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Propagation of Bamboo (*Dendrocalamus giganteus*, Munro) Through Culm-Branch Cuttings in Egypt

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Key words: Bamboo, vegetative propagation, cutting type, IBA, planting method.

Abstract:

Bamboo plants are an essential element in Egyptian agriculture development. Nothing was found on propagation of *Dendrocalamus giganteus* under the Egyptian conditions. Thus, two trials were done to evaluate the effect of position of cuttings on the stem, time of propagation, indole-3-butyric acid (IBA) treatments, planting method on rooting of culm and culm-branch cuttings of bamboo. Three cutting types (basal, middle and tip) of single and double nodes were collected from culm (main stem) and culm-branch (lateral branch) cuttings of bamboo during September 2004 and March 2005. Culm-branch cuttings were treated for 24h with IBA at 0, 50, 100 and 200 ppm. Cuttings were planted horizontally and/or vertically in clay soil. The experiments were arranged in Randomized Complete Block Design as split plot with three replicates. The obtained data were statistically analyzed and revealed the following:

Culm-cuttings showed better rooting and growth parameters compared to culm-branch cuttings. In general, single-node cuttings of culm and culm-branch were better than the double nodes ones. Both branch types showed the highest rootability at March period of propagation. Meanwhile, September propagation was suitable to culm-branch cuttings only. Treated cuttings with IBA showed marked improvement in rootability. Basal cuttings contained more C/N ratio than that in tip ones. The best results were obtained from treating basal culm-branch cuttings with 100 ppm IBA. Vertical planting of double nodes cuttings reduced its rootability.

Introduction

Bamboo plant is native to Southeast Asia, Africa, and Americas. This popular plant is used in many purposes such as ways from constructing of housing , food and medicine. Bamboo is a member of family Poacaceae (Graminae). There are approximately 70 genera making up over 1200 species. Consequently, huge differences in propagation methods and growing conditions due to the wide variety of bamboo species were noticed. Thus, selected species should be grown on a small scale and tested before investing large amounts of money.

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Propagation of bamboos types is not similar. Selecting the proper method of propagation for a specific bamboo species or varieties is not easy because of many affecting factors. Several factors were found such as sexual or vegetative propagation means; culm, culm-branch, season, hormonal treatment, planting method, characteristics of cutting plantlets, environments…etc. Therefore, each country needs to discover the proper method and the prevailing conditions of propagation for their own bamboo species.

Branch cutting was possible to propagate some bamboos as *Gigantochola verticillata* and *Sinocalamus oldhami* (White, 1947). However, using branch cuttings showed poor rooting percentages as pointed by McClure and Durand (1951). Under mist-tent propagation, Suzuki and Ordinano (1977) showed that treating culm cuttings with IBA (indole butyric acid) resulted in 45, 80 and 60% survival of *B. blumena*, *B. vulgaris* and *D. merrillianus* compared to 32, 75 and 54% in their controls, respectively. Surendran and Seethalakshmi (1985) reported that IBA and NAA application significantly enhanced certain species of *D. strictus* and *D. scriptoria*. Das (1988) achieved 60-80% rooting of single node culm cutting of *D. hemitonii*, *D. hookni* and *D. nigrociliata*. Palijon (1983) reported that cuttings treated with rooting hormones were higher in shoot production and the shoots were taller and thicker than those of untreated cuttings.

Many years ago, Mabayag (1937) indicated that the basal portions of culm cuttings of *B. blumeana* were better than middle and top portions of the culm. On the contrary, Bumalong and Tomolang (1980) found that unsplited culm cutting of *G. levis* gave better results and the middle and top portions of the culm were the best materials for propagation.

In India, Sharma and Kaushal (1985) obtained best rooting and survival in one-node culm cutting taken from 1-10 basal nodes of 8-month old culm in spring (March) for propagating of *D. strictus.*

Starch and nutrients content in the cutting have influenced rooting of the culm cuttings as found by Joseph (1958) in *B. arundinacea* during February and March. Meanwhile, Banik (1987) taking culm segments in April–May for mid-zone of young culm was critical for obtaining successful results in *Dendrocalamamus giganteus, D. longispathus, B. vulgaris, B. balcooa , B. tulda* and *Melocana baccifera.*

Concerning the seed propagation of bamboo, Anantachote (1988) found that large sized bamboos produce smaller seeds than small-sized ones. Besides, Banik (1991) added that the seed weight has a significant effect on seedling survival.

In Egypt, *Dendrocalamus giganteus* plant is an important element in afforestation and landscaping. The known method of propagation in Egypt is through plant divisions and this is tedious way because of the hard mechanism of separation and shortage in the availability of mother-plants. Nothing was found on using other means of vegetative propagations of this plant under our environments. Thus, the aim of the present trials was to evaluate the timing of certain methods of planting and propagating it from different parts of stem treated with indole butyric acid (IBA) at certain levels to enhance rooting.

Materials and Methods

This investigation was carried out at the Experimental Farm of Floriculture, Faculty of Agriculture, Assiut University, Egypt during the 2004 and 2005 seasons. Under semi-controlled conditions of greenhouse. Two experiments were conducted to study the effect of position of cuttings, indole-3- butyric acid (IBA) treatments, planting method and seasonal variation on propagation of bamboo (*Dendrocalamus giganteus*) plants, as in the following:

First Experiment :

This experiment was carried out at the beginning of September 2004 and March 2005 to examin the effect of period of propagation and planting method on rooting of different types of bamboo (*D. giganteus*) culm cuttings. The experiment was arranged in a Randomized Complete Block Design as split plot with three replicates. The whole plots represented two periods of propagation date (September and March). Meanwhile, type of cuttings (tip, middle and basal), planting method (horizontally and vertically) and number of nodes per cutting (single or double-node), were distributed in sub-plots and sub-sub plots, respectively. Mature culms (main stems) were collected from bamboo mother plants at the beginning of September 2004 and March 2005. Each culm (ca. 10 m long) was divided into three equal portions; terminal, middle and basal. Single-node and double-nodes culm cuttings were prepared from each portion by electric saw. Each unit of experimental sub-sub plots consisted of 10 culm cuttings were planted either horizontally or vertically in clay soil beds under plastic house conditions.

Second Experiment:

This experiment was conducted at the beginning of September 2004 and March 2005 to investigate the effect of indole-3-butyric acid (IBA) treatments, type of cuttings, planting method and seasonal variation on rooting of culm-branch cuttings of bamboo. The experiment was arranged in a split-split-plot design, with three replicates. The whole plots represented four IBA concentrations (0, 50, 100 and 200 ppm). Meanwhile type of cuttings (tip, middle and basal) and planting method (horizontally

with single-node cutting, vertically with single-node cutting and vertically with double-nodes cutting) were distributed in sub-plots and sub-sub plots, respectively. Culm-branches (lateral branches) were collected from bamboo (*D. giganteus*) mother plants. The collected material was excised of all leaves. Each culm-branch was divided into three equal portions; terminal, middle and basal. Each portion was cut into single-node and double-nodes of culm-branch cuttings and treated for 24h with IBA at 0, 50, 100 and 200 ppm. Each treatment consisted of 10 culm-branch cuttings. The treated cuttings were planted horizontally or vertically in clay soil beds under same conditions of the previous experiment.

One centimeter sample of the basal end represented each type of cutting were taken at the beginning of each experiment for determination of carbohydrates and nitrogen. Total carbohydrates colorimeterically determined with the anthrone sulphuric acid method, Fales (1951). Total nitrogen for each period was determined by the semi-micro Kjeldahl method as described by Black *et al*. (1982). Then carbon/nitrogen ratio (C/N) was calculated.

At each period of propagation; three months planting after, cuttings were digged up, cleaned and data were recorded on; rooting percentage, root number per cutting, length of the longest root, number of sprouts and length of sprout per cutting. Also, after 7 months from propagation data were recorded on number of sprouts and length of sprout per cutting.

All the obtained data of each experiment were statistically analyzed after transforming data by adding one for the second experiment data (first season) according to Steel and Torrie (1982) using the MSTAT computer software.

Results

First Experiment :

The present study clearly shows that culm cuttings (main stem cuttings) failed to form adventitious root at September period of propagation. Meanwhile, March propagation was suitable to propagate *D. giganteus* by culm cuttings (Table 1).

Data in Table (1) show that rooting percentage of *Dendrocalamus giganteus* culm cuttings was significantly affected by different types of cuttings at March period of propagation. Generally, it is clearly appeared that the highest rooting percentages were obtained with the middle- (ca. 72%) and tip culm cuttings (ca. 61%) compared to the basal ones (ca. 53%). Also, significant differences in rooting percentage were noticed between the planting methods of culm cuttings at March period of propagation. Planting of single-node culm cutting horizontally or vertically showed remarkably better rooting percentage compared to double-nodes ones planted vertically. However, the interaction between

the type of cuttings and planting methods was also found to be significant on rooting percentage of culm cuttings. The maximum rooting percentages were obtained with single-node culm cutting collected from the middle part of culm (main stem) and planted horizontally (ca. 93%) or vertically (ca. 80%) (Fig.1).

Table (1): Percentage of rooted culm cuttings in *Dendrocalamus gi ganteus* as affected by type of cuttings and planting method at 3 months planting after during March propagation period.

Type of cuttings	Planting method			
	Horizontally with single-node cutting	Vertically with single-node cutting	Vertically with double-nodes cutting	Mean
Tip	76.7	66.7	40.0	61.1
Middle	93.3	80.0	43.3	72.2
Basal	63.3	60.0	36.7	53.3
Mean	77.8	68.9	40.0	

L.S.D.	0.05	0.01
Type of cuttings	5.46	9.12
Planting method	3.23	4.55
Type of cuttings x planting method	5.61	7.88

On the other hand, it is evident from the data in Tables (2 and 3) and Fig. (1) that the middle culm cuttings resulted in the highest number and length of roots at 3 months planting after as well as the highest branch number and plantlet length at 3 and 7 months from planting after, followed by the tip and basal ones, respectively. Propagation of *Dendrocalamus giganteus* by single-node culm cutting planted horizontally or vertically resulted in the best results of all previous parameters, but the double-nodes culm cutting planted vertically gave the lowest results. The interaction between the type of cuttings and planting method on root and plantlet length were significant at 3 months from planting after. Meanwhile, the interaction between type of cuttings and planting method on root and branch number was not significant at 3 months planting after. In addition, the interactions between type of cuttings and planting method on branch number and plantlet length were significant at 7 months planting after during March period of propagation.

Single-node tip cutting (horizontal)

Single-node tip cutting (vertical)

Double-nodes tip cutting (vertical)

Single-node middle cutting (horizontal)

Single-node middle cutting (vertical)

Double-nodes middle cutting (vertical)

Single-node basal cutting (horizontal)

Single-node basal cutting (vertical)

Double-nodes basal cutting (vertical)

Tip culm cuttings

Middle culm cuttings

Basal culm cuttings

Fig. (1): Rooting and vegetation of culm cuttings of *Dendrocalamus giganteus*, 7 months planting after, for March propagation period.

Table (2): Means of number and length of roots per culm cutting in *Dendrocalamus giganteus* as affected by type of cuttings and planting method at 3 months planting after during March propagation period.

Type of cuttings	Planting method							
	Root number				Root length (cm)			
	Horizontally with one-node cutting	Vertically with one-node cutting	Vertically With 2-nodes cutting	Mean	Horizontally with one-node cutting	Vertically with one-node cutting	Vertically with 2-nodes cutting	Mean
Tip	19.8	16.3	10.3	15.5	14.6	14.9	9.2	12.9
Middle	20.5	18.1	11.7	16.8	16.9	14.8	10.6	14.1
Basal	15.6	12.7	5.7	11.3	12.1	11.6	9.0	10.9
Mean	18.6	15.7	9.2		14.5	13.8	9.6	

L.S.D. at 0.05:	Root number	Root length
Type of cuttings	0.83	0.98
Planting method	1.02	0.99
Type of cuttings x planting method	N.S.	1.69

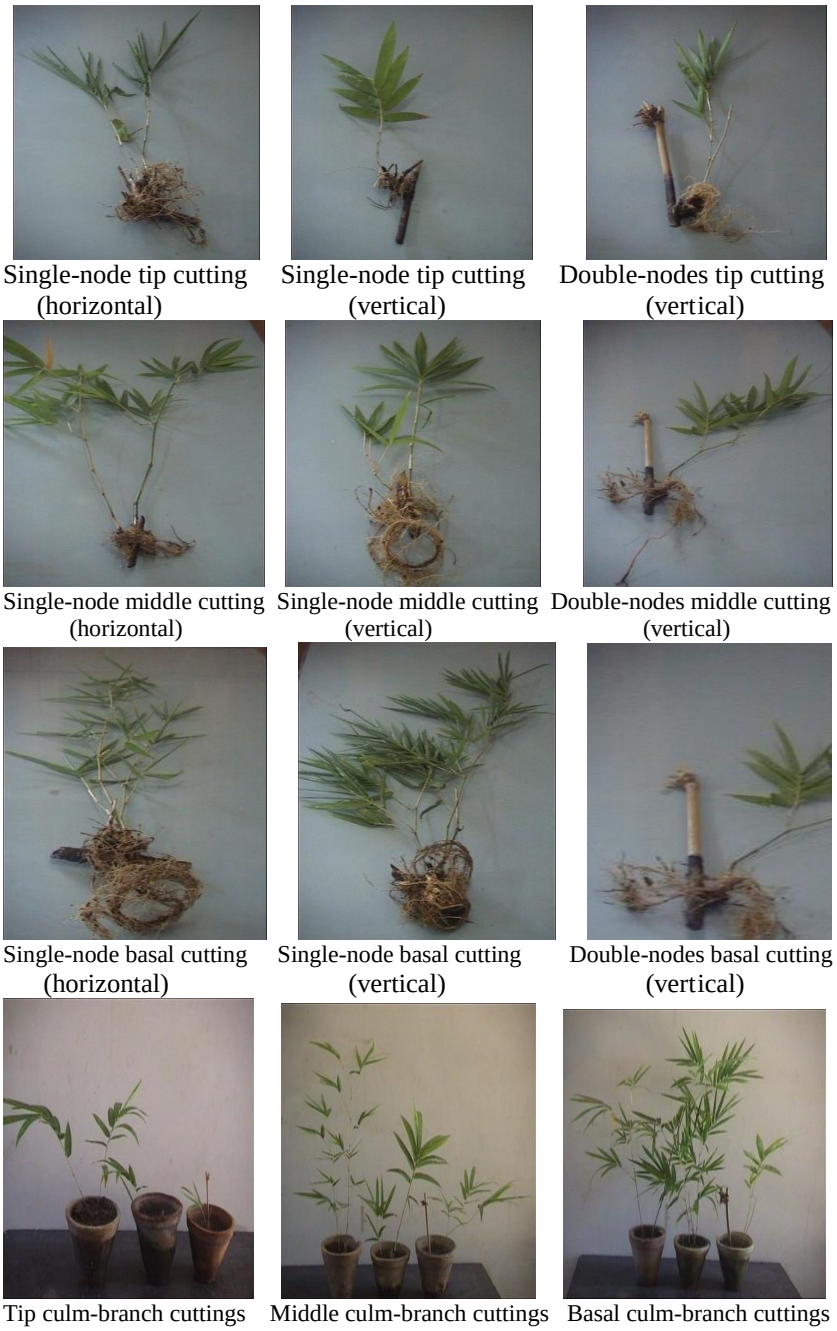

Fig. (2): Rooting and vegetation of culm-branch cuttings of *Dendrocalamus giganteus* treated with 100 ppm IBA during March propagation period.

Second Experiment :

Data presented in Table (4) indicate that treatment of culm-branch cuttings with IBA at various concentrations resulted in significant increments in percentage of rooted cuttings compared to the control at both periods of propagation used (September and March). The maximum rootability was obtained as a result of IBA treatment at 100 ppm. Apparently, culm-branch cuttings showed the highest rootability at March period of propagation compared to September propagation. Besides, rooting percentages of basal and middle culm-branch cuttings were better than the tip ones at both periods of propagation used. The rooting percentages were 45.5%, 40.3% and 14.2% at September period of propagation and 57.5%, 48.9% and 26.7 at March period of propagation for basal, middle and tip cuttings, respectively. In addition, planting the single-node cuttings which had been taken from culm-branch (lateral branch) horizontally or vertically significantly increased the percentage of rooted cuttings compared to the double-nodes cuttings, planted vertically at both periods of propagation. Generally, the best rooting percentages were obtained from the single-node basal cuttings of culm-branch, planted vertically or horizontally and treated with IBA at 100 ppm at September (73 and 76%) and March (80-86%) periods of propagation (Fig. 2).

On the other hand, it is evident from the data in

Tables (5, 6, 7 and 8) that IBA treatments significantly increased number and length of roots per cutting at 3 months planting after as well as branch number and plantlet length at 3 and 7 months planting after compared to the control during both periods of propagation. The most effective concentration was 100 ppm in increase root and vegetative characteristics. Propagation of *Dendrocalamus giganteus* by basal culm-branch cuttings resulted in the best results of all previous parameters followed by the middle ones. Moreover, the single-node cuttings planted horizontally or vertically formed more roots and branches as well as higher plantlets with longer roots compared to the double-nodes cuttings planted vertically for both periods of propagation. Generally the single-node basal cuttings of culm-branch, planted horizontally or vertically and treated with 100 ppm IBA resulted in the highest root and vegetative characteristics at September and March periods of propagation (Fig. 2). Apparently, March propagation showed remarkably better root and vegetation than September.

The chemical analysis of basal segments of cuttings showed that the highest C/N ratio in *Dendrocalamus giganteus* cuttings was obtained at March period of propagation compared to September propagation period. Also, using the culm cuttings

gave higher C/N ratio compared to the culm-branch cuttings. In addition, basal portions of culm and culm-branch contained the highest C/N ratio compared to the other ones (Fig. 3).

Table (4): Rooting percentage of culm-branch cuttings in *Dendrocalamus giganteus* as affected by IBA concentrations, type of cuttings and planting method at 3 months planning after during September 2004 and March 2005 propagation periods.

IBA Concn. (ppm) "A"	Type of cuttings "B"	Planting method "C"							
		September 2004				March 2005			
		Horizontal single-node	Vertically single-node	Vertically 2-node	Mean	Horizontal single-node	Vertically single-node	Vertically 2-node	Mean
Cont.	Tip	00.0	00.0	0.0	00.0	13.3	06.7	03.3	07.8
	Middle	20.05	23.3	13.3	18.9	33.3	36.7	16.7	28.9
	Basal	26.3	23.3	06.7	18.8	43.3	40.0	23.3	35.6
Mean		15.4	15.5	06.7	12.5	30.0	27.8	14.4	24.1
50	Tip	16.7	16.7	06.7	13.4	33.3	26.7	16.7	25.6
	Middle	46.7	43.3	26.7	38.9	53.3	53.3	30.0	45.6
	Basal	53.3	56.7	30.0	46.7	66.7	70.0	43.3	60.0
Mean		38.9	38.9	21.1	33.0	51.1	50.0	30.0	43.7
100	Tip	23.3	26.7	16.7	22.2	43.3	40.0	26.7	36.7
	Middle	70.0	66.7	40.0	58.9	73.3	70.0	46.7	63.3
	Basal	76.7	73.3	43.3	64.4	86.7	80.0	46.7	71.1
Mean		56.7	55.6	33.3	48.5	67.8	63.3	40.0	57.0
200	Tip	26.7	30.0	06.7	21.1	40.0	43.3	26.7	36.7
	Middle	56.7	50.0	26.7	44.4	70.0	63.3	40.0	57.8
	Basal	60.0	63.3	33.3	52.2	70.0	73.3	46.7	63.3
Mean		47.8	47.8	22.2	39.3	60.0	60.0	37.8	52.6
General Mean		39.7	39.4	20.8	33.3	52.2	50.3	30.6	44.4
General effects of cuttings type:									
Tip		16.7	18.3	7.5	14.2	32.5	29.2	18.3	26.7
Middle		48.3	45.8	26.7	40.3	57.5	55.8	33.3	48.9
Basal		54.1	54.2	28.3	45.5	66.7	65.8	40.0	57.5
L.S.D. at 0.05		A= 3.08 B= 2.52 AB= 5.04 C= 2.63 AC= 5.26 BC= 4.56 ABC= N.S.				A= 3.39 B= 4.11 AB= N.S. C= 3.03 AC= N.S. BC= 5.24 ABC= N.S.			

Table (5): Means of number of roots per culm-branch cutting in *Dendrocalamus giganteus* as affected by IBA concentrations, type of cuttings and planting method at 3 months planting after during September 2004 and March 2005 propagation periods.

IBA Concn. (ppm) "A"	Type of cuttings "B"	Planting method "C"							
		September 2004				March 2005			
		Horizontally with one-node cutting	Vertically with one-node cutting	Vertically with 2-nodes cutting	Mean	Horizontally with one-node cutting	Vertically with one-node cutting	Vertically with 2-nodes cutting	Mean
Cont.	Tip	0.0	0.0	0.0	0.0	7.8	7.6	3.9	6.4
	Middle	3.3	3.0	2.2	2.8	9.6	10.0	5.5	8.4
	Basal	3.5	3.5	2.3	3.1	10.9	11.0	6.2	9.3
Mean		2.3	2.2	1.5	2.0	9.4	9.5	5.2	8.0
50	Tip	4.7	4.3	2.5	3.8	9.5	8.9	4.2	7.5
	Middle	6.0	5.8	2.8	4.9	12.6	11.7	7.0	10.4
	Basal	6.8	6.4	3.8	5.7	12.7	12.4	8.6	11.2
Mean		5.8	5.5	3.0	4.8	11.6	11.0	6.6	9.7
100	Tip	5.8	5.2	3.6	4.9	11.7	9.5	5.8	9.0
	Middle	6.9	7.0	4.5	6.2	13.8	14.9	9.1	12.6
	Basal	9.0	8.8	4.7	7.8	15.4	18.8	10.3	14.8
Mean		7.3	7.0	4.6	6.3	13.6	14.4	8.4	12.1
200	Tip	5.4	5.4	3.2	4.7	11.5	11.0	6.7	9.7
	Middle	7.4	7.2	3.7	6.1	12.9	14.0	8.2	11.7
	Basal	7.8	7.7	4.6	6.7	15.3	14.8	9.6	13.2
Mean		6.9	6.8	3.8	5.8	13.2	13.3	8.2	11.6
General Mean		5.6	5.4	3.2	4.7	12.0	12.1	7.1	10.4
General effects of cuttings type:									
Tip		4.0	3.7	2.3	3.3	10.1	9.3	5.2	8.2
Middle		6.0	5.8	3.3	5.0	12.2	12.7	7.5	10.8
Basal		6.8	6.6	4.1	5.8	13.6	14.3	8.7	12.2
L.S.D. at 0.05						A: 0.45 B: 0.39 AB: 0.78			
A: 0.38 B: 0.21 AB: 0.42 C: 0.17						C: 0.40 AC: 0.79 BC: 0.71			
AC: 0.31 BC: 0.28 ABC: N.S.						ABC: 1.42			

Table (6): Means of root length (cm) per culm-branch cutting in *Dendrocalamus giganteus* as affected by IBA concentrations, type of cuttings and planting method at 3 months planting after during September 2004 and March 2005 propagation periods.

IBA Concn. (ppm) "A"	Type of cuttings "B"	Planting method "C"							
		September 2004				March 2005			
		Horizontally with one-node cutting	Vertically with one-node cutting	Vertically with 2-nodes cutting	Mean	Horizontally with one-node cutting	Vertically with one-node cutting	Vertically with 2-nodes cutting	Mean
Cont.	Tip	0.0	0.0	0.0	0.0	7.2	8.3	5.2	6.9
	Middle	3.6	3.8	2.1	3.2	10.9	10.8	7.7	9.8
	Basal	3.8	3.6	2.1	3.2	12.6	12.3	7.8	10.9
Mean		2.5	2.5	1.4	2.1	10.2	10.5	6.9	9.2
50	Tip	5.3	5.2	2.1	4.2	10.3	10.5	7.3	9.4
	Middle	6.9	6.7	3.3	5.6	13.2	12.6	8.4	11.4
	Basal	6.8	6.8	4.0	5.9	14.6	13.8	9.2	12.5
Mean		6.3	6.2	3.1	5.2	12.7	12.3	8.3	11.1
100	Tip	7.1	6.7	3.5	5.8	11.5	12.6	7.5	10.5
	Middle	8.5	8.7	4.8	7.3	16.2	16.6	10.7	14.5
	Basal	13.5	12.7	6.2	10.8	14.8	14.5	12.3	13.9
Mean		9.7	9.4	4.8	8.0	14.2	14.6	10.2	13.0
200	Tip	6.8	6.6	3.8	5.7	12.0	12.0	7.2	10.4
	Middle	7.4	7.0	4.6	6.3	15.8	15.3	9.9	13.7
	Basal	11.5	11.2	6.3	9.7	15.6	14.1	10.0	13.2
Mean		8.6	8.3	4.9	7.2	14.5	13.8	9.0	12.4
General Mean		6.8	6.6	3.6	5.6	12.9	12.8	8.6	11.4
General effects of type of cuttings:									
Tip		4.8	4.6	2.4	3.9	10.3	10.9	6.8	9.2
Middle		6.6	6.6	3.7	5.6	14.0	13.8	9.2	12.3
Basal		8.9	8.6	4.7	7.4	14.4	13.7	9.8	12.6
L.S.D. at 0.05 A= 0.17 B= 0.18 AB= 0.33 C= 0.17 AC= 0.31 BC= 0.28 ABC= 0.54						A= 0.31 B= 0.24 AB= 0.48 C= 0.25 AC= 0.51 BC= 0.42 ABC= 0.85			

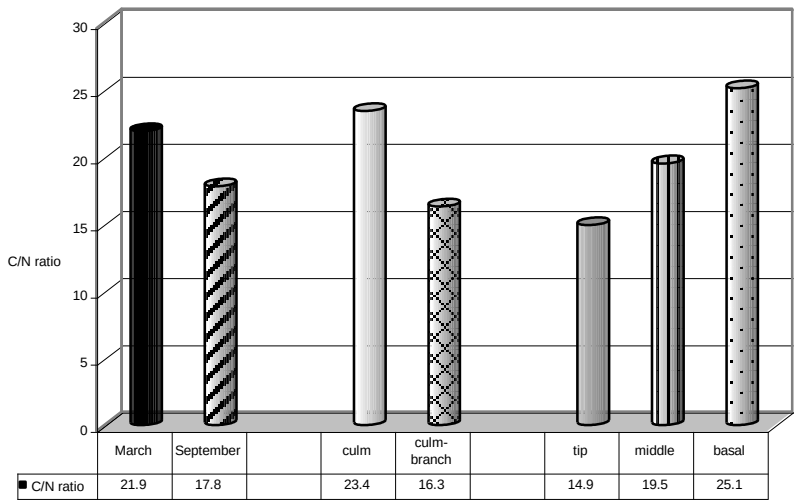

Fig. (3): Means of C/N ratio in the base of *Dendrocalamus giganteus* cutting tissues as affected by period of propagation, cutting position on the mother plant and type of cuttings.

DISCUSSION

Seasonal timing, or the period of the year in which cuttings are taken, can play an important role in rooting (Hartmann *et al*., 2002). With many species there is an optimal period of the year for rooting (Anand and Heberlein, 1975; Barham *et al*., 2000; Singh *et al*., 2004). In bamboos, the cessation of winter and the onset of spring resulted in emergence of new leaves on the lateral branches, resumption of active extension growth and upward mobilization of stored photosynthates and auxiliary substance from the underground rhizome, coincides with good rooting (Singh *et al*., 2004). Trewavas (1991) argued that the acquisition of sensitivity by cells/tissues towards photohormones for the process of differentiation and organization into a specific organ depends on several external and internal factors, including environmental conditions such as atmospheric temperature and humidity. Thus, the present investigation results showed that seasonal changes influenced rooting *of Dendrocalamus giganteus* cuttings . Both culm and culm-branch cuttings exhibited better adventitious rooting at March than September period of propagation. The present results are in accordance with those obtained by several investigators; Agnihotri and Ansari (2000) on *Bambusa vulgaris* var. *striata* and *Dendrocalamus strictus*, WenYan *et al*. (1997) on sympo-

dial bamboo species and Singh *et al*. (2004) on *Dendrocalamus asper*.

Concerning the effect of branch position on mother plant (culm and culm-branch), the obtained results in this study indicate that rooting and sprouting responses were higher in culm cuttings than culm-branch cuttings. These results are in agreement with those of several investigators; Castillo (1990) on some bamboo species, Singh *et al*. (2002) on *Bambusa nutans* and Singh *et al*. (2004) on *Dendrocalamus aper*. Superior adventitious root formation in culm cuttings relates to their proximal position from the underground rhizome and morphological features such as plump thick walls with abundant reserves. Scientists believed that the starch content and the levels of various nutrients in the cuttings might have influenced the rooting. The present investigation results (Fig. 3) show that the highest C/N ratios in used *Dendrocalamus giganteus* cuttings were obtained with culm cuttings compared to the culm-branch cuttings during March and September period of propagation. Also, culm-branch cuttings contained the highest C/N ratio during March compared to September period of propagation. So, it could be noticed that the highest rootability of culm and culm-branch cuttings in *Dendrocalamus giganteus* at March are paralleled to carbohydrates and nitrogen contents. Joseph (1958) found that high amount of starch content in culm cutting of *Bambusa arundinacea* during February and March.

As for the effect of various parts of the branch (type of cuttings), the present results show that the middle and tip portions of culm were better than the basal one. Meanwhile, the basal portion of culm-branch generally performed best compared to the middle and tip ones. These results may be due to the physiological and/or C/N ratio in the tissue of the plant. The basal culm cutting contained higher C/N ratio, but it was mature (hardwood cuttings), so the physiological status of the mother plant played an important role in rooting. On contrast, the middle and tip portions of culm had little amount of C/N ratio but they were more active than the basal one. Culm-branch cuttings were juvenile but the C/N ratio on plant tissues was higher in the basal portion. Marked differences are known to exist in the chemical composition of such shoots from base to tip (Tukey and Green, 1934). Variation in root production on cuttings taken from different portions of the shoot are often observed, with the highest rooting, in many cases, found in cuttings taken from the basal portion of the shoots. These results are in accordance with Bumalong and Tamolang (1980), Banik (1987) and Castillo (1990) on some bamboo species.

On the other hand, IBA treatments positively influenced rooting and vegetation of culm-

branch cuttings. Using IBA at 100 ppm had the most effectiveness. The observed positive influence of IBA treatments on various characteristics of adventitious roots and vegetation is in agreement with that on other bamboos, e.g. *Bambusa arundinacea*, *Dendrocalamus strictus* (Surendran *et al*., 1989), *Bambusa balcooa* Roxb (Pattanaik *et al*., 2003), *Dendrocalamus asper* (Singh *et al*., 2004) and *Bambusa vulgaris* (Hossain, 2005). Low levels of auxin often resulted in failure of adventitious rooting (Cooper, 1935; Smith and Wareing, 1972). Thus, exogenous application of IBA becomes effective if their endogenous level declines because of either inactive growth phase or less accumulation in distal plant parts. This account for tremendous rooting response of culm-branch cuttings of *Dendrocalamus giganteus* due to IBA application.

The present study clearly indicated that planting single-node cuttings of culm and culm-branch horizontally or vertically gave a sufficient rooting and vegetation systems compared to the double-node cutting. These results are in agreement with those obtained by Sharma and Kaushal (1985), Das (1988), Ujjaini *et al* (1998), Palanisamy and Bisen (2001) and Singh *et al*. (2004).

Conclusion

From these results and discussion it may be concluded that:

- In general, March is the best time for propagation of *Dendrocalamus giganteus* through culm and culm-branch cuttings. Meanwhile, September was suitable for culm-branch cuttings only.
- Rooting and sprouts response were higher in culm cuttings than culm-branch cuttings.
- Middle and tip portions of culm was better than the basal one. Meanwhile, basal portion of culm-branch cuttings generally performed best compared to the middle and tip ones.
- Single-node cuttings of culm and culm-branch planted horizontally or vertically are generally advisable compared to the double-nodes cuttings.
- Exogenous application of IBA at 100 ppm is much beneficial for rooting and vegetation in culm-branch cuttings that are viable in abundance for commercial use.
- Finally, it is suggested that single node culm-branch cuttings treated with 100 ppm IBA at March or September and planted horizontally or vertically in clay beds can be effectively utilized for *Dendrocalamus giganteus* large-scale vegetative propagation.

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تكاثر نبات البامبو من خلال العقل الساقية الفرعية فى مصر

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نبات البامبو فى مصر djم jقييم إكثاره تحت الظروف المصرية ، لذلك أجريت محاولتين لتقييم موقع العقل الساقية على الساق، موعد التكاثر، المعاملة باندول حمض البيوتريك وطريقة زراعة العقل المأخوذة من الساق الرئيسية والفروع الجانبية لنبات البامبو. استعمل 3 أنواع من العقل (طرفية، وسطية، قاعدية) لعقدة واحدة أو عقدتين خلال شهرى سبتمبر 2004 ، مارس 2005 وتم المعاملة باندول حمض البيوتريك بتركيزات 50، 100، 200 جزء فى المليون بالإضافة الى معاملة المقارنة (الكنترول). ثم زرعت العقل إما أفقية أو رأسية (قائمة) فى أصص مملوءة بالتربة الطينية، ووزعت المعاملات بنظام القطاعات العشوائية المنشقة مرتين ومكررة ثلاثة مرات. أخذت النتائج على النمو الجذرى والخضرى وحللت إحصائيا وأوضحت النتائج المتحصل عليها ما يلى:

- أظهرت العقل الساقية نسبة تجذير وخصائص نمو أفضل بالمقارنة بالعقل المأخوذة من الفروع الجانبية.
- بصفة عامة، كانت العقلة ذات العقدة الواحدة أحسن من ذات العقدتين.
- كان موسم التكاثر فى الربيع (مارس) ملائما لتجذير الأنواع المختلفة من العقل، بينما موسم التكاثر فى الخريف (سبتمبر) كان مناسبا للعقل المأخوذة من الفروع الجانبية فقط.
- معاملة العقل المأخوذة من الفروع الجانبية باندول حمض البيوتريك (IBA) نتج عنها تحسن واضح فى القدرة على التجذير.
- إحتوت العقل القاعدية على نسبة مرتفعة من الكربون/النيتروجين مقارنة بالعقل الطرفية.
- الزراعة الرأسية للعقلة ذات العقدتين تؤدى الى تقليل القدرة على التجذير.
- لاكثار نبات البامبو خضريا على نطاق تجارى واسع، ينصح بمعاملة العقل ذات العقدة الواحدة المأخوذة من الفروع الجانبية باندول حمض البيوتريك بتركيز 100 جزء فى المليون فى مارس أو سبتمبر والزراعة رأسيا أو أفقيا.