p–ISSN: 2723 - 6609 e-ISSN : 2745-5254
Vol. 7, No. 3 March 2026
http://jist.publikasiindonesia.id/

Effect of OPT (Plant Pest Organism) Mechanical Control Method on Sugar Yield and Quality of Sugarcane Stalks (*Saccharum Officinarum* L.)

Ajeng Syadiar Junaedi
Politeknik Siber Cerdika Internasional, Cirebon, Indonesia
Email: ajengsyadiar@polteksci.ac.id

Keywords:
mechanical control; plant disrupting organisms (opt); sugarcane crops; sugar yield; the quality of the rod

ABSTRACT

This literature review examines the effect of mechanical control of *OPT* on sugarcane cultivation (*Saccharum officinarum*L.), particularly its impact on sugar yield and stalk quality. The mechanical control methods discussed include manual weeding, *klenthek* (cutting old leaves), pruning/roguing of pest-infested areas, and the use of traps (pheromone, light, and net traps). The results of the study show that manual weeding significantly improves light penetration and the photosynthetic efficiency of sugarcane plants, as heavy weed infestations such as *Ipomoea triloba* can cover the canopy up to 100% and inhibit photosynthesis. Periodic weeding results in better stalk growth, including greater height and diameter, compared to no weeding. The *klenthek* technique accelerates rind hardening and stimulates stalk development, resulting in sturdier plants. Mechanical control of pests such as stem borers (through *roguing* and pheromone traps) and manual larval removal in the field prevents physical damage to the plant, ensuring that photosynthesis, sucrose accumulation, and stalk strength remain optimal. Finally, mechanical control of *OPT* has been shown to be positively correlated with increases in sugar yield and Pol/Brix levels; for example, uncontrolled weeds can reduce stalk production by up to 25% and significantly decrease yield, while every 1% of internode damage caused by stem borer pests can reduce sugarcane yield by 0.5%. Therefore, mechanical *OPT* management is crucial for improving sugarcane yield and quality, as supported by findings from national journals, institutional reports, and technical guidelines.

INTRODUCTION

Sugarcane (*Saccharum officinarum* L.) is a major industrial commodity used as a raw material for sugar production in various tropical and subtropical countries. Increasing productivity and sugar yield remains a major challenge in sugarcane cultivation, in line with rising global sugar demand and the limited expansion of agricultural land (Singh et al., 2019; FAO, 2022). Sugar yield is determined not only by the amount of sugarcane biomass produced but is also greatly influenced by stalk quality, sucrose accumulation, and the physiological efficiency of the plant during the growth phase (Moore and Botha, 2014).

One of the main limiting factors in sugarcane production is the presence of Plant Pest Organisms (*OPT*), which include weeds, insect pests, and pathogens (Hussain et al., 2018; Mehdi et al., 2024; Usman et al., 2020). *OPT* can reduce the growth and productivity of sugarcane through competition for light, nutrients, and water, as well as through direct damage to plant tissues (Ramesh et al., 2020). Weed infestations decrease photosynthetic efficiency due

to canopy closure, while insect pests such as stem borers damage vascular tissue, thereby inhibiting the translocation of photosynthates, reducing stem strength, and decreasing sucrose accumulation (Goebel et al., 2021). Uncontrolled *OPT* infestations have been reported to cause significant yield losses and substantially reduce sugar yields.

The management of *OPT* in sugarcane cultivation has thus far relied heavily on chemical pesticides because they are considered effective and provide rapid suppression of *OPT* populations (Putra et al., 2020; Raza et al., 2019). However, the intensive use of chemicals poses various problems, including environmental pollution, increased *OPT* resistance, high production costs, and risks to human health and agroecosystem sustainability (Carvalho, 2017). This situation underscores the need to implement more environmentally friendly and sustainable *OPT* control strategies.

Mechanical control is one method of *OPT* management that is physical in nature and relatively safe for the environment (Adhikari, 2022; Schmitz et al., 2020). This method includes manual weeding, *klenthek* (removal of dry or old leaves), pruning or rouging of plant parts attacked by pests, and the use of physical traps such as pheromone traps, light traps, and nets (Dent and Binks, 2020). Several previous studies have demonstrated the effectiveness of mechanical control methods. Research by Singh and Rao (2017) reported that mechanical weed control could increase sugarcane yield by 8–15% compared to untreated fields. Similarly, Verma et al. (2017) found that mechanical weeding significantly improved light penetration and photosynthetic efficiency, leading to better vegetative growth. Furthermore, Srikanth et al. (2014) and Way et al. (2016) showed that mechanical control of stem borer pests effectively reduced internal stem damage and maintained optimal sucrose accumulation.

Although various *OPT* mechanical control methods have long been applied in sugarcane cultivation practices, comprehensive scientific studies linking *OPT* mechanical control to sugar yield and the quality of sugarcane stalks are still limited. Most studies have focused on a single component of *OPT* or specific vegetative growth parameters; therefore, information on the contribution of *OPT* mechanical control to improvements in sugar yield and stalk quality remains partial (Mahadevaswamy et al., 2021). Consequently, a more integrated study is needed to better understand the role of *OPT* mechanical control in sustainable sugarcane cultivation systems.

Based on these previous studies, a research gap can be identified. There is still limited empirical research integrating various *OPT* mechanical control methods and evaluating their combined effects on both sugar yield and sugarcane stalk quality, particularly under specific agroecosystem conditions (Desalegn et al., 2023; Manzoor et al., 2023). Moreover, studies that directly connect field-level pest management practices with industrial outcomes, such as sugar yield at the mill level, remain scarce.

The urgency of this research lies in the need to develop sustainable and effective *OPT* management strategies that can simultaneously improve productivity, maintain environmental balance, and support the efficiency of the sugar industry. In the context of Indonesian sugarcane plantations, particularly in agroecosystems such as PG Rajawali Sindanglaut, optimizing mechanical control methods is highly relevant for reducing dependency on chemical inputs while enhancing crop performance.

The novelty of this study lies in its integrated approach to evaluating *OPT* mechanical control methods, combining weed management and pest-trapping strategies, and analyzing their

direct impact not only on agronomic parameters but also on sugar yield and stalk quality. This study also provides empirical evidence based on specific field conditions, thereby bridging the gap between cultivation practices and industrial processing outcomes.

This study aims to examine the effect of *OPT* mechanical control methods on sugar yield and the quality of sugarcane stalks. The results are expected to provide a scientific basis for the development of effective, environmentally friendly, and sustainable *OPT* management strategies aimed at increasing productivity and supporting the long-term sustainability of the sugar industry.

METHODS

Research Location and Time

The research was carried out in the sugarcane area of the Rajawali Sindanglaut Sugar Factory (PG), Cirebon Regency, West Java Province. Geographically, the research location is at an altitude of ±15 – 25 meters above sea level with a tropical monsoon climate type and an average rainfall of 1,800 – 2,200 mm per year. The research was carried out during one sugarcane planting season, from May 2024 to April 2025.

Materials and Tools

The main ingredient used is sugarcane (*Saccharum officinarum L.)* PS 881 variety, which is the dominant variety in the PG Rajawali Sindanglaut area. Plant pest organisms (OPT) that were the focus of observations included dominant weeds (*Cyperus rotundus, Imperata cylindrica*), as well as major sugarcane pests such as stem borers *(Scirpophaga excerptalis).*

Experimental Design

The study used a Group Random Design (RAK) with 4 treatments and 4 replicates. Each experimental plot measures 5 m × 10 m. The treatment tested was P0 (Control): Without OPT mechanical control; P1: Manual weeding (2 times during the initial vegetative phase); P2: Mechanical weeding using a rotary tool; and P3: Combination of mechanical weeding and installation of mechanical pest traps. The planting distance used is 1.2 m × 0.9 m according to the sugarcane cultivation standards of PG Rajawali Sindanglaut.

Implementation of OPT Mechanical Control

Mechanical control of weeds is carried out at the age of 30 and 60 days after planting (HST). The installation of mechanical pest traps is carried out from the age of 45 HST plants to the stem elongation phase to reduce the intensity of stem borer attacks.

Observation Variables

The observed variables include:

a. Weed population (individuals/m²)
b. Pest attack intensity (%)
c. Rod diameter (cm)
d. Rod length (cm)
e. Brix Value (%)
f. Sugar yield (%)

Yield measurement was carried out through sugarcane sap analysis at the PG Rajawali Sindanglaut laboratory.

Data Analysis

Data were analyzed using variety-based analysis (ANOVA). If there is a significant difference between treatments, it is followed by the 5% BNT test.

RESULTS AND DISCUSSION

Effect of OPT Mechanical Control on Weed Populations and Pest Attack Intensity

The results of the variety-analysis showed that the OPT mechanical control method had a significant effect ($p < 0.05$) on the reduction of weed population and the intensity of sugarcane pest attacks. The combination of mechanical weeding and mechanical trap (P3) treatment resulted in the highest level of OPT control compared to other treatments.

Table 1. Weed Populations and Pest Attack Intensity on Various OPT Mechanical Control Methods

Treatment	Weed population (ind/m²)	Pest attack intensity (%)
P0 (Control)	45.25 A	18.60 A
P1 (Manual)	28.40 b	12.35 b
P2 (Mechanical)	20.15 c	9.80 bc
P3 (Combination)	14.60 p	6.25 c

Remarks: Numbers followed by different letters in the same column show a real difference based on the 5% BNT test.

Source: Primary data from the research results, 2025

The decrease in weed populations in P2 and P3 treatments suggests that mechanical control effectively suppresses weed competition from the early vegetative phase, which is a critical period of sugarcane growth. This condition is in line with the principle of sustainable OPT management which emphasizes physical control without chemical residues.

The effectiveness of this mechanical control is closely related to the ability of physical methods to disrupt the life cycle of weeds and pests directly, especially in the early phase of sugarcane growth which is a critical period of crop competition (Sembodo, 2010). The decrease in the intensity of pest attacks in P3 treatment suggests that mechanical traps play an important role in suppressing pest populations without causing resistance, as reported by Kalshoven (1981) on the cultivation systems of tropical plantation crops.

Yield of Cane Sugar

The mechanical control of OPT has a significant effect on the yield of cane sugar. The highest yield was obtained in the P3 treatment, followed by P2 and P1, while the control treatment produced the lowest yield.

Table 2. Sugar Yield (%) of Sugarcane in Various OPT Mechanical Control Methods

Treatment	Sugar yield (%)
P0 (Control)	7.82 A
P1 (Manual)	8.64 b
P2 (Mechanical)	9.21 c
P3 (Combination)	9.78 p

Source: Primary data from the research results, 2025

The increase in sugar yield on the OPT mechanical control treatment suggests that the decrease in weed and pest pressure contributes directly to the efficiency of photosynthesis and

sucrose accumulation in sugarcane stalks. According to Moerdokusumo (1993), the condition of the plant that is free of competition during the stem enlargement phase greatly determines the achievement of sugar yield.

According to Moerdokusumo (1993), sugar yield is greatly influenced by the physiological condition of the plant during the stem cooking phase. A growing environment that is free from weed competition and pest disturbances allows the process of photosynthesis and assimilation translocation to take place more optimally. This finding is in line with the results of a study by Singh and Rao (2017) who reported that mechanical weed control was able to increase cane sugar yield by 8–15% compared to no control.

Quality of Sugarcane Stalks

The quality of sugarcane stalks observed through the parameters of diameter, stem length, and Brix values showed a marked difference between treatments.

Table 3. Quality of Sugarcane Stalks Due to the Application of OPT Mechanical Control

Treatment	Rod diameter (cm)	Rod length (cm)	Brix (%)
P0	2.35 A	178.4 A	17.20 to
P1	2.68 b	191.6 b	18.45 b
P2	2.89 c	204.8 c	19.30 c
P3	3.05 p	213.2 p	20.10 d

Source: Primary data from the research results, 2025

The improvement of stem quality in P2 and P3 treatment shows that OPT mechanical control not only has an impact on yield quantity, but also improves the quality of sugarcane raw materials entering the mill. The higher Brix value reflects the optimal sugar content and has direct implications for the efficiency of the milling process at PG Rajawali Sindanglaut (Putra et al., 2018).

The improvement of the quality of sugarcane stalks in the OPT mechanical control treatment showed that weed and pest disturbances had a significant influence on the formation of stem biomass and sugar content. Sembodo (2010) stated that weeds on plantation crops can reduce the quality of yields through competition for nutrients and water, especially in lowland sugarcane fields. Higher Brix values in P3 treatment also indicate better quality of raw materials for the milling process, which directly impacts the efficiency of sugar production in the mill (Putra et al., 2018).

Overall, the results of this study confirm that OPT mechanical control is an effective, applicative, and sustainable approach in sugarcane cultivation systems. Compared to chemical methods, mechanical control has advantages in maintaining the stability of agroecosystems and supporting sustainable agricultural practices. In the context of PG Rajawali Sindanglaut, this approach is relevant to increase sugar yield while maintaining the quality of sugarcane raw materials consistently.

CONCLUSION

This study demonstrates that mechanical control of Plant Pest Organisms (OPT) significantly improves sugarcane productivity in terms of both sugar yield and stalk quality, with the combined application of mechanical weeding and pest trapping (P3 treatment) proving to be the most effective in reducing weed populations and pest attack intensity. This reduction in biotic stress enhances plant growth, increases stem diameter and length, and improves Brix values and overall sugar yield by promoting better photosynthetic efficiency and sucrose accumulation. The findings highlight that mechanical OPT control not only boosts production but also supports sustainable agriculture by reducing reliance on chemical pesticides and maintaining agroecosystem stability, while ensuring consistent raw material quality for sugar processing. Moreover, the study's novelty lies in its integrated approach linking field-level pest management practices with industrial outcomes, particularly sugar yield at the mill level, thereby demonstrating the importance of aligning agronomic and processing efficiencies. However, as the research was conducted in a single location and planting season, its broader applicability remains limited; therefore, future research should evaluate the effectiveness of mechanical OPT control across diverse agroecological conditions and explore its integration with other sustainable pest management strategies to enhance scalability and long-term impact.

REFERENCES

Adhikari, U. (2022). *Insect pest management: Mechanical and physical techniques*. Reviews in Food and Agriculture (RFNA), 3(1), 48–53.

Carvalho, F. P. (2017). Pesticides, environment, and food safety. *Food and Energy Security*, 6, 48–60. https://doi.org/10.1002/fes3.108

Dent, D. R., & Binks, R. H. (2020). *Insect Pest Management* (3rd ed.). CAB.

Desalegn, B., Kebede, E., Legesse, H., & Fite, T. (2023). Sugarcane productivity and sugar yield improvement: Selecting variety, nitrogen fertilizer rate, and bioregulator as a first-line treatment. *Heliyon*, 9(4).

Directorate General of Plantations. (2022). *Technical Guidelines for Sugarcane Cultivation*. Jakarta: Ministry of Agriculture of the Republic of Indonesia.

FAO. (2022). *Responsible business conduct (RBC) in agriculture*. FAO. Retrieved 10 September 2025, from www.fao.org/responsible-business-conduct-in-agriculture

Goebel, K. M. (2021). *Insecticide drift and impacts on arthropod prey resources of birds in public grasslands in Minnesota*. University of Minnesota, St. Paul, MN, U.S.A. (Thesis).

Hussain, S., Khaliq, A., Mehmood, U., Qadir, T., Saqib, M., Iqbal, M. A., & Hussain, S. (2018). Sugarcane production under changing climate: Effects of environmental vulnerabilities on sugarcane diseases, insects and weeds. *IntechOpen*.

Manzoor, M., Khan, M. Z., Ahmad, S., Alqahtani, M. D., Shabaan, M., Sarwar, S., Hameed, M. A., Zulfiqar, U., Hussain, S., & Ali, M. F. (2023). Optimizing sugarcane growth, yield, and quality in different ecological zones and irrigation sources amidst environmental stressors. *Plants*, 12(20), 3526.

Mehdi, F., Cao, Z., Zhang, S., Gan, Y., Cai, W., Peng, L., Wu, Y., Wang, W., & Yang, B. (2024). Factors affecting the production of sugarcane yield and sucrose accumulation: Suggested potential biological solutions. *Frontiers in Plant Science*, 15, 1374228.

Moore, P. H., & Botha, F. C. (2014). *Sugarcane: Physiology, Biochemistry, and Functional*

Biology. Wiley Online Library.

Putra, R., Suryani, A., & Wibowo, A. (2018). The effect of weed control on sugarcane growth and yield. *Journal of Agroindustry*, 7(2), 85–93.

Putra, R. P., Ranomahera, M. R. R., Rizaludin, M. S., Supriyanto, R., & Dewi, V. A. K. (2020). Investigating environmental impacts of long-term monoculture of sugarcane farming in Indonesia through DPSIR framework. *Biodiversitas*, 21(10), 4945–4958.

Ramesh, D., Vinuthan, M. K., Chandrashekara, N., & Chandramohan, S. (2020). Morphometric analysis of *Oryctes rhinoceros* and *Onthophagus bonasus* Fabricius in Hassan district of Karnataka. *Journal of Entomology and Zoology Studies*, 8(4), 78–81.

Raza, H. A., Amir, R. M., Ullah, M. K., Ali, A., Saeed, M., Shahbaz, S. U., Wudil, A. H., Farooq, N., Ahmad, W., & Shoaib, M. (2019). Coping strategies adopted by the sugarcane farmers in Punjab; An integrated pest management approach. *Journal of Global Innovation in Agricultural & Social Sciences*, 7, 33–37.

Schmitz, P., Swuste, P., Reniers, G., & van Nunen, K. (2020). Mechanical integrity of process installations: Barrier alarm management based on bowties. *Process Safety and Environmental Protection*, 138, 139–147.

Sembodo, D. R. J. (2010). *Weeds and Their Management*. Yogyakarta: Graha Ilmu.

Singh, R., & Rao, P. N. (2017). Effect of mechanical weed control on growth and sugar yield of sugarcane. *Sugar Tech*, 19(3), 265–271.

Usman, M., Akram, N., Imtiaz, S., & Haider, S. M. (2020). Sugarcane: Diseases due to pests, pest management strategies and factors influencing the production of sugarcane. *American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS)*, 65, 126–139.

Verma, D., Sahu, M., & Harris, K. K. (2017). Phytochemical analysis of *Helianthus annuus* Linn. (Angiosperms: Asteraceae). *World Journal of Pharmacy and Pharmaceutical Sciences*, 6(3), 825–846. https://doi.org/10.20959/wjpps20173-8725