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Sugarcane growth through fermented bamboo shoot application

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ABSTRACT

This study was conducted to determine the growth of sugarcane *(Saccharum officinarum)* as affected by fermented bamboo shoot application in terms of plant height, number and diameter of nodes, number of leaves, and average number of tillers. Study results would help farmers to find an alternative source in growth promotant hormone that could find in fermented bamboo shoot (FBS) that is locally available compared to synthetic cytokinin. There were four treatments used: t_1- 2 ml synthetic cytokinin/L of water (control); t_2- 2 ml of FBS/L of water; t_3- 7 ml of FBS/L of water, t_4- 12 ml of FBS/L of water. These treatments were arranged in Completely Randomized Design (CRD) and were replicated four times. The Analysis of Variance (ANOVA) was used as a statistical tool of the study and comparison among means using Honest Tukeys Significant difference at 5% level of significance. Sugarcane plants applied with 7 ml bamboo shoot concoctions has highest mean in plant height and number of leaves which is significantly higher than synthetic cytokinin and 2 ml concoction. On the other hand, application of 12 ml concoction got the highest mean in number of nodes and nodes diameter which is statistically higher than synthetic cytokinin and 2 ml concoction but comparable to 7 ml concoction. Based on results, FBS is better source of cytokinin and could be an alternative of using synthetic cytokinin. Results also revealed that using 7 ml and 12 ml concoctions performs better in all agronomic parameters. It is recommended to use FBS as a replacement of using the synthetic cytokinin at the levels of 7 ml and 12 ml concoctions per litre of water. Further study on the effect of FBS must be conducted to determine significance in tiller production of sugarcane. Further research study for the FBS to be analyzed for cytokinin content and will be used as fertilizer to other crops and vegetables are recommended to truly validate the results.

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INTRODUCTION

Sugarcane is a monocotyledonous, perennial, tropical, and subtropical grass widely grown in a zone around the world (Tolera et al., 2014). It is endemic to warm temperate, tropical regions of Asia and has fibrous stalks rich in sugar, although it is now grown in more than 100 different countries around the world (Gopi et al., 2018; El Chami et al., 2020). Sugarcane is one of the major crops in the Philippines and is popularly known as "Tobo" that is planted everywhere in the country but is most abundant in the Visayas and particularly on Negros Island, sugar has always been a significant contributor to the Philippine economy (SRA, 2021). The Philippine Statistics Authority reported that the largest producer of sugarcane was Western Visayas, contributing 1.44 million metric tons or 55.00 percent. Sugar accounted for 93.5 percent of the total sugarcane production in 2019.

The fast-growing plant is essential when making FPJ because it has very active growth hormones, and Bamboo shoot is an excellent example of this (KNF, 2017). Bamboo is a fast-growing plant and elongates as high as about 100 cm in a span of 24h. The growth of a bamboo stem is attributed to sequential elongation from the basal to the top internode (Fu, 2001; Gamuyao et al., 2017; Cui et al., 2013). The active trans-zeatin (tZ) and its derivatives are the most abundant forms of Cytokinin found in the bamboo shoots (Ashikari, 2017). Cytokinin was found best for shoot formation and the number of leaves of the sugarcane plant (Khan et al., 2009). Cytokinins are chemical signals that regulate many developmental processes throughout the cycle of plant, including gametogenesis, root meristem specification, vascular development, shoot and root growth, meristem homeostasis, senescence, and more (Zürcher et al., 2016).

However, the April to June 2019 production of sugarcane registered an abrupt decrease of 59.6 percent from 6.46 million metric tons a year ago to its current 2.61 million metric tons (PSA, 2019). This low farm production and productivity have always blamed for technology inefficiency and access to information (Padilla-Fernandez, & Nuthall, 2012). The rate of leaf production increases less with temperature, leading to a comparatively low level of shooting formation and delayed stem elongation. Nevertheless, to influence seed germination and plant growth by producing plant regulators like Cytokinin to regulate numerous developmental processes including cell proliferation, branching, seedling vigor, regulate shoot meristem size and growth, leaf primordial number and root growth, as well as response to biotic and abiotic stress (Romanov et al., 2018; Kieber & Schaller, 2014; Zurcher & Muller, 2016). Cytokinin is an essential hormone that helps the growth of plants (Le Bris, 2017). For this reason, the researcher decided to experiment on the growth of sugarcane through fermented bamboo shoot application to help increase the production of sugarcane.

Objectives

Generally, the study aims to determine the growth of sugarcane through fermented bamboo shoot application. Specifically, the study aims to determine the growth of sugarcane through fermented bamboo shoot application in terms of: Characterization of fermented bamboo shoot, and determine the effect of the fermented bamboo shoot to different growth parameters: Plant height, Number of nodes, Diameter of nodes, Number of leaves, and Average number of tillers.

METHODS

This study used Complete Randomized Design (CRD) with four (4) treatments replicated four (4) times with a total of sixteen (16) experimental units. Randomization was done through a drawing of lots.

Experimental set-up

The collection of 3 kg bamboo shoots taken from the mountainous area of Brgy. San Isidro, Toboso, Negros Occidental, Philippines. The age of bamboo shoot was two (2) months old. After collecting, bamboo shoots were washed and chopped into smaller pieces. In a pail, the 3 kg chopped bamboo shoots were put and mixed with

three liters of molasses following a ratio of 1:1. After mixing, the pail covered with a clean sheet of manila paper then the paper was affixed to the pail using a rubber band. The container placed in a cool, dry, and shaded place. Fermentation was completed in 7-15 days. After 7-15 days of fermentation, the liquid was strained and put in the empty bottle. After straining, the liquid is ready to use (Lim et al., 2018). The FBS analyzed from the Sugar Regulatory Administration (See Appendix A). A poly-ethylene bag used for this study. The poly-ethylene filled with soil up to 22 centimetres. The soil collected from a field planted with sugarcane. One (1) cane point of 88-354 variety. The soil was analyzed. Treatment one (1) contains synthetic Cytokinin, which is the control. Treatment two (2) contains 2ml of FBS, treatment three (3) contains 7ml of FBS, and treatment four (4) contains 12ml of FBS. Each treatment dose was diluted to 1 litre of water. Treatments were applied to the sugarcane plant one week after planting the sugarcane point until the duration of the study using a hand sprayer for application. The study was conducted in a greenhouse environment.

Data gathering procedure

The study was limited to determine the growth of sugarcane through fermented bamboo shoot application in terms of: characterization of FBS; determine the effect of FBS to different growth parameters: plant height, number and diameter of nodes, number of leaves and tillers. For characterization of FBS, the data was collected from the laboratory centre before the conduct of the study. Data collected are the nutrient content of FBS. The plant height was measured from the base up to the tip of the longest leaf using a meter stick. Measurement was done one week after the last application of the treatment (in centimetre). The number of nodes, leaves, and average number of tillers was counted one week after the last application of the treatment. The diameter of nodes was done after the last application of treatment using vernier caliper (in centimetre).

Statistical analysis

Data was consolidated, tabulated, and analyzed based on Analysis of Variance (ANOVA) in Complete Randomized Design (CRD) using the Statistical Tool for Agricultural Research (STAR). Comparison among means was done at 5% level of significance using Honest Tukey's Significance Difference.

RESULTS

Characterization of fermented bamboo shoot

As received basis from the sugar regulatory administration laboratory, the table 1 below shows the analysis of FBS for % total of Nitrogen (N), Phosphorus (P_2O_5), Potassium (K_2O), and pH content.

Table 1. Analysis of Fermented Bamboo Shoot for % total of N, P_2O_5, K_2O and pH

Nutrients and pH content	Nutrients found, % and pH
%N	0.62
% P_2O_5	1.73
%K_2O	2.41
pH	4.22

Based on the nutrient analysis of FBS from the Laboratory of Sugar Regulatory Administration. Laboratory results revealed that FBS is rich in potassium with 2.41%, phosphorus is 1.73% and nitrogen is 0.62% with 4.22 pH content.

Cytokinin content of FBS

Table 2 below shows the levels of cytokinin contained in bamboo shoots. Value given is the mean from two assays. One gas chromatographic (GC) injection is equivalent to extract from 2.4 of bamboo shoots.

Table 2. Nanograms of Cytokinin found per 2.4 grams of bamboo shoot

Cytokinin	Cytokinin found, ng
iPA	<1
ms-iPA	<1
cis-zR	1.3
trans-zR	1.5
ms-zR	<1

Based on literature, bamboo shoot contains cytokinin with 1.3 ng of the cis-zR and 1.5 ng of the trans-zR and other cytokinin compound at less than 1 ng out of the 2.4 grams bamboo shoots. The newly emerging bamboo shoots are actively producing tZ-type cytokinins, specifically in the shoot apical meristem region of the bamboo shoots (McCloskey et al., 1979; Gamuyao et al., 2017).

Agronomic parameters

Table 3 shows the means of different parameters such as plant height, number and diameter of nodes, number of leaves and tillers. Each agronomic parameter is very important in the growth, and development of sugarcane.

Table 3. Means of different agronomic parameters of Sugarcane as Affected by different levels of fermented bamboo shoot

Treatments	Plant Height (cm)	No. of Nodes	Diameter of Nodes (cm)	No. Of Leaves	Tillers
Control Synthetic Cytokinin	164.59b	3.25ab	1.90ab	14.75bc	3.25
2 ml concoction/L of water	194.88a	3.00b	1.85b	13.75c	3.25
7 ml concoction/L of water	198.69a	3.50ab	1.95ab	16.25a	3.75
12 ml concoction/L of water	193.70a	4.00a	2.08a	15.75ab	4.00

Means of the same letter did not differ significantly

Plant height

In plant height, table 3 shows that application of 7 ml concoction/L of water got the highest mean of 198.69 cm followed by application of 2 ml of concoction/L of water and then 12 ml of concoction/L of water with a mean of 194.88 cm and 193.75 cm respectively, while application of synthetic Cytokinin got the lowest mean of 164.59 cm. Results reveal that application of 7 ml concoction per liter of water is significantly taller than plants applied with synthetic cytokinin. However, application of FBS at any levels has the same effect on the plant height of sugarcane. This means that at any rate of FBS, it has enough and more cytokinin compared to NAA that promotes the elongation of sugarcane stalks. Purification of bamboo shoots for cytokinin showed 1.5 ng of cytokinin in 2.4 grams bamboo shoot (McCloskey et al., 1979), which is possibly higher than the cytokinin content found in NAA which is applied to sugarcane plants.

Average number of nodes

Number of nodes in table 3 shows that plants applied with 12 ml of concoction/L of water got the highest mean of 4 followed by 7 ml concoction/L of water with a mean of 3.50 and then application of synthetic cytokinin with a mean of 3.25 while 2 ml of concoction/L of water got the lowest mean of 3. Data reveals that application of 12 ml concoction per liter of water is statistically higher compared to application of 2 ml concoction per liter of water. However, 12 ml concoction per liter of water has comparable effect on nodes between 7 ml concoction per liter of water and 2 ml synthetic cytokinin per liter of water. Nodes and plant height could have a positive correlation and when height increases, number of nodes will be added also. As application of 7 ml concoction and 12 ml concoction, nodes increase at this level of application. Cytokinin plays a vital role in regulating shoot meristem size and initiate axillary buds formation (Le Bris, 2017), thus, 7 ml and 12 ml concoctions perform best in node formation.

Average diameter of nodes

Average diameter of nodes in table 3 shows that plants applied with 12 ml of concoction/L of water got the highest mean of 2.08 followed by 7 ml concoction/L of water with a mean of 1.95 and synthetic cytokinin with a mean of 1.9 while 2 ml of concoction/L of water got the lowest mean of 1.85. Results reveal that application of 12 ml concoction per liter of water is statistically bigger than 2 ml concoction per liter of water and synthetic cytokinin. Average diameter of nodes has the same effect on the application of 7 ml concoction per liter of water. McCloskey (1979) and Le Bris (2017) stated that bamboo shoot has cytokinin that helps regulate shoot meristem size of sugarcane crop. This explains why t_4 attained the highest mean in the diameter of nodes for the growth of sugarcane.

Average number of leaves

For the number of leaves, table 3 shows that application of 7 ml concoction/L of water got the highest mean of 16.25 followed by application of 12 ml of concoction/L of water with a mean of 15.75 and then synthetic cytokinin with a mean of 14.75 while 2 ml of concoction/L of water got the lowest mean of 13.75. Data reveal that sugarcane plants applied with 7 ml concoction per liter of water produces a greater number of leaves compared to synthetic cytokinin and 2 ml concoction per liter of water. Sugarcane plants applied with 12 ml concoction per liter of water has the same effect on the production of leaves with 7 ml concoction per liter of water. Moreover, 12 ml concoction per liter of water has the same effect to synthetic cytokinin while synthetic cytokinin has same effect to 2 ml concoction per liter of water. Thus, this supports to the study of Khan (2009) wherein states that cis-zR and trans-zR cytokinin of Bamboo Shoot helps stimulate the number of leaves of sugarcane.

Average Number of Tillers

In the average no. of tillers, table 3 shows that 12 ml of concoction/L of water got the highest mean of 4 followed by 7 ml concoction/L of water with a mean of 3.75 while 2 ml of concoction/L of water and synthetic cytokinin got the lowest and the same mean of 3.25. Results reveal that application of 2ml, 7ml and 12ml of FBS per liter of water have almost the same effect on the application of synthetic cytokinin. However, the effect of cytokinin in sugarcane with early maturing and sugar content has less effect in tillering. Tillering in sugarcane can be determined by the genetic base of the genotype (Tolera, 2017).

CONCLUSION AND RECOMMENDATION

It is concluded that the application of FBS at 7ml and 12ml per liter of water have the same effect but is significantly different in synthetic cytokinin. FBS can be used as a substitute for using synthetic cytokinin in the growth of sugarcane since it performs better than synthetic cytokinin. Based on the result of the study, FBS concoction performs better than the application of synthetic cytokinin in terms of plant height, nodes, diameter of

nodes, and number of leaves. FBS at 7 ml and 12 ml per liter of water has the same effect but is significantly different in the application of synthetic cytokinin. FBS can be a replacement for using the synthetic cytokinin at the levels of 7 ml and 12 ml concoctions per liter of water since it performs better than synthetic cytokinin.

It is recommended to use FBS at 7ml and 12ml per liter of water in the growth of sugarcane. In addition, a study on the effect of FBS should be conducted to determine significance in tiller production of sugarcane or another variable as to the sucrose content of sugarcane since FBS gains high potassium content. Moreover, further research for the FBS to analyse the cytokinin content as potential fertilizer to other crops and vegetables to validate the results.

REFERENCES

Authority, P.P.S. (2019). Sugarcane Production in the Philippines. Philipp. Stat. Auth.

Bhattacharya, A. (2019). *Effect of high temperature on crop productivity and metabolism of macro molecules*. Academic Press.

Buckingham, K.C., Wu, L. & Lou, Y. (2014). Can't see the (bamboo) forest for the trees: Examining bamboo's fit within international forestry institutions. *Ambio*, *43*(6), 770-778.

Cui, K., He, C.Y., Zhang, J.G., Duan, A.G. & Zeng, Y.F. (2012). Temporal and spatial profiling of internode elongation-associated protein expression in rapidly growing culms of bamboo. *Journal of proteome research*, *11*(4), 2492-2507.

El Chami, D., Daccache, A. & El Moujabber, M. (2020). What are the impacts of sugarcane production on ecosystem services and human well-being? A review. *Annals of Agricultural Sciences*, *65*(2), 188-199.

Fu, J. (2001). Chinese moso bamboo: its importance. *Bamboo*, *22*(5), 5-7.

Gamuyao, R., Nagai, K., Ayano, M., Mori, Y., Minami, A., Kojima, M. & Reuscher, S. (2017). Hormone distribution and transcriptome profiles in bamboo shoots provide insights on bamboo stem emergence and growth. *Plant and Cell Physiology*, *58*(4), 702-716.

Gopi, K., Srinivas, J., Manikyam, N., Nag, R.H., Maheshwar, D., Anjaneyulu, B. & Kumar, C.S. (2018). Performance evaluation of mechanical and manual harvesting of sugarcane. *Int. J. Current Microbiol. Appl. Sci*, *7*, 3779-3788.

He, C.Y., Cui, K., Zhang, J.G., Duan, A.G. & Zeng, Y.F. (2013). Next-generation sequencing-based mRNA and microRNA expression profiling analysis revealed pathways involved in the rapid growth of developing culms in Moso bamboo. *BMC plant biology*, *13*(1), 1-14.

He, C.Y., Cui, K., Zhang, J.G., Duan, A.G. & Zeng, Y.F. (2013). Next-generation sequencing-based mRNA and microRNA expression profiling analysis revealed pathways involved in the rapid growth of developing culms in Moso bamboo. *BMC plant biology*, *13*(1), 1-14.

Khan, S.A., Rashid, H., Chaudhary, M.F., Chaudhry, Z., Fatima, Z., Siddiqui, S.U. & Zia, M. (2009). Effect of cytokinins on shoot multiplication in three elite sugarcane varieties. *Pak. J. Bot*, *41*(4), 1651-1658.

Kieber, J.J. & Schaller, G.E. (2014). Cytokinins. *The Arabidopsis Book/American Society of Plant Biologists*, *12*.

Korean Natural Farming Inputs (2017). The Seeds You Plant: All about Fermented Plant Juice. Globalcal. www.theseedsyouplant.com

Lim, A. K. & Gamboa , J.C. (2018). The Essentials of Natural farming in the Philippine Context. Natural Farmers Institute of the Philippines, Inc.

Manuel Le Bris (2017). Hormone Distribution and Transcriptome Profiles in Bamboo Shoots Provide Insights on Bamboo Stem Emergence and Growth. Oxford University.

McCloskey, J.A., Hashizume, T., Basile, B., Sugiyama, T. & Sekiguchi, S. (1979). Determination of cytokinins in bamboo shoots by mass spectrometry using selected ion monitoring. *Proceedings of the Japan Academy, Series B*, *55*(9), 445-450.

Murashige, T. & Skoog, F. (1962). A revised medium for rapid growth and bio assays with tobacco tissue cultures. *Physiologia plantarum*, *15*(3), 473-497.

Osugi, A. & Sakakibara, H. (2015). Q&A: How do plants respond to cytokinins and what is their importance?. *BMC biology*, *13*(1), 1-10.

Padilla-Fernandez, M.D. & Nuthall, P.L. (2012). Farm size and its effect on the productive efficiency of sugar cane farms in Central Negros, the Philippines. *J. ISSAAS*, *18*(1), 49-61.

Peng, Z., Zhang, C., Zhang, Y., Hu, T., Mu, S., Li, X. & Gao, J. (2013). Transcriptome sequencing and analysis of the fast growing shoots of moso bamboo (Phyllostachys edulis). *PloS one*, *8*(11), e78944.

Romanov, G.A., Lomin, S.N. & Schmülling, T. (2018). Cytokinin signaling: from the ER or from the PM? That is the question!. *New Phytologist*, *218*(1), 41-53.

Song, X., Peng, C., Zhou, G., Gu, H., Li, Q. & Zhang, C. (2016). Dynamic allocation and transfer of non-structural carbohydrates, a possible mechanism for the explosive growth of Moso bamboo (Phyllostachys heterocycla). *Scientific reports*, *6*(1), 1-8.

Srivastava, L.M. (2002). *Plant growth and development: hormones and environment*. Elsevier.

Terefe, G., & Tolera, B. (2017). Interaction Effects of 6-Benzylaminopurine, Indole-3-Butyricacid and Urea Fertilizer to Enhance Tillering Potential of Sugarcane (Sacharum officinarum L) Plants. *J Biotechnol Biomater*, *7*(254), 2.

Tolera, B., Diro, M. & Belew, D. (2014). Effects of Gibberellic acid and Kinetin on in vitro aseptic shoot tip culture establishment of sugarcane (Saccharum officinarum L.) varieties grown in Ethiopian sugar estates. *Int. J. Sci. Basic Appl. Res*, *16*(1), 496-504.

Xu, Y., Wong, M., Yang, J., Ye, Z., Jiang, P. & Zheng, S. (2011). Dynamics of carbon accumulation during the fast growth period of bamboo plant. *The Botanical Review*, *77*(3), 287-295.

Zhou, M.B., Yang, P., Gao, P.J. & Tang, D.Q. (2011). Identification of differentially expressed sequence tags in rapidly elongating Phyllostachys pubescens internodes by suppressive subtractive hybridization. *Plant molecular biology reporter*, *29*(1), 224-231.

Zürcher, E. & Müller, B. (2016). Cytokinin synthesis, signaling, and function—advances and new insights. *International review of cell and molecular biology*, *324*, 1-38.

APPENDIX

Special Analysis Report of Fermented Bamboo Shoot given by the Department of Agriculture, Sugar Regulatory Administration from the Sugar Center in Diliman, Quezon City, Philippines.

Republic of the Philippines
Department of Agriculture
SUGAR REGULATORY ADMINISTRATION

SPECIAL ANALYSIS REPORT

Ramil A. Ardeña
San Carlos City

Analysis of Fermented Bamboo Shoot

		as received basis			
192-20		0.62	1.73	2.41	4.22

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