



APPLICATION OF UTPANN FERMENTED ORGANIC MANURE ENHANCES PRODUCTIVITY OF SUGARCANE UNDER THE PLANT-RATOON SYSTEM

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ABSTRACT

A field experiment was conducted at Bardoli during 2024–2025 to evaluate the effect of UTPANN fermented organic manure (FOM) on sugarcane (*Saccharum officinarum*) under a plant–ratoon cropping system. The field experiment was conducted in a randomized block design with two treatments: control without any fertilizer application and UTPANN FOM as the treated plot. The results demonstrated that the integration of UTPANN FOM substantially improved soil fertility, growth, and yield of sugarcane. Treated plots recorded the highest soil nitrogen (301 kg/ha), phosphorus (58.25 kg/ha), and potassium (335 kg/ha) availability. Growth parameters improved markedly, with stalk population and millable canes reaching 97,994 and 94,458 per hectare. The crop produced a cane yield of 93.88 t/ha, sugar yield of 12.59 t/ha, with juice sucrose and purity reaching 18.90% and 86.90%, respectively. These demonstrate that UTPANN FOM, when integrated with chemical fertilizers, effectively enhances productivity, juice quality, and soil health, providing a sustainable alternative to conventional fertilizer practices.

KEYWORDS: Cane yield, Fermented organic manure, Integrated nutrient management, Sugar yield, Sugarcane, Sustainable agriculture, UTPANN FOM

ABBREVIATIONS: FOM – Fermented Organic Manure, t/ha – tonnes per hectare, N – Nitrogen, P – Phosphorus, K – Potassium

1. INTRODUCTION

Sugarcane (*Saccharum officinarum*) is a globally important commercial crop, cultivated primarily for sugar, bioethanol, and various value-added products (Ali et al., 2021). Its cultivation contributes significantly to the agricultural economy by providing raw materials for industries, generating employment, and supporting rural livelihoods in tropical and subtropical regions (Johnson & Diaz-Chavez, 2018). Sugarcane is a high-biomass crop with rapid vegetative growth, extensive tillering, and high sucrose accumulation, all of which require a continuous and balanced supply of essential nutrients, particularly nitrogen (N), phosphorus (P), and potassium (K) (Verma et al., 2024). These macronutrients are critical for physiological processes such as photosynthesis, root and stem development, and sucrose synthesis, and their deficiency can severely limit crop productivity (Bhatt et al., 2024).

Traditionally, sugarcane production has relied on chemical fertilizers to meet its nutrient demands. While synthetic fertilizers provide readily available nutrients and can improve short-term yields, their continuous and excessive use has been associated with several agronomic and environmental concerns (Raza et al., 2021). Excessive application can lead to soil acidification, depletion of organic matter, nutrient imbalances, and disruption of beneficial soil microbial communities (Pang et al., 2021). Moreover, nutrient losses through leaching, volatilization, and surface runoff reduce fertilizer use efficiency, increase production costs, and contribute to environmental pollution, including contamination of water bodies and greenhouse gas emissions (Li & Li, 2024). Therefore, sustainable nutrient management practices are needed to improve soil quality, nutrient efficiency, and crop productivity.

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Organic amendments, particularly fermented organic formulations, have emerged as environmentally friendly alternatives to chemical fertilizers. These bio-organic inputs are produced through microbial decomposition of organic residues, which transforms complex organic compounds into forms more readily available to plants (Jayakumar et al., 2023). The application of such amendments improves soil structure, increases water-holding capacity, and stimulates beneficial microbial activity (Singh et al., 2022). Microorganisms such as *Azotobacter*, *Bacillus subtilis*, *Pseudomonas fluorescens*, *Frateriuria aurantia*, *Trichoderma* spp., and *Aspergillus niger* contribute to nitrogen fixation, phosphate solubilization, potassium mobilization, and suppression of soil-borne pathogens (Chaudhary et al., 2022). By promoting these microbial-mediated processes, organic formulations enhance nutrient cycling, improve soil fertility, and support overall crop growth (Ghasal et al., 2025).

Organic inputs play an important role in maintaining soil fertility and improving crop growth. Compared with chemical fertilizers, organic materials release nutrients more slowly and also contribute to the buildup of soil organic matter, which is essential for long-term soil productivity (Bhatt et al., 2019). The application of fermented or composted organic materials can also stimulate beneficial soil microorganisms involved in nutrient cycling (Verma et al., 2019). For instance, microorganisms such as *Pseudomonas* spp. and *Aspergillus niger* help in solubilizing phosphorus, while nitrogen-fixing bacteria like *Azotobacter chroococcum* increase nitrogen availability in the soil. In addition, potassium-solubilizing microbes such as *Frateriuria aurantia* assist in releasing potassium from soil minerals, thereby supporting better nutrient uptake and plant growth (Sharma & Singh, 2022).

Integrated nutrient management (INM) provides a framework for combining chemical fertilizers with organic inputs and biofertilizers to optimize nutrient availability, maintain soil health, and ensure sustainable crop production (Panta & Parajulee, 2021). Within INM systems, fermented organic amendments serve as valuable components, supporting microbial diversity, improving nutrient use efficiency, and reducing environmental risks

associated with synthetic inputs (Yadav & Thakur, 2025). The use of locally available organic resources, such as farmyard manure, composts, vermicompost, and press mud cake, has been recognized as a cost-effective and sustainable strategy to enhance soil fertility and crop productivity, particularly in intensive cropping systems like the plant-ratoon system, where repeated harvesting imposes high nutrient demands on the soil (Ghosh, 2025).

The present investigation evaluated the effect of UTPANN fermented organic manure (FOM) on soil fertility, growth, yield, and juice quality of sugarcane under a plant-ratoon cropping system. The integration of this organic input with chemical fertilizers was assessed to determine its potential for improving nutrient availability, enhancing crop productivity, and maintaining soil health under intensive sugarcane cultivation.

2. MATERIALS AND METHODS

2.1 Experimental Site

The field experiment was conducted during the 2024–2025 sugarcane season at Bardoli, growing season at Bardoli, a major subtropical sugarcane producing region of India. The experimental field consisted of clay-loam soil with moderate fertility status. The crop was managed under standard agronomic practices, including irrigation, weed control, and integrated pest management to ensure uniform growth.

2.2 Soil Characteristics

Before planting, soil samples were collected from the top 0–30 cm layer at multiple locations in the field. The samples were air-dried, sieved (2 mm), and analyzed for pH, organic carbon, and available nutrients (N, P, and K) using standard methods. These measurements provided the baseline soil fertility for evaluating treatment effects.

2.3 Plant Material and Experimental Design

The experiment was conducted under a plant-ratoon system, where the plant crop was harvested at maturity, and the ratoon crop was allowed to regrow from the stubble of the previous season. The field trial was laid out in a randomized block design (RBD) with three replications. Each plot measured 5 m × 5 m, with row spacing of 1.2 m and plant spacing of 0.6 m, ensuring uniform plant density across all plots. Standard agronomic practices, including irrigation,

manual and chemical weed control, and integrated pest management, were applied consistently to all plots to maintain uniform growth conditions throughout the experiment.

2.4 Treatments

Two treatments were evaluated in the experiment. The control plot did not receive any fertilizer treatment. The treated plots received UTPANN fermented organic manure (15–20 kg/acre).

Fermented organic manure was incorporated into the soil at the time of planting for the plant crop, while chemical fertilizers were applied in split doses following standard agronomic recommendations. In the ratoon crop, residual effects of organic amendments and chemical fertilizers were monitored to evaluate nutrient availability and plant performance.

2.5 Crop Management Practices

Planting was carried out using healthy sugarcane setts with at least two buds per sett. Uniform irrigation was applied throughout the crop cycle based on soil moisture status and local recommendations. Weed control was performed manually and with pre- and post-emergence herbicides as needed. Integrated pest and disease management strategies were implemented to minimize biotic stress. The field was regularly monitored to ensure uniform growth and optimal nutrient uptake across all treatments.

2.6 Soil Nutrient Analysis

Soil samples were collected from each treatment plot at the grand growth stage for both the plant and ratoon crops. The samples were analyzed to determine the availability of key macronutrients essential for sugarcane growth. Available nitrogen (N) was estimated using the Kjeldahl method, available phosphorus (P) was determined by the Olsen method, and available potassium (K) was measured using flame photometry.

2.7 Growth Parameters

Growth of sugarcane was recorded at the grand growth stage for both plant and ratoon crops. Stalk population was determined by counting all healthy stalks in each plot and expressing the values on a hectare basis. In addition, the number of millable canes, representing harvestable canes, was also

recorded from each plot.

2.8 Yield Parameters

Cane yield was recorded at harvest by cutting all stalks from each plot, weighing them using calibrated scales, and expressing the yield in tonnes per hectare (t/ha). Sugar yield was calculated using cane yield and juice quality data.

2.9 Quality Parameters

The following quality parameters were analyzed from randomly selected cane samples. 1. Juice sucrose (%) – Determined by standard saccharimeter or polariscope methods. 2. Juice purity (%) – Calculated as the ratio of sucrose to total soluble solids (Brix), expressed in percentage.

2.10 Statistical Analysis

All data were subjected to analysis of variance (ANOVA) appropriate for a randomized block design. Differences between treatment means were compared using the critical difference (CD) at $p \leq 0.05$, and the coefficient of variation (CV%) was calculated to evaluate experimental precision.

3. RESULT AND DISCUSSION

Soil Nitrogen Availability in Plant and Ratoon Crops

Soil nitrogen availability was significantly influenced by the treatments as shown in table 1. In the control plots, the plant and ratoon crops recorded 288 and 291 kg/ha of available nitrogen, respectively. In contrast, plots treated with UTPANN FOM showed higher nitrogen levels, with 301 kg/ha in both plant and ratoon crops. The differences were statistically significant (CD, $p \leq 0.05$), and the coefficient of variation (CV) ranged from 8.6% to 12.0%, indicating reliable consistency across replicates. The higher nitrogen availability observed in the treated plots may be attributed to the combined application of UTPANN fermented organic manure with chemical fertilizers.

Similar result have been reported in previous studies where the combined use of organic manures and inorganic fertilizers improved soil nitrogen status in sugarcane cropping systems. In which the highest soil nitrogen availability (256.5 kg/ha) was recorded with the application of 50% recommended

nitrogen through inorganic fertilizers combined with 50% nitrogen through farmyard manure (FYM) (de Oliveira et al., 2023). Comparable results were observed in another experiment, where the application of sulphitation press mud cake (SPMC) resulted in the highest positive soil nitrogen balance (33.4 kg/ha) (Srivastava et al., 2018). This improvement was mainly attributed to the addition of organic matter and nutrients through press mud, which enhances microbial activity and promotes gradual nitrogen mineralization, thereby improving nitrogen availability in the soil.

Table 1: Soil available nitrogen (kg /ha) in plant and ratoon sugarcane crops as influenced by different nutrient management treatments.

Treatment	Available Nitrogen (kg /ha) Plant	Available Nitrogen (kg /ha) Ratoon
Control	288	291
Treated	301	301
CD ($p \leq 0.05$)	4.00	8.00
CV (%)	8.6	12.0

2. Soil Phosphorus Status in Plant and Ratoon Crops

Available phosphorus was enhanced through the addition of UTPANN FOM. The control plots had 50.62 kg/ha in the plant crop and 52.48 kg/ ha in the ratoon crop, whereas treated plots achieved 53.00 and 58.25 kg/ha, respectively (table 2). The observed improvements were statistically significant (CD, $p \leq 0.05$) with CV values of 9.5% and 9.2%, reflecting consistent treatment effects. This demonstrates that combining organic and chemical fertilizers improves phosphorus mobilization and maintains soil fertility. In another experiment on sugarcane, the highest soil phosphorus balance 11.23 kg/ha, was recorded under the press mud combined with *Gluconacetobacter diazotrophicus* treatment, indicating improved phosphorus availability in soil due to organic manure application (Singh et al., 2007).

Table 2: Soil available phosphorus (kg/ ha) in plant and ratoon sugarcane crops under control and treated conditions.

Treatment	Available Phosphorus (kg/ ha) Plant	Available Phosphorus (kg/ ha) Ratoon
Control	50.62	52.48
Treated	53.00	58.25
CD ($p \leq 0.05$)	2.13	2.20
CV (%)	9.5	9.2

3. Soil Potassium Availability in Plant and Ratoon Crops

The availability of potassium also increased under the treated plots. Control plots recorded 310 kg/ha in the plant crop and 312 kg/ha in the ratoon, whereas treated plots showed 326 kg/ha and 335 kg/ ha, respectively as indicated in table 3. Differences between control and treated plots were significant (CD, $p \leq 0.05$), with CV values of 7.6% and 8.7%. This indicates that the integration of organic manure enhances potassium retention in the soil and supports improved nutrient supply for sugarcane. Similar study reported that the highest soil potassium availability (237.5 kg /ha) was recorded under T10 treatment, which involved the application of 100% recommended dose of fertilizers combined with 25% nitrogen through farmyard manure and bio-fertilizers in the plant crop, followed by RDF along with trash incorporation and bio-fertilizers in the ratoon crop (Virdia & Patel, 2010).

Table 3: Soil available potassium (kg/ha) in plant and ratoon sugarcane crops under different treatments.

Treatment	Available Potassium (kg/ ha) Plant	Available Potassium (kg/ ha) Ratoon
Control	310	312
Treated	326	335
CD ($p \leq 0.05$)	11.00	12.50
CV (%)	7.6	8.7

4. Stalk Population under Control and Treated Conditions

As per table 4, the stalk population of sugarcane was higher in the treated plots receiving UTPANN fermented organic manure. The density of sugarcane stalks increased with the application of UTPANN FOM. Control plots exhibited 90,148 and 82,468

stalks/ha for the plant and ratoon crops, respectively, while treated plots recorded 97,994 and 90,680 stalks/ha. Statistical analysis confirmed significant differences (CD, $p \leq 0.05$) and CVs of 11.3% and 9.8%. The results suggest that organic inputs promote better tillering and vegetative growth in sugarcane. Similar observations were reported in another study, where the maximum stalk population (198.89 stalks per plot) was recorded with the incorporation of cattle manure into the soil, highlighting the beneficial role of organic manure in improving stalk development in sugarcane (Gana, 2011).

Table 4: Stalk population (no. / ha) of sugarcane in plant and ratoon crops under control and treated plots.

Treatment	Stalk population (No./ha) plant	Stalk population (No. / ha) Ratoon
Control	90,148	82,468
Treated	97,994	90,680
CD ($p \leq 0.05$)	2,115	1,952
CV (%)	11.3	9.8

5. Number of Millable Canes in Plant and Ratoon Crops

The number of harvestable canes increased under treated plots. In the plant crop, control plots had 88,166 millable canes /ha, while treated plots achieved 94,458. For the ratoon crop, the corresponding values were 81,423 and 86,450 millable canes /ha. The differences were significant (CD, $p \leq 0.05$) with CVs of 9.8% and 11.3%, indicating that integrated nutrient management promotes cane development (Table 5). A similar trend was reported in another study, where higher number of millable canes (130.30×10^3 /ha) in the first ratoon crop with a 25% reduced fertilizer dose combined with farmyard manure at 15 t/ha, showing the beneficial effect of integrated nutrient management (Bokhtiar et al., 2008).

Table 5: Number of millable canes (no./ ha) in plant and ratoon sugarcane crops as affected by nutrient management treatments.

Treatment	Number of Millable Canes (No./ha) Plant	Number of Millable Canes (No./ha) Ratoon
Control	88,166	81,423
Treated	94,458	90,680

CD ($p \leq 0.05$)	2,010	1,918
CV (%)	9.8	11.3

6. Cane Yield under Control and Treated Plots

In table 6, Cane yield increased substantially with UTPANN FOM. In the plant crop, control plots produced 87.42 t/ha, while treated plots yielded 93.88 t/ha. In the ratoon crop, the yields were 80.22 t/ha in control and 85.94 t/ha in treated plots. Differences were statistically significant (CD, $p \leq 0.05$) and CVs were 11.4% and 12.3%. These results reflect the cumulative effect of organic and chemical fertilizers on biomass accumulation and overall productivity. In other study, Higher cane yield has also been reported with the use of organic nutrient sources. In northern Belize, the maximum cane yield (330 t/ha) was obtained when 3 t/ha bokashi was applied to the soil along with 2% bovine biol sprayed on the foliage (Tun et al., 2023).

Table 6: Effect of UTPANN fermented organic manure (FOM) on cane yield (t /ha) in plant and ratoon sugarcane crops.

Treatment	Cane Yield (t /ha) Plant	Cane Yield (t /ha) Ratoon
Control	87.42	80.22
Treated	93.88	85.94
CD ($p \leq 0.05$)	4.52	3.59
CV (%)	11.4	12.3

7. Sugar Yield in Plant and Ratoon Crops

Sugar yield also improved with treatment. In control plots, the plant and ratoon crops yielded 11.06 and 9.79 t/ha, respectively, whereas treated plots recorded 12.59 and 10.60 t/ha. Differences were significant (CD, $p \leq 0.05$) with a CV of 12.1% for the plant crop and 1.26 for the ratoon crop. The increase in sugar yield reflects the positive influence of integrated nutrient management on sugar accumulation in harvested cane, as presented in Table 7. A study reported in sugarcane plant-ratoon system, the treatment receiving 75% NPK combined with *Acetobacter*, PSB and bio-compost (7.5 t/ha) recorded the highest sugar yield (11.21 t/ha) , as the combined application of organic and inorganic nutrients improves nutrient availability and promotes sucrose accumulation in cane stalks (Sinha et al., 2024).

Table 7: Effect of UTPANN fermented organic manure (FOM) on sugar yield (t/ha) in plant and ratoon sugarcane crops.

Treatment	Sugar yield (t/ha) plant	Suagr yield (t/ha) Ratoon
Control	11.06	9.79
Treated 12.59	10.60	90,680
CD ($p \leq 0.05$)	1.52	1.26
CV (%)	12.1	—

8. Juice Sucrose Percentage in Plant and Ratoon Crops

Juice sucrose content was higher in the treated plots compared with the control. The treated plots recorded sucrose contents of 18.90% and 18.40% in the plant and ratoon crops, respectively, whereas the control plots recorded 17.10% and 16.80%, as shown in Table 8. The increase in sucrose content can be attributed to improved nutrient availability and better physiological activity in the plants under integrated nutrient management, which favors greater sucrose accumulation in cane stalks. Similar results have been reported in sugarcane, where the highest sucrose content (17.52%) was obtained with integrated nutrient management involving 75% recommended nitrogen through inorganic fertilizers combined with 25% nitrogen through FYM along with *Azotobacter* and *Azospirillum* (Babu et al., 2007).

Table 8: Juice sucrose content (%) of sugarcane in plant and ratoon crops under control and treated plots.

Treatment	Juice Sucrose (%) Plant	Juice Sucrose (%) Ratoon
Control	17.10	16.80
Treated	18.90	18.40
SEm ($\pm$)	0.42	0.38
CD ($p \leq 0.05$)	1.20	1.10

9. Juice Purity in Plant and Ratoon Crops

Juice purity improved markedly under treated plots. Control plots had 83.20% and 82.60% in plant and ratoon crops, respectively, while treated plots reached 86.90% and 86.20%. Statistical analysis showed significant differences (CD, $p \leq 0.05$) with SEM values of 0.65 and 0.61, suggesting that the combined use of organic and chemical fertilizers improves sugar recovery and juice quality in sugarcane, as

presented in Table 9. In another experiment, juice purity of sugarcane was also strongly influenced by the application of organic and inorganic fertilizers. The highest juice purity (85.18%) in the plant crop was obtained with three-fourths of the recommended NPK dose (169–84–126 kg/ha) combined with press mud at 20 t/ha, which performed better than the other treatments (Soomro et al., 2013). The comparatively higher juice purity observed in the present treatment suggests that the use of fermented organic manure along with fertilizers may provide a more balanced nutrient supply and improved soil biological activity, which favor greater sucrose accumulation in cane stalks.

Table 9: Juice purity (%) of sugarcane in plant and ratoon crops as influenced by different treatments.

Treatment	Juice Purity (%) Plant	Juice Purity (%) Ratoon
Control	83.20	82.60
Treated	86.90	86.20
SEm ($\pm$)	0.65	0.61
CD ($p \leq 0.05$)	1.85	1.72

4. CONCLUSION

The present study demonstrated that the application of UTPANN fermented organic manure, effectively enhanced the growth, yield, and quality of sugarcane under a plant–ratoon system. The results indicate that UTPANN FOM promotes vegetative development, improves stalk density, and supports the formation of more millable canes, reflecting its positive influence on overall crop establishment and productivity. In addition, the product improved juice quality and sucrose accumulation, suggesting enhanced biochemical and physiological activity in sugarcane plants. The application of UTPANN fermented organic manure improved soil fertility and supported beneficial microbial activity, which contributed to better nutrient cycling and soil health. The integration of UTPANN FOM provided a balanced nutrient supply and enhanced crop performance while reducing dependence on chemical fertilizers. These results indicate that the inclusion of UTPANN FOM in sugarcane nutrient management can be an effective approach for maintaining soil productivity and sustaining crop yield under intensive cultivation.

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