

**Branch Cutting Propagation  
of Kawayang Tinik (*Bambusa  
blumeana* Schultes), Kawayang  
Kiling (*Bambusa vulgaris* Schrad es  
Wendl.), Bayog (*Dendrocalamus  
merrilianus* (Elm.) Bolo *Gigantochloa  
levis* (Blanco) Merr.) and Striated  
Bamboo (*Bambusa vulgaris*  
Schrad. ex. var *striata* (Lodd.)  
Gamble ) Using Indole-Butyric Acid**

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ABSTRACT

*Species and position of the three node-cutting were found to be highly significant along with interaction between species and type of branch and between type of branch and position of cutting in the branch.*

*Striated bamboo had the most number of cuttings (16.67-50% survival rate). Yet, in all treatments, the higher number of live cuttings with shoots and roots were in the pruning branch position. Kawayang kiling basal branch section had the most number of cuttings at 100 ppm IBA (76.77%) while striated bamboo performed well at 500 ppm (46.67%) and 1000 ppm (43.33%). More live cuttings were found in the basal section of the primary branch treated with 100 ppm IBA.*

## INTRODUCTION

To meet an increasing demand for bamboo, there is a need to establish plantation on a large scale concentrating on bamboo production emphasizing outstanding quality and productivity. Hence, the necessity for developing the most efficient and effective means of nursery propagation and plantation cultural techniques.

Bamboo may be propagated by reproductive methods (sexual) using seeds and also by a sexual methods. The sexual method is rarely used because bamboo generally flowers only towards the end of its life span and at very long intervals. Thus, vegetative propagation should be given top priority.

If planting stork is to be mass-produced, use of rhizomes and offshoots may not be practical because of their lower availability. Layering and marcotting techniques are laborious though economical. But cuttings offer many possible sources of propagation, culms, branches and twigs.

Use of culms, although somewhat successful, has been observed to be both wasteful and economical for the method requires the use of potential marketable stems. However, owing to larger sizes of culms, potting is impractical and handling "both in nursery and field planting" is very difficult. Thus, the best alternative propagation method would be one that does not require the cutting of the whole culm - leaving branch cutting as one of the economical methods of bamboo propagation.

Yet, hormonal effects of performance in bamboo has not been given much attention. Technology on vegetative propagation of branch cuttings using growth hormones is still wanting.

Thus, this study aimed to determine and evaluate the combined effect of three-indole butyric acid (IBA) on rotting development of branch cuttings of five different species of bamboo.

## MATERIALS AND METHODS

### Preparation of Propagating Medium and Shed

Forest soil was sieved through a one-eighth (1/8) - inch screen-wire mesh. The soil was sterilized by heating to kill fungus and other microorganisms that might contaminate the cuttings. Riversand was also sieved using the 1/8 - inch screen wire mesh. It was then mixed with sterilized soil at the ratio of 1:1 (v/v). The mixture was then placed in plastic bags (4" x 6" x .003) and used as the rooting medium.

The College of Forestry of the University of the Philippines Los Banos through its Department of Forest Biological Science housed the experiment using Kaong (*Arenga pinnata*) leaves as the covering material.

### Collection of Propagules

Branch cutting propagules were collected from different clumps located within the Makiling Botanical Garden near the dipterocarp plantation with the use of bolo and pruning shears. Branches were carefully cut from the culm, leaving the lowest branch node of each type of branch untouched. Only those branches from mature culms and located in the middle and top sections were used as planting propagules. The branches were subdivided according to type of branch (primary, secondary) and position of cutting (bottom, middle, top). The propagules were then wrapped in moist gunny sacks, bundled, and immediately placed in shade to avoid loss of moisture and excessive drying. They were then arranged in a standing position with a portion of their bases partly submerged in tap water prior to immersion in the corresponding IBA treatment.

### Preparation of Cuttings

Bolo and pruning shears were used for crosscutting of propagules into desired length. Care was observed so as not to injure any portion of the cuttings, especially the dormant buds. Three-node cuttings from the base, middle and top sections of the primary and secondary branches of each species were prepared. All prepared cuttings bearing the corresponding treatment labels were placed under the shade in a standing position with the uppermost portion covered with a moist gunny sack before treatment and planting in polyethelene plastic bags.

### Hormonal Treatment

The propagules were divided at random right after their collection and preparation. For cuttings assigned to 0 ppm (parts per million) and 100 ppm of IBA, the lots were dipped and immersed in the solution for 24 hours. Sufficient mixtures were made to ensure that the enlarge basal portion of each cutting was submerged. For 550 ppm and 1000 ppm IBA concentration, the cuttings were dipped for 5 seconds and immediately planted in plastic pots.

All cuttings were labelled corresponding to each treatment before planting in the propagating plastic pots. The cuttings were

allowed to produce roots and sprouts during a 90-day period after which the number of cuttings for each species which produced shoots and roots were counted and recorded. One month after the experiment was set up, cuttings producing shoots were also counted.

### Experimental Design and Layout

A 5 x 4 x 2 x 3 factorial in CBD was used in the study. The type of bamboo species was designated as factor S with five types of species, concentration of IBA growth hormones as factor C with four levels of concentration, type of branch cutting as factor T with two types and position of the branch cutting as factor P with three kinds of position.

A total of 120 treatment combinations with 10 cuttings each and three replications were laid out.

The different factors and treatments were as follows:

- |                |   |  |
|----------------|---|--|
| Factor S       | = | Species of bamboo  |
| S <sub>1</sub> | = | Kawayang tinik ( <i>Bambusa blumeana</i> Schultes)   |
| S <sub>2</sub> | = | Kawayang kiling ( <i>Bambusa vulgaris</i> Schrad es Wendl.)  |
| S <sub>3</sub> | = | Bayog ( <i>Dendrocalamus merillianus</i> (Elm.)  |
| S <sub>4</sub> | = | Bolo ( <i>Gigantochloa levis</i> (Blanco) Merr.  |
| S <sub>5</sub> | = | Striated bamboo ( <i>Bambusa vulgaris</i> Schard.ex. Mendl. var. <i>striata</i> (Lodd.) Gamble   |
| Factor C       | = | Concentration of IBA (indole-butyric acid)   |
| C <sub>1</sub> | = | 0 ppm (control)  |
| C <sub>2</sub> | = | 100 ppm (dilute solution-soaking method) 24 hours  |
| C <sub>3</sub> | = | 100 ppm (concentratd solution-dip method) 5 seconds  |
| C <sub>4</sub> | = | 1000 ppm (concentrated solution-dip method) 5 seconds  |
| Factor T       | = | Type of branch cutting   |
| T <sub>1</sub> | = | Primary (refers to the branches attached to the main culm of the bamboo)   |
| T <sub>2</sub> | = | Secondary (refers to those branches located more or less parallel to the primary branch)   |
| Factor P       | = | Position of cuttings on each branch  |
| P <sub>1</sub> | = | Base (three-node cuttings from the base section of the branch; also refers to the lower third of the branch)                               |
| P <sub>2</sub> | = | Middle (three-node cuttings from the middle section of the branch; also refers to the mid-third portion of the total length of the branch) |

$P_3$  = Top (three-node cuttings from the top section of each branch; also refers to the top-third of the total length of the branch)

All treatment combinations were assigned at random.

A total of 300 experimental units were planted and observed.

## RESULTS AND DISCUSSION

### Effects of Different IBA Hormone Concentration

A total of 3600 different cuttings and species of bamboo were studied and observed for three months. Results of analysis of variance showed that different hormone concentration of IBA had no significant effect in the production of roots and shoots of bamboo (Table 1).

Table 1. Analysis of variance of the different factors studied.

	S.V.	df	SS	MS	Fc
Replicates (Block)		2	887.20	443.60	1.42 NS
Treatment	119		907.04	7.62	0.42 NS
S	4		43397.17	10824.29	34.73 **
C	3		82.17	27.39	0.09 NS
T	1		403.05	403.05	1.29 NS
P	2		2475.58	1237.790	3.97 **
SC	12		2572.51	214.38	0.69 NS
ST	4		5419.43	1354.88	4.35 **
SP	8		445.58	55.71	0.18 NS
CT	3		1054.811	351.62	1.13 NS
CP	6		222.34	37.06	0.12 NS
TP	2		8769.41	4384.21	14.07 **
SCTP	24		7139.96	297.50	0.95 NS
Error	239		105972.2	311.68	
Total	359		179647.59		

NS - Not significant.

\*\* - Highly significant

For kawayang tinik, the highest number of cuttings that produced roots and shoots were observed in 0 ppm IBA (10%) and 500 ppm (10%) treatments. However, both treatments had only three cuttings of the primary branch producing roots out of 30 cuttings planted. A total of 23 (76%) branch cuttings survived at the end of the experiment for kawayang tinik at 1000 ppm of IBA. At 0 ppm of the top portion of the secondary branch were found dead after three months.

Bayog at 0 ppm produced the most number of cuttings with roots and shoots (30%). All treatments using the top portion of the secondary branch. With the same treatment, a 100% production of shoots was observed during the first month.

Among the five species studied, Striated bamboo had the most number of live cuttings - from 16.6% to 50% survival for the different concentration with no treatment having no live cuttings. The highest percentage survival was with 0 ppm and 1,000 ppm, both having 50% survival of basal sections of primary and secondary branches, respectively.

The IBA hormone used in the experiment was found not significant enough in the development of roots and shoots of bamboo. Findings of Palijon (1980) using 100 ppm IAA to have significantly improved root and sprout growth of Kawayang tinik, however, support the fact that for some species like Kawayang kiling, 100 ppm hormone concentration is enough to increase rooting percentage. But bamboo soaked for 24 hrs (Oppm) produced more live cuttings than those treated with 100, 500 and 1,000 ppm of BA hormone. For 500ppm and 1,000ppm, the percentage rooting and production of shoots were low due to excessive concentration which may have led to inhibition of sprout development and eventual death of cuttings. The highest number of live cuttings was found in Oppm and 100ppm of the primary branch for Striated bamboo, Kawayang tinik, Bayog, Bolo and Kawayang kiling. This was because of the presence of adventitious roots already developing at the base of the node and its bigger diameter. The diameter of the basal section ranged from 3 to 5 cm and materials like auxin, carbohydrates, nitrogenous, compounds and other plant materials were stored in large tissues of plants to support early development of roots and shoots.

### **Effects of the Types of Branches and Portion of the Branch Cutting**

The tabulated analysis of variance found that position of cutting in the type of branch is not significant.

*Basal portion of the primary branch.* The number of bamboo cuttings of the basal section of the primary branch against different IBA concentration (Fig. 1) showed that Kawayang kiling had the most number of live cuttings. At 0 ppm the same species had 115 cuttings (50%); 23 (77%) at 100 ppm among the different species studied. For 500 ppm and Bolo 1,000 ppm, Striated bamboo had 14 (46.67%) and 13 (43.33%) cuttings respectively. Bayog cuttings had poor survival late 100 ppm (6.67%) while Kawayang tinik at 1,000 ppm (0.00%) and Bolo at 500 ppm (10.0%) responded poorly.

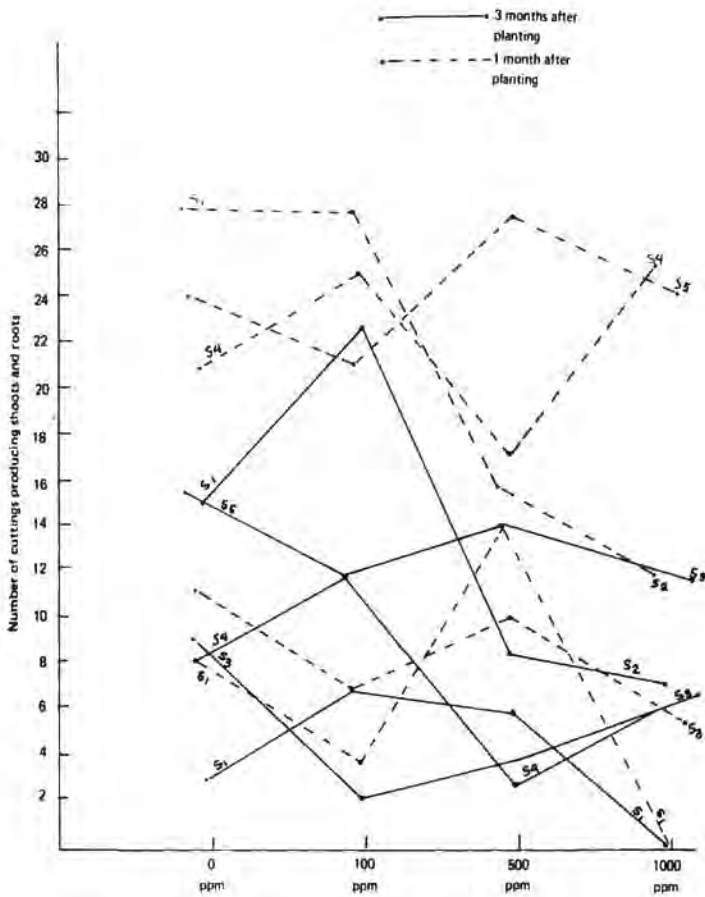


Fig. 1. Number of cuttings that produced roots and shoots of the basal portion of the primary branch at different IBA concentration of the different species of bamboo studied.

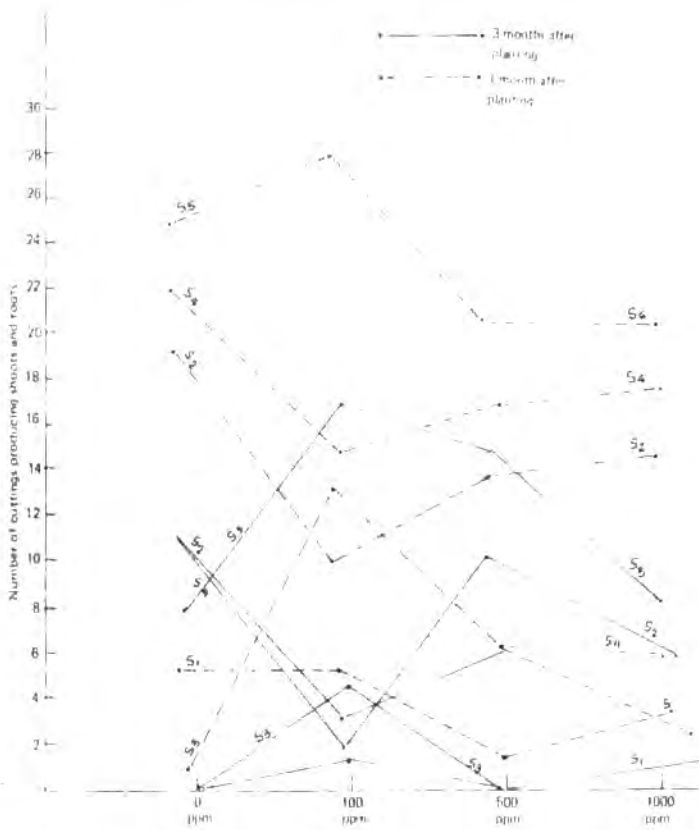


Fig. 2. Number of cuttings that produced roots and shoots of the middle section of the primary branch at different IBA concentration of the different species of bamboo studied.



*Middle portion of the primary branch.* For the middle section, results of the experiment showed that striated bamboo cuttings at 100 ppm, 500 ppm and 1,000 ppm of IBA hormone correspond to the highest number of live cuttings. As reflected in Fig. 2 the species had six cuttings (20.00%) at 100 ppm; 15 (50.00%) at 500 ppm and nine (26.67%) at 1,000 ppm. The result revealed that percentage of rooting decreased as IBA concentration increased. Kawayang kiling middle section had increased live cuttings from 0 ppm with 10 (33.33%) of the total experimental units. Kawayang tinik had poor survival percentage with a survival number of one (3.33%) and 0 (1.00%) for all treatments

*Top section of the primary branch.* The trend in Fig. 3 is similar to the pattern in the middle section of the primary branch. Striated bamboo had good shoot and root development at 100 ppm (50%), 500 ppm (43.33%), and 1000 (30.30%) ppm was the best treatment for the top section. With no IBA hormone treatment, the production of roots and shoots was comparatively low. Kawayang kiling, Bayog, Bolo, and Kawayang tinik had poor percentage of rooting and production of shoots. With 500 ppm and 1000 ppm of IBA, kawayang kiling had no live cuttings at the end of the experiment. While Bolo and Bayog had only four (13.33%) and 0 (0.00%) number of cuttings, respectively, with roots and shoots.

*Basal section of the secondary branch.* Using the secondary branch cutting, the basal section of Striated bamboo at 1000 ppm produced the most number of live cuttings with roots and shoots representing 23.33% survival (Fig. 4). Kawayang kiling basal section had a very poor number of cuttings having roots and shoots with results of 0.00% (0 ppm IBA), 3.33% (100 and 500 ppm IBA) and 6.67% (1000 ppm IBA). Kawayang kiling had better growth at 500 ppm (30%) with a total of 10 live cuttings out of 30 experimental units planted. Bolo also had a higher number of live cuttings at 500 ppm (23.33%) compared only to 13.33% (0 ppm) with no hormone treatment.

*Middle section of the secondary branch.* Three months after planting, Kawayang kiling cuttings from the middle section showed better root development at 100 ppm (20.00) and 500 ppm (23.33%) IBA than cuttings soaked in water (0 ppm) which had only 13.33% (Fig. 5). Although striated bamboo showed slight decrease as concentration of IBA increased from 16.67% (0 ppm IBA) to 13.33%, the species had the highest live cuttings among the five different species studied in the experiment.

*Top section of the secondary branch.* Top section of the secondary branch of Bolo at 100 ppm had a very high rooting and shooting percentage at 53.33%. The species had 100% production of shoots one month after planting for both 0 ppm IBA

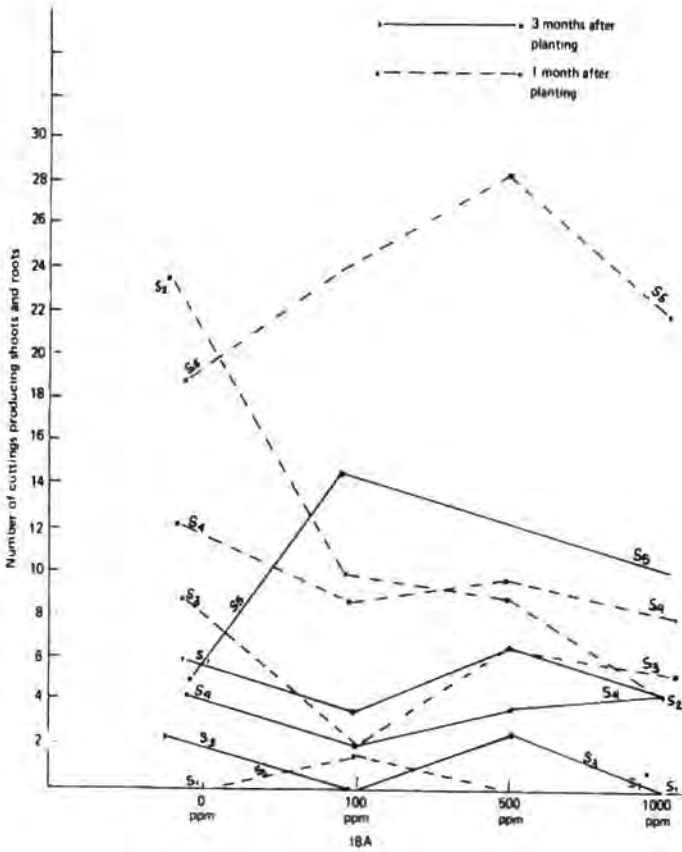


Fig. 3. Number of cuttings that produced roots and shoots of the top section of the primary branch at different IBA concentration of the different species of bamboo studied.

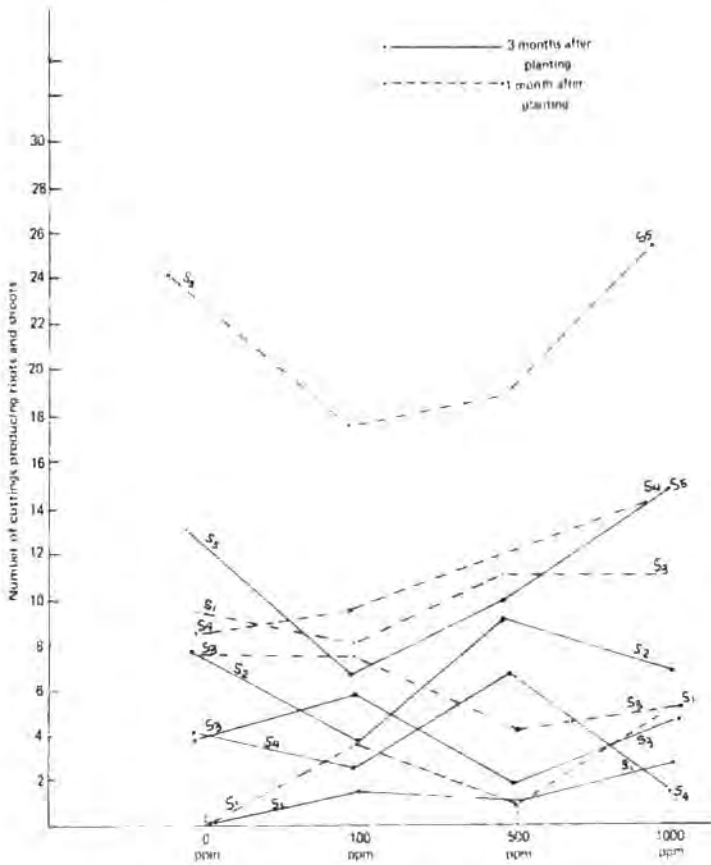


Fig. 4. Number of cuttings that produced roots and shoots of the basal section of the secondary branch at different IBA concentration of the different species of bamboo studied.

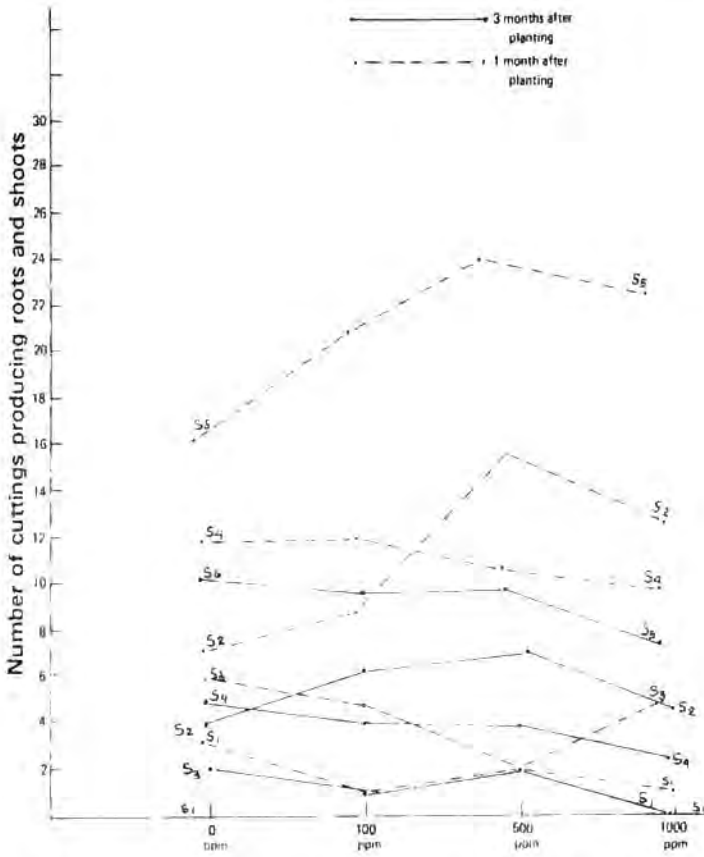


Fig. 5. Number of cuttings that produced roots and shoots of the middle section of the secondary branch at different IBA concentration of the different species of bamboo studied.

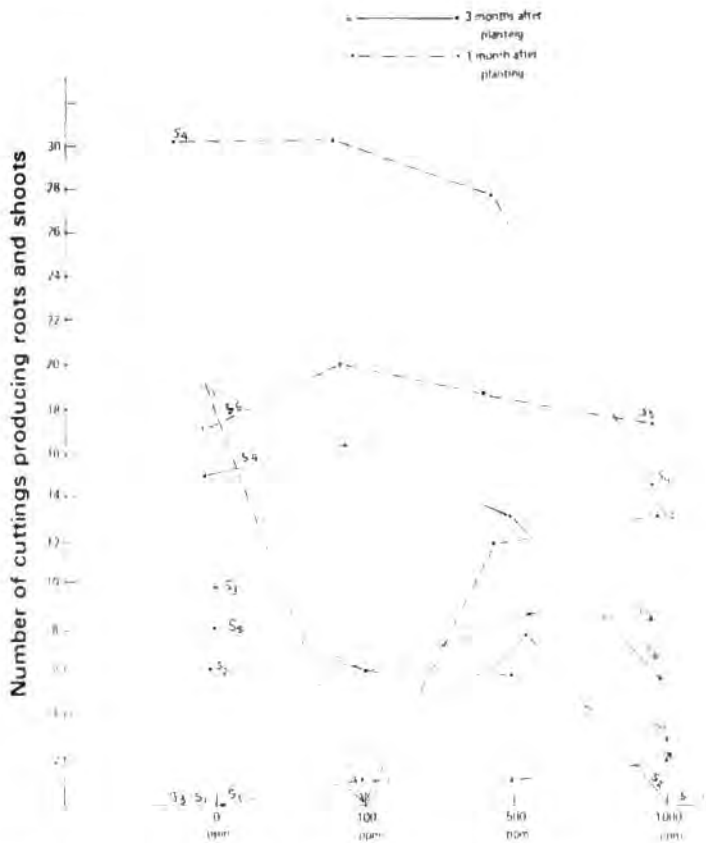


Fig. 6. Number of cuttings that produced roots and shoots of the top section of the secondary branch at different IBA concentration of the different species of bamboo studied.

and 100 ppm IBA (Fig. 6). The number of live cuttings rapidly declined to 50% at 500 ppm IBA and 20% at 1000 ppm IBA. Just like in other types and position of a bamboo branch cuttings, kawayang tinik had a poor response to IBA treatment

Of all the species studied, striated bamboo primary branch cutting in the basal, middle, and top section at 100 ppm IBA had the highest and most number of live cuttings by the termination of the experiment. The cuttings were affected by the IBA hormone in the development of roots and shoots. The highest percentage survival was found in the basal section in which some of the cuttings had some roots already developing. Kawayang tinik responded poorly to all the treatments which ranged from 3.33% to 10% of all the cuttings producing roots and shoots compared to striated bamboo with survival percentage ranging from 23.33% to 50%.

All cuttings of the five bamboo species which had produced one to three sprouts one month after planting showed a decrease in the total number of cuttings that survived 3 months after planting taken from basal sections.

Apart from hormone concentration position of cuttings, the double-layered kaong leaves (*Arenga pinnata*) reduced temperature and increase relative humidity in the greenhouse. This prevented excessive drying and loss of moisture of the different cuttings. Kaong leaves reduced the light intensity of incoming solar radiation compared to open areas. This, in turn, reduced transpiration and soil temperature to a minimum level favoring the rooting and shooting process of bamboo cuttings studied. The sprouts ranged from 1.5 cm to 9.0 cm at the end of the experiment.

The secondary branch of Bolo at 100 ppm had the most number of live cuttings. Basal section of Bolo had more roots and shoots among the five species of bamboo studied. A sharp decline was observed as IBA concentration increased from 100 to 1000 ppm.

For the middle section, striated bamboo had the most number of cuttings with roots and shoots from 0 to 500 ppm. All species had a low number of survival at 1000 ppm.

For the top section of the secondary branch, striated bamboo also had more rooted cuttings. In all portions and different hormone concentration, Kawayang tinik had a very low survival rate one month after the emergence of shoots. Higher survival rates were found in the primary branch whether the cutting was in the base, middle or top portion as compared to the secondary branch survival rate. Three months after planting in the potting medium, the shoots ranged from 10 cm to 120 cm while the root from 0.5 cm to 4.

### **Species Effect**

Species effect was found to be highly significant. Kawayang kiling, however, had a poor number of cuttings with many treatments having no live cuttings by the end of the experiment. The number of cuttings ranged from one to three only.

Striated bamboo had the most number of cuttings for all treatments which had five to 15 cuttings with roots and shoots. These represent 16.67% - 50% survival rate 1 month after the production of sprouts having 56.67% - 93.33% sprouting with no treatments producing no survival. Bolo had a 10.00% - 53.33% survival rate while Kawayang kiling had a higher rate of 76.6% at 100 ppm IBA. Bayog, on the other hand, had poor growth from 0 to 20% survival 3 months after planting.

### **Interaction Effect of the Different Factors Studied**

Results of analysis of variance found that species, type of branch, and position of cutting in the branch were highly significant. This is shown in striated bamboo with high percentage of roots and shoots at the basal section of the primary branch. A high number of live cuttings were also recorded for the basal section of the secondary branch. This is due to the presence of adventitious roots at the base of the three-node cuttings. Striated bamboo is also characterized by a thick succulent branch which does not dry up easily.

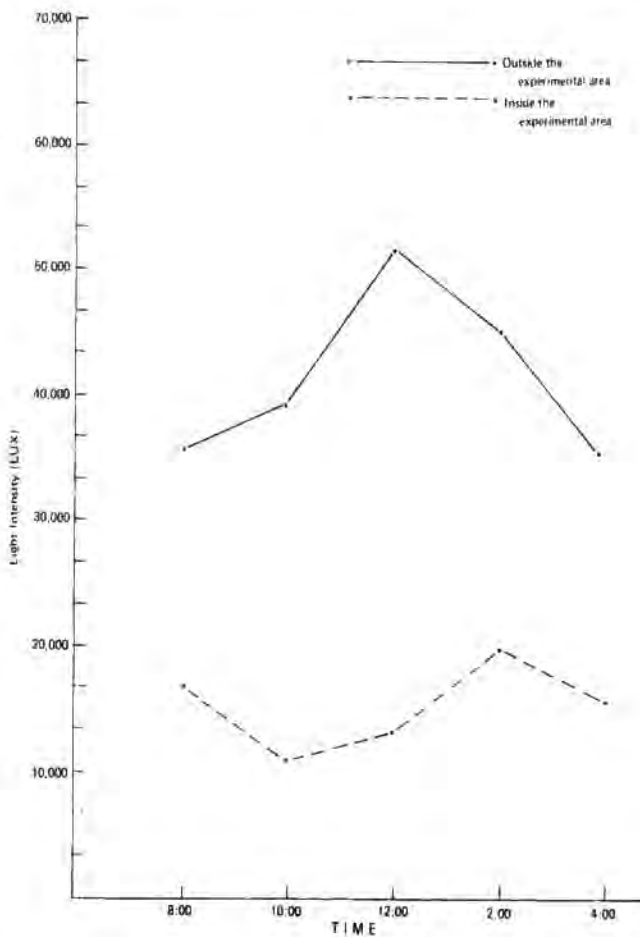
Kawayang tinik live cutting was mostly in the basal section of the primary and secondary branch. The highest rooting in kawayang kiling was also found in the basal section of the primary branch and secondary branch. The same was true for Bolo which implies that the best portion is the basal section of the branch. The basal section has a bigger diameter, close nodes, and noticeable dormant intercalary bud developing rooting system which significantly affected the results of this experiment.

### **Rooting and Shooting Percentage Using the Tip/Top Portion of the Primary Branch**

A total of 600 primary branch tips of five different bamboo species were planted simultaneously at the onset of the rainy season (August 6, 1987). Rooting and shooting percentage at the end of the study are presented in Table 2. During the first month, a few Kawayang kiling, bayog, bolo and striated bamboo tops produced roots and shoots against different IBA concentration (Fig. 7).

**Table 2. Average light intensity inside and outside the experimental area.**

TIME	INSIDE (Lux)	OUTSIDE (Lux)	DIFFERENCE (Lux)	% DIFFERENCE
8:00	18003.10	37982.20	19979.10	52.60
10:00	11070.81	39639.45	28568.64	72.07
12:00	13600.83	55960.00	42359.17	75.70
2:00	20079.83	47666.67	27586.84	57.87
4:00	16051.87	36905.56	20853.69	56.50



**Fig. 7. Showing the average light intensity at different time of the day inside and outside the experimental area.**



The highest rooting among the different species of bamboo was in Kawayang kiling tops treated with 100 ppm of IBA hormone having 4 out of 30 (13.33%) experimental units producing shoots mostly in the second node of the three-node bamboo top. Bayog at 0 ppm and Bolo at 100 ppm of IBA followed both having three live cuttings out of 30 (10.00%) producing roots and shoots. Three months after the establishment of the experimental units, only kawayang kiling and Bayog had roots and shoots but with a reduction in the number of survival. Kawayang kiling at 100 ppm had two out of four (6.67%) survived cuttings producing shoots and roots. The other species at 500 and 1000 ppm had either one and zero results, respectively, out of 30 sampling units. The other species producing shoots 1 month after establishment were found dead by the end of the experiment.

Interaction effect between species and concentration was found not significant (Table 3). All hormone concentration did not show significant difference from control (0 ppm) in terms of root and shoot formation. However, the application of IBA hormone contributed to improvement of rooting and shooting percentage from 0.00% to 6.67% for Kawayang kiling and Bayog three-node tops of the branch cuttings.

Table 3. Analysis of variance for the number of branch tops of the different bamboo species 3 months after planting.

S.V.	df	SS	MS	Fc
Replicates (Block)	2	0.133	0.067	0.433 NS
Treatments	19	4.00	0.211	1.365 NS
S	4	1.15	0.288	1.863 NS
C	3	0.40	0.133	0.860 NS
SC	12	2.38	0.198	1.261 NS
Error	40	6.05	0.151	
Total	59	14.11		

NS. = Not significant

The failure of majority of the twigs/top branch cuttings among the different bamboo species studied to produced roots and shoots may be attributed mainly to freak environmental conditions during the period of observation. The experimental unit was set up during the early part of August (peak of rainy season) with the expectation of more precipitation. On the contrary, continuous sunshine for more than 2 weeks and less rainfall in the afternoon resulted in

more than 2 weeks and less rainfall in the afternoon resulted in drying of some plants. The low humidity and high temperature wilted some of the twigs/tops, especially the upper portion of Kawayang tinik, Bolo and Striated bamboo tops having very thin branches and leaves in the upper portion. Just like some grasses wherein the bamboo species belongs to, the tops/twigs dried up easily to open air even though the greenhouse had two-layered kaong leaves (*Arenga pinnata*) to reduce high temperature, excessive loss of moisture and increase in relative humidity.

Another critical factor which may have contributed to low percentage rooting and shooting was the unavailability of water from 9:00 a.m. to 4:00 p.m. As a result, watering was done twice only in the early morning and late in the afternoon. If controlled misting spray was used, a more satisfying result could have been obtained. Moisture is really a critical factor for cuttings. The rooting media used (sterilized forest soil and sand at 50:50 v/v) was already a good medium for better aeration and drainage. The result however showed that cuttings using tops of the branches for vegetative propagation is possible for some species like Kawayang kiling species not included in the study.

## CONCLUSION AND RECOMMENDATIONS

A total of 3600 different types of cuttings using five different species of bamboo were laid out and observed for 3 months.

Species and position of the three-node cutting were found significant. Percentage amount of different IBA hormone concentration is insignificant although this improved the formation of roots and shoots for some species of bamboo studied. The interaction effect between species and type of branches as well as type of branches and position of the cutting (basal, top, middle) was also highly significant.

Of all the species studied, the basal section of the primary branch of Kawayang kiling had the most number (15 or 50%) of live cuttings at 0 ppm and 100 ppm (23 or 76.6%). For 500 ppm and 1000 ppm striated bamboo performed well with 46.67% and 43.33% survival rate, respectively. Using the middle section of the primary branch, striated bamboo cuttings at 100 ppm, 500 ppm and 1000 ppm of IBA hormone had the highest number of live cuttings, respectively. At 500 ppm Kawayang kiling performed well with 26.67% rooting percentage. Striated bamboo still performed well in cuttings using the top section of the primary branch with 50% (100 ppm), 43.33% (500 ppm) and 36.67%

(1000 ppm) performance. However, the trend showed that as the cutting moved away from the base of the primary branch and as concentration of IBA concentration increased, the number of cutting with roots and shoots decreased.

Cuttings using the secondary branch resulted in higher percentage in striated bamboo at 1000 ppm (23.33%) using the basal section. Kawayang kiling had a good rate of survival at 500 ppm (30%) followed by Bolo with 23.33% survival rate after the emergence of shoots one month after planting. Kawayang kiling cuttings from the middle section had a better root development at 100 ppm (20%) and 500 ppm (23.33%) IBA. The top section of the secondary branch of bolo at 100 ppm had a very high rooting percentage (53.33%). The number of live cuttings decreased to 50% at 100 ppm IBA and 20% at 1000 ppm IBA. Meanwhile, kawayang tinik had a very poor response to all the different treatments studied.

In all treatments, the higher number of live cuttings with shoots and roots was in the primary branch portion compared to the secondary branch. Striated bamboo responded very well to different IBA concentration except for the top section of the secondary branch. Primary branch basal section had bigger diameter with some adventitious roots already developing. Species effect was found highly significant for striated bamboo which had the most number of cuttings representing a range of 16.67% to 50% survival rate. Bolo also had a 10% to 53.33% rate while Kawayang kiling had a higher rate of 76.67% at 100 ppm IBA. Kawayang tinik had a poor growth from 0% to 10% just like Bolo with 0 to 20% survival rate.

Thus, it can be concluded that some species of bamboo root easily using branch cuttings, which is more economical and easy to handle than using culms or rhizomes. IBA hormone treatment, although insignificant in the study, improved the production of roots and shoots as compared to soaking in water method (24 hrs). Basal section performed well in production of roots and shoots whether it is located in the primary or secondary portion of the branch of bamboos. This is attributed to the bigger diameter and the presence of roots at the base of the branch.

Thus, the further away from the base of the branch, the number of live cuttings decreased in number and in percentage.

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