Effect of Compost and Nitrogen Fertilizer on Sugarcane (*Saccharum officinarum* L.) Productivity at Kenana Sugar Scheme, Sudan

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Abstract— *Sugarcane (Saccharum officinarum L.) is recognized as one of the world's most economically significant crops. The climatic conditions and soil types in Sudan, particularly within the central clay plains, are highly suitable for sugarcane cultivation. Organic fertilizer (compost) is a vital natural resource for improving soil fertility by increasing organic matter content, enhancing soil structure, and stimulating microbial activity, which collectively improve nutrient uptake and crop productivity. This study aimed to evaluate the effects of different levels of compost and nitrogen fertilizers on the productivity of sugarcane (variety Co6806) grown on heavy clay soils (Vertisol). The experiment was conducted during the 2023/2024 season at the Research and Development Farm of the Kenana Sugar Scheme, Sudan. The experimental design was a split-plot arrangement with four replications. Nitrogen fertilizer was assigned to the main plots at four levels (0, 55, 110, and 164 kg/ha), while compost was applied to the subplots at four rates (0, 12, 24, and 36 t/ha). The results demonstrated that increasing nitrogen fertilizer rates significantly enhanced both the number of cane internodes and overall cane yield, while higher compost rates significantly improved internode number, and cane yield. Moreover, the combination of compost and nitrogen fertilizer further increased stalk population, number of internodes, and cane yield compared to their sole applications. The highest cane yield (172.0 t/ha) was recorded with the combined application of 36 t/ha compost and 164 kg/ha nitrogen. Based on the results of this study, it could be recommended that to obtain a high cane yield of sugarcane (variety Co6806), the crop should be fertilized by Nitrogen at the rate of 164 kg/ha and Compost at the rate of 36 tons/ha.*

***Keywords—* Sugarcane productivity, Compost application, Nitrogen fertilizer, Integrated nutrient management, Vertisol soils, Sustainable agriculture, Kenana Sugar Scheme, Organic and inorganic fertilizers.**

I. INTRODUCTION

Sugarcane (*Saccharum officinarum* L.) is a globally vital crop, primarily cultivated for sugar production and increasingly as a renewable source for bioethanol (Nair & Sachan 2022). Originating from New Guinea, sugarcane is now widely grown across tropical and subtropical regions between latitudes 35° North and South and at varying elevations from sea level to high altitudes (Moore et al. 2013). Adapted to warm, humid climates and various soil types, including sandy loams and heavy clays, sugarcane is a highly productive C4 plant with an efficient photosynthetic mechanism that supports rapid biomass accumulation (Mwasinga 2018); (Tew & Cobill 2008). The economic importance of sugarcane lies mainly in its accumulation of sucrose in the stalk internodes, which constitutes the raw material for sugar production. The chemical composition of sugarcane stalks varies according to variety, age, climate, soil conditions, and agronomic practices, directly affecting sugar extraction efficiency (James 2008). However, this high productivity often leads to significant soil nutrient depletion.

Sugarcane is generally cultivated under intensive monoculture systems with cycles of planting and ratooning, practices that demand consistent inorganic fertilizer applications to sustain soil fertility and achieve high yields (Kusumawati & Noviyanto 2025). Rising fertilizer costs and environmental concerns have drawn attention to the importance of recycling organic matter within agricultural systems to improve soil health and support sustainable crop production (Unagwu 2019). Incorporation of organic matter such as compost enhances soil physical and chemical properties, improving nutrient uptake and plant growth.

Global sugarcane cultivation generates substantial amounts of organic waste. Harvesting produces between 20 and 25 tons per hectare of trash mainly leaves and tops not sent for processing (Toharisman 1991). Additionally, sugar processing yields by-products like bagasse, filter mud, and molasses (Singh et al. 2021). For each ton of sugarcane processed, approximately 250 kg of bagasse and 36 kg of filter mud are generated, with filter mud comprising 1–7% of cane weight (Mena et al. 1985) ; (Salman et al. 2023). Traditionally, bagasse is used as fuel or raw material for other industries, while filter mud serves as a nutrient-rich organic amendment. Recycling these residues as compost improves soil fertility and physical characteristics and promotes sustainable farming (Iqbal 2018); (Stephen et al. 2024).

Application of compost derived from sugarcane residues enhances key soil chemical properties such as organic carbon, total nitrogen, available phosphorus, and potassium by stimulating microbial activity and nutrient cycling (Teshome et al. 2014). When integrated with inorganic nitrogen fertilizer, compost can further improve agronomic traits including cane height, stalk weight, and yield, as well as sugar quality parameters like Brix and sucrose content (Bekheet et al. 2018). Organic amendments also increase soil water holding capacity by 15–25% and microbial biomass carbon by 30–50%, contributing to annual increases in soil organic matter (Diacono & Montemurro 2011);(M. Sá et al. 2001). Although rich in organic matter (90–95%), compost generally has lower nutrient concentrations than commercial fertilizers and functions primarily as a soil conditioner (Khater 2015). Composting of residues such as filter mud, vinasse sludge, and animal wastes using methods like windrow composting produces stable, mature compost with optimal nutrient profiles (Meyer 2013);(Misra et al. 2003); (Nemet et al. 2021). The ideal compost quality is indicated by a carbon-to-nitrogen ratio between 10 and 25 (Sullivan & Miller 2001);(Gao et al. 2010); (Guo et al. 2012) ; (Mahapatra et al. 2022).

Sugarcane's high nitrogen demand (200–300 kg N/ha) has led to extensive chemical fertilizer use, yet nitrogen use efficiency remains low (30–50%), causing environmental issues such as groundwater nitrate contamination and greenhouse gas emissions (Otto et al. 2016);(Thorburn et al. 2017);(Chen et al. 2022) ;(Van Beneden et al. 2010). Nitrogen is vital for tillering, early crop population, and photosynthetic efficiency since leaf nitrogen content influences photosynthesis rates (Otto et al. 2014);(Bassi et al. 2018). Studies show that integrating nitrogen fertilizer with compost improves yield components such as stalk girth, weight, and sugar yield; for instance, 46 kg N/ha combined with 15 t/ha compost produced superior cane and sugar yields on clay soils compared to sole applications (Zeng et al. 2020);(Sopandie et al. 2011).

Long-term sugarcane monoculture leads to soil degradation characterized by 30–40% loss of original soil organic carbon over 20 years, adversely affecting yield potential (up to 35% productivity reduction) and processing quality (2–4% sucrose loss) (Bottinelli et al. 2020);(Obour et al. 2017);(Verma et al. 2024). The industry faces ongoing challenges including biotic and abiotic stresses, high production costs, post-harvest losses, and low sugar recovery (Bhatt 2020). These factors underscore the need for sustainable cultivation practices and balanced nutrient management combining organic and inorganic inputs to maintain productivity and environmental sustainability (Chattopadhyay 2012).

In Sudan, sugarcane yields average around 60 t/ha, lower than many irrigated regions globally (Ibrahim 2020). Given the strategic importance of sugar production for domestic consumption and export, sustainable practices are essential. The Kenana Sugar Scheme, located on Vertisol soils of the White Nile, features heavy clay soils with high smectite content, significant shrink-swell behaviour, moderate fertility with low nitrogen and organic matter, and cation exchange capacity and electrical conductivity below 2 mS/cm³ (Emam & Musa 2011); (Ganawa & Kheiralla 2011).

Mechanization and exclusive reliance on chemical fertilizers have contributed to soil compaction and degradation (Pankhurst et al. 2003); (Batey 2009) ; (Iqbal 2018). There is limited research on integrated use of compost and nitrogen fertilizer in this context, making investigation necessary to optimize both yield and soil health.

Accordingly, a research project was initiated in 2023/2024 to investigate the effects of compost application on sugarcane production under the conditions of the Kenana Sugarcane Estate. For the above mention reasons the main objective of this research is:

Main objectives:

- To evaluate the effects of compost and nitrogen fertilizer applications on the productivity of sugarcane at the Kenana Sugar Scheme.

Specific objectives:

- To determine the optimum application rates of compost and nitrogen fertilizer to achieve the highest yield of sugarcane.

II. LITERATURE REVIEW

2.1 Compost and Soil Fertility:

Compost application improves soil organic carbon, microbial biomass, nutrient availability, and physical properties such as water retention and aggregation (Teshome et al. 2014); (Diacono & Montemurro 2011). Compost from bagasse and filter mud enriches nutrients and enhances microbial activity, facilitating sustainable nutrient cycling (Rahmad et al. 2019) ; (Arefin et al. 2022). Improved soil quality translates to increased crop growth and yield in sugarcane (Iqbal 2018); (Aguilar-Paredes et al. 2023) as the primary center of genetic diversity for sugarcane (Dulfer et al. 2022).

2.2 Nitrogen Fertilization in Sugarcane:

Nitrogen critically influences tillering, stalk elongation, dry matter accumulation, and yield (Sharma et al. 2013); (Mischan et al. 2011). However, excessive nitrogen can delay maturity and reduce sugar quality, affecting purity and sucrose concentration (Berding et al. 2005);(Mudassar et al. 2022). Balanced nitrogen management with organic amendments reduces environmental impact while maximizing productivity (Yusuf et al. 2018; Liu et al. 2018).

2.3 Integration of Compost and Nitrogen:

Combining compost with nitrogen fertilizer enhances nitrogen use efficiency, soil microbial activity, and overall crop performance (Sasy & Abu-Ellail 2021); (Bebber & Richards 2022). Compost supplies slow-release nutrients and improves soil structure, while nitrogen supports rapid vegetative growth. This integration aligns with sustainable agricultural goals by reducing mineral fertilizer dependence and improving soil health (Sayara et al. 2020);(Wright et al. 2022).

III. MATERIALS AND METHODS

3.1 Experimental Site Description:

The experiment was conducted at the Research and Development Farm of the Kenana Sugar Scheme, Sudan, during the 2023/2024 growing season. Kenana is geographically situated between the White Nile and Blue Nile rivers, at approximately 33° E longitude and 13° N latitude, with an elevation of 410 meters above sea level (Ibrahim & Workneh 2023). The site is located about 330 km south of Khartoum, the capital city of Sudan, and 30 km southeast of Rabak Town (Ahmed & others 2016). The climate of the area is characterized as tropical aridic, with a distinct summer rainy season lasting approximately five months, from June to October, peaking in August. The average annual rainfall for the two seasons under study was 379 mm, although rainfall varies considerably from year to year. Temperature extremes range from a mean maximum of 42 °C in May to a minimum of 13.7 °C in January. Relative humidity fluctuates between 20.5% and 79.8%. The soil at the experimental site is classified as a brown, heavy clay Vertisol. The top 60 cm soil profile consists of cracking clay with a clay content ranging from 40% to 60% (Mohamed 2018). Soil pH values range from 7.50 to 8.50 (Antille et al. 2016). More than 90% of the upper soil horizon exhibits electrical conductivity values below 3 mS/cm^3. Extractable sodium percentage (ESP) ranges between 510 and 770 ppm (MOHAMMED 2006).

3.2 Experimental Layout Design and Treatments:

This study examines the individual and interactive effects of compost and nitrogen fertilization on various growth, yield of sugarcane. The experimental material consisted of four nitrogen levels (0, 55, 110, and 164 kg/ha) and four compost levels (0, 12, 24, and 36 tons/ha). The experiment employed a split-plot design (factorial arrangement) with four replications. Nitrogen levels were assigned to the main plots, and compost levels to the subplots. The total plot area was 60 m^2 (plot size: 4 furrows, each 10 meters long and 1.5 meters wide). The test variety used was Co6806. Statistical analysis was conducted using Duncan's Multiple Range Test (DMRT).

3.3 Cultural Practices:

3.3.1 Fertilizer and Compost Application:

Compost was applied as a single dose and uniformly spread along the ridges at the time of planting. Nitrogen fertilizer was also applied as a single dose at planting. All agronomic practices including irrigation, weeding, and other management operations were carried out uniformly across all experimental plots, following the standard protocols of the Sugar Estate.

The compost used in this study was produced by the Kenana Sugar Company using the windrow composting method. Windrow composting involves piling organic materials, such as agricultural and industrial byproducts, into long rows (windrows) that are regularly turned to ensure adequate aeration, moisture distribution, and temperature control. This aerobic process accelerates the decomposition of organic matter, reduces Odor, and minimizes the risk of soil and water pollution. The temperature of the windrows is monitored to ensure the process passes through the necessary mesophilic and thermophilic phases, which are critical for pathogen reduction and compost stabilization.

Before field application, the maturity of the compost was assessed by evaluating its odor and colour, which are reliable indicators of stability and readiness for use. Additional parameters, such as the C/N ratio and cation exchange capacity, may also be used to confirm compost maturity and biological stability.

The compost formula consisted of organic raw materials with balanced nutrient content, specifically tailored for agricultural use by the Kenana Sugar Company. The composition was as follows: filter mud (45–50%), green cane trash (25–30%), cow manure (8–10%), and poultry manure (4–5%), and vinasse sludge (3–5%). This blend provides a rich source of macro- and micronutrients, improves soil structure, and enhances water-holding capacity, contributing to long-term soil fertility and sustainability.

3.3.2 Land Preparation:

Land under continuous sugarcane cultivation was used. The stubble of the previous crop was uprooted using a disc plow in April, and the land was then left fallow during the summer months and rainy period. When it was dry, it was deeply plowed using the same disc plow, disk harrowed by a wide level disc, levelled using a planer and ridged at 1.5 meters spacing using a ridger.

3.3.3 Planting Method:

Planting was carried out using the continuous double-set furrow method. Seed cane was obtained from ten-month-old stalks of the plant crop, which were cut into short setts, each containing three buds. Following fertilizer application, these setts were uniformly placed in the furrows at a rate of 264 setts per plot. To protect the setts from termite damage, the insecticide Regent was applied directly by spraying at a rate of 2.38 L/ha. After treatment, the setts were manually covered with soil and irrigated immediately to ensure proper establishment.

3.3.4 Weed Control:

A combination of the herbicides Stomp (pendimethalin) and Gezaprim (atrazine) was applied as a pre-emergence treatment, following commercial recommendations, just prior to the second irrigation. The application rates were 1.43 L/ha for Stomp and 1.79 kg/ha for Gezaprim. To ensure effective weed control, plots were maintained weed-free by supplementary hand weeding whenever necessary throughout the growing season.

3.3.5 Hilling-Up Practice:

Hilling up of the plant rows was performed three months after planting. This involved raising the soil around the cane plants by employing the split ridging technique to cover the furrows in which the cane was planted. This practice helps improve soil aeration, moisture retention, and supports healthy crop growth.

3.3.6 Irrigation Management:

During the germination phase, setts were irrigated at 12-day intervals to ensure optimal moisture for sprouting. After the completion of germination, subsequent irrigations were applied as needed based on crop requirements and prevailing environmental conditions.

3.3.7 Pre-Harvest Drying Off:

Prior to each harvest, irrigation was withheld from the plots scheduled for harvesting for a period of one month to allow the fields to dry adequately. This pre-harvest drying off facilitates easier harvesting and improves cane quality.

3.3.8 Harvesting Procedure:

The harvested area for each plot was 30 m^2, consisting of two rows, each 10 meters in length and 1.5 meters in width. Harvesting was conducted manually. Stalks were cut precisely at the soil surface to maximize yield and ensure uniformity. After cutting, all stalks were thoroughly cleaned by removing leaves and tops, ensuring that only the cane stalks were retained for subsequent analysis and yield determination. This standardized harvesting method ensures accurate assessment of productivity and quality parameters across all experimental plots.

3.4 Collection of Data for Cane Yield Components:

A random sample of 10 stalks was collected from each plot for yield component analysis. These stalks were weighed and subsequently used to determine stalk height, stalk thickness (diameter), and the number of internodes per stalk. This sampling method ensured the accurate and representative assessment of the key yield parameters for each treatment.

3.4.1 Stalk Height (m):

Stalk height was measured for each sampled stalk from the base to the top visible dewlap (TVD) using a measuring tape. The measurements were then averaged and expressed as the mean stalk height in meters for each plot.

3.4.2 Stalk Thickness (Diameter) (cm):

Stalk thickness was measured at the middle internode of each sampled stalk using a Vernier caliper. The measurements were averaged and expressed as mean stalk diameter in centimeters for each plot.

3.4.3 Number of Internodes per Stalk:

The number of internodes was counted for each sampled stalk, and the results were expressed as the average number of internodes per stalk for each plot.

3.4.4 Stalk Weight (kg):

A random sample of 10 stalks was collected from each plot and weighed. The results were expressed as the average stalk weight in kilograms per stalk for each plot.

3.4.5 Stalk Number (Population) (1000/ha):

The number of millable stalks in each harvested plot was counted and the data were converted to express stalk population as the number of millable stalks per hectare (in thousands). This parameter provides an estimate of cane population density, which is a key component of yield assessment.

3.4.6 Final Cane Yield (ton/ha):

The crop was harvested in February 2024 when it reached 13 months of age. All millable cane from the two inner rows of each plot (30 m^2) was manually cut at the soil surface and arranged in bundles for weighing. The weights of the samples taken for other observations were also included in the total yield calculation. The harvested millable stalks from each plot were weighed using a portable spring balance (MD Totco™) attached to a tractor-mounted grab crane. The total weight was then converted to tons per hectare to determine the final cane yield for each plot.

3.5 Data Statistical Analysis:

The data were analyzed using standard analysis of variance (ANOVA) appropriate for the split-plot design, utilizing the MSTATC statistical software package. Means found to be significant were separated using Duncan's Multiple Range Test (DMRT) as described by Gomez and Gomez (1976). This approach ensured robust evaluation of treatment effects and reliable comparison among means.

IV. RESULTS AND DISCUSSION

4.1 Yield components:

4.1.1 Effect of Compost and Nitrogen fertilizer and their interaction on cane Height (cm):

Table (1) shows the effect of compost and nitrogen fertilizer levels, and their interaction, on cane Height. The results indicate that nitrogen fertilizer application had no significant effect on stalk height across treatments, with values ranging from 267.6 to 269.9 cm. These findings are consistent with (Saleem et al. 2023), who reported that sugarcane height is primarily governed by genetic factors rather than nutrient inputs under well-fertilized conditions. (Desalegn et al. 2023) also found that varying nitrogen fertilizer rates did not significantly influence plant height in sugarcane.

Compost application levels likewise exhibited a non-significant effect on stalk height, with mean values ranging from 266.1 to 273.4 cm across treatments. This observation aligns with previous research suggesting that compost may not always provide immediately available nitrogen for rapid crop growth, particularly when the nitrogen present is largely in organic form and its mineralization does not coincide with crop demand (Maucieri et al. 2019).

The interaction effect between compost and nitrogen fertilizer levels on cane height was also found to be non-significant. These results suggest that, under the conditions of this study, neither compost nor nitrogen fertilizer application, nor their interaction, had a significant impact on cane height, highlighting the overriding influence of genetic and environmental factors on this trait.

TABLE 1
EFFECT OF COMPOST AND NITROGEN FERTILIZER AND THEIR INTERACTION ON CANE HEIGHT (CM).

Compost (ton/ha)	Nitrogen(kg/ha)				Mean
	0	55	110	164	
0	280.8 a	270.5 ab	272.5 ab	270.0 ab	273.4 A
12	262.0 b	269.8 ab	270.5 ab	264.3 ab	266.6 A
24	270.3 ab	273.8 ab	268.3 ab	275.0 ab	271.8 A
36	257.3 b	268.3 ab	268.5 ab	270.5 ab	266.1 A
Mean	267.6 A	270.6 A	269.9 A	269.9 A	
SE ± for Nitrogen	7.1				
SE ± for Compost	4.12				
SE ± for Interaction	8.3				
CV(%)	6.1				

Means followed by the same letter (s) are not significantly different according to Duncan's Multiple Range Test (DMRT).

4.1.2 Effect of Compost and Nitrogen fertilizer and their interaction on internodes number:

Table (2) presents the effect of compost and nitrogen fertilizer levels, as well as their interaction, on the number of internodes in sugarcane. The results indicate that both compost and nitrogen fertilizer applications, individually and in combination, had significant effects on internode number. Increasing nitrogen fertilizer rates from 0 to 164 kg/ha resulted in a significant increase in the number of internodes. The highest mean value (25.7) was observed at the 164 kg/ha nitrogen level, while the lowest mean (24.5) was recorded at 0 kg/ha nitrogen. These findings are consistent with (Sharma et al. 2013), who reported that nitrogen fertilization promotes internode formation and elongation, with increases of 12–18% in internode numbers at optimal nitrogen rates.

Compost application levels also had a significant effect on internode number. Increasing the compost rate from 0 to 36 t/ha led to a significant increase in the number of internodes. The highest mean (26.4) was recorded at 36 t/ha compost, which was significantly greater than all other compost levels, while the lowest mean (23.6) was observed in the control (0 t/ha compost). These results are in agreement with (Sousa & Grichar 2024), who demonstrated that compost application promotes tillering and node development in grasses such as sugarcane.

The interaction effect between compost and nitrogen fertilizer was also significant, as indicated by the standard error for interaction (SE = 2.8). The greatest number of internodes (27.0) was recorded with the combined application of 36 t/ha compost and 164 kg/ha nitrogen, whereas the lowest value (23.0) was observed with no compost and no nitrogen. This significant interaction can be attributed to the role of compost in enhancing nitrogen availability, which in turn directly affects meristematic activity and internode development.

TABLE 2
EFFECT OF COMPOST AND NITROGEN FERTILIZER AND THEIR INTERACTION ON INTERNODES NUMBER

Compost (ton/ha)		Nitrogen(kg/ha)			Mean
	0	55	110	164	
0	23.0 d	23.0 d	24.0 c	24.3 c	23.6 D
12	24.0 c	24.3 c	25.0 b	25.5 b	24.7 C
24	25.0 b	25.0 b	25.0 b	26.0 a	25.3 B
36	26.0 a	26.0 a	26.8 a	27.0 a	26.4 A
Mean	24.5 C	24.6 C	25.2 B	25.7 A	
SE ± for Nitrogen	0.3				
SE ± for Compost	0.6				
SE ± for Interaction	2.8				
CV(%)	2.5				

Means followed by the same letter (s) are not significantly different according to Duncan's Multiple Range Test (DMRT).

4.1.3 Effect of Compost and Nitrogen and their interaction on stalk thickness (mm):

Table (3) presents the effects of compost and nitrogen fertilizer levels, as well as their interaction, on cane girth (stalk thickness). The results showed that neither compost nor nitrogen nor their interaction significantly affected stalk thickness. Nitrogen fertilizer application did not significantly influence cane girth. These findings are in agreement with (Pei Tukuljac et al. 2023), who reported that nitrogen fertilizer application rates had no significant effect on cane girth in their study on sugarcane productivity and sugar yield improvement.

Compost application levels also had a non-significant effect on cane girth. This finding is consistent with (Desalegn et al. 2023), who found that compost application did not significantly affect internode number or stalk girth under certain soil fertility and nutrient availability conditions.

The interaction between compost and nitrogen fertilizer levels was also not significant for cane girth.

TABLE 3
EFFECT OF COMPOST AND NITROGEN FERTILIZER AND THEIR INTERACTION ON STALK THICKNESS (mm)

Compost (ton/ha)	Nitrogen(kg/ha)				Mean
	0	55	110	164	
0	25.3 a	26.0 a	23.8 a	24.5 a	24.9 A
12	24.3 a	24.8 a	25.3 a	25.5 a	24.9 A
24	25.0 a	26.0 a	25.8 a	25.0 a	25.4 A
36	25.5 a	25.0 a	24.3 a	25.3 a	25.0 A
Mean	25.0 A	25.4 A	24.8 A	25.1 A	
SE ± for Nitrogen	0.32				
SE ± for Compost	0.29				
SE ± for Interaction	0.65				
CV(%)	5.2				

Means followed by the same letter (s) are not significantly different according to Duncan's Multiple Range Test (DMRT).

4.1.4 Effect of Compost and Nitrogen fertilizer and their interaction on Stalk Population (1000 plant/ha):

Table (4) shows the effect of compost and nitrogen fertilizer levels, as well as their interaction, on cane population density. The results indicate that nitrogen fertilizer alone did not have a significant effect on cane population, with stalk counts ranging from 107,000 to 151,000 plants per hectare across treatments. This finding aligns with the conclusions of (Balaganesh et al. 2020) and (Nawaz et al. 2017), who emphasized that stalk population is primarily influenced by planting density, seed cane quality, and initial establishment conditions rather than fertilization.

Compost application levels also exhibited a non-significant effect on cane population. This observation is consistent with previous studies indicating that although compost improves soil fertility and plant vigor, it does not necessarily lead to an increase in the number of cane stalks per unit area. For example, (Balaganesh et al. 2020) and (Otto et al. 2016) found that in soils with moderate fertility, the application of compost or other organic amendments did not significantly increase cane population.

The interaction between compost and nitrogen fertilizer levels had a significant effect on stalk population. The highest stalk count (151,000 plants/ha) was achieved with the combined application of 36 tons/ha compost and 110 kg/ha nitrogen.

TABLE 4
EFFECT OF COMPOST AND NITROGEN FERTILIZER AND THEIR INTERACTION ON STALK POPULATION (1000 PLANT/HA)

Compost (ton/ha)	Nitrogen(kg/ha)				Mean
	0	55	110	164	
0	119 abc	117 abc	126 abc	107 c	117 A
12	140 abc	123 abc	126 abc	129 abc	129 A
24	128 abc	133 abc	145 ab	117 abc	131 A
36	113 bc	118 abc	**151 a**	133 abc	129 A
Mean	125 A	123 A	137 A	122 A	
SE ± for Nitrogen	4.9				
SE ± for Compost	5.8				
SE ± for Interaction	9.9				
CV(%)	15.6				

Means followed by the same letter (s) are not significantly different according to Duncan's Multiple Range Test (DMRT).

4.1.5 Effect of Compost and Nitrogen fertilizer and their interaction on cane yield (ton/ha):

The effect of compost and nitrogen fertilizer levels, as well as their interaction, on sugarcane yield are shown in Table (5). The results indicate that both compost and nitrogen fertilizer, individually and in combination, had significant effects on cane yield. Nitrogen fertilizer application significantly increased cane yield, with the highest yield (153.9 t/ha) recorded at 110 kg N/ha. This finding is consistent with (Mudassar et al. 2022), who reported that higher nitrogen rates significantly enhance both cane and sugar yields, reflecting the strong positive influence of nitrogen on sugarcane productivity.

Compost application also had a significant effect on cane yield. The highest yield (163.9 t/ha) was achieved with the application of 36 t/ha compost. This result aligns with (Teshome et al. 2014), who found that compost improved soil chemical properties, such as organic carbon and total nitrogen, thereby contributing to yield increases.

The interaction between compost and nitrogen fertilizer levels had a highly significant effect on cane yield. The highest yield (172.0 t/ha) was obtained with the combined application of 36 t/ha compost and 164 kg/ha nitrogen, while the lowest yield (119.1 t/ha) was observed in the control treatment.

TABLE 5
EFFECT OF COMPOST AND NITROGEN FERTILIZER AND THEIR INTERACTION ON CANE YIELD (TON/HA)

Compost (ton/ha)	Nitrogen(kg/ha)				Mean
	0	55	110	164	
0	119.2 c	142.3 abc	126.2 bc	119.1 c	126.7 D
12	139.6 abc	144.9 abc	161.4 a	124.7 bc	142.6 C
24	155.7 ab	151.6 abc	163.7 a	145.7 abc	154.2 B
36	159.9 a	159.6 a	164.1 a	172.0 a	163.9 A
Mean	143.6 B	149.6 B	153.9 A	140.4 B	
SE ± for Nitrogen	3.3				
SE ± for Compost	5.5				
SE ± for Interaction	6.6				
CV(%)	9.0				

Means followed by the same letter (s) are not significantly different according to Duncan's Multiple Range Test (DMRT).

V. CONCLUSIONS AND RECOMMENDATION

5.1 Conclusion:

From this study it could be concluded that:

1) Compost application showed dominant effects (29.4% increase) over nitrogen.

2) Nitrogen effects are optimized and variable across parameters.
3) Increasing nitrogen fertilizer levels significantly increased the number of internodes and cane yield.
4) Increasing compost application levels significantly increased the number of internodes and cane yield.
5) There were significant interactions in the stalk population, number of internodes, and cane yield.
6) The highest cane yield (172.0 tons/ha) was obtained when 164 kg/ha of nitrogen and 36 tons/ha of Compost were applied.

This experiment demonstrates that the combined application of compost and nitrogen fertilizer is a more effective strategy for sustainable sugarcane production. Achieving a yield of 172.0 tons per hectare with 36 tons of compost and 164 kg of nitrogen input represents a paradigm shift toward combination fertilization systems. The findings suggest that a fundamental combination of "nitrogen-centric" and "organic matter-centric" sugarcane nutrition strategies may be warranted. Therefore, a transformation to compound fertilizer recommendations is needed and opens new possibilities for sustainable production intensification.

5.2 Recommendations:

Based on the results of this study, it could be recommended that to obtain a high cane yield of sugarcane (variety Co6806), the crop should be fertilized by Nitrogen at the rate of 164 kg/ha and Compost at the rate of 36 tons/ha.

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