

Effects of Vermicompost on Sugarcane Productivity and Soil Carbon Accumulation

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ABSTRACT

Background and Objective: The application of vermicompost in sugarcane cultivation leads to an increase sugarcane yield by enhancing soil nutrient content, cane growth and boosting soil carbon accumulation as well as through enrichment of soil fertility. This study investigates the impact of vermicompost application on sugarcane productivity and soil carbon accumulation. It aims to determine how vermicompost influences crop yield, soil fertility, and carbon sequestration, providing insights into sustainable sugarcane cultivation practices. **Materials and Methods:** The field experiment was conducted on over four cropping seasons. The soil of the area was silt loam and moderate fertility. The experiment followed a Randomized Complete Block Design (RCBD) with eight treatments combining different rates of vermicompost and chemical fertilizers. Results revealed that the highest sugarcane yield of 143.40 t/ha was found in T₄ treatment where vermicompost @ 5 t/ha along with N₁₈₀P₄₀K₉₀S₄₅Mg₁₀Zn₄ kg/ha was applied. Soil organic carbon and carbon stock were also substantially improved by vermicompost application, with the highest carbon accumulation of 1.82 t/ha was observed in T₄. **Results:** The trends of increased yield in sugarcane of 69%>62%>45%>34% in the cropping year of 2020-2021, 2019-2020, 2021-2022 and 2022-2023, respectively where the integrated use of vermicompost at 5 t/ha along with inorganic fertilizers of N₁₈₀P₄₀K₉₀S₄₅Mg₁₀Zn₄ kg/ha. In 2022-2023 cropping season, the highest level of carbon storing or accumulation of 95% was occurred where incorporation of vermicompost at 5 t/ha along with in organic fertilizers of N₁₈₀P₄₀K₉₀S₄₅Mg₁₀Zn₄ kg/ha were applied. **Conclusion:** The application of vermicompost with the recommended dose of fertilizer significantly increased tiller number, millable cane count, and overall yield across all cropping years but sugar quality measured by Brix percentage did not show any significant variation among treatments. Overall, the use of vermicompost in combination with chemical fertilizers enhanced sugarcane productivity that contributed to soil carbon accumulation, supporting its role in sustainable crop production.

KEYWORDS

Sugarcane, vermicompost, yield, soil organic carbon, carbon accumulation, sustainable agriculture

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INTRODUCTION

Sugarcane is a long-duration, nutrient-exhaustive crop that removes a substantial amount of nutrients from the soil, leading to soil degradation¹. Maintaining soil fertility is therefore critical for sustainable sugarcane cultivation, particularly in tropical regions like Bangladesh, where soils are inherently low in organic matter and often degraded due to intensive cropping².



Vermicompost, a nutrient-rich organic amendment derived from the decomposition of organic matter by earthworms, has emerged as an effective solution to improve soil health and crop productivity³. When applied as a fertilizer, vermicompost not only enhances plant growth and yield but also improves the nutritional value of the crops⁴. It significantly contributes to the improvement of soil physico-chemical properties, including aggregation, structural stability, pH, electrical conductivity, bulk density, water holding capacity, organic matter content, and the availability of both micro- and macronutrients^{5,6}. Moreover, vermicompost enhances biological properties by increasing microbial populations and enzymatic activities, thereby promoting a more biologically active soil environment⁷. The application of vermicompost strengthens soil structure and reduces susceptibility to degradation from natural calamities such as erosion. Its positive effects are evident at both early and later stages of plant development, although the optimum concentration is crucial for maximizing benefits⁸. Beyond improving soil fertility, vermicompost plays a key role in carbon accumulation by increasing soil organic carbon levels and reducing carbon dioxide emissions associated with intensive agricultural practices⁹, a balanced nutrient supply is essential to achieve high crop productivity and nutritional quality. Integrating chemical fertilizers with organic amendments like vermicompost is increasingly recommended to address nutrient deficiencies and reverse soil quality deterioration caused by continuous cropping and heavy chemical inputs¹⁰.

The application of vermicompost with inorganic fertilizer resulted in increased sugarcane yield and accumulated organic carbon with the addition of nitrogen, phosphorus, potassium and sulphur in soils, which indicated increasing trend of soil fertility. The combined use of vermicompost and inorganic fertilizers enhanced absorption capacity of N, P, K and S in sugarcane leaf tissues that led to higher sugarcane yield. For the balanced fertilization of sugarcane, vermicompost is crucial for maximizing yield and maintaining soil fertility¹¹.

In Bangladesh, soils are typically low in organic carbon and essential plant nutrients due to factors such as intensive cropping, high organic matter decomposition rates, and a hot humid climate¹². Additionally limited use of organic manures and green manuring practices has further contributed to the decline in soil quality. Recently sugarcane does not compete with high-value crops due to its long life span and low profitability. Sugarcane is now growing marginal and low laying land having soil fertility is very low. Therefore, to overcome this situation, it is needed to adopt best management practices that enhance soil carbon accumulation and restore long-term soil fertility for sugarcane cultivation.

Carbon accumulation is fundamental to improving soil health, crop productivity, and input use efficiency. Vermicompost has shown great promise as a miracle soil conditioner and plant growth promoter capable of revitalizing soil and boosting yields¹³. Therefore, the present study was undertaken to evaluate the effect of vermicompost on sugarcane yield and carbon accumulation in soil.

MATERIALS AND METHODS

Experimental site and duration: The experiment was conducted over four consecutive cropping seasons: 2019-2020, 2020-2021, 2021-2022, and 2022-2023, at Chandra, Jamalpur Sadar, Jamalpur, located in the Young Brahmaputra and Jamuna Floodplain (Agro Ecological Zone 8). This region is characterized by alluvial soils with low to moderate fertility (Table 1) but prone to nutrient depletion due to intensive cropping¹⁴.

Experimental design and treatments: The study was laid out in a Randomized Complete Block Design (RCBD) with three replications, a commonly used design in agronomic field trials to reduce variability and improve accuracy. Eight treatments were included: T₁: Control (no fertilizer), T₂: Recommended Fertilizer Dose (RFD) 2018, T₃: RFD 2018+Vermicompost @ 2.5 t/ha, T₄: RFD

Table 1: Nutrient status of initial soil

Soil analysis interpretation	Texture	pH	OC (%)	Total N (%)	Available P (mg/kg)	Exchangeable K (cmol (+)/kg)	Available S (mg/kg)
	Silt loam	6.75	0.84	0.08	7.7	0.19	10.11

Table 2: Nutrient composition of vermicompost

Elements	pH	OC (%)	N (%)	P (mg/kg)	K (cmol(+)/kg)	S (mg/kg)
	6.24	17.50	1.44	0.90	0.98	0.68

2018+Vermicompost @ 5.0 t/ha, T₅: A 75% RFD 2018+Vermicompost @ 2.5 t/ha, T₆: A 75% RFD 2018+Vermicompost @ 5.0 t/ha, T₇: A 50% RFD 2018+Vermicompost @ 2.5 t/ha and T₈: A 50% RFD 2018+Vermicompost @ 5.0 t/ha. This integrated nutrient management approach follows established protocols to evaluate organic and inorganic fertilizer interactions in sugarcane^{14,15}.

Preparation of vermicompost and nutrient status: Vermicompost used in the experiment was produced at the research station premises using cow dung as the primary substrate. The composting process was carried out using the Chari system with the earthworm species *Eisenia fetida*¹⁶. The entire decomposition process generally was taken 3 months and nutrient statuses of this compost were determined (Table 2).

Cultural practices: Sugarcane was planted following standard agronomic practices undertaken by Bangladesh Sugarcrop Research Institute. Vermicompost was applied as a basal dose before planting, and chemical fertilizers were applied according to the treatment schedules. Intercultural operations such as weeding, irrigation, earthing up, and pest management were uniformly applied across all treatments to maintain consistency.

Data collection and soil sampling: Data were collected on the growth and yield parameters like as number of tillers per clump, number of millable canes per hectare, Cane yield (t/ha), Soil samples were collected from 0-15 cm depth before planting and after harvesting each season, consistent with standard soil sampling procedures for agronomic research¹⁷. Parameters analyzed included: Organic carbon (%) using the Walkley and Black method¹⁸, bulk density (g/cm³)¹⁷, soil organic carbon stock (Mg C/ha), soil carbon stock was calculated using the formula⁷:

$$\text{SOC stock (Mg C/ha)} = \text{SOC (\%)} \times \text{Bulk Density (g/cm}^3\text{)} \times \text{Soil Depth (cm)} \times 10 \text{ as applied in soil carbon studies}$$

Statistical analysis: All collected data were subjected to Analysis of Variance (ANOVA) using appropriate statistical software. The significance of treatment effects was tested at the 5% probability level, and treatment means were separated using the Least Significant Difference (LSD) test.

RESULTS

Effect of vermicompost on sugarcane tillering: The number of tillers per hectare was significantly influenced by the application of vermicompost in combination with chemical fertilizers across all four cropping seasons (2019-20 to 2022-2023). As shown in Table 3 in the 2020-2021 and 2022-2023 cropping seasons, tiller production was consistently highest in T₄ (RFD+Vermicompost @ 5 t/ha) treatment. In the 2020-2021 cropping seasons, tiller production was highest in T₄ ($182.56 \times 10^3/\text{ha}$) followed by T₃ ($155.38 \times 10^3/\text{ha}$) > T₂ ($150.51 \times 10^3/\text{ha}$) > T₈ ($147.52 \times 10^3/\text{ha}$) > T₇ ($147.52 \times 10^3/\text{ha}$) > T₅ ($145.30 \times 10^3/\text{ha}$) > T₆ ($127.18 \times 10^3/\text{ha}$). In the 2022-2023 cropping seasons, tiller production was highest in T₄ ($178.06 \times 10^3/\text{ha}$) treatment which was followed by T₃ ($158.19 \times 10^3/\text{ha}$) > T₅ ($150.14 \times 10^3/\text{ha}$) > T₇ ($144.58 \times 10^3/\text{ha}$) > T₆ ($142.06 \times 10^3/\text{ha}$). In the 2019-2020 cropping season, the highest tiller count ($118.70 \times 10^3/\text{ha}$) was recorded in T₃, although not significantly different from T₂ ($111.11 \times 10^3/\text{ha}$), T₄ ($114.81 \times 10^3/\text{ha}$) and T₆ ($117.96 \times 10^3/\text{ha}$) and followed by T₇ ($109.29 \times 10^3/\text{ha}$) > T₅ ($106.66 \times 10^3/\text{ha}$) > T₈ ($101.09 \times 10^3/\text{ha}$). In the 2021-2022 cropping season, T₃ had a significantly higher tiller count

Table 3: Effect of vermicompost and chemical fertilizer combinations on sugarcane tiller production ($\times 10^3/\text{ha}$)

Treatments	Tiller ($\times 10^3/\text{ha}$)			
	2019-2020	2020-2021	2021-2022	2022-2023
T ₁	91.04 ^b	95.64 ^b	100.00 ^{ab}	117.92 ^c
T ₂	111.11 ^a	150.51 ^{ab}	116.67 ^a	130.97 ^{bc}
T ₃	118.70 ^a	155.38 ^{ab}	133.47 ^a	158.19 ^{ab}
T ₄	114.81 ^a	182.56 ^a	132.22 ^a	178.06 ^a
T ₅	106.66 ^{ab}	145.30 ^{ab}	116.94 ^a	150.14 ^{ac}
T ₆	117.96 ^a	127.18 ^{ab}	118.75 ^a	142.06 ^{ac}
T ₇	109.29 ^{ab}	136.07 ^{ab}	103.74 ^{ab}	144.58 ^{ac}
T ₈	101.09 ^{ab}	147.52 ^{ab}	80.55 ^b	139.17 ^{bc}
LSD _{0.05}	9.21	30.72	27.72	17.84

Means within a column followed by the same letter are not significantly different at $p \leq 0.05$

Table 4: Effect of vermicompost and chemical fertilizer combinations on millable cane production ($\times 10^3/\text{ha}$)

Treatments	Millable cane ($\times 10^3/\text{ha}$)			
	2019-2020	2020-2021	2021-2022	2022-2023
T ₁	66.66 ^c	55.38 ^b	61.67 ^b	71.77 ^c
T ₂	89.62 ^{ab}	90.12 ^a	81.81 ^b	80.38 ^{bc}
T ₃	95.92 ^a	94.02 ^a	86.81 ^{ab}	96.59 ^{ab}
T ₄	86.85 ^{ab}	95.43 ^a	113.75 ^a	109.42 ^a
T ₅	86.66 ^{ab}	89.32 ^a	76.95 ^b	91.08 ^{abc}
T ₆	98.33 ^a	91.41 ^a	72.36 ^b	86.84 ^{abc}
T ₇	84.62 ^{ab}	87.61 ^a	68.47 ^b	88.13 ^{abc}
T ₈	81.66 ^b	88.57 ^a	60.27 ^b	84.92 ^{bc}
LSD _{0.05}	6.59	5.94	6.94	11.35

Means within a column followed by the same letter are not significantly different at $p \leq 0.05$

(133.47 $\times 10^3/\text{ha}$) which was similar with T₂ (116.67 $\times 10^3/\text{ha}$), T₄ (132.22 $\times 10^3/\text{ha}$), T₅ (116.94 $\times 10^3/\text{ha}$), T₆ (118.75 $\times 10^3/\text{ha}$) and followed by T₁ (100.00 $\times 10^3/\text{ha}$) > T₇ (103.74 $\times 10^3/\text{ha}$). Overall, all vermicompost supplemented treatments performed better than the control (T₁), indicating a positive role of organic inputs in enhancing early growth and tiller production in sugarcane.

Effect on number of millable canes: The number of millable canes per hectare was also significantly affected by the treatments across all four years. As shown in Table 4, T₄ again showed the best performance, particularly in the three consecutive years (2020-2021, 2021-2022 and 2022-2023). In the 2020-2021 cropping season, the highest millable cane was counted in T₄ (95.43 $\times 10^3/\text{ha}$) which was statistically similar with T₂ (90.12 $\times 10^3/\text{ha}$), T₃ (94.02 $\times 10^3/\text{ha}$), T₅ (89.32 $\times 10^3/\text{ha}$), T₆ (91.41 $\times 10^3/\text{ha}$), T₇ (87.61 $\times 10^3/\text{ha}$) and T₈ (88.57 $\times 10^3/\text{ha}$) except T₁ (55.38 $\times 10^3/\text{ha}$). In the 2021-2022 cropping season, T₄ was statistically similar with T₃ (86.81 $\times 10^3/\text{ha}$) but different and superior from others. On the other hand T₃ (86.81 $\times 10^3/\text{ha}$) was statistically similar with T₂ (81.81 $\times 10^3/\text{ha}$), T₅ (76.95 $\times 10^3/\text{ha}$), T₆ (72.36 $\times 10^3/\text{ha}$), T₇ (68.47 $\times 10^3/\text{ha}$), T₁ (61.67 $\times 10^3/\text{ha}$) and T₈ (60.27 $\times 10^3/\text{ha}$). In 2022-2023, T₄ (109.42 $\times 10^3/\text{ha}$) was significantly higher all other treatments but followed by T₃ (96.59 $\times 10^3/\text{ha}$), T₅ (91.08 $\times 10^3/\text{ha}$), T₆ (86.84 $\times 10^3/\text{ha}$), T₇ (88.13 $\times 10^3/\text{ha}$). The lowest millable cane numbers were consistently observed in T₁ (71.77 $\times 10^3/\text{ha}$) highlighting the importance of imbalanced nutrition. In the 2019-2020 cropping season, the highest millable cane was found in T₆ (98.33 $\times 10^3/\text{ha}$) which was statistically similar with T₃ (95.92 $\times 10^3/\text{ha}$) and was followed by T₂ (89.62 $\times 10^3/\text{ha}$), T₄ (86.85 $\times 10^3/\text{ha}$), T₅ (86.66 $\times 10^3/\text{ha}$), T₇ (86.42 $\times 10^3/\text{ha}$).

Sugarcane yield: Sugarcane yield was significantly influenced by the application of vermicompost across all four cropping seasons (2019-2020 to 2022-2023). The yield increased markedly in the treatments where vermicompost was applied in combination with chemical fertilizers compared to the control or only fertilizer used plots. As shown in Table 5, in 2019-2020 cropping season, the highest yield was recorded

Table 5: Effect of vermicompost and fertilizer combinations on sugarcane yield (t/ha)

Treatments	Yield (t/ha)			
	2019-2020	2020-2021	2021-2022	2022-2023
T ₁	43.21 ^c	39.10 ^c	78.35 ^c	63.10 ^b
T ₂	80.63 ^b	107.20 ^{ab}	97.13 ^{bc}	70.46 ^b
T ₃	103.33 ^a	124.00 ^{ab}	124.09 ^{ab}	84.22 ^{ab}
T ₄	112.33 ^a	127.17 ^a	143.40 ^a	95.15 ^a
T ₅	86.47 ^b	107.43 ^{ab}	101.54 ^{bc}	80.10 ^{ab}
T ₆	104.33 ^a	108.73 ^{ab}	84.62 ^c	75.95 ^{ab}
T ₇	78.56 ^b	104.60 ^b	85.22 ^c	76.97 ^{ab}
T ₈	80.08 ^b	106.27 ^{ab}	95.06 ^{bc}	74.25 ^{ab}
LSD _{0.05}	5.48	10.18	10.18	9.98

Means within a column followed by the same letter are not significantly different at $p \leq 0.05$

Table 6: Effect of vermicompost and fertilizer combinations on Brix (%) of sugarcane juice

Treatments	Brix (%)			
	2019-2020	2020-2021	2021-2022	2022-2023
T ₁	17.50	17.50	18.50	18.50
T ₂	17.00	17.00	18.50	18.50
T ₃	17.00	17.00	19.00	19.00
T ₄	18.00	18.00	19.50	19.50
T ₅	17.50	17.50	19.50	19.50
T ₆	17.00	17.00	18.50	18.50
T ₇	18.00	18.00	19.00	19.00
T ₈	18.00	18.00	19.00	19.00
LSD _{0.05}	ns	ns	ns	ns

ns: Not significant at $p \leq 0.05$

in T₄ (112.33 t/ha), it was statistically similar with T₃ (103.33 t/ha) and T₆ (104.33 t/ha). Treatment T₅ (86.47 t/ha) performed better and it was statistically similar with T₂ (80.63 t/ha), T₇ (78.56 t/ha) and T₈ (80.08 t/ha). In 2020-2021 cropping season, the highest yield was recorded in T₄ (127.17 t/ha) which was followed by T₃ (124.00 t/ha) > T₆ (108.37 t/ha) > T₅ (107.43 t/ha) > T₂ (107.20 t/ha) > T₈ (106.27 t/ha) > T₇ (104.60 t/ha). In 2021-2022 cropping season, the highest yield was recorded in T₄ (143.43 t/ha) which was similar with T₃ (124.09 t/ha). Treatment T₅ (101.54 t/ha) was recorded second highest yield that was similar with T₂ (97.13 t/ha) and T₈ (95.06 t/ha) followed by T₇ (85.22 t/ha) > T₆ (84.62 t/ha). In 2022-2023 cropping season, the highest yield was recorded in T₄ (95.15 t/ha) which was followed by T₃ (84.22 t/ha) > T₅ (80.10 t/ha) > T₇ (76.97 t/ha) > T₆ (75.95 t/ha) > T₈ (74.25 t/ha). The lowest yield was observed in T₁ (63.10 t/ha) in all years, indicating the necessity of nutrients supplementation for sustainable sugarcane production.

Brix percentage: Brix (%) indicates the sugar content of sugarcane juice, and is an important quality trait in evaluating cane suitability for sugar production. The recorded Brix values across the four cropping seasons (2019-2020 to 2022 -2023) are presented in Table 6. Although minor differences in Brix values were observed among all treatments, the differences were not statistically significant (ns) at the 5% level in any year. This suggests that the application of vermicompost, either alone or in combination with chemical fertilizers, did not significantly affect sugar accumulation in sugarcane juice.

Carbon accumulation in soil: Soil organic carbon (SOC) and carbon stock significantly increased following the application of vermicompost, particularly when combined with chemical fertilizers (Table 7). All treatments started with the same baseline SOC (0.84%) and carbon stock (18.02 t/ha), but T₄ (RFD+VC @ 5 t/ha) achieved the highest post-harvest SOC (0.90%) and carbon stock (19.84 t/ha), reflecting an accumulation of carbon 1.82 t/ha. Treatments T₃, T₅ and T₆ also showed appreciable carbon gains (≥ 1.12 t/ha), while the control (T₁) showed a slight carbon loss of -0.10 t/ha, likely due to depletion from continuous cropping without organic inputs.

Table 7: Carbon accumulation in soil under different treatments on 2022-2023

Treatments	Initial soil			Post harvest soil			Carbon accumulation (t/ha)
	SOC (%)	BD (%)	C Stock (t/ha)	SOC (%)	BD (%)	C Stock (t/ha)	
T ₁	0.84	1.43	18.02	0.83	1.44	17.92	-0.10
T ₂	0.84	1.43	18.02	0.87	1.44	18.74	0.77
T ₃	0.84	1.43	18.02	0.88	1.45	19.14	1.12
T ₄	0.84	1.43	18.02	0.90	1.47	19.84	1.82
T ₅	0.84	1.43	18.02	0.88	1.45	19.14	1.12
T ₆	0.84	1.43	18.02	0.90	1.46	19.71	1.69
T ₇	0.84	1.43	18.02	0.87	1.45	18.92	0.90
T ₈	0.84	1.43	18.02	0.87	1.46	19.05	0.93

SOC: Soil organic carbon, BD: Bulk density and C Stock: Carbon stock

DISCUSSION

This study demonstrated that vermicompost significantly improved sugarcane growth, yield, and soil carbon accumulation over four consecutive cropping seasons. These findings confirm the effectiveness of organic amendments in enhancing both crop productivity and soil quality, consistent with the conclusions of earlier studies¹⁹. Vermicompost acts not only as a nutrient source but also as a soil conditioner, enhancing microbial diversity, nutrient cycling, and physical structure²⁰. These benefits are especially crucial in tropical and subtropical agroecosystems like Bangladesh, where soil degradation is a growing concern.

The improved tiller number and millable cane yield in vermicompost treated plots, especially T₄ (RFD+VC 5 t/ha), likely resulted from the balanced and slow-release nutrients provided by vermicompost, along with improved soil aeration, water retention, and root zone conditions^{21,22}. Earthworm-processed compost enhances plant-available forms of nitrogen, phosphorus, potassium, and micronutrients^{2,22}.

Similar yield gains were reported in sugarcane under integrated nutrient management using organic and inorganic fertilizers²³. Dutta *et al.*²⁴ observed that vermicompost, when applied at 5-10 t/ha, enhanced tillering, cane girth, and internode elongation. Devi and Khwairakpam¹⁶ suggested that getting maximum production and increasing soil fertility, application of vermicompost with inorganic fertilizer is very important in sugarcane field. Additionally, partial substitution of synthetic fertilizers by vermicompost in treatments T₅-T₈ continued to maintain yields significantly higher than the control, reflecting the capacity of organic inputs to reduce fertilizer dependency while sustaining productivity²⁵.

The application of vermicompost significantly increased SOC and soil carbon stock, especially in T₄, which recorded the highest carbon accumulation (1.82 t/ha). This effect is attributed to the addition of stable organic matter and stimulation of microbial biomass and enzymatic activity^{7,26}. Vermicompost is known to contribute to aggregate stability and microbial-derived carbon accumulation, helping form microbially-bound carbon that is resistant to decomposition. Organic amendments like compost and farmyard manure have been shown to significantly enhance SOC in long-term sugarcane experiments in India²⁷. The loss of SOC in control plots highlights the threat of degradation under conventional chemical fertilizer regimes, which has been widely reported in South Asian rice-wheat and sugarcane cropping systems²⁸. Increasing SOC through vermicompost is therefore vital for improving water use efficiency, soil buffering capacity, and climate change resilience^{19,29}.

The absence of significant changes in Brix across treatments suggests that juice quality in sugarcane is largely influenced by genotype, climatic conditions, and crop maturity rather than nutrient sources³⁰. Similar conclusions were reached³¹, reported that while vermicompost improved vegetative parameters

and cane yield, sugar content remained relatively stable. Moreover, quality parameters like Brix and sucrose percent are strongly influenced by solar radiation, temperature at maturity, and harvest timing^{2,31,32}. However, some studies have suggested that the availability of micronutrients, particularly boron, zinc, and molybdenum, can influence juice quality under certain soil conditions^{31,32}. Future research may explore whether vermicompost enriched with micronutrients can contribute to improvements in cane juice parameters in nutrient deficient soils.

CONCLUSION

Sugarcane yield increases significantly by the vermicompost application united with inorganic fertilizer across four multiple cropping seasons. The best result of yield (95.15 to 143.40) in four consecutive years was found where 5 tons of vermicompost was applied per hectare of land united with full doses of inorganic fertilizer of $N_{180}P_{40}K_{90}S_{45}Mg_{10}Zn_4$ kg/ha. Soil organic carbon (SOC) increases by the use of vermicompost which follow similar trend with carbon stock that assists to increase soil quality contributed to carbon accumulation in soil. Result shows that vermicompost not only boost up crop production but also cares sustainable soil management. The sugar content (Brix) was not significantly affected by the application of vermicompost suggesting that sugar quality depends on plant genetics and ecofriendly condition. From the above observation we can tell that it is crucial to conduct further studies on the residual effects of vermicompost on soil microbial activity, nutrients recycling and long-term productivity under different agro-ecological zones.

SIGNIFICANCE STATEMENT

This study demonstrates that integrating vermicompost with inorganic fertilizers significantly improves sugarcane yield, soil organic carbon, and carbon accumulation under field conditions. The findings highlight the potential of vermicompost as an eco-friendly soil amendment for enhancing soil fertility, promoting sustainable sugarcane production, and supporting long-term soil health and carbon sequestration in agricultural systems.

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