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Research Article

Enhancing Rooting and Biomass of Sugarcane Setts with Bio-Stimulant at Germination Stage

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ABSTRACT

The study aims to determine the effect of the application of bio-stimulant to one-eyed and two-eyed sugarcane setts as planting materials in enhancing the rooting and biomass. The study was conducted at UNO-R School of Agriculture, Philippines from November to December 2023. Phil 2006-2289 variety was used as planting materials. The study was laid out in a two-way factorial Completely Randomized Design with the kind of materials as the main plot and the four (4) levels of concentration of bio-stimulant solutions (BSS) plus the control as the sub-plots replicated 4 times. Cane setts preparation was done a day before the planting operations. Leaf sheaths were remove and only those setts with good and viable eye buds were selected for planting. Soaking was done for 24 hours. Bio-stimulants (BSS) were diluted in water and used as a soaking solution and succeeding application was done 15 days after planting. Statistical analysis revealed highly significant differences among treatments on the germination, biomass accumulation, weight and length of roots, number, weight, and height of tillers applied with 500ml of BSS. There was a high significant difference on the root length and biomass as influence by type of cane setts and the levels of concentration of BSS. Two-eyed cane setts applied with 500ml of BSS got the heaviest root weight and biomass. The study recommends the use of 500ml of BSS and two-eyed cane setts in enhancing the rooting and biomass of sugarcane plants during the germination phase.

Keywords: *Biomass accumulation, Bio-stimulant, Natural farming, Rooting capacity, Sugarcane sett, Sugar rendement*

Introduction

Saccharum officinarum, commonly known as sugarcane, stands as an indispensable and economically consequential crop cultivated for centuries, primarily esteemed for its saccharine juice and subsequent sugar production. It attains distinction due to its exceptionally high sucrose content, positioning itself as a primary

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source of sucrose for global human consumption (Smith & Johnson, 2020).

Sugarcane holds significant value as a crop in the Philippines, being cultivated in various soil types and under diverse climatic conditions and cultural management practices (Oñal & Jinon, 2022). Moreover, managing fertilizer is a crucial element in sugarcane cultivation. It is essential to replenish the nutrients taken from the soil by sugarcane to achieve high cane tonnage and sugar yields.

Presently, the agriculture sector confronts a significant hurdle in creating sustainable and eco-friendly systems to fulfill the nutritional needs of the continually expanding global population. Given the reduction in available arable lands and the declining genetic capabilities of crops, a viable solution for enhancing crop yields and safeguarding produce lies in adopting innovative agricultural technologies and improving existing ones (Szparaga et al, 2019).

Roots are vital components of plant anatomy, serving as the hidden foundation for the growth, development, and survival of terrestrial plants. Root architecture is a multifaceted trait that encompasses various aspects, including root length, density, branching patterns, and depth. It is highly influenced by genetic factors, environmental conditions, and interactions with soil microorganisms. The study of root architecture involves a combination of disciplines, including plant physiology, genetics, soil science, and computational modeling, making it an interdisciplinary field of research (Smith & Jones, 2021).

Bio-stimulants are a diverse group of natural or biologically derived substances, such as humic acids, seaweed extracts, beneficial microorganisms, and various organic compounds, that are applied to plants or soil to elicit beneficial effects on crop growth and development. These mechanisms may include improving nutrient uptake, stimulating root growth, modulating plant hormonal balance, and enhancing stress tolerance, (Ochoa-Hueso &Vargas, 2019). These products, which include seaweed extracts, humic acids, beneficial microorganisms, and organic compounds, function by enhancing a plant's inherent ability to cope with environmental stress, promote growth, and optimize resource utilization (Yakhin et al, 2017).

The utilization of bio-stimulants in sugarcane agriculture has gained momentum due to their eco-friendly nature and potential to reduce the reliance on synthetic chemicals. This introduction will explore the effects of bio-stimulants on sugarcane roots, focusing on their influence on root morphology, nutrient absorption, and stress tolerance (Silva et al, 2019).

Numerous studies conducted have shed light on the specific mechanisms through which bio-stimulants affect sugarcane roots. These mechanisms include the modulation of hormone signaling pathways, the promotion of beneficial microbial communities in the rhizosphere, and the enhancement of antioxidant systems. This introduction will delve into these findings, showcasing the potential of bio-stimulants as a sustainable solution to improve sugarcane root health and ultimately enhance crop yields (Souza & Machado, 2019).

The early stages of sugarcane growth, particularly germination and rooting formation, are critical for establishing healthy crops and optimizing yields. In recent years, there has been growing interest in harnessing the potential of bio-stimulants to enhance these essential phases of sugarcane development. Bio-stimulants are natural or naturally derived substances that stimulate plant growth and development through various mechanisms. Furthermore, as sugarcane is susceptible to various environmental stresses during its initial growth stages, improving germination and title formation is crucial for achieving robust plant establishment. The use of bio-stimulants offers a promising avenue for enhancing these processes while minimizing the reliance on synthetic chemicals (De Oliveira et al, 2019).

The cultivation of sugarcane demands substantial investment in terms of resources and effort. Therefore, maximizing biomass production is a central objective for sugarcane growers. The findings underscore the potential of bio-stimulants as a sustainable and environmentally friendly approach to optimize sugarcane biomass production, contributing to the economic viability of sugarcane cultivation and bioenergy production. In recent years, there has been growing interest in harnessing the potential of bio-stimulants to augment the biomass yield of sugarcane (Azevedo & Souza, 2019).

Hence, the primary objective of this research study was to empirically investigate the efficacy of a bio-stimulant solution in the context of sugarcane germination and rooting capacity and its relation to using different kinds of planting materials. The overarching aim of this study was to provide valuable scientific insights that could potentially facilitate the acceleration of the germination process in sugarcane and induce notable modifications in sugarcane rooting. These modifications hold the potential to significantly impact the cultivation of high-quality sugarcane crops, characterized by optimal germination and rooting capacity of the crop under study.

This study also aims to contribute to the field and body of knowledge on natural farming, agroecology, and root physiology of the plant.

General Objective

The general objective of this study is to determine the effect of different levels of concentrations of Bio-stimulant solution (BSS) on enhancing rooting and biomass capacity using the different kinds of sugarcane setts as planting materials.

Specifically, this study aims to:

1. Determine the effect of the application of different levels of concentrations of bio-stimulant solutions on the rooting and biomass capacity of sugarcane setts using the one-eyed and two-eyed materials as planting materials.
2. Determine the optimal and/or effective levels of concentrations of bio-stimulant solutions that could enhance the rooting and biomass accumulation of sugarcane setts using the different kinds of planting materials.
3. Determine the interaction between the levels of concentration of bio-stimulant applied and the kind of planting materials of sugarcane setts vis-à-vis the rooting and biomass capacity of the crop.
4. Determine the specific effect of bio-stimulant on the various characteristics of sugarcane cane during its germination phase vis-à-vis the use of different planting materials.

Methods and Materials

Materials

The variety used was Phil 2006-2289 (Phil 98-258-3403 x Phil 8477). Its habit of growth is erect to recumbent and a fast grower variety. Its potential yield is 129.92 tons cane/hectare with an average sugar rendement of 2.41 LKg/TC.

Experimental Design and Treatments

This study employed a two-way factorial Completely Randomized Design. The two (2) types of cane setts were the main treatments and the five (5) levels of bio-stimulant were the sub-treatments including the control. The sub-treatments were replicated four (4) times. Data were gathered from five (5) sample plants per replication

Main Treatment:

CP – Type of Cane setts
CP1- one-eyed cane setts
CP2 – two-eyed cane setts

Sub-Treatments:

BSS – Bio-Stimulant Solution
BS1 – control (no BSS)
BS2 - 200 ml BSS
BS3 – 300 ml BSS
BS4 – 400 ml BSS
BS5 - 500 ml BSS

Cultural Management

Preparations of Polyethylene Bags and Planting Materials;

1. The experimental area of 100 square meters was cleaned and leveled off.
2. Around 200 polyethylene bags were filled up with garden soil as planting medium.
3. After filling up with soil, the P-bags were laid out in the area as per the treatment design.
4. Soil samples were taken from each P-bag for analysis.
5. One hundred (100) pieces each of 2-eyed and 1-eyed cane setts of Phil 2006-2289 variety were used as planting materials.
6. The cane setts were soaked in the water for twenty-four (24) hours.

7. Soaked cane setts were air-dried for thirty (30) minutes before planting.
8. One cane sett was planted in each polyethylene bag.

Weed Management

Hand weeding was done before the application of bio-stimulant solution or as the need arises.

Water Management

Watering was done manually using a garden hose and was conducted to provide sufficient water supply among the plants.

Pest and Disease Control

Pest and disease control was monitored regularly to check the presence of pests and diseases.

Preparation and Application of Bio-stimulant Solutions:

1. Preparation of solutions was done separately per treatment before application.
2. Application of solutions was done after the planting of cane points.
3. Succeeding applications of Bio-stimulant solution was done 15 days after planting.

Research Environment

The experiment was conducted at the UNO-R School of Agriculture Field, Bacolod City, Philippines last November-December, 2023.

Data Gathered

The following data were gathered as per schedule:

1. Period of germination
2. Data taken 30 days after planting.
   a. Height of tillers
   b. Number of tillers
   c. Weight of tillers
   d. Weight of roots
   e. Length of roots
   f. Biomass

Statistical Analysis

All data gathered were statistically computed, and subjected to Analysis of Variance (ANOVA) in CRD using STAR 2.0.1.

The Least Significant Differences (LSDs) were used to determine significant differences among treatments.

Pearson's Product Moment Correlation Coefficient or simply Pearson's Correlation Analysis was used to measure the strength of the linear correlation between two variables.

Results and Discussion

Period of Germinations

Table 1 presents the period of germination of two type of cane setts (CP) applied with different levels of concentrations of Bio-stimulant solutions (BSS). This was taken by counting the number of days when 60 percent of the cane points have germinated. Statistical analysis showed that type of cane setts (Factor A) and different levels of concentrations of Bio-stimulant solutions (Factor B) had high significant effect on period of germination. However, there was no significant effect on the interaction.

One-eyed sett had germinated early at 5.46 days compared to two-eyed sett, which germinated at 5.96 days. In terms of application of Bio-stimulant solutions, cane setts treated with 500 ml BSS (T5) had obtained the earliest period of germination at 5.00 days, followed by 5.25 days from application of 400ml BSS (T4). Whereas 300ml BSS (T3) and 200ml BSS (T2) application had comparable effect which obtained a germination period of 5.61 and 5.85 days, respectively. On the other hand, cane setts without BSS application got the longest period of germination of 6.83 days.

Table 1. Period of germination (days).

Level of Bio-stimulant	Type of Cane Setts		Mean
	One-eyed	Two-eyed	
Control (no BSS)	6.68	6.98	6.83[a]
200 ml BSS	5.70	6.00	5.85[b]
300 ml BSS	5.30	5.93	5.61[b]
400 ml BSS	5.00	5.50	5.25[c]

Level of Bio-stimulant	Type of Cane Setts		Mean
	One-eyed	Two-eyed	
500 ml BSS	4.60	5.40	5.00^{d}
Mean	**5.46b**	**5.96a**	
Pr (>f) CS		0.0000**	
Pr (>) BSS		0.0000**	
Pr (>F) CS x BSS		0.2008^{ns}	
CV (%)		4.22	

*Means with same letter/s are not significantly different from each other, **=highly significant, ns=not significant*

This result is anchored to the study of Alí et al. (2021), that the bio-stimulant solution used in crop production had a significant impact on the germination of the crops. They investigated also the growth of the crops until harvesting and consequently derived the same result for as long as proper cultural and water management had been employed.

The study of Lucini et al. (2018) also found that bioactive compounds present bio-stimulants to help in controlling the main processes in plants and are linked to improving germination, plant growth, and crop production when these are applied. These processes helped induce the development of tillers. This will eventually result in faster growth processes resulting in the early emergence of parts vital in plant development.

On an economic note, the sugarcane is typically planted using cutting the stalks; might it be in seeds or cane points? Hence, the buds or the eye-bud acted as the emergence of a new sugarcane plant and the start of another cropping season. Once the bud has sprouted or otherwise germinated, this will mean that it is a living and economically viable sugarcane plant for yield.

Furthermore, when the cane points are sown, every bud has the potential to develop into a main shoot. Subsequently, secondary shoots, known as tillers, can emerge from the buds located beneath the ground on this primary shoot. Then, photosynthetic and other enzymatic processes will continue to support plant growth (Silva et al., 2022).

The physiological characteristics of cane setts will also relate to their growth. The bigger the sugarcane setts or propagation material this will slightly influence the germination of the sett. The 2-3-eye cane setts are recorded and scientifically proven that the germination rate is higher compared to one-eye cane setts (Singh et al, 2019).

Tiller Height

Results revealed high significant differences on the tiller height as influenced by type of cane setts and levels of concentrations of Bio-stimulant solutions, but no significant differences on its interaction as indicated on Table 2. Thirty days from planting, two-eyed cane sett obtained a height of 76.80cm which was significantly taller by 12.82cm compared to one-eyed type which only got 63.98cm.

Cane setts treated with 500ml BSS (T5) obtained the tallest tiller with a mean of 80.83cm and comparable with 400ml BSS (T4) with a height of 75.12cm. This was followed by 300ml BSS (T3) with average height of 71.65cm. Comparably, 200ml BSS (T2) and control group (T1) had shortest tillers of 63.91cm and 60.42cm, respectively.

Table 2. Tiller height (cm) 30 days after planting

Level of Bio-stimulant	Type of Cane Setts		Mean
	One-eyed	Two-eyed	
Control (no BSS)	56.95	63.90	60.42^{c}
200 ml BSS	59.90	67.93	63.91^{c}
300 ml BSS	65.40	77.90	71.65^{b}
400 ml BSS	66.85	83.40	75.12^{ab}

Level of Bio-stimulant	Type of Cane Setts		Mean
	One-eyed	Two-eyed	
500 ml BSS	70.80	90.85	80.83[a]
Mean	**63.98[b]**	**76.80[a]**	
Pr (>f) CS	0.0000**		
Pr (>) BSS	0.0000**		
Pr (>F) CS x BSS	0.1914[ns]		
CV (%)	8.74		

*Means with same letter/s are not significantly different from each other, **=highly significant, ns=not significant*

The results are parallel to the study of De Vasconcelos and Chaves (2020) that the bio-stimulant solution applied to the test crops has significantly helped the development of tillers mainly in the height of tillers.

The application of bio-stimulant solution enhanced the biological processes and enzymes in the soil promoting faster and better development of the plants. Furthermore, these bio-stimulant solutions not only plant growth but also soil fertility (Rong et al, 2019). Hence, bio-stimulant solution encompasses higher plant growth because of the presence of active components that favor the development of tillers and other vital parts (Drobek and Cybulska, 2019)

Number of Tillers

Statistical analysis revealed high significant differences on both two factors on the number of tillers. Two-eyed cane setts got the highest number of tillers with an average count of 2.6, significantly better by 1.26 tillers compared to one-eyed type with an average of 1.35 tillers only as shown on Table 3.

Cane setts applied with 500ml BSS (T5) were observed to have more tillers at 30DAP with an average count of 2.45 tillers, and followed by 2.15 tillers from 400ml BSS (T4). Comparable effects were observe from 300ml (T3) and 200ml BSS (T2) with average count of 1.90 and 1.82 tillers, respectively, while untreated cane setts (T1) got the least number of 1.57 tillers. Moreover, results showed no significant effect on the interaction between type of cane setts and different levels of concentrations of Bio-stimulant solutions.

Table 3. Number of tillers 30 days after planting.

Level of Bio-stimulant	Type of Cane Setts		Mean
	One-eyed	Two-eyed	
Control (no BSS)	1.05	2.10	1.57[d]
200 ml BSS	1.20	2.45	1.82[c]
300 ml BSS	1.25	2.55	1.90[c]
400 ml BSS	1.50	2.80	2.15[b]
500 ml BSS	1.75	3.15	2.45[a]
Mean	**1.35[b]**	**2.61[a]**	
Pr (>f) CS	0.0000**		
Pr (>) BSS	0.0000**		
Pr (>F) CS x BSS	0.4867[ns]		
CV (%)	9.85		

*Means with same letter/s are not significantly different from each other, **=highly significant, ns=not significant*

These results conform with the study conducted by Yulia et al, (2022) that the bio-stimulant solution influenced the development of different parameters in sugarcane production such as some tillers or the tiller count. Due to high levels of micronutrients present in the bio-stimulant formulation.

According to Adorada et al, (2023), the application of a bio-stimulant solution has significantly influenced the development of vital parts of plants compared to no BSS applied or the control treatment. However, bio-stimulants work well with efficient and effective farming methods and practices employed in integrated crop management and practices. Therefore, making farming a homeostatic activity; where everything should be balanced (Calvo et al, 2019).

Tiller Weight

Results revealed high significant differences of type of cane setts and levels of concentrations of Bio-stimulant solutions in the weight of tillers as indicated on Table 4. Two-eyed cane setts obtained the heaviest tiller with average weight of 0.108kg which was significantly heavier by 0.044kg compared to one-eyed type with average weight of 0.064kg.

Application of 500ml BSS (T5) obtained a heaviest tiller weight of 0.098kg, followed by T4, T3 and T2 with average of 0.090kg, 0.086kg and 0.081kg, respectively. On the other hand, plant with no BSS (T1) obtained the lightest weight of 0.076kg which was significantly inferior by 0.022kg compared to cane setts treated with 500ml BSS (T5). Nonetheless, there was no significant differences on the interaction between type of cane setts and different levels of concentrations of Bio-stimulant solutions.

Table 4. Tiller weight (gm) 30 days after planting

Level of Bio-stimulant	Type of Cane Setts		Mean
	One-eyed	Two-eyed	
Control (no BSS)	0.055	0.096	0.076^{d}
200 ml BSS	0.060	0.101	0.081^{cd}
300 ml BSS	0.065	0.106	0.086^{bc}
400 ml BSS	0.063	0.113	0.090^{ab}
500 ml BSS	0.073	0.124	0.098^{a}
Mean	**1.064^{b}**	**0.108^{a}**	

Pr (>f) CS	0.0000**
Pr (>) BSS	0.0000**
Pr (>F) CS x BSS	0.6851^{ns}
CV (%)	9.49

*Means with same letter/s are not significantly different from each other, **=highly significant, ns=not significant*

According to the study of Santos et al, (2020) bio-stimulant solution applied to the test crops promotes the emergence of new shoots and enhances the quality; weight, and height of tillers for better photosynthetic processes done by the plants.

Furthermore, bio-stimulant solution influences the utilization efficiency, resilience to abiotic stresses, and overall crop quality of crops (Hazra et al, 2020). These BSSs contribute to the growth of plants directly and indirectly. This includes bio-fertilization and biomass production of crops and plants (Shahrajanian et al, 2020).

Root Weight

Results showed high significant differences on the root weight as influenced by type of cane setts and levels of concentrations of Bio-stimulant solutions, as well as significant effects on its interaction. Additionally, heaviest root weight was obtained from two-eyed setts across all levels of concentrations of Bio-stimulant solutions compared to one-eyed setts.

Two-eyed setts applied with 500ml BSS (T5) got the heaviest root weight with average of 0.079kg, comparably followed by 400ml BSS (T4) and 300ml BSS (T3) with average of 0.064kg and 0.059kg, respectively. Two-eyed setts applied with 200ml BSS (T2) obtained an average weight of 0.044kg and lightest weight of 0.031kg from setts without BSS (T1) as indicated on Table 5.a.

Table 5.a. Root weight comparison (gm) of bio-stimulant at each type of cane setts

Level of Bio-stimulant	Type of Cane Setts	
	One-eyed	Two-eyed
Control (no BSS)	0.005^{c}	0.031^{d}
200 ml BSS	0.009^{bc}	0.044^{c}
300 ml BSS	0.010^{bc}	0.059^{b}
400 ml BSS	0.015^{b}	0.064^{b}
500 ml BSS	0.025^{a}	0.079^{a}
Mean		
Pr (>) BSS	0.0000**	
Pr (>F) CS x BSS	0.0007**	
CV (%)	18.92	

One-eyed cane setts had lightest root weight with average of 0.025kg from 500ml BSS (T5), followed by 0.015kg from 400ml BSS (T4), and comparable weight of 0.010kg and 0.009kg from 300ml BSS (T3) and 200ml BSS (T2), respectively. Among all levels of concentrations, untreated one-eyed sett got the lightest weight of 0.005kg (Table 5.b).

Table 5.b. Root weight comparison of cane setts (gm) at each level of bio-stimulant solution.

Type of Cane Setts	Level of Bio-stimulant Solution				
	Control (no BSS)	200ml BSS	300ml BSS	400ml BSS	500ml BSS
One-eyed	0.005^{b}	0.009^{b}	0.010^{b}	0.015^{b}	0.025^{b}
Two-eyed	0.031^{a}	0.044^{a}	0.059^{a}	0.64^{a}	0.079^{a}
Mean					
Pr (>) BSS	0.0000**				
Pr (>F) CS x BSS	0.0007**				
CV (%)	18.92				

*Means with the same letter/s are not significantly different from each other, **=highly significant, ns=not significant*

The results of this study matched the findings of Oñal et al, (2023) that bio-stimulant solution induces the formation of roots. Therefore, the crops respond well to the bio-stimulant solution applied and utilize the minerals and nutrients efficiently present in the soil.

According to Shahrajabian et al, (2021), the bio-stimulant solution helps the plants in different ways; that includes making the roots longer and better. The roots of the plants act as an anchorage to the soil making it resilient in climatic activities, reducing stresses and better yield.

On the economic side, sugarcane production relies more on commercial fertilizers bringing the prices of sugar and related products higher. The bio-stimulant solution has the potential to reduce the reliance on synthetic chemicals that cause ecological hazards (Silva et al, 2019). Moreover, Souza and Machado

(2019) suggest that the introduction of bio-stimulant solution to a more sustainable solution to improve sugarcane root health and will eventually enhance crop yields.

Root Length

Root length was significantly influenced by type of cane setts and level of concentrations of Bio-stimulant solutions and its interaction. Results revealed a comparable effect on the root length between one-eyed and two-eyed setts across all levels of concentrations of Bio-stimulant solutions, except the application of 300ml (T3) showing that two-eyed setts was more heavier with average root length of 26.00cm compared to 20.83cm obtained by one-eyed which was significantly inferior by 5.17cm.

Results showed that effects of Bio-stimulant solutions to one-eyed setts obtained longest root length of 35.20cm from 500ml BSS (T5), followed by 30.25kg from 400ml (T4) and 20.83cm from 300ml BSS (T3). While 200ml BSS (T2) got an average root length of 18.30cm and the shortest root length of 15.45cm was achieved from untreated setts as shown on Table 6.a.

Table 6.a. Root length comparison (cm) of bio-stimulant at each type of cane setts.

Level of Bio-stimulant	Type of Cane Setts	
	One-eyed	Two-eyed
Control (no BSS)	15.45^{d}	11.80^{c}
200 ml BSS	18.30^{cd}	15.33^{c}
300 ml BSS	20.83^{c}	26.00^{b}
400 ml BSS	30.25^{b}	28.15^{b}
500 ml BSS	35.20^{a}	33.85^{a}
Mean		
Pr (>) BSS	0.0000**	
Pr (>F) CS x BSS	0.0337*	
CV (%)	12.31	

Moreover, longest root length of two-eyed setts was 33.85cm from application of 500ml BSS (T5), and followed by comparable root length of 28.15cm and 26.00cm from 400ml BSS (T4) and 300ml BSS (T5), respectively as shown on Table 6.b. Similarly, shortest root length was achieve both, by 200ml BSS (T2) and untreated two-eyed setts with average of 15.33cm and 11.80cm, respectively.

Table 6.b. Root length comparison of cane setts (gm) at each level of bio-stimulant solution.

Type of Cane Setts	Level of Bio-stimulant Solution				
	Control (no BSS)	200ml BSS	300ml BSS	400ml BSS	500ml BSS
One-eyed	15.45^{a}	18.30^{a}	20.83^{b}	30.25^{a}	35.20^{a}
Two-eyed	11.80^{a}	15.33^{a}	26.00^{a}	28.15^{a}	33.85^{a}
Mean					
Pr (>) BSS	0.2929^{ns}				
Pr (>F) CS x BSS	0.0337*				
CV (%)	12.31				

*Means with the same letter/s are not significantly different from each other, **=highly significant, ns=not significant*

According to Pierre et al, (2019) researchers today, have less focus on the roots and what is not seen underneath the soil. Hence, in the research studied by De Vasconcelos and Chaves

(2020), statistics show that bio-stimulant solution applied to the soil has significantly improved the soil's physical properties, and biochemical and biological characteristics which resulted in better root architecture and root system.

Anchored to Khonghintaisong et al, (2017) an extensive root system provides support for the physiological characteristics of the above-ground components specifically during drought stresses. Ultimately, the longer the roots of sugarcane the better the absorption of the plant to the nutrients, minerals, and water to provide better drought resistance.

Bhattacharya et al, (2022) stated that a good root architecture and root lengths are key to using the soil resources well and growing successfully. They also added that strong and effective roots are very important for the plants to adapt well in climates like in Asia where there are limited rain activities and possibilities of drought and dry season.

Biomass

Two-eyed setts treated with 500ml BSS (T5) obtained the heaviest biomass of 1,012.50kg, followed by 400ml BSS (T4) and 300ml BSS (T3) with comparable weight of 881.25kg and 825.00kg, respectively. Application of 200ml BSS (T2) got an average biomass of 725.00 kg, while the lightest biomass of 637.50kg was obtained from untreated setts which was significantly inferior by 375kg compared to setts treated with 500ml BSS (T5), (Table7.a.)

Table 7.a. Biomass comparison (gm) of bio-stimulant at each type of cane setts.

Level of Bio-stimulant	Type of Cane Setts	
	One-eyed	Two-eyed
Control (no BSS)	301.25^{c}	637.50^{d}
200 ml BSS	346.25^{bc}	725.00^{c}
300 ml BSS	375.00^{b}	825.00^{b}
400 ml BSS	412.50^{b}	881.25^{b}
500 ml BSS	487.00^{a}	$1,012.50^{a}$
Mean		
Pr (>) BSS	0.0000**	
Pr (>F) CS x BSS	0.0000**	
CV (%)	7.76	

On the other hand, one-eyed setts had lighter biomass with average of 487.00kg, 412.50kg, 375.00kg, 346.25kg and 301.25kg from T5, T4, T3, T2 and T1, respectively, (Table 7.b.)

Table 7.b. Biomass comparison of cane setts (gm) at each level of bio-stimulant solution.

Type of Cane Setts	Level of Bio-stimulant Solution				
	Control (no BSS)	200ml BSS	300ml BSS	400ml BSS	500ml BSS
One-eyed	301.25^{b}	346.25^{b}	375.00^{b}	412.50^{b}	487.00^{b}
Two-eyed	637.50^{a}	725.00^{a}	825.00^{a}	881.25^{a}	$1.012.50^{a}$
Mean					
Pr (>) BSS	0.0000**				
Pr (>F) CS x BSS	0.0028**				
CV (%)	7.76				

*Means with the same letter/s are not significantly different from each other, **=highly significant, ns=not significant*

Biomass refers to any organic matter derived from plants, encompassing vegetation such as algae, trees, and crops. It is generated through the process of photosynthesis in the plants, wherein, green plants convert sunlight into plant material. This category includes both terrestrial and aquatic vegetation, as well as organic waste materials, (Gonçalves, 2024).

The results of the study of Toscano (2023) also suggest that it will yield a significant economic implication to sugarcane production if the biomass is higher within the same area or location.

Correlation Analysis of Germination and Rooting of Sugarcane Setts

Correlating data in this study about the effects of different concentrations of the bio-stimulant solution to the given parameters is crucial for understanding the complex relationships between variables, thereby enabling the development of a more accurate conclusion to this study. By analyzing correlated data, researchers can identify and quantify the impact of the bio-stimulant solution on the given parameters.

Correlated Characteristics with Root Length

Table 8 shows that of the three parameters considered, it is the tiller height that is highly significant. It is moderately correlated with the root length, with r-value of 0.6054. The tables further indicates that there is a weak correlation between the biomass and number of tillers with a r-value of 0.3201 and 0.3140, respectively.

Table 8. Characteristics of sugarcane setts that significantly correlated with root length applied with different level of bio-stimulant.

Parameters	Correlation Coefficient *(r)*	P-value	Interpretation
Germination	-0.7547	0.0000**	Moderate (-) linear correlation
No. of tillers	0.3140	0.0485*	Weak (+) linear correlation
Tiller height	0.6054	0.0000**	Moderate (+) linear correlation
Biomass	0.3201	0.0441*	Weak (+) linear correlation

***=highly significant at 1%level of probability, *=significant at 5%level of probability*

Sugarcane roots are embedded in the soil making it difficult to ocularly examine the status of the roots generally without damaging the roots. The root structure is important in plant growth according to Petropoulos and Spyridon (2020) the roots promoted nutrient uptake and also contributed to the observed increase in yield and plant growth including the height of the tillers.

In the context of plant biology, the root system is fundamentally critical to the survival, growth, and overall performance of plants, including sugarcane. This significance goes from the reliance on other parts of the plant to the roots for overall growth. This includes the absorption of bio-stimulants applied within the scope of this study, highlighting the integral role of roots in facilitating the effectiveness of such treatments.

Length of tillers is important in sugarcane production because it is in tillers that the leaves are attached. Leaves primary role is to photosynthesize food for the sugarcane plant vital in plant growth. According to De Vasconcelos and Chaves (2020), bio-stimulant solutions are used in the root development and tillering of sugarcane as one of the agricultural practices.

Correlated Characteristics with Root Weight

On table 9 shows that root weight are strongly correlated with the biomass, number of tillers, weight of tillers, and tiller height roots with r-value of 0.9745, 0.9398, .8961, and 0.8027, respectively. The relationships between the four parameters were highly significant at 1% level of probability.

Table 9. Characteristics of sugarcane setts that significantly correlated with root weight applied with different level of bio-stimulant

Parameters	Correlation Coefficient *(r)*	P-value	Interpretation
No. of tillers	0.9398	0.0000**	Strong (+) linear correlation
Tiller height	0.8027	0.0000**	Strong (+) linear correlation
Tiller weight	0.8961	0.0000**	Strong (+) linear correlation
Biomass	0.9745	0.0000**	Strong (+) linear correlation

***=highly significant at 1%level of probability, ns=not significant, no linear correlation*

The study of the group of Gomez-Koskey (2019) indicates that sugarcane fresh weight of roots, number of roots, and length of the longest root had a superior result with the applications of two bio-stimulants they studied, with significant differences to the control.

The study of the group Lovera (2021) assessed the development of sugarcane root systems as an influence of different soil tillage systems and cover crops for three cycles. The results show that during the first three sugarcane cycles, the 0.0 – 0.2 meters depth surface layer concentrated the highest amount of dry biomass of roots. It represents between 36% and 62% of roots in the first 0.6 meter deep.

Conclusions

The different concentrations of bio-stimulant resulted in enhancing the rooting and biomass capacity of sugarcane plants. The use of 500ml bio-stimulant has a highly significant influence on the germination period, tiller height, number of tillers, weight of tillers, length of roots, weight of roots, and biomass accumulation at the germination period of the sugarcane plants

On the kind of planting materials, the use of two-eyed sugarcane setts had significantly influenced on the root weight, length of roots and biomass accumulation.

Based on the findings, this study recommends the use of 500ml bio-stimulant as well as using of two-eyed sugarcane setts in enhancing the germination, rooting formation, biomass accumulation, and increasing the tiller number and weight of sugarcane plant during its germination stage.

For correlated traits with the root weight, all of the parameters and variables resulted in strong positive linear correlation. Making it true that the tiller height, weight as well as the number of the same and biomass is directly correlated with the weight of the roots at the germination stage or 30 DAP.

The researchers suggest further study of the effects of different concentrations of bio-stimulant solution on the different variables in sugarcane production. The duration of the study will also be subject until the harvesting time.

Conflict of Interest

No other group is involved in this study

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