environmental factors. This will not exhibit the factor chances in a greater extent in case of a hardy, maximum genetic flexibilities rather maximum adaptive cultivar like bamboo. Naturally, we can have to assess the varietal performances of this bamboo crop in this particular location. To analyse the varietal performance, we can follow the simple model for co-variance analysis. The analysis of co-variance is fully dependent upon the model of analysis of variance (ANOVA). Now, let us explain the method of Analysis of Variance (ANOVA) and Analysis of Co-variance (ANCOVA) calculations.

In the biometrical model, there are two main objectives of the analysis of variance. Firstly, it helps in sorting out the variance due to different sources. If we consider the performance of some varieties in an experiment, the observation can be partial into two parts, one representing the variation between the varieties and another within the varieties. The second objective of analysis of variance is to provide a basis for test of significance.

RESULTS AND DISCUSSION

The environment has a vital role which manifested in the present study as seed propagation showed better induction and growth of adventitious roots than culm cuttings. The value of replication based mean raw data was presented in Table 2, Table 4 and Table 6. The values of variance ratio against genotypes in all the characters as calculated in Table 3, Table 5 and Table 7 that denote the potentiality of genotypes undertaken for the experiment. The factors of environment and replications did not influence by any means. Again in the Table 8, it has also been confirmed that the metrical characters i.e. height/plant, girth/plant, and rhizome/plant which is primary yield indicator of this type of crop is no doubt fit for the location. The value of components of variances of height/plant, girth/plant, and rhizome/plant are 14.453, 18.349375 and 16.327, respectively. The values of components of co-efficient of variations are also greater than that of all other components which further re-confirmed the computation of the earlier (Table 9). The components of co-variances for genotypes have found greater significant value than that of environment and phenotypic matrix (Table 12).

Table 2. Data on height/plant (m)

Var.	R-I	R-II	R-III	R-IV	∑	$\bar{X}$
1	7.6	7.9	7.3	8.3	31.1	7.77
2	8.2	7.7	7.4	7.9	31.2	7.80
3	6.5	6.9	6.4	6.7	26.5	6.62
4	4.2	4.8	4.4	4.6	18.0	4.50
5	3.4	3.9	3.8	3.5	14.6	3.65
∑	29.9	31.2	29.3	31.0	121.4	
$\bar{X}$	5.98	6.24	5.86	6.20	6.07	

Table 3. ANOVA for height/plant (m)

Source of Variation	df	SS	MS	F	Remarks
Replication	3	0.490	0.16333	2.1420	Variety is
Variety	4	58.117	14.52925	190.54754**	significant at P
Error	12	0.915	0.07625		0.01%
∑	19	59.522	14.76883		

Table 4. Data on basal girth (cm)/plant

Var.	R-I	R-II	R-III	R-IV	∑	$\bar{X}$
1	24.2	23.2	25.5	23.9	96.8	24.20
2	22.2	22.4	24.1	24.7	93.4	23.35
3	18.5	19.1	17.9	17.6	73.1	18.28
4	18.2	18.7	19.0	17.0	72.9	18.22
5	13.5	14.0	13.2	13.9	54.6	13.65
∑	96.6	97.4	99.7	97.1	390.8	
$\bar{X}$	19.2	19.48	19.94	19.42	78.16	

Table 5. ANOVA for basal girth (cm)/plant

Source of Variation	df	SS	MS	F	Remarks
Replication	3	1.132	0.37733	0.437484	Variety is
Variety	4	297.013	74.25325	86.090725**	significant at P
Error	12	10.323	0.86025		0.01%
∑	19	308.468	75.49308		

Table 6. Data on rhizome number/plant

Var.	R-I	R-II	R-III	R-IV	∑	$\bar{X}$
1	10.5	11.2	11.5	12.0	45.2	11.3
2	4.3	4.7	5.8	5.2	19.5	4.88
3	14.2	16.7	17.1	15.4	63.4	15.85
4	11.3	11.6	12.5	12.9	48.3	12.08
5	9.4	8.8	7.9	9.5	35.6	8.9
∑	49.7	53.0	54.3	55.0	212.0	
$\bar{X}$	9.94	10.6	10.86	11.0	42.4	

Table 7. ANOVA for rhizome number/plant

Source of Variation	df	SS	MS	F	Remarks
Replication Variety Error	3 4 12	3.316 263.575 7.029	1.10533 65.89375 0.58575	1.8870337 112.49466**	Variety is significant at P 0.01%
∑	19	273.914	67.58483		

Table 8. Components of variances

Components	Height/plant	Basal girth/plant	Rhizome/plant
∂^2_g	14.453	18.349375	16.327
∂^2_e	0.07625	0.86025	0.58575
∂^2_p	3.6895	19.211875	16.91275

Table 9. Components of Co-efficient of variation

Components	Height/plant	Basal girth/plant	Rhizome/plant
PCV	62.631139	5.4805745	9.5298779
GCV	1.2561779	1.186664	1.8050543
h^2	0.020056762	0.216521826	0.189410013

Table 10. ANCOVA for height/plant vs basal girth/plant

Source	df	SP	MP	F	Remarks
Replication Treatment Error	3 4 12	-0.45 120.6115 0.7775	-0.15 30.152075 0.0647916	2.3151149 465.38247**	** indicates significant at P 0.01 level

Table 11. ANCOVA for height/plant vs rhizome number/plant

Source	df	SP	MP	F	Remarks
Replication Treatment Error	3 4 12	0.284 -15.995 40.711	0.0946666 -3.99875 3.3925833	0.27904 -1.1786741	No significant result

Table 12. Component of Co-variances

Components	Height/plant vs Basal girth	Height/plant vs Rhizome/plant
$\partial g_i g_j$	7.5218208	- 0.9834896
$\partial e_i e_j$	0.0647916	3.3925833
$\partial p_i p_j$	7.5866124	2.4090937

Co-heritability of characters 1 and 2 [h^2] = 0.9914597
Co-heritability of characters 1 and 3 [h^2] = 0.408240493
Considering genotypic values ($\partial^2 g_i$ and $\partial g_i g_j$) correlation values are as follows:

r_{12} = 0.887500003
r_{13} = 0.064023229

In a simple matrix it can be written as:

[1.000 0.887500003 0.064023229]

Similarly, phenotypic correlations matrix may be calculated as:

[1.000 0.901113016 0.038607523]

And the matrix for environmental correlations is as follows:

[1.000 0.252980147 16.05293516]

All these factors become available for differentiation and growth of organs such as culms and adventitious roots (Agnihotri and Ansari, 2000). Role of other external factors especially temperature and long day length in adventitious rooting is well recommended (Dykemen, 1973; Kester, 1983; Carpernter *et al*., 1973; Stoutemyer *et al*., 1961).

The growth and development of the plant like bamboo are upto the standard in this location, when it was not influenced by any hormones in nursery stage on to the culms or seedlings in our experiment materials. But there are few examples that exogenous application of auxins greatly enhances adventitious rhizogenesis in most species, including those of bamboos (Uchimara, 1977; Suzuki and Ordinaro, 1977; Surendran *et al.*, 1983, 1989; Seethalakshmi *et al.*, 1989).

Sustained investment in an institutional and industrial setting will show many new and exciting applications that will help keep the industry viable and profitable in the years ahead. The properties of the local bamboo needs to be continuously explored and the findings must be fed back into training programmes for local craftsmen and farmers so that these are assimilated into the local knowledge which will be at the centre of the value addition strategy of the proposed local district clusters. Such a knowledge rich approach will provide a stable demand for the produce of the region and help it compete with other species and materials occupying the product landscape of an active market economy that India is heading towards. Promoting the local innovations and protecting it through brand building and exposure to markets across India would fall on Government promotional agencies working in concert with the associations of local producers. Such an integrated development model can be sustained since bamboo is such a versatile material and the social and political hope and economic value that the proposed process can unfold and release will make it a major economic driver of the State economy if carefully managed and implemented as an integrated multi-layered strategy as suggested and exercised by Charles and Ray, 1958; Papanek, 1972; Beer, 1975; Naipaul, 1979; Ranjan *et al.*,1986; Peters,1993; Panchal and Ranjan, 1994; Ranjan, 1994, 1998, 1999, 2000, 2001, 2003, 2004; Balaram, 1998; Singh, 2001; Thomas, 2001; Wheelan, 2002; Sen, 2001; Bhalla, 2003; Gandhi, 1955.

CONCLUSION

The standardization of vegetative propagation and seed propagation for adventitious rooting under natural condition in the location was investigated in view of the problem of inadequate adventitious rhizogenesis in four bamboo cultivars namely, *Bambusa aurindinacea, Bambusa ballocia, Bambusa vulgaris, Bambusa bamboos.* Out of those four cultivars *Bambusa bamboos* was untaken both for vegetative and seed propagation following schedule agronomical measures. Induction and growth of adventitious rhizogenesis in both types propagated population were noted to be more in June than May. However, seed propagated population exhibited markedly better adventitious root formation and growth, compared to culm cuttings. Prime yield data were collected and computed following standard biometrical model for exclusive study.

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