J. Bamboo and Rattan, Vol.5, Nos. 3&4, pp. 117-126 (2006)

Rooting ability of *Bambusa vulgaris* var. *striata* branch cuttings as influenced by cutting type and rooting hormones

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Abstract: Base cuttings and secondary branch cuttings of *Bambusa vulgaris* var. *striata* were collected from phenotypically superior clumps and treated with 0.2 per cent and 0.4 per cent IBA and NAA to assess the rooting ability of cuttings and steckling capacity under mist propagation system. The study revealed that both the cutting types are amenable to mass clonal propagation. Rooting ability of the cuttings was significantly enhanced by the application of IBA. The highest percentage of rooting (63.33) was observed in the base cuttings treated with 0.4 per cent IBA followed by 0.2 per cent IBA (60) and the lowest (30) was in the cuttings without treatment (control). However, the highest percentage of rooting in secondary cuttings was in samples treated with 0.2 per cent IBA, followed by 0.4 per cent IBA and the lowest was in the control. The maximum number of roots developed per cutting (11.16 and 4.88 for base cuttings and secondary cuttings respectively) was obtained from samples treated with 0.4 per cent IBA followed by 0.2 per cent IBA (9.88 and 4.0 for base cuttings and secondary cuttings respectively), and the lowest (6.00 and 2.66 for base cuttings and secondary cuttings respectively) was in the control. The average length of longest root was maximum in the cuttings treated with 0.2 per cent IBA followed by 0.4 per cent IBA and the lowest was in the control for both the cutting types. The steckling capacity did not vary between the cutting types and the concentrations of rooting hormones applied. But, the highest shoot length was obtained from the cuttings treated with 0.4 per cent NAA followed by 0.2 per cent NAA and the lowest was in the control. Considering all aspects, treating both types of branch cuttings with 0.2 to 0.4 per cent IBA is recommended for mass clonal propagation for large-scale plantation programmes.

Key words: *Bambusa vulgaris* var. *striata*, branch cuttings, secondary cuttings, rooting ability, steckling capacity.

INTRODUCTION

Bambusa vulgaris var. *striata* is known as "Sharna Bans" in Bangladesh. Although the bamboo species is widely used for various purposes, very little is known about its propagation system. However, regeneration of this bamboo through seeds is not

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practical since most of the *B. vulgaris* varieties do not produce viable seeds after flowering. John and Nadgauda (1993) studied the taxonomy and morphology of *B. vulgaris* var. *vittata* (synonym with *striata*) from India and mentioned that this variety of bamboo flowered irregularly and does not set seeds as the lemma and palea fail to open properly (Negi. 1996), and the pollen are not viable. Seedling progenies are therefore not possible for this variety of bamboo (McClure, 1966), and this species could be propagated only through vegetative methods (Koshy and Pushpangadan, 1997; Banik, 2000).

Although *B. vulgaris* has been propagated by different vegetative methods like rhizome cutting, offset planting, culm or stem cutting, branch cutting and pre-rooted branch cutting, ground layering, stump sprout, *etc.*, the most common method is rhizome cutting. However, in large-scale plantation programmes, rhizome cutting method is not practised because of high cost and limited availability of material. Also, the bamboo clump loses its regeneration potential if more rhizomes are excavated. Moreover, the survival percentage of rhizome cutting is not always satisfactory.

Treatment of cuttings with exogenous rooting hormone is believed to enhance the rooting ability of branch cuttings of different bamboo species (Agnihotri and Ansari, 2000; Singh *et al.*, 2002; Pattanaik *et al.*, 2004; Hossain *et al.*, 2005). However, there are very few studies which address the potential of *B. vulgaris* var. *striata* for vegetative propagation through branch cuttings. So, a study was designed to examine the clonal propagation potential of the species and the effect of IBA and NAA on rooting ability of branch cuttings and their steckling capacity (*i.e.*, survival percentage and number of shoots produced per cutting) .

MATERIALS AND METHODS

The study was conducted in the nursery of Bangladesh Forest Research Institute (BFRI), Chittagong, Bangladesh over a period of nine months from April to December 2005. The study area enjoys a typically tropical climate, characterised by hot humid summer and cool dry winter. The maximum temperature varies from 28.3 to 31.9°C and the minimum temperature from 15.2 to 25.2°C. Relative humidity is generally lowest in February and highest during July to September. Mean annual rainfall of the area is about 3000 mm which is mostly from June to September.

Preparation of cuttings

Healthy vigorous clumps were selected for the cuttings based on: i) clump maturity, ii) growth potential of the clumps, *i.e.*, number of culms per clump, height, diameter and internode length of the culms, and iii) resistance to diseases and pests. Branches, not more than two years old, were collected from pre-selected clumps by separating with handsaw and secateur. Leaves, axillary branches and tips of the collected branches were trimmed carefully. The branches were then transported to the nursery as quickly as possible for further processing.

Two types of cuttings were used to determine the rooting ability. Primary branch cutting or base cutting consisted of 3 to 4 nodes of primary branch along with the swollen base of the branch. Secondary cuttings were made keeping one node from the primary branch (approximately 5 cm on both sides of the node) as the base of secondary branch along with 3 to 4 nodes from the secondary branch. In the case of branches with shorter internodes, 5-nodal segments were made. However, the average length and diameter of the cuttings were kept random to avoid non-treatment variations. The length of cuttings ranged from 39.5 to 42.9 cm in the base cuttings and from 27.5 to 32.1 cm in secondary cuttings. The diameter of segments in base cuttings ranged from 10.5 to 11.9 mm and from 5.5 to 6.2 mm in secondary cuttings (Fig. 1). Special care was taken to avoid splitting at the cut end. Immediately after cutting, segments were immersed in water to avoid desiccation. A total of 300 cuttings were used in the experiment.

Treatment of cuttings

Thirty cuttings from each cutting types were treated with indole 3-butyric acid (IBA) and naphthalene acetic acid (NAA) at two concentrations (0.2% and 0.4% w/v). The

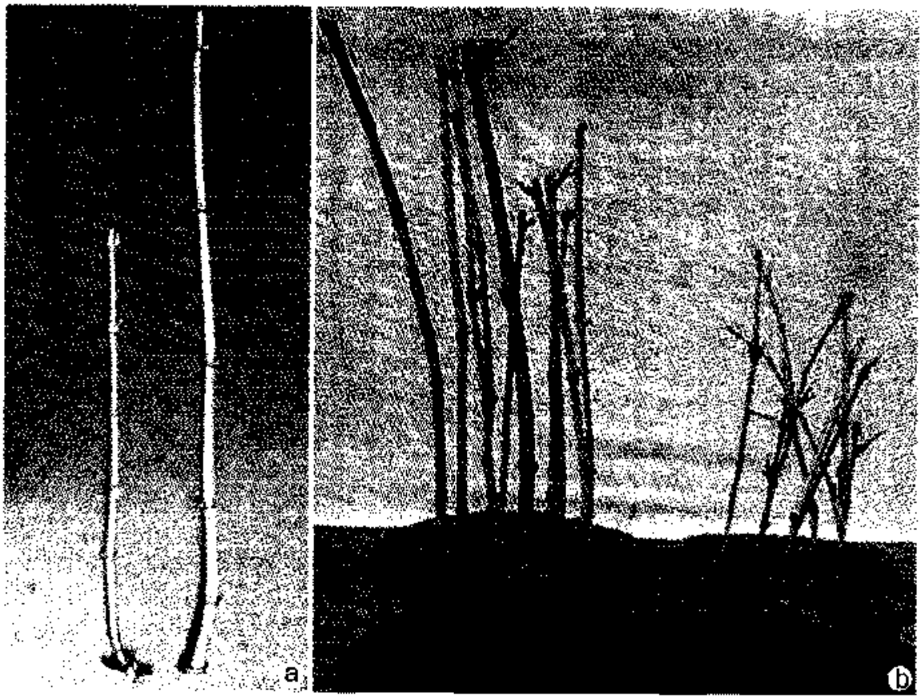

Figure 1. Secondary and base cutting of *B. vulgaris* var. *striata* (a) and cuttings (b) planted in perforated plastic tray filled with coarse sand mixed with gravel.

Figure 2. Arrangement of rooting trays of base cuttings (a) and secondary cuttings (b) in the experiment.

Figure 3. Rooting performance of base cutting s (a) and secondary cuttings (b) under different treatments.

Figure 4. Steckling performance of base cuttings (a) and secondary cuttings (b) rooted under various treatments.

base of the cutting was dipped into the hormone solution for about one minute. Thirty cuttings each from the two cutting types were also kept as control by dipping in water for a minute. The cuttings were planted into perforated plastic trays filled with coarse sand mixed with fine gravel (Fig. 1). Each tray contained 10 cuttings and three trays served as a plot. The trays were placed under mist propagation system for rooting. A complete randomized block design was adopted and the arrangements of rooting trays for the experiment are shown in Figure 2.

Weaning and transfer of rooted cuttings

The cuttings started rooting in about six weeks. The cuttings were subjected to weaning towards the end of rooting period during root lignification. The rooted cuttings were then transferred into polybags (25 x 15 cm) filled with soil and decomposed cow dung in the ratio 3:1. Rooted cuttings were allowed to grow in the nursery for about six months to assess the steckling capacity and growth performance (Figs.3,4). Observations on the rooting percentage, root number, and the length of the longest root of each cutting during transferring the rooted cuttings into polybags were recorded. Survival percentage, number of shoots developed and height of the longest shoot were also recorded after 6 months. The data were analysed statistically by using SPSS. Analysis of variance (ANOVA) and Duncan's Multiple Range Test (DMRT) were done to assess the possible treatment variations.

RESULTS AND DISCUSSION

Rooting ability of branch cuttings

Rooting percentage in base cuttings ranged from 30 to 63.33 (Fig.5) among the treatments. The highest rooting percentage (63.33) was observed in the cuttings treated with 0.4 per cent IBA solution. In the secondary cuttings also, rooting percentage varied from 30 to 63.33. However, the highest rooting percentage was obtained from

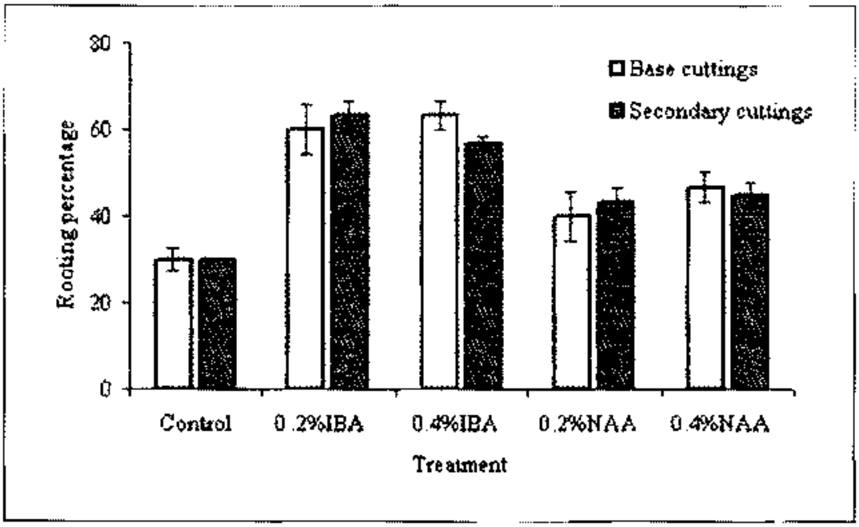

Figure 5. Rooting percentage of base cuttings and secondary cuttings under different treatments.

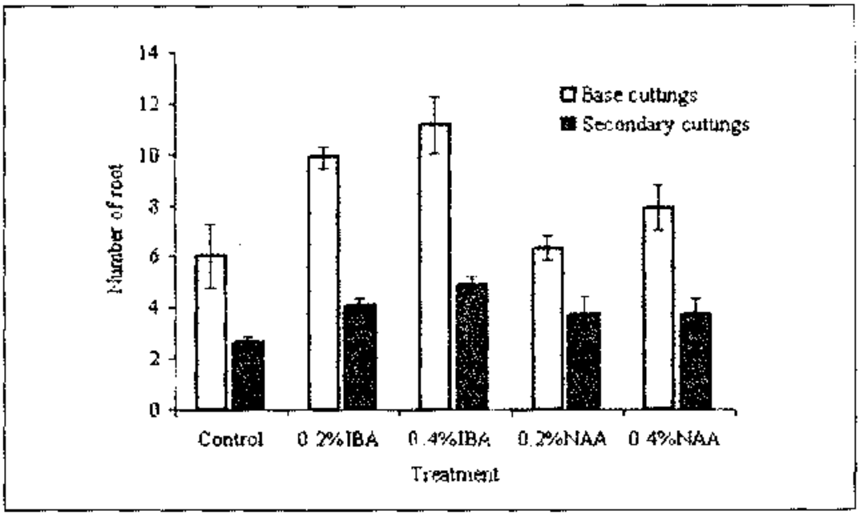

Figure 6. Number of roots of base cuttings and secondary cuttings under different treatments with IBA and NAA.

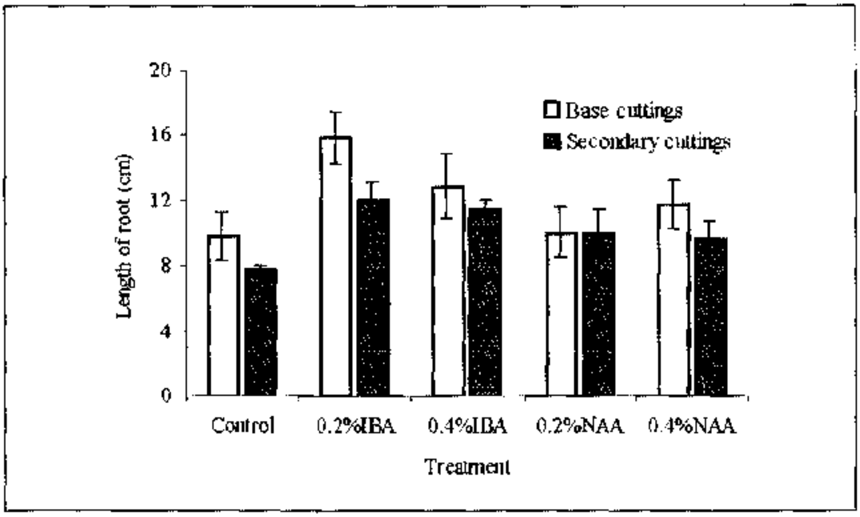

Figure 7. Root length of base cuttings and secondary cuttings under different treatments of IBA and NAA.

those treated with 0.2 per cent IBA solution. In both the control sets (without rooting hormones), only 30 per cent rooting was observed. Surendran and Seethalakshmi (1985) found IBA and NAA to enhance rooting and sprouting responses of bamboo species significantly. Castillo (1990) reported the best rooting, shoot production and survival of base cuttings of *B. vulgaris* var. *striata* treated with 0.1 per cent IBA. Nagarajaiah *et al.* (1994) reported the effect of IBA in increasing survival, rooting and sprouting of stem cuttings of *B. vulgaris*. Somashekar *et al.* (2004) reported the maximum rooting percentage (85% in leafy branch cuttings with tip and 80% in nodal cuttings) in cuttings treated with 0.25 per cent IBA. Again, Hossain *et al.* (2005) reported highest rooting ability in *B. vulgaris* branch cuttings (84%) treated with 0.2 per cent IBA solution.

Root number

In the base cuttings, average number of roots produced per cutting ranged from 6 to 11.16 across the treatments. The highest number of roots per cutting was produced in treatment with 0.4 per cent IBA solution followed by 0.2 per cent IBA solution (9.88) and the lowest was in the control. A similar trend was observed in the secondary cuttings also (Fig. 6). However, in the case of secondary cuttings, number of roots produced per cutting ranged from 2.66 to 4.88 among the treatments. Hossain *et al.* (2005) also reported that the number of roots developed per cutting was significantly influenced by IBA treatment in the secondary cuttings of *B. vulgaris*. Castillo (1990) mentioned that the maximum number of roots were produced in the base cuttings when treated with 0.1 per cent IBA.

The number of roots produced per base cutting was higher than that of the secondary cuttings even under same concentration of rooting hormone. This might be due to the higher cutting volume of the base cuttings since rooting ability is sometimes positively related to the cutting volume. Larger volume means larger amount of assimilates which are utilized to produce more roots and higher root biomass in the cuttings (Hossain, 1999).

Root length

The average length of roots of base cuttings varied from 9.8 to 15.8 cm (Fig. 7). In the secondary branch cuttings, average length of roots varied from 7.8 to 12.0 cm across the treatments. In base cuttings as well as secondary branch cuttings, 0.2 per cent IBA solution gave highest values for root length, whereas the lowest values were recorded in the control treatments.

The results of Abdullah *et al.* (2005) support the results of the present study; the root length of *Baccaurea sapida* cuttings was significantly enhanced with 0.4 per cent IBA solution. However, Hossain *et al.* (2005) reported that the mean root length ranged from 13.3 cm to 17.1 cm in untreated secondary cuttings of *B. vulgaris* and from 9 cm to 11.1 cm in the cuttings treated with 0.2 per cent IBA solution, six weeks after setting them for rooting trial.

Steckling performance

Survival percentage

Survival percentage of rooted cuttings ranged from 75 to 95 in base cuttings and from

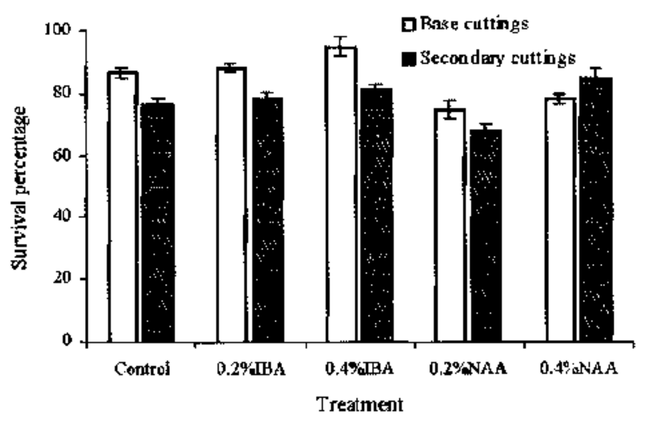

Figure 8. Effect of IBA and NAA on the survival percentage of rooted base cuttings and secondary cuttings in the nursery.

68.3 to 85.0 in secondary cuttings (Fig. 8) across the treatments. Although the highest survival percentage was observed in the cuttings treated with 0.4 per cent IBA in base cuttings and 0.4 per cent NAA in secondary cuttings, there was no significant difference in survival percentage of cuttings due to the applied rooting hormones. However, Hossain *et al.* (2005) reported the highest survival percentage (95.2) in the cuttings of *B. vulgaris* secondary cuttings rooted with 0.2 per cent IBA followed by those without IBA treatment (90). Similarly, Pattanaik *et al.* (2004) reported 100 per cent field survival of *B. balcooa* cuttings rooted with 200 ppm IBA, two years after field planting. Again, in the present study, base cuttings were found to survive better than the secondary cuttings. Similar result was reported by Banik (1989) who mentioned that the cuttings from the basal sections survived better than the middle and top sections of culms. Furthermore, Hoanh and Baltazar (1988) reported 100 per cent survival of 2-node culm cuttings of *B. vulgaris* in the field after five months of transplanting and the cuttings taken from the base performed better than that from the top of the culm.

Shoot production

The average number of shoots produced per cutting varied from 2.78 to 4.67 in base cuttings and from 2.83 to 3.93 in secondary cuttings (Table 1). In base cuttings, highest shoot number was observed in the cuttings treated with 0.4 per cent NAA followed by 0.2 per cent IBA and the lowest was in the control cuttings. In secondary cuttings, the highest shoot number was observed in treatment with 0.2 per cent IBA, followed by 0.4 per cent NAA and the lowest was in the control. However, there was no significant difference in number of shoots produced among the treatments in the cutting types.

Table 1. Number of shoots produced from *B. vulgaris* var. *striata* cuttings rooted under different treatments

Variables	Treatments					p
	Control	0.2% IBA	0.4% IBA	0.2% NAA	0.4% NAA	
Base cuttings	$2.78 \pm 0.67^{a*}$	4.15 ± 0.52^{a}	3.67 ± 0.24^{a}	4.11 ± 0.44^{a}	4.67 ± 0.16^{a}	0.112
Secondary cuttings	2.83 ± 0.16^{a}	3.93 ± 0.17^{a}	3.85 ± 0.07^{a}	3.33 ± 0.66^{a}	3.89 ± 0.58^{a}	0.324

* Means followed by the same superscript letter (s) are not significantly different at $p < 0.05$; ± indicates standard error of mean.

Table 2. Length of shoots developed from *B. vulgaris* var. *striata* cuttings rooted under different treatments

Variables	Treatments					p
	Control	0.2% IBA	0.4% IBA	0.2% NAA	0.4% NAA	
Base cuttings	$23.2 \pm 3.9^{b*}$	27.37 ± 1.3^{b}	27.15 ± 1.5^{b}	31.0 ± 2.6^{ab}	36.53 ± 2.4^{a}	0.037
Secondary cuttings	12.7 ± 1.14^{a}	15.9 ± 0.96^{a}	16.0 ± 1.1^{a}	16.3 ± 3.1^{a}	20.37 ± 2.1^{a}	0.152

* Means followed by the same superscript letter (s) are not significantly different at $p < 0.05$; ± indicates standard error of mean.

Shoot length

The average length of the shoot that developed in the cuttings varied from 23.2 to 36.5 cm in base cuttings and from12.7 to 20.4 cm in secondary cuttings (Table 2). The highest shoot length of 36.5 cm was obtained in treatment with 0.4 per cent NAA solution followed by 0.2 per cent NAA solution (31.0 cm) and the lowest (23.2 cm) in the control. Similar results were obtained in treatments with NAA solution (0.2%, 0.4%) in secondary cuttings (Table 2). The shoot length in the base cuttings rooted under different treatments was significantly enhanced by the applied rooting hormones, but there was no significant difference among the treatments in the secondary cuttings (Table 2).

CONCLUSION

The rooting percentage, root number and root length of both base cuttings and secondary cuttings of *B. vulgaris* var. *striata* were enhanced with the application of rooting hormones (IBA, NAA). Rooting ability in terms of rooting percentage, root number and root length of cuttings of the species was found best when cuttings were treated with 0.4 per cent IBA solution. Again, IBA treated cuttings showed better survival capability than the NAA treated ones and the control in steckling performance. The results of the present study could help in opening a new window for the propagation of this variety of ornamental bamboo. However, the field performance of the planting stock developed through branch cuttings in this experiment needs to be assessed.

ACKNOWLEDGEMENTS

The authors express their acknowledgement to the Director, Officials and Staff of the Bangladesh Forest Research Institute (BFRI), Chittagong, Bangladesh for their assistance during the research work. The authors also extend their gratitude to the reviewers of the paper for their valuable suggestions and necessary corrections made in this paper for improving quality.

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