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Growth of *Gigantochloa levis* branch cuttings in nursery and field planting in response to indole butyric acid rooting hormone

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Abstract—A range of practical nursery methods was examined in order to obtain high survival of branch cuttings of *Gigantochloa levis* showing good rooting, culm/shoot and rhizome formation when field planted. Polybag branch cuttings gave the highest survival after one year in field planting although nursery beds tended to provide better growing conditions for preparing planting materials. However, use of commercial indole butyric acid (IBA) 2000 powder enhances both survival and growth of polybag cuttings and was found to be more effective than other applications of IBA. The planting of *G. levis* in the field showed that the polybag branch cuttings had a higher survival percentage (88.9%) than those of the bare root planting (41.7%) and the newly branch cutting planting (33.3%).

Key words: Propagation; branch cutting; field survival.

INTRODUCTION

The main problem faced in establishing large-scale bamboo plantations is the availability of the planting materials. Bamboos can be propagated by seed and vegetative parts. Seeding is an impractical method because a large number of Malaysian bamboos produce sterile seeds and flower infrequently. The most common method is by planting offsets. However, the availability of bamboo offsets is very limited, and offsets are also very laborious and costly to extract and transport.

Although the propagation by using branch cuttings is new and not quite successful [1], a preliminary study shows that five Malaysian bamboo species can be propagated by branch cuttings, giving a high survival rate in field planting. This method of propagation is limited to bamboo species with a large and dominant primary branch, consisting of root primordia and dormant buds at the based of the branch [2].

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MATERIAL AND METHODS

Branch cuttings of *G. levis* were extracted from culms aged 2–3 years from bamboo clumps planted in FRIM research plots. The branches were carefully removed from the culm sections to prevent damage to the delicate dormant buds. They were subsequently cut to a 50-cm length (containing four nodes).

A split-plot factorial design consisting of two planting methods as the main plot and seven concentrations of IBA rooting hormone as the sub-plot was used. The two planting methods used are planting of branch cuttings in nursery beds (Fig. 1) and in polybag (Fig. 2). The hormone treatment consisted of 100, 200, 300 or 500 ppm (parts per million) Seradix 2, IBA 2000 powder (containing 0.2% IBA and 99.8% inert ingredients in terms of weight) and control (distilled water). The trial was conducted in five replicates with ten experimental units for each treatment. A total of 700 cuttings were studied in this trial. The percentage of soil moisture and temperature in the nursery is shown in Table 1.

To prepare the 100, 200, 300 and 400 ppm IBA solutions, ethyl alcohol was used to dilute 0.1, 0.2, 0.3 and 0.5 g concentrated IBA and then 1000 ml of distilled water was added. The branch cuttings are soaked in the different concentration IBA solutions prepared for 24 h before being planted in the nursery (Fig. 3). The two commercial IBA rooting hormones (Seradix 2 and IBA 2000 powder) were directly applied to the cuttings before planting in the nursery (Fig. 4). In the nursery, the

Figure 1. Branch cuttings planted in nursery beds.

Figure 2. Cuttings planted in polybag.

Table 1.
The soil moisture and temperature recorded in the nursery

Time	Soil moisture (%)		Temperature (°C)		
	Nursery beds	Polybag	Outside nursery	Polybag	Nursery beds
9.00 am	91.5	81.7	28.5	24.1	24.6
12.00 noon	85.6	75.7	32.5	28.9	27.3
3.00 pm	80.1	70.2	32.5	30.7	28.7

cuttings were placed under 60% shade and watered twice a day (in the morning and evening).

The percentage of survival and culm production by the branch cuttings was assessed five months after planting in the nursery. Data on number of new culms and survival rate of propagules were subjected to Analysis of Variance (ANOVA) using SAS software programme version 6.03. Means were compared using Duncan's Multiple Range Test (DMRT).

The planting materials prepared in the nursery were then transferred for field planting. 100 cuttings from the polybag branch cuttings, bare rooted branch cuttings (prepared in nursery beds) and fresh branch cuttings respectively were directly planted to the field. The area selected for field planting is undulating and the soil classification of the planting site is deep soil with coarse sandy clay loam. The soil

Figure 3. Cuttings soaked in IBA.

Figure 4. Commercial IBA applied directly.

pH was between 4.3 and 5.2. The average annual rainfall, temperature and humidity of the site are 1500 mm, 30°C and 89%, respectively. Observation on percentage of survival and growth performance of the cuttings was carried out 1 year after field planting.

RESULTS AND DISCUSSION

Growth of branch cuttings in nursery beds and polybag

Results on the percentage of survival, rooting, culm/shoot production and rhizome formation of branch cuttings are given in Table 2. The results show that the cuttings planted in nursery beds and polybag did not cause any significant difference on the percentage of survival and percentage of rooting. The percentages of survival and rooting of cuttings planted in polybag and nursery beds were 57.7% and 54% and 56.6% and 51.7%, respectively (Table 3).

However, the percentage of culm/shoot and rhizome production was highly significant. The planting of branch cuttings in nursery beds produced a significantly higher percentage of culms/shoots and rhizomes (17.4% and 13.4%, respectively) compared with planting in polybag. The results indicate that the nursery beds can produce more vigorous cuttings than polybag.

Growth conditions in the nursery beds are more favourable and enhance the growth of cuttings compared with polybag. In the nursery beds the soil moisture

Table 2.
Analysis of variances on percentage of survival, percentage of culm/shoot production, percentage of rooting and percentage of rhizome formation of *G. levis* branch cuttings

Source of variation	Degrees of freedom	*F* values			
		Survival	Rooting	Culm/shoot production	Rhizome formation
Beds	1	0.51^{ns}	0.88^{ns}	7.00*	9.09*
Hormone	6	2.05^{ns}	1.97^{ns}	1.73^{ns}	1.88^{ns}
Beds × Hormone	6	0.90^{ns}	0.82^{ns}	0.39^{ns}	1.73^{ns}

Note: ns, not significant at $P < 0.05$; *significant at $P < 0.01$.

Table 3.
Effects of planting method on the percentage of survival, shoot/culm, rooting and rhizome production of *G. levis*

Planting method	Mean percentage values			
	Survival	Rooting	Shoot/culm production	Rhizome formation
Nursery beds	54.0^{a}	51.7^{a}	17.4^{a}	13.4^{a}
Polybags	57.7^{a}	56.6^{a}	8.9^{b}	5.1^{b}

Note: Values with the same letter(s) are not significantly different at $P < 0.05$.

Table 4.
Effects of hormone treatment on the percentage of survival, shoot/culm, rooting and rhizome production of *G. levis*

IBA hormone treatment	Mean percentage values			
	Survival	Rooting	Shoot/culm production	Rhizome formation
Control	52.0[a,b]	52.0[a,b]	14.0[a,b]	9.0[a,b]
100 ppm	59.0[a,b]	59.0[a,b]	16.0[a,b]	13.0[a,b]
200 ppm	52.0[a,b]	49.0[a,b]	9.0[a,b]	5.0[a,b]
300 ppm	62.0[a,b]	57.0[a,b]	12.0[a,b]	9.0[a,b]
500 ppm	38.0[b]	37.0[b]	5.0[b]	3.0[b]
Seradix 2	59.0[a,b]	57.0[a,b]	13.0[a,b]	8.0[a,b]
2000 powder	69.0[a]	68.0[a]	23.0[a]	18.0[a]

Note: Values with the same letter(s) are not significantly different at $P < 0.05$.

is higher and constant and the temperature on soil surface is lower (Table 1). The minimum obstacle in nursery beds for root and rhizome development and elongation also provides better growth. This factor is crucial for successful cuttings and growth in the nursery [3]. In this experiment the higher rate of moisture and lower temperature in nursery beds helps to promote the development of roots and buds of the cuttings [4] and results in better growth compared with polybag cuttings.

Growth trial on *Bambusa arundinacea* seedlings using different sizes of polybag was reported in Ref. [5]. Results showed that sizes gave significantly different root elongation, biomass production and rhizome and culms formation. In this early stage, nursery beds provide the space, favourable soil conditions and nutrient needed for better root formation until the stage of competition where the cuttings are ready for field planting.

Effect of IBA hormone treatments on bamboo cuttings

IBA hormone treatments were not significant on the percentage of survival, rooting, culm/shoot and rhizome formation of *G. levis* branch cuttings (Table 2). However, as shown by the DMRT (Table 4), compared with other IBA hormone, the contact method of application using IBA 2000 powder on cuttings gave better success, while 500 ppm IBA concentration produced the lowest success rate. Mean percentage of survival, rooting and culm/shoot and rhizome production varied mostly between 50–60%, 49–59%, 9–16% and 5–13%, respectively, for the IBA hormone treatments used. With IBA 2000 powder, the percentage of survival, rooting and culm/shoot and rhizome production was the highest, 69, 68, 23 and 18%, respectively, while 500 ppm IBA gave the lowest results, 38, 37, 5 and 3%, respectively.

Rooting hormone applied in this experiment was not significant for the growth of the cuttings in the nursery; however, a certain concentration of IBA can help to promote rooting compared with control (Fig. 5). This trial showed that 100 ppm IBA

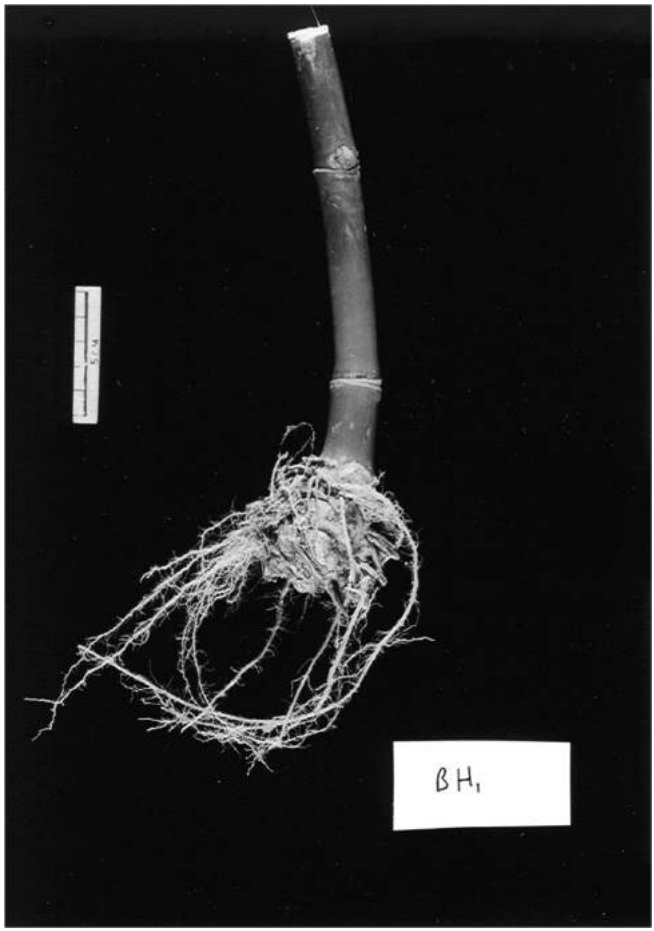

Figure 5. Control.

concentration gave the best effect on root and rhizome formation of *G. levis* branch cuttings; the effect decreased as the concentration increased. The same result also is reported by [6] using *Bambusa vulgaris* cuttings. This experiment showed that a commercialised IBA 2000 Powder (Fig. 6) can further promote growth of cuttings better than IBA 100 ppm concentration (Fig. 7).

Growth of G. levis by branch cuttings in field planting

The results of survival and growth performance in the field planting are shown in Table 5. The polybag branch cuttings gave the highest survival percentage (88.9%) compared with bare root planting (41.7%) and fresh branch cuttings planted directly (33.3%). The growth performance was also influenced by the type of cutting prepared in the nursery. Polybag cuttings were superior to the other two types of cuttings used. The percentage of culm/shoot production, number of culms and

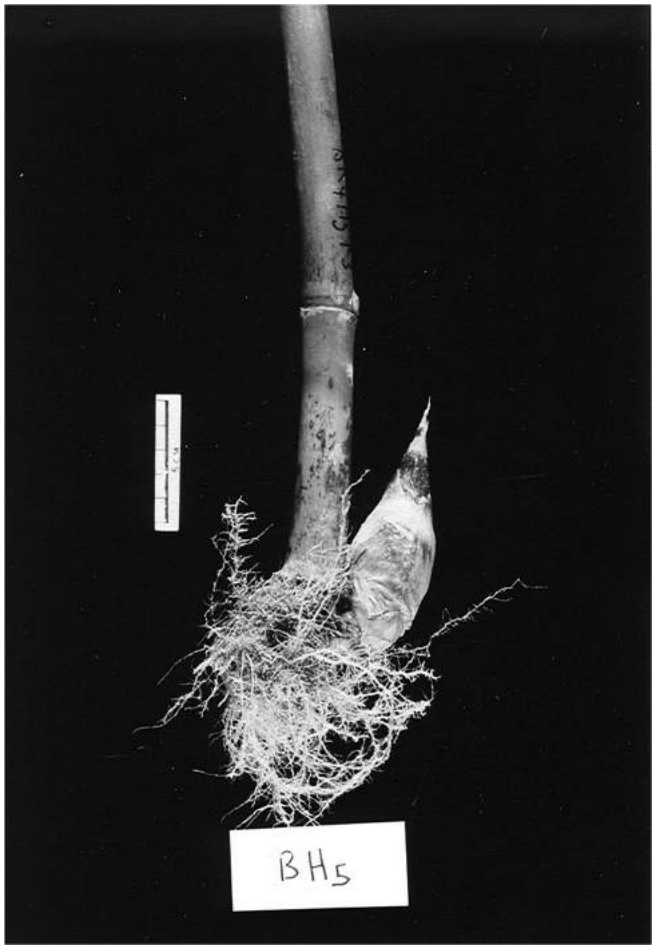

Figure 6. 100 ppm IBA.

Table 5.
The percentage of survival and shoot/culm production, mean number of culms and culm height of *G. levis* using different branch cuttings propagules one year after field planting

Type of branch cutting propagules	Survival (%)	Shoot/culm production (%)	No. of culms	Culm height (cm)
Fresh branch cuttings planted directly	33.3	5.08	0.42	6.94
Bare rooted	41.7	13.72	1.22	24.41
Polybags	88.9	27.85	1.94	45.99

culms height of polybag cuttings was 27.85%, 1.94 and 46 cm; for bare rooted cuttings and fresh cuttings the values were 13.72%, 1.22 and 24.4 cm; and 5.08%, 0.42 and 6.9 cm, respectively.

Figure 7. IBA 2000 powder.

The advantage and successful of using polybag branch cuttings planting material is that the cuttings had a established and intact rooting system with minimum root injuries during transporting and planting activities compared with bare rooted and fresh cutting. These findings have also been reported for other seedlings [7, 8].

CONCLUSIONS

The results indicate that nursery beds can provide better growing conditions for branch cuttings compared with polybags in terms of percentage of culm/shoot and rhizome production during the preparation of cuttings in the nursery stage. However, polybags cutting gave the best percentage of survival after 1 year of field planting compared with bare root (prepared in nursery beds) plantings. For field

planting, it is more practical to prepare polybags cuttings and this can be further enhanced using commercial IBA 2000 powder applied by contact method.

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