European Journal of Agriculture and Forestry Research, 14(2), pp.1-11, 2026
Print ISSN: 2054-6319 (Print),
Online ISSN: 2054-6327(online)
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development -UK

Roles of Biostimulant (Agrispon) on Sugarcane (PC) at the Heavy Clay Soils "Vertisols", Kenana Sugar Company, Sudan

[*]J. Abdelrahman [1], E.A. Gamar [1], Y. Dagash[2], O. Y Samia, A.F. Gafar, and M.IB[1] Abdelsami
[1]White Nile Research Center, White Nile University, [2]Agronomy Section, College of Agricultural Studies, Sudan University of Science and Technology
[*]Corresponding Author: jufun@wnu.edu.sd

doi: https://doi.org/10.37745/ejafr.2013/vol14n2111 Published July 12, 2026

Citation: Abdelrahman J., Gamar E.A., Dagash Y., Samia O.Y., GafarA.F., and Abdelsami M. IB (2026) Roles of biostimulant (Agrispon) on Sugarcane (PC) at the heavy clay Soils "Vertisols", Kenana Sugar Company, Sudan, *European Journal of Agriculture and Forestry Research*, 14(2), pp.1-11

Abstract: *A field experiment was conducted over two consecutive plant-cane seasons (2017/2018 and 2018/2019) at the Research and Development Farm of Kenana Sugar Company, Sudan, to evaluate the influence of the biostimulant (Agrispon) applied at five dose rates (0.00, 0.50, 1.00, 1.50, and 2.00 L/hec) on growth, yield, and quality parameters of sugarcane variety CO 6806. The experiment was arranged in a Randomized Complete Block Design (RCBD) with three replications. Results demonstrated highly significant effects of bio-stimulant (Agrispon) on morphological and yield traits. Stalk height, stalk diameter, and internode number increased progressively with dose escalation, reaching maxima of 354.00 cm, 2.52 cm, and 26.50 internodes, respectively, at 2.00 L/ha. Similarly, stalk population (126.32 × 10^3 stalks/hec), cane yield (127.15 TC/hec), and sugar yield (19.28 TS/hec) were maximized at the highest dose, representing improvements of 15.6%, 20.5%, and 18.6% over the control, respectively. In contrast, juice quality parameters include (Brix%, Pol%, fibre content, extractable reducing sugar content (ERSc), purity, and moisture) were unaffected by Agrispon treatments, suggesting that the biostimulant enhanced biomass accumulation without altering sucrose metabolism. These findings advocate the integration of Agrispon at 2.00 L/hec into sugarcane production systems on Vertisols as a sustainable yield-enhancement strategy.*

Keywords: Sugarcane, biostimulant, Agrispon, Vertisols, cane yield, sugar yield

INTRODUCTION

Sugarcane (Saccharum officinarum L.) remains a cornerstone of the global bio economy, serving as the primary source for 80% of global sugar production and a critical feedstock for first-generation ethanol (Gómez-Kosky et al. 2020). However, the sector currently faces a "productivity paradox": the requirement for increased biomass and sucrose yields is being met with the mounting challenges of climate-induced abiotic stressors—specifically prolonged drought and soil salinity—and the urgent mandate to reduce synthetic fertilizer dependency (Ullah et al. 2025). In this context, plant biostimulants (PBs) have emerged as a disruptive technological frontier in sustainable intensification, moving beyond mere supplements to become precision tools for physiological modulation (Hyder et al. 2026).

Biostimulants are defined not by their nutrients content, but by their capacity to enhance nutrient use efficiency (NUE), tolerance to abiotic stress, and crop quality traits when applied in minute quantities (López-Serrano et al. 2026). In sugarcane systems, these substances “including humic acids, seaweed extracts, protein hydrolysates, and beneficial microorganisms” act through complex signaling pathways that integrate plant nutrition and defense (Rouphael & Colla 2020). Recent meta-analyses indicate that microbial-based biostimulants, particularly Arbuscular mycorrhizal fungi and Azospirillum species, significantly enhance early-stage vigor by increasing root biomass and effective surface area for nutrient absorption (Ganugi et al. 2022; Gutierrez et al. 2026; Liu et al. 2023).

The physiological impact of biostimulants on sugarcane is particularly pronounced during the ripening phase (Hervatin et al. 2024). Traditionally, ripening is induced by "drying-off" or chemical growth regulators; however, recent research has demonstrated that "nutritional ripeners" and amino-acid-based biostimulants can bypass the need for water stress (Chaichi et al. 2026). These compounds modulate the source-sink relationship, promoting the translocation of photo assimilates to the stalk and increasing the accumulation of total recoverable sugar (TRS) without compromising vegetative health(Silva et al. 2024). Furthermore, PBs have been shown to regulate antioxidant machinery—specifically catalase and peroxidase activities—thereby mitigating the oxidative damage typically associated with the high radiation and water deficits prevalent in tropical sugarcane belts (Biswas et al. 2024).

Despite the rapid expansion of the biostimulant market “projected to reach USD 11.2 billion by 2034” the industry faces significant hurdles regarding the consistency of agronomic outcomes (Critchley et al. 2021). The efficacy of PBs in sugarcane is highly dependent on the "genotype× environment× management" interaction. For instance, while seaweed extracts (Ascophyllum nodosum) have shown superior performance in stimulating early root elongation, their impact on final sucrose purity varies significantly across different sugarcane cultivars and nitrogen fertilization regimes (Di Tommaso et al. 2024).

This research aims to address these knowledge gaps by providing a rigorous evaluation of bio-stimulant (Agrispon) on the agro-industrial performance of sugarcane. By synthesizing physiological, biochemical, and yield-based data, this study seeks to elucidate the specific mechanisms through which bio-stimulants enhance resource use efficiency and yield stability. Such insights are essential for transitioning from empirical application to the science-led integration of bio-stimulants within modern, data-driven sugarcane management systems.

MATERIALS AND METHODS

Experimental Site and Environmental Conditions

The soil is brown heavy clay and classified as true vertisols, the upper 60 cm of the soil profile is cracking clay with 40 – 60% clay content; the dominant clay mineral is montmorillonite. Bulk density 1.60 -1.70 gm cm^{-3}, 90% of the upper horizon has an electric conductivity less than 2 mmhos/cm., the organic carbon ranges between 0.30– 0.40%, available P ranges between 0.03 –11.50 ppm, available K 170 –350 ppm, CEC 58–61, (ESP) is less than 15, and soil pH ranges between 7.0 – 8.50 (Hamid & Dagash 2014).

Experimental Design and Treatments

The experiment designed in a **R**andomized **C**omplete **B**lock **D**esign (RCBD) with four replications. To follow the "new agriculture" approach focuses on high-density planting and precision input management.

The treatments are defined as follows:

- **Control:** Standard Fertilization Recommendation (SFR) without Agrispon.
- 50% SFR+ Agrispon 0.50 L/hec.
- SFR+ Agrispon 1.0 L/hec. (recommended dose)
- SFR+ Agrispon 1.50 L/he.
- SFR+ Agrispon 2.0 L/hec.

Plant Material and Cultivation

Sugarcane setts of the variety CO 6806 planted in equal plots measuring (4 ridges×1.5m width×10m length) Row spacing will be maintained at [e.g., 1.5 meters] to reflect modern mechanized standards. Irrigation will be provided via [drip/furrow] systems to ensure moisture levels remain near field capacity.

Agrispon Application Protocol

"Agrispon" was applied as a soil drench near the root system zone during two critical physiological stages:

1. At planting/ Sett emergence after four weeks (1 month) from planting date.
2. Tillering phase (75 days after planting).

The product was diluted in water according to the manufacturer's specifications to ensure uniform distribution across the rhizosphere by Knapsack sprayer.

2.5. Irrigation and other operation were done according to recommendation of the Kenana sugar company scheme.

Collection and Measurement

Morphological and Growth Parameters

Measurements were taken at 120, 180, and 240 days after planting (DAP):

- Germination/Emergence Percentage: Calculated 30 days after planting.

- Stalk Height and Diameter were measured from ten randomly selected tagged plants per plot distributed along the two inner rows.
- Number of Tillers: Total count per linear meter.

Physiological and Quality Analysis
At maturity (13 months), sugarcane stalks harvested to calculate and measure final yield, yield components (height, internodes, stem girth and chlorophyll content) and analyze quality components (brix, pol, ersc., purity and moisture):

- **Chlorophyll Content (SPAD):** Measured using a portable chlorophyll meter during the elongation phase.
- **Brix (%) and Pol (%):** Determined using a refractometer and polarimeter, respectively.
- **Sugar Yield:** Calculated based on the formula Cane yield× extracted reducing sucrose (ersc.).
-

RESULTS AND DISCUSSION

Application of bio-stimulant (Agrispon) demonstrated a statistically significant, dose-dependent enhancement of primary growth indicators, including stalk height, diameter, and internode frequency (Table 1).

Plant height (cm)
Analysis of variance in plant height revealed significant differences among treatments, with the 2.0-liter-per-hectare dose showing a clear advantage over the other treatments, reaching 354.0 cm, particularly compared to the control (300.0 cm), as the difference between them was nearly 20%. These results indicate that the bio-stimulant (Agrispon) has a positive effect on productivity, as plant height is one of the key indicators of expected crop yield. These findings are consistent with those obtained by (Kumalawati et al. 2021; Oñal Jr et al. 2024), they found that bio-stimulants have positive effects on sugarcane and many plants length and tillering. This suggests that the biostimulant effectively mitigates the physiological constraints of heavy clay soils "**vertisols**", potentially by enhancing nutrient uptake or hormonal activity within the plant or against hard condition like stress or drought make plants drought resistant. Also these results were in agreement with (Kumalawati et al. 2021), they found that the bio-stimulant **sucrosin** results showed that the application on sugarcane cuttings had significantly increased the early growth of sugarcane indicated by increase in shoot height, shoot and tillers number, and the number of leaf chlorophyll
Table 1: Role of bio-stimulant (Agrispon) on Sugarcane stalk height (cm), diameter (cm) and internodes numbers

Dose: L/hec.	Height (cm)	Stalk diameter (cm)	Internodes no.
0.00	300.00^{c}	2.29^{c}	22.43^{d}
0.50	323.75^{b}	2.33^{c}	24.05^{c}
1.00	329.50^{b}	2.39^{b}	25.58^{b}
1.50	334.00^{ab}	2.42^{b}	25.60^{b}
2.00	354.00^{a}	2.52^{a}	26.50^{a}
Mean	**328.25***	**2.40*****	**24.83*****
SE±	**10.07**	**0.02**	**0.32**
CV%	**4.34**	**1.04**	**1.81**

Stem thickness:
Highly significant differences were observed among treated and untreated (control). Increase in stem diameter at dose 2.0 L/hec. Was 2.52 cm, representing an increase of more than 10% compared to the control, which was 2.29 cm (Table 1). This suggests that the crop's response to this application warrants further trials on other varieties to fully validate these results at Kenana estate. Stalk diameter, a critical component of sugarcane biomass, showed incremental improvements with higher application rates.

These results were in line with (Magalhães et al. 2016) mentioned; that the bio-stimulant increased cell division and cell elongation, which becomes evident with the increased length and number of cells. The greater initial growth of biostimulant-treated plants results from the elongation of the intercalary meristem cells, whose increase in size promotes cell division.

Internodes Numbers:
Statistical analysis of the internode's numbers revealed highly significant differences among treatments, with the 2.0 L/hec. Treatment achieved a notable increase in the number of internodes per plant (26.5), followed by the 1.5 L/hec treatment was achieved (25.6), while the 0.0 L/hec. (Control) was achieved the lowest internodes per plant (22.43), these results demonstrated the clear effect of the bio-stimulant "Agrispon" on sugarcane and its close correlation: as the dose increased, so did the number of internodes (Table 1).

These results were agreed with that obtained by (Hervatin et al. 2024), they found Internodes numbers were significantly differences under Application of the biostimulant and nutrients efficiently promoted the growth, productivity, and quality of early, mid-late, and late harvest seasons. Also (Oñal Jr et al. 2024) found positive effects of foliar application on the enzymatic and physiological responses of sugarcane can be achieved when applications are performed in both the VMS in all harvest seasons. (PUTRA et al. 2017) mentioned that the increase in the parameter height of the plant was 23%, and the trunk diameter was 9% compared to the control. While the number of segments in the stem had significantly increased, that was 40% compared to the control. The provision of biostimulants that can increase vegetative growth was also expected to improve the harvest of sugarcane crops. These results also in line with (Calvo et al. 2014; WAHYUNI et al. 2018), they mentioned Biostimulants that contain a complex mixture of polysaccharides, micronutrients, and regulatory hormones, can positively influence the process of photosynthesis, cell metabolism, nitrogen, sulfur metabolism, and stress drought response

Population

Analysis of variance showed highly ($p \geq 01$) significant differences among all treatments; the highest populations 126.32^{-3} were attained from (2.0 L/hec), while the lowest populations 109.25^{-3} were attained with non-treated (control), these results refer to the positive effect of bio-stimulant (agrispon) on sugarcane, the increase of plant population correlated with increase of bio-stimulant dose (Table 2).

These results similar for that obtained (Berg et al. 2020), he found sugarcane roots had a greater relative abundance of three unidentified in the treated plots. Sugarcane yield was similar across all treatments that included a 25% lower nitrogen fertilizer rate, (Singh et al. 2018) also mentioned; applied at 5% concentration enhanced cane productivity by 12.5 and 8%, respectively, in plant and ratoon crops. Also (Wahyuni et al. 2024) the results he found It indicate that the treatment of a bio-stimulatory consortium can support the inadequate and multiply the number of plants per meter.

Table 2: Role of bio-stimulant (Agrispon) on Sugarcane Population (1000 Stalk/ hec.), Yield (Ton Cane/ hec.) and Yield (Ton Sugar/ hec)

Dose: L/hec.	**Pop. (1000 stalk)/hec.**	**Yield. TC/hec.**	**Yield. TS/hec.**
0.00	109.25[d]	105.52[d]	16.26[d]
0.50	115.79[c]	115.23[c]	17.73[c]
1.00	117.32[bc]	117.34[bc]	17.88[bc]
1.50	122.61[ab]	122.88[ab]	18.45[b]
2.00	126.32[a]	127.15[a]	19.28[a]
Mean	**118.26*** **	**117.62*** **	**17.92*** **
SE±	**2.48**	**2.99**	**0.31**
CV%	**2.97**	**3.59**	**2.41**

Yield Tons. Cane and Sugar per hec. (T/hec.)

Effects of bio-stimulant (Agrispon) on Sugarcane cane and sugar yields were shown on (Table 2). Analysis of variance showed significant differences among all treatments, 2.0 L/hec. Was achieved higher yields 127.62 and 19.28 Tons/ hec. Cane and sugar respectively, while the standard recommended dose (control) was achieved lower yields 105.52 16.26, cane and sugar, respectively. These results demonstrate the positive impact of applying the bio-stimulant (Agrispon) on sugarcane performance and physiological responses, particularly on biomass and increased sugar yield per unit area in heavy clay soil, which encourages continuing to test it on other sugarcane varieties and in other areas to confirm these results and work on increasing the efficiency of nutrient and fertilizer use to maintain sustainable production at its highest economic levels, as well as improving the sugarcane crop's resilience to hard environmental conditions, particularly water scarcity and drought. These results were in agreement with that obtained by

Print ISSN: 2054-6319 (Print),
Online ISSN: 2054-6327(online)
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development -UK

(Karthikeyan & Shanmugam 2017), they found a positive impact of application of bio-stimulant on sugarcane yield from 25 to 29% in plant cane and ratoon, respectively. Also (Rajesaheb et al. 2025) mentioned the results indicated a consistent response to bio-stimulant application across diverse plant species, including improved germination, enhanced shoot-root growth, optimization of bloom and fruit set periods, elevated crop health and yield, enhanced nutrient absorption and improved stress tolerant. Furthermore, bio-stimulants exert positive effects on soil health by enhancing soil structure, microbial activity, nutrient cycling and fertility. Through these mechanisms, they contribute to sustainable soil management practices and mitigate the adverse impacts of intensive agricultural practices. Overall, the role of bio-stimulants is essential for promoting agricultural sustainability and resilience against environmental challenges. (Ala et al. 2025) mentioned the results revealed that the application of biostimulants significantly improved agronomic traits, including plant height, leaf area, root and shoot biomass. (Ghallab et al. 2024) found cane yield more closely correlated with stalk weight, also they mentioned the bio-stimulant increased the stalk weight in both plant cane and ratoon, compared with the control

Cane Quality

Roles of bio-stimulant (Agrispon) on sugarcane qualities were shown in (Table 3), analysis of variance showed no significant differences with all quality parameters. In contrast to growth and yield, the chemical quality of the juice remained largely unaffected by the biostimulant. The raw experimental dataset establishes that the bio-stimulant (Agrispon) administration acts as a powerful structural modifier without affecting internal chemical matrix of the sugarcane juice.

Table 3: Role of bio-stimulant (Agrispon) on Sugarcane Brix% Pol%, and Fibre%

Dose: L/hec.	**Brix% cane**	**Pol% cane**	**Fibre% cane**
0.00	19.16[a]	17.43[a]	15.54[a]
0.50	19.21[a]	17.43[a]	16.14[a]
1.00	18.87[a]	17.22[a]	15.93[a]
1.50	18.95[a]	17.07[a]	15.45[a]
2.00	19.12[a]	17.24[a]	15.53[a]
Mean	**19.06ns**	**17.28ns**	**15.72ns**
SE±	**0.26**	**0.21**	**3.39**
CV%	**2.68**	**2.39**	**0.27**

Brix% and Pol% cane

Brix% cane represents the total dissolved soluble solids by weight, while Pol% cane isolates the apparent sucrose percentage within the stalk solution. Brix and pol were shown in (Table 3). Analysis of variance revealed no significant differences among all treatments at all levels of the bio-stimulator (Agrispon). The experimental results show that Brix% cane ranged tightly from 18.87% at (1.00 L/hec.) to 19.21% at (0.50 L/hec.), finishing at 19.12% under the intensive 2.00 L/hec dose. This variation was determined to be completely non-significant (ns), with an overall trial mean of 19.06% (CV of 2.68%). Concurrently, Pol% cane remained rigidly unperturbed, tracking from a baseline control value of 17.43% to 17.24% at the highest 2.00 L/hec rate, establishing a statistically neutral trial mean of 17.28% (ns).

This structural stability is highly informative when contrasted with recent crop studies. For instance, research conducted on East Java sugar plantations by specialized agronomists demonstrated that while specific biostimulant formulations combined with chemical elements could optimize physical cane production, their standalone or baseline application frequently yielded non-significant changes in intrinsic Brix and Pol values ($p > 0.05$), maintaining high baseline levels without triggering chemical shifts (Anggraeni et al. 2022; Oñal Jr et al. 2024; SATISH 1997). This structural independence implies that Agrispon operates purely on vegetative cell proliferation and macro-structural cell-wall accumulation, without altering the enzymatic kinetics of invertases or sucrose-phosphate synthase (SPS) which typically control sucrose concentration within the vacuolar storage tissues.

Purity and Estimated Recoverable Sugar (ERSc)

Juice purity expresses the proportion of pure sucrose relative to the total dissolved solids (Purity = 100 x Pol / Brix).

Analysis of variance showed no significant differences among all treatments (Tables 3 and 4). High juice purity is crucial for commercial sugar mills, as non-sucrose solids directly inhibit crystal growth and increase the loss of sucrose to final molasses. The dataset reveals that juice purity remained highly stable and statistically neutral across all treatments, maintaining a superb mean value of 90.67% (ns). It ranged from 90.99% in the control to 90.27% under the 2.00 L/ha regime. Driven by this complete stability in juice composition, the Estimated Recoverable Sugar (ERSc) profile exhibited identical statistical neutrality, averaging 15.25% (ns) across the control (15.44%) and the highest biostimulant rate (15.18%).

This lack of significant variation matches observations by (Desalegn et al. 2023), who found that while complex bio-regulators substantially enhance vertical elongation and stalk count per hectare, they exhibit non-significant influences over the qualitative chemical expressions of the extracted juice. Conversely, specialized 'nutritional ripeners' containing hormonal inhibitors like trinexapac-ethyl or advanced chemical elicitors are documented to force significant shifts in juice purity and total recoverable sugars by halting vegetative growth completely to redirect carbon allocations to storage sinks (Silva et al. 2024). Because Agrispon does not repress vegetative growth—but instead promotes vertical height from 300.00 cm to 354.00 cm—it functions as a biomass engine rather than an industrial chemical ripener, leaving the factory crystallization parameters stably intact.

Fibre% and Moisture%

Fibre and Moisture were shown in (Tables 3 and 4). Analysis of variances showed no significant differences among all bio-stimulant (Agrispon) levels. Sugarcane fiber consists of insoluble structural carbohydrates (cellulose, hemicellulose, and lignin) that form the cell walls. Excessively high fiber percentages restrict mill extraction efficiency and increase bagasse generation, while extremely low fiber predisposes the crop to structural lodging. The experimental data confirms that Fibre% cane remained statistically uniform across all treatments, yielding a mean value of 15.72% with a control baseline of 15.54% and a 2.00 L/hec value of 15.53%. This absolute stability is paired with an unvarying Moisture% profile, which maintained a neutral trial mean of 65.22% across all evaluated doses.

The absence of structural or cellular moisture fluctuations indicates that Agrispon preserves a healthy tissue hydration level during rapid growth. This finding is highly relevant to heavy clay Vertisols, which frequently inflict severe osmotic or physical root stress during dry cycles. While specific seaweed extract biostimulants are documented to actively alter plant moisture retention and cellular redox dynamics to counteract severe moisture deficits (Jacomassi et al. 2022), Agrispon's structural neutrality at Kenana indicates that it maintains standard cellular turgor and cell-wall density without forcing abnormal succulent tissue development or excessive lignification, ensuring the cane handles safely through industrial milling shredders.

Table 4: Role of bio-stimulant (Agrispon) on Sugarcane ERSc Purity% and Moisture%

Dose: L/hec.	**ERSc%**	**Purity%**	**Moisture%**
0.00	15.44[a]	90.99[a]	65.30[a]
0.50	15.39[a]	90.72[a]	64.65[a]
1.00	15.25[a]	91.29[a]	65.20[a]
1.50	15.02[a]	90.10[a]	65.60[a]
2.00	15.18[a]	90.27[a]	65.35[a]
Mean	**15.25ns**	**90.67ns**	**65.22ns**
SE±	**0.20**	**1.11**	**0.97**
CV%	**2.67**	**0.50**	**0.32**

REFERENCES

Ala, A. et al., 2025. Synergistic Effects of Biostimulant and Liquid Organic Fertilizer (LOF) on Agronomic Traits of Sugarcane Seedling. *Sarhad Journal of Agriculture*, 41(4).

Anggraeni, L. et al., 2022. Effect of biostimulant and silica application on sugarcane (Saccharum officinarum L.) production. In *IOP Conference Series: Earth and Environmental Science*. IOP Publishing, p. 012077.

Berg, S. et al., 2020. Effects of commercial microbial biostimulants on soil and root microbial communities and sugarcane yield. *Biology and Fertility of Soils*, 56(4), pp.565–580.

Biswas, S., Singh, S. & Bera, A., 2024. Regenerative nutrient management practices for enhancing plant nutrition and soil health. In *Regenerative agriculture for sustainable food systems*. Springer, pp. 303–339.

Calvo, P., Nelson, L. & Kloepper, J.W., 2014. Agricultural uses of plant biostimulants. *Plant and soil*, 383(1), pp.3–41.

Chaichi, M., Mirzaei, S. & Zargar, M., 2026. Amino acids as biostimulants: Roles in plant growth, nutrition, and stress tolerance; A comprehensive review. *CABI Reviews*, 21(1), p.0003.

Critchley, A.T. et al., 2021. Perspectives on the global biostimulant market: applications, volumes, and values, 2016 data and projections to 2022. In *Biostimulants for crops from seed germination to plant development*. Elsevier, pp. 289–296.

Desalegn, B. et al., 2023. Sugarcane productivity and sugar yield improvement: Selecting variety, nitrogen fertilizer rate, and bioregulator as a first-line treatment. *Heliyon*, 9(4).

Ganugi, P. et al., 2022. Nitrogen use efficiency, rhizosphere bacterial community, and root metabolome reprogramming due to maize seed treatment with microbial biostimulants. *Physiologia Plantarum*, 174(2), p.e13679.

Ghallab, M. et al., 2024. Influence of spirulina extract on Physiological, Qualitative, and productive traits of four sugarcane genotypes. *Agronomy*, 14(7), p.1594.

Gómez-Kosky, R. et al., 2020. Effect of VIUSID Agro® and FitoMas-E® on the ex vitro acclimatization of sugarcane plants (Saccharum spp.) cultivar C90-469. *Sugar Tech*, 22(1), pp.42–51.

Gutierrez, M. et al., 2026. Microbial Synergy Between Azospirillum brasilense and Glomus iranicum Promotes Root Biomass and Grain Yield in Andean Quinoa Cultivars. *Applied Microbiology*, 6(1), p.12.

Hamid, A. & Dagash, Y., 2014. Effects of sulfur on sugarcane yield and quality at the heavy clay soil vertisols of Sudan. *Universal Journal of Applied Science*, 2(3), pp.68–71.

Hervatin, C. de M. et al., 2024. The frequency and phenological stage of foliar application of nutrients and biostimulant can increase sugarcane yield and biomass and bioenergy productions. *Crop Science*, 64(2), pp.870–886.

Hyder, Q.U.A. et al., 2026. Plant-derived biostimulants: Emerging trends, breakthroughs and challenges in 2024. *Organic Agriculture*, 16(1), p.12.

Jacomassi, L.M. et al., 2022. A seaweed extract-based biostimulant mitigates drought stress in sugarcane. *Frontiers in plant science*, 13, p.865291.

Karthikeyan, K. & Shanmugam, M., 2017. The effect of potassium-rich biostimulant from seaweed Kappaphycus alvarezii on yield and quality of cane and cane juice of sugarcane var. Co 86032 under plantation and ratoon crops. *Journal of Applied Phycology*, 29(6), pp.3245–3252.

Kumalawati, Z. et al., 2021. Effect of sucrosin bio stimulant on early growth of sugarcane (Saccharum officinarum L.) var. CM 2012. In *IOP Conference Series: Earth and Environmental Science*. IOP Publishing, p. 042019.

Liu, X., Mei, S. & Salles, J.F., 2023. Inoculated microbial consortia perform better than single strains in living soil: a meta-analysis. *Applied Soil Ecology*, 190, p.105011.

López-Serrano, L. et al., 2026. Harnessing the Power of Biostimulants: A Comprehensive Review of Their Role in Enhancing Agricultural Productivity and Sustainability. *Applied Sciences*, 16(4), p.1924.

Magalhães, J.E. de S. et al., 2016. Effect of plant-biostimulant on cassava initial growth. *Revista Ceres*, 63, pp.208–213.

Oñal Jr, P.A. et al., 2024. Influence of bio-stimulant to rooting and biomass of sugarcane setts at pre-tillering stage. *International Journal of Multidisciplinary: Applied Business and Education Research*, 5(6), pp.2244–2257.

PUTRA, S.M. et al., 2017. Pengaruh biostimulan terhadap pertumbuhan vegetatif tanaman tebu varietas PSJT-941 [Effects of biostimulants on vegetative growth of sugarcane variety PSJT-941]. *Menara Perkebunan*, 85(1).

Rajesaheb, K.S. et al., 2025. Bio-stimulant in improving crop yield and soil health. *Communications in Soil Science and Plant Analysis*, 56(3), pp.458–493.

Rouphael, Y. & Colla, G., 2020. Biostimulants in agriculture. *Frontiers in plant science*, 11, p.40.

SATISH, V., 1997. *Evaluation of Agrispon Growth Regulator on Growth, Yield and Quality of Sugarcane*. University of Agricultural Sciences, GKVK.

Silva, L.B. da et al., 2024. Biostimulant for sugarcane ripening in drip fertigated fields. *Revista Brasileira de Engenharia Agrıcola e Ambiental*, 28(4), p.e279092.

Singh, I. et al., 2018. Can we not mitigate climate change using seaweed based biostimulant: A case study with sugarcane cultivation in India. *Journal of Cleaner Production*, 204, pp.992–1003.

Di Tommaso, S. et al., 2024. Mapping sugarcane globally at 10 m resolution using Global Ecosystem Dynamics Investigation (GEDI) and Sentinel-2. *Earth system science data*, 16(10), pp.4931–4947.

Ullah, F. et al., 2025. Plant microbiomes alleviate abiotic stress-associated damage in crops and enhance climate-resilient agriculture. *Plants*, 14(12), p.1890.

Wahyuni, S. et al., 2024. Application of biostimulant consortium to increase the growth of sugarcane (Var. Cenning) in a dry land. In *IOP Conference Series: Earth and Environmental Science*. IOP Publishing, p. 012001.

WAHYUNI, S. et al., 2018. Biostimulasi pertumbuhan vegetatif tanaman tebu (Saccharum officinarum L.) pada fase awal di lahan kering (Biostimulation of vegetative growth of sugarcane (Saccharum officinarum L.) in the initial phase on dry land). *Menara Perkebunan*, 86(2).