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INFLUENCE OF NATURAL GROWTH REGULATORS ON THE GROWTH OF DIFFERENT CULM SIZES OF *Bambusa vulgaris* (SCHRAD.) J. C WEND

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Abstract
Exploitation of bamboo for numerous uses keeps on increasing and there have been observation of low percentage survival from culm cuttings propagation. This study therefore investigated effects of Natural Growth Regulators (NGRs) on the growth of different culm sizes of Bambusa vulgaris with aim to enhancing survival and growth of the species with the use of NGRs. Bamboo culms with 2 nodes of 3 different diameter sizes: 21-30 mm, 31-40 mm and 41-50 mm were collected and dipped into four different NGRs in different bowls for 30 minutes. The growth regulators included honey, palm wine, coconut water and papain. The culms soaked in growth regulators were then planted into polythene pots filled with 8kg of top soil in the silviculture nursery. The experimental design was 3 x 4 factorial experiment and treatmentswere replicated 10 times. Shoot heights, collar diameter and sprout counts were assessed fortnightly. Data were collected for a period of six (6) months. Data were subjected to Analysis of Variance (ANOVA) and descriptive analysis.The effects of NGRs and interaction with culm sizes on shoot heights and collar diameter were significantly different (P<0.05) except on sprout counts. The culm size 41-50mm gave the highest shoot height in all NGRs with papain having the highest value (104.2cm while the least was recorded for the control treatment (35.5cm). The collar diameter was highest in culm size 41-50mm with honey (14.85mm). The Sprout counts of 7 were recorded forhoney, coconut water and papain.The NGRs had significant influence on the morphometric parameters of the Bambusa vulgaris and they can be used as alternative growth hormones in place of synthetic growth regulators.

Key Words: *Natural Growth Regulators, Culms, Propagation, Morphometric*

Introduction

Bamboo (*Bambusa vulgaris* (Schrad.) J. C. Wend) is economically important with innumerable uses such as furniture and medicinal purposes and many environmental benefits (Omiyale, 2003). The plant species is regarded as 'The Green Gold' of the 21st century and commonly known as 'poor man's timber'. They played a significant role in human society since time immemorial and today contributes to the subsistence needs of over a billion people worldwide (Salam, 2008). Bamboos occupy over 3% of the

world's forest and provide income, subsistence or life goods for an estimated one billion people (INBAR, 2010). It has been estimated that bamboo are used by more than half of the world's human population every day. In India over 2.5 billion people live in association with bamboo and the money value of the annual usage worldwide runs into billions of dollars (Rajamani, 2004). In India, There are about 2000-recorded uses and nearly 4000 commercial products made out of it. Based on its diversified uses and its potential to give livelihood security to millions of people, bamboo has earned the sobriquet, "Green Gold." (Aryaye, 2007). Africa has about 43 species of bamboo covering about 1.5 million hectares (Kigomo, 1988). Forty of these species are mainly distributed in Madagascar while the remaining three species are found in mainland Africa. Ethiopia is one of the countries in Eastern Africa that possess considerable bamboo resources. Ethiopia has over one million hectares of highland and lowland bamboo resources (Ensermu *et al.*, 2000). This means that 86% of the African bamboo resource is found in Ethiopia. In Nigeria, there are two indigenous species of bamboo: *Oxytenanthera abyssinica* and *Bambusa vulgaris* (Omiyale, 2003).

Bamboo has been traditionally used as fuel, food, shelter (rural housing), fence, tools, and various other purposes. In modern days, it is being used as industrial raw material for pulp and paper, construction and engineering materials, panel products, and so on. Also, present day industry uses one of the numerous species of bamboo - *B. vulgaris* for more modern products, such as baskets, vases, pencil and pen holders, kitchen containers, wall plagues, table mats and lamp shades, all of which have a decorative-cum-utility value (Badejo *et al.,* 2013). It has more than 1,500 documented applications, ranging from medicine to nutrition and from toys to aircraft (Salam, 2008). Studies on many traditional multipurpose woody species, such as bamboo and rattan, were neglected in the past as attention was focused on timber species (IFAR/INBAR, 1991).

The earth is well endowed with biodiversity and species of bamboo to sustain all lives therein if properly managed. However, dearth of information on the potentials of species like Bamboo could be a great limitation to its propagation and utilization, since present consumption/utilization profile is based on indigenous knowledge (Ogunjinmi *et al*., 2009). It was on this basis that some timber species are over utilized. The enormous uses of Bamboo and its potentials (that considered it as an alternative to timber) makes Bamboo a central focus in the face of endangered and threatened timber species in our forests. Perhaps bamboo could even improve the national economy. Though, bamboo is a fast growing species after it might have been established. But a lot of dieback had been experienced when propagated through culms and twigs (Asinwa and Gbadebo, 2019). Therefore, in order to ensure the continuous availability of this wonderful resource as an alternative to timber utilization, this study assessed influence of natural growth regulators on growth Potentials of *B. vulgaris* with a view to enhancing its sustainable mass propagation as alternative to tree crops.

The use of natural growth regulators has been confirmed to be cheap and effective as plant growth enhancer. They can also be easily accessed by rural dwellers. Among natural growth regulators that are effective are honey,

palm wine, coconut water and papain. They contain many kinds of sugars, amino acids, minerals and antioxidants. These chemicals have both antibacterial and antifungal properties, which help prevent root rot and maintain a cleaner environment for adventitious roots (Mauseth, 2014). Honey is known to contain; organic acids, protein, amino acids, vitamins, minerals, antioxidants, flavonoids and phenolic compounds. Application of honey to the end of a cutting protects it from harmful bacteria or moulds in the soil and plants needs a certain level of acid to grow which honey can supply in the right proportion. Palm wine is the fermented sap of certain varieties of palm trees including raphia palm (*Raphia hookeri* or *Raphia vinifera*), coconut palm (*C. nucifera*) and *Caryota* palm (jeeluga). Palm wine containsvitaminsB1,B2, B3, B6 and C, zinc, magnesium and others which plays a very important role in the improvement and promoting of new living cells by removing the dead cells in the body and replacing it, thereby giving the skin a soft, smooth and better appearance (Du Toit and Lambrechts, 2002*)*. These characteristics are expected to help enhance the growth and survival of bamboo.

Coconut water contains significant amounts of important nutrients which correct nutritional imbalances and other health conditions in humans. It has been found that the chemical constituents have effects on plants by promoting strong root systems and more rapid growth and development (Young *et al*., 2009).Papain, also known as papaya proteinase I, is a cysteine protease (EC3.4.22.2) enzyme present in papaya (*Carica papaya*) and mountain papaya (*Vasconcellea cundinamarcensis*).The primary active ingredient of papaya tree is papain which is a protein cleaving enzyme and called as – vegetable pepsin. The leaves and unripe fruit contain a milky juice rich in proteolytic enzymes amongst which papain is most effective one and can enhance plant growth. (*Bawazer et al., 2018*). This study therefore investigated effects of Natural Growth Regulators (NGRs) on the growth of different culm sizes of *B. vulgaris* with aim to enhancing survival and growth of the species with the use of NGRs.

Materials and Methods

Study Area

The experiments were carried out at the Silviculture Nursery of Forestry Research Institute of Nigeria (FRIN) Headquarters, Jericho Ibadan. It is located between longitudes 07º23'18" N and 07º23'43" N and latitudes 03º51'20" E and 03º 51'43" E. The climate of the study area is the West African monsoon with dry and wet seasons. The dry season is usually from November through March and is characterized by dry cold wind of harmattan. The wet season usually starts from April to October with occasional strong winds and thunderstorms. Mean annual rainfall is about 1548.9 mm, falling within approximately 90 days. The mean maximum temperature is 31.9ºC, minimum 24.2ºC while the mean daily relative humidity is about 71.9% (FRIN 2015).

Experimental Procedure and Design

Bamboo culms with 2 nodes of 3 different diameter sizes: 21-30 mm, 31-40 mm and 41-50 mm were collected from Asanmagbe Watershed in Forestry Research Institute of Nigeria. The different culm sizes were dipped into four different natural growth regulators in different bowls for 30 minutes (Plate 1A

and 1D). The growth regulators included Honey, Palm wine, Coconut water and Papain. The culms soaked in growth regulators were then planted into polythene pots filled with 8kg of top soil in the silviculture nursery (Plate 1B and 1C).

The experimental design was 3 x 4 factorial experiment in Completely Randomized Design (CRD). The treatments were replicated 10 times. Shoot heights, Collar diameter and Sprout counts were assessed. The first set of data were collected at 4th week after planting while subsequent data were collected fortnightly. Data were collected for a period of six (6) months. Data were subjected to Analysis of Variance (ANOVA) and Descriptive analysis.

Plate 1: A: Soaking of Culms in Coconut water; B: Planting of culms that were soaked in different Natural growth hormones; C: Bamboo Seedlings of different treatment; D: Different experimental process

Results and Discussion

Table 1 shows the analysis of variance (ANOVA) for Influence of Natural Growth Regulators (NGRs) on the Growth of different Culm Sizes of *Bambusa vulgaris*. The effects of NGRs on shoot heights and collar diameter were significantly different (P<0.05) except on sprout counts. The interactive effect of NGRs and culm sizes were also statistically significant (P<0.05) for shoot heights and collar diameter except sprout count. According to Saharia and Sen (1990), Varying responses among bamboo species generally resulted due to the differences in morphological features and endogenous levels of stored photosynthates and axillary substances. These generally enhance sprouting potentials of bamboo culms within 7 to 10 days while rooting can take over 30 days. The results corroborate findings of Agnihotri and Ansari, (2000) and Singh *et al.* (2002) that application of various growth regulators, mostly auxins, has been reported to positively influence on induction and growth in culm cuttings of bamboos. Exogenous application of auxins laden growth regulators become effective if their endogenous level is low for example due to inactive growth phase or less accumulation in distal plant parts. Similar trends of results were earlier reported by Nath *et al.* (1986) in *Bambusa pallid* and *Teinostachyum dullooa*.

Table 1: Analysis of Variance (ANOVA) for Influence of Natural Growth Regulators on the Growth of different Culm Sizes of *Bambusa vulgaris*

Variables	SV	df	SS	MS	F-cal	P-value
Shoot Height (cm)	Growth Regulators (GR)	4	116175.249	29043.812	6590*	.000
	Culm Sizes (CZ)	2	37572.867	18786.433	4263*	.000
	GR* CZ	8	4343.854	542.982	123.209*	.000
	Error	135	594.983	4.407		.
	Total	149	158686.953			
Collar Diameter (mm)	Growth Regulators (GR)	4	2934.558	733.640	7889*	.000
	Culm Sizes (CZ)	2	571.843	285.921	3074*	.000
	GR* CZ	8	65.500	8.188	88.04*	.000
	Error	135	12.516	.093		
	Total	149	3584.417			
Sprout Count	Growth Regulators (GR)	4	376.000	94.000	00.00ns	0.237
	Culm Sizes (CZ)	2	289.333	144.667	00.00ns	0.300
	GR* CZ	8	24.000	3.000	00.00ns	0,190
	Error	135	.000	.000		
	Total	149	689.333			

*=significant at P<0.05

ns =not significant at P>0.05

In the follow up test on ANOVA for shoot height, papain had the highest separated mean of 81.793±0.1 mm followed by coconut water (76.650±0.1 mm) while control treatment had the least value (12.900±0.01 mm) (Table 2). From Table 3, the separated mean of collar diameter of leading shoot produced by *B. vulgaris* as influenced by different NGRs was highest in honey (12.737±0.01 mm) followed by coconut water (10.187±0.02 mm) with the least (1.5233±0.01 mm) recorded for the control treatment.

The significant difference among NGRs used most especially with least values from control treatment could be ascribed to potential of these NGRs to initiate roots from plant cuttings. Chee, (1995) reported that honey which is a natural source of many vitamins like vitamin B1 and vitamin C have long been found to promote root formation in numerous plant species. Also, yeast which is main component of palm wine is a natural stimulator characterized by its richness in protein (47%), carbohydrates (33%), nucleic acid (8%), lipids (4%) and different minerals (8%) such as Na, Fe, Mg, K, P,S, Zn, Mn, Cu, Si, Cr, Ni, Va and Li, in addition to thiamin, riboflavin, pyridoxine, hormones and other growth regulating substances, such as biotin, B12 and folic acid (Nagodawithana, 1991). Coconut milk contains a content of cytokinins (especially zeatin) and auxin which helps to stimulate the growth of roots and shoots (Dunsin *et al*., 2016 and Yong *et al*., 2013).

Table 2: Post- hoc Test for Shoot Height (cm) as influenced by Natural Growth Regulators on the Growth of different Culm Sizes of *Bambusa vulgaris*

Growth regulators	Mean
Papain	81.793±0.1 [a]
Coconut water	76.650±0.1 [b]
Honey	58.226±0.03 [c]
Palm wine	23.371±0.21 [d]
Control	12.900±0.01 [d]

Means with the same superscript are not significantly different (p> 0.05)

Table 3: Post- hoc Test for Collar Diameter (mm) as influenced by Natural Growth Regulators on the Growth of different Culm Sizes of *Bambusa vulgaris*

Growth regulators	Mean
Honey	12.737±0.01 [a]
Coconut water	10.187±0.02 [b]
Papain	8.920±0.21 [a]
Palm wine	2.397±0.02 [d]
Control	1.5233±0.01 [d]

Means with the same superscript are not significantly different (p> 0.05)

The culm cuttings of size 41-50 mm gave the highest mean shoot height and collar diameter of 72.534±0.11 cm and 9.638±0.03 mm respectively while the culm cuttings of size 21-30 mm gave the least mean shoot height and collar diameter of 35.806±0.1 cm and 4.868±0.05 mm respectively (Tables 4 and 5).

The age of bamboo is mainly function of the culm size and its wall thickness provided the biotic and edaphic factors are

sacrosanct. Bwanali *et al*. (2006) reported that the best culm cutting propagules are generally obtained from the middle parts of the culm with sizes above 30 mm because of sufficient vigour for generation of roots and shoots. Ntirugulirwa *et al*. (2012) found that cuttings of the middle region had the highest number of sprouts (21.73) in comparison to the parts of the culm

Table 4: Post- hoc Test for Shoot Height (cm) as influencedby Natural Growth Regulators on the Growth of different Culm Sizes of *Bambusa vulgaris*

Culm sizes (mm)	Mean
41-50	72.534±0.11 [a]
31- 40	43.424±0.03 [b]
21- 30	35.806±0.1 [a]

Means with the same superscript are not significantly different (p> 0.05)

Table 5: Post- hoc Testfor Collar Diameter (mm) as influencedby Natural Growth Regulators on the Growth of different Culm Sizes of *Bambusa vulgaris*

Culm sizes (mm)	Mean
41-50	9.638±0.03 [a]
31- 40	6.952±0.07 [b]
21- 30	4.868±0.05 [a]

Means with the same superscript are not significantly different (p> 0.05)

The Influence of NGRs on the Shoot height (cm) of different Culm Sizes of *Bambusa vulgaris* at the end of 6th month of study is shown in figure 1. The culm size 41-50 mm gave the highest shoot height in all NGRs including control with papain having the highest value (104.2 cm) followed by coconut water (97.68 cm), Honey (70.64 cm), palm wine (59. 5 cm) while the least was recorded for the control treatment (35.5 cm).

In the same vein, the collar diameter was highest in culm size 41-50 mm with honey (14.85 mm), followed by coconut water (13.85 mm), papain (9.93 mm), palm wine (5.97 mm) and the least for the control (3.97 mm) (Figure 2). It is shown in figure 3 that culm size 41-50 mm had the sprout counts of 7 for honey, coconut water and papain while palm wine had 5 and control had 3.

It could be stated that different constituents of the NGRs differently affected vegetative growth characters (shoot collar diameter and sprout counts). These may be ascribed to growth regulatory properties such as cytokinins in coconut water, vitamins and amino acids in honey, papain and palm wine. They enhance growth and chemical constituents of growing plant parts. These results came in the similar point of view with those reported by Krajnc *et al*. (2013); Shidiki *et al*. (2013); Dunsin *et al.* (2016); Ibironke (2016 a and b).

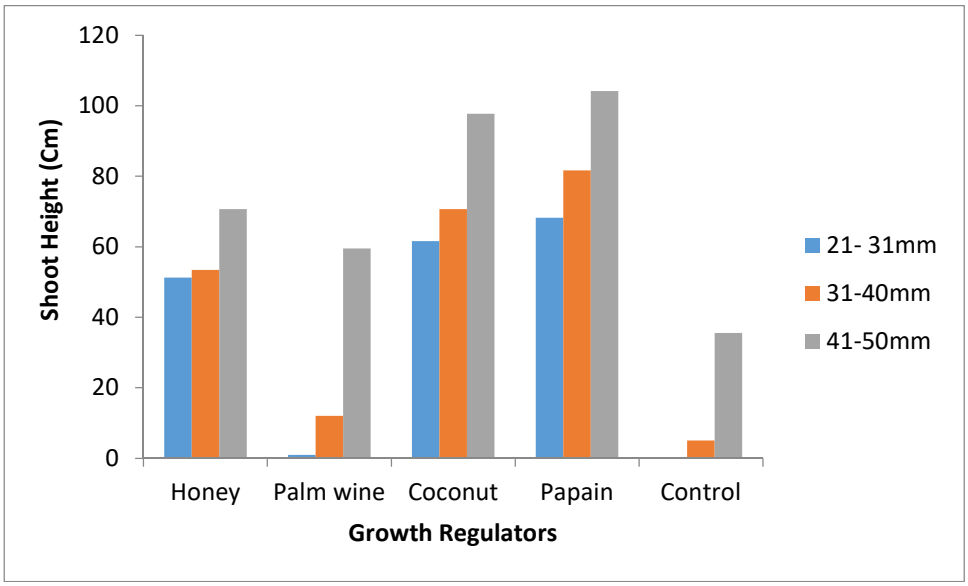

Fig. 1: Influence of Natural Growth Regulators on the Shoot height (cm) of different Culm Sizes of *Bambusa vulgaris* at the end of 6th month of study

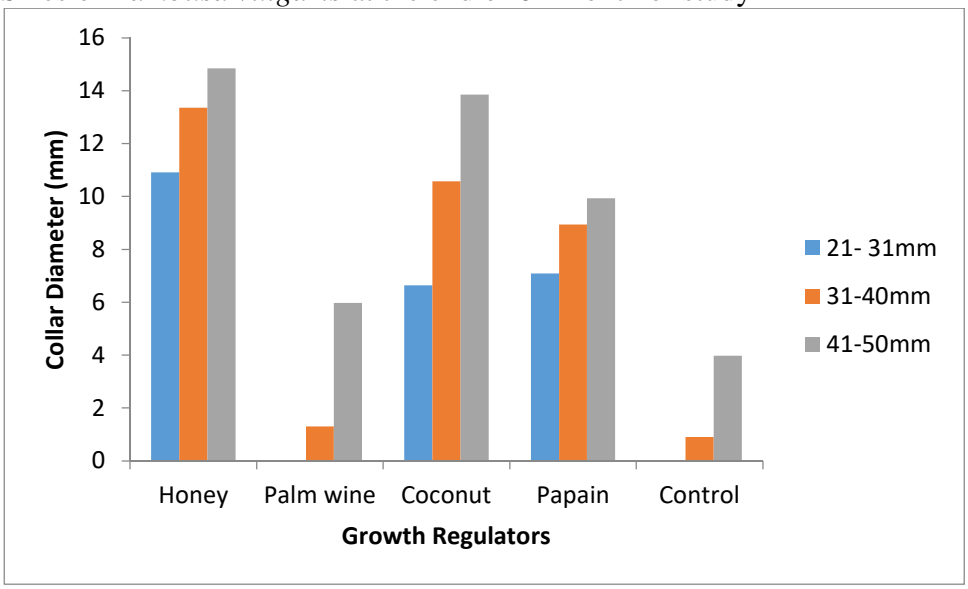

Fig. 2: Influence of Natural Growth Regulators on the Collar Diameter (mm) of different Culm Sizes of *Bambusa vulgaris* at the end of 6th month of study

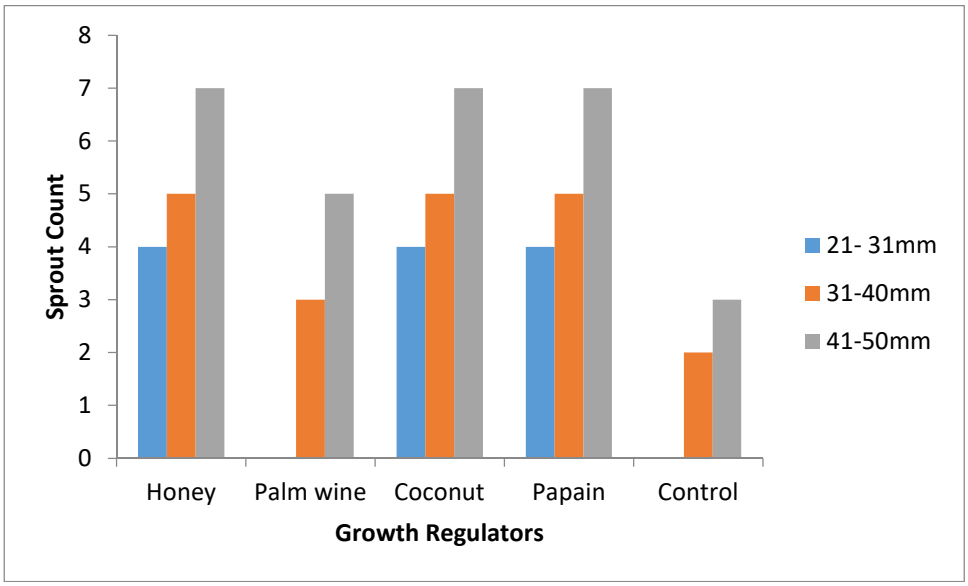

Fig. 3: Influence of Natural Growth Regulators on the Sprout Count of different Culm Sizes of *Bambusa vulgaris* at the end of 6th month of study

Conclusion

The results so far indicate that the Natural Growth Regulators had influence on the morphometric parameters of the *Bambusa vulgaris* when compared with the control treatments. Honey, Papain, Coconut water and Palm wine proved from the findings that they can effectively serve as alternative growth hormones in place of synthetic growth regulators. It was found that consideration of size of culms is very germane during propagation of bamboo through culm cuttings. It is therefore recommended that culm sizes above 31mm could be used with NGRs; most especially honey, papain and coconut water for optimum growth of *B. vulgaris* culm cuttings

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