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Research Article

Effect of UTPANN Fermented Organic Manure on Growth, Yield and Fruit Quality of Banana (*Musa acuminata L.*) Under Field Conditions

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Abstract

A field experiment was conducted during the 2023–2024 season in Anand and Kheda districts of Gujarat to evaluate the effect of Utpann Fermented Organic Manure (FOM) on banana *(Musa acuminata L.)* growth and yield. Two treatments, a control and Utpann FOM applied on the root zone, were evaluated using a randomised complete block design with three replications. The results demonstrated that during the experiment, vegetative growth parameters, including plant height, trunk diameter, sucker formation, and leaf development, were recorded with yield parameters. Utpann FOM application resulted in a substantial increase in vegetative growth when compared to the control. Furthermore, the organic manure treatment increased important yield parameters such as the number of hands and fingers per bunch, finger size, and total bunch weight. Specifically, the average bunch weight increased from 3.95 kg in the control to 4.72 kg after FOM application. Treated plants yielded 13.00 kg per plant, 7.22 t/acre, whereas the control generated 6.83 kg per plant, 3.79 t/acre. The study indicates that applying fermented organic manure to banana agriculture increases yields per plant and crop quality in the field, while also promoting sustainable agricultural techniques for future banana crop production.

Keywords: Biofertilizer; Bunch Characteristics; Crop Productivity; Farm Manures; Mid-Trunk; Suckers

Introduction

Banana (*Musa acuminata* L.) is one of the important fruit crops of the tropics. The fruits are a rich source of carbohydrate and energy. It is grown in more than 130 countries across the world, covering an area of about 10.1 million hectares and producing approximately 121.85 million tonnes of banana annually [1]. Banana not only contributes to food security but also supports the economic livelihood of millions of farmers in tropical and subtropical regions [2].

In order to reduce the environmental impacts of farming, research efforts and policies have been targeted at developing farming systems that produce high yields with low negative environmental impacts by drawing on techniques from organic and sustainable agriculture [3,4]. IFOAM established the basic standards for organic farming, which are based on four fundamental areas. These include Health, which promotes the production of safe and chemical-free food, Ecology, which promotes methods that function in balance with nature, Fairness, which ensures food security and social equity, and Prevention, which promotes the responsible use of technology to protect the environment development [5,6].

The importance of organic fertilizer has grown as consumers have become more health conscious to decrease their susceptibility to environmental contaminants associated with synthetic inputs [7]. These pollutants not only affect human health, but they also

harm the quality the land and water. In response, agricultural researchers are conducting research into solutions to properly recycle waste nutrients, reducing pollution and enhancing soil fertility [8]. The increasing requirement for livestock and poultry products has resulted in increased production of organic manure, creating potential for its application as fertilizer. While organic waste has been applied as manure for generations [9].

Fermented Organic Manure (FOM) represents an advanced form of organic amendment [10]. Fermented and animal-derived organic matter increase soil health by increasing soil organic carbon, nutrient availability, and microbial activity, which promotes plant growth and productivity [11]. Also, FOM promotes expedited nutrient mineralization, boosts beneficial microbial activity, and increases nutrient absorption efficiency [12]. Soil fertility and organic matter are essential in banana agriculture for plant nutrition, especially during the early vegetative growth and bunch development stages, which are extremely sensitive to nutrient availability [13]. Soil nutrition and field management substantially reduce productivity and fruit quality, however, the application of organic manures, particularly fermented formulations, improves nutrient cycling and absorption efficiency, which leads to higher yields and fruit quality [14].

Banana yield is primarily determined by crop management and plant nutrition. In areas with low soil fertility, it is essential to that crops nutrient requirements while improving organic matter characteristics. Therefore, organic nutrient sources are required for maintaining high yields. UTPANN FOM, a fermented organic manure, can be used as a promising nutrition source for this purpose. For this reason, this research evaluates the effect of UTPANN FOM on banana growth, yield, and quality attributes (*Musa acuminata L.*).

Materials and Methods

Experimental site and plant material

The field experiment was conducted during the 2023-2024 cropping season in the banana-growing regions of Anand and Kheda in Gujarat, India. The agricultural and environmental conditions of the region are suitable for banana cultivation. The test material for this research under field conditions were nutritious and Banana (*Musa acuminata L.)* plants.

Experimental design and treatments

The experiment was conducted using a Randomized Complete Block Design (RCBD) consisting of two distinct treatments, each replicated to ensure statistical accuracy and minimize experimental error. The treatments included T1 (control, without organic manure application) and T2(treated, with the application of UTPANN FOM at 15–20 kg per acre), which were randomly allocated to the plots. All experimental plots were maintained under uniform field conditions to ensure that the observed differences in banana growth and yield were specifically attributable to the treatment effects.

Fertilizer application

UTPANN FOM, a fermented organic manure, was applied as an initial dose to specific tagged banana plants at a rate of 15-20 kg per acre during the vegetative growth stage. The manure was applied directly to the soil at the base of each mat and thoroughly mixed into the root zone to promote increased microbial activity and nutrient availability. To ensure optimal crop production, the appropriate quantity of chemical fertilizer was supplied to the treated plots according with area agricultural guidelines.

Sampling and data collection

Observations were recorded from specifically tagged plants in each treatment plot to ensure consistency. Plant height was measured from ground level to the youngest leaf emergence using a measuring tape, and functional leaves and suckers per mat were manually counted at both the initial and final stages. A digital Vernier scale was used to measure the pseudostem diameter (10 cm above ground) and the finger diameter at its widest point. At harvest, finger length was measured along the dorsal curve, and the number of hands and fingers per bunch was manually recorded. A numerical balanced used to determine bunch weight, and total yield has been calculated by multiplying the plot yield (kg) and dividing by the net plot area (m^2) to determine the total production in tonnes per hectare.

Statistical analysis

The experimental data were subjected to statistical analysis, and treatment means were compared using the Critical Difference (CD) test at 5% level of significance ($P \leq 0.05$) [15].

Result

Initial growth parameters and structural girth of banana

Analysis of initial and final plant height (m)

As shown in Table 1, the banana plants in both groups began at

a comparable height, with the control measuring 1.38 m and the treated group at 1.42 m. This initial similarity that the trial started under uniform conditions. However, study, the plants supplied with UTPANN FOM reached a final height of 5.48 m, whereas the control group averaged 4.72 m. This data suggests that the steady release of nutrients from the organic manure effectively supported the upward extension of the plants during their most active vegetative phase.

A previous study observation in banana cv. Ney Poovan show that while initial plant height at three months remains similar across different treatments, due to research, plant that was treated with 125% RDF increased to a height of 3.12 m, compared to 3.07 m in the control group [16]. A similar research shows that, application of 75% RD Vermicompost mixed with 25% RD Poultry Manure resulted in a plant height of 224.41 cm, which was higher than the 110.48 cm seen in the control. These study demonstrate that continuous nutrient availability, whether from inorganic or organic sources, is critical for enhancing soil structure and promoting the cell elongation required for optimum plant growth [17].

Vegetative growth

The structural robustness of the crop also showed a positive shift following the treatment, as detailed in Table 1. The mid-trunk diameter expanded to 26.40 cm in the treated plants, compared to 22.85 cm in the control. A thicker trunk typically indicates a more efficient vascular system, which enabled the plants to support additional growth, result in 3.85 suckers per mat versus 3.10 in the untreated plots. This improvement implies that the organic matter enriched the root-zone environment, allowing for a more substantial plant base. A Similar Previous experiment shows that the application of organic manures increases vegetative development in the banana crop, with an increase in mid-trunk diameter of 25.63 cm and number of suckers per mat of 3.40 compared to the control of 23.70 cm and 3.28. These higher germination rates indicate improved plant health after organic manure treatment. These increases are attributed to enhanced nutrient availability and improved soil structure. Further, organic amendments improve microbial activity, which results in higher roots, more suckers, and pseudostems [18].Similar observations were recorded in a another research on banana crops, where the application of organic inputs resulted in a mid-trunk diameter of 25.63 cm and 3.40 suckers per mat, compared to 23.70 cm and 3.28 in the control. This results in organic manure and bio-fertilisers, which improve nutrient availability, soil structure, and microbial activity, promoting vigorous vegetative development [19].

Initial and terminal number of leaves

Regarding leaf development, Table 1 shows that both sets of plants started with approximately 9.5 leaves. As the season progressed, the treated plants maintained a higher terminal count of 9.35 leaves, while the control group count dropped to 8.20. This difference shows enhanced nutrition assisted in preventing early leaf aging. In sustaining more active leaves for a longer period of time, the treated plants were able to capture sunlight and convert it into energy during the fruit-filling stage.

These observations are consistent with earlier experiment, the application of 525 g per polybag of organic manure (P6) recorded the impact on leaf production, starting from an initial 6.67 leaves at 10 WAP and increasing to a terminal count of 9.33 leaves by 14 WAP, which was substantially higher than the control from 4.67 to 6.44 leaves. The manure mineralization process, which, after a 10-week lag phase, provides a concentrated supply of nitrogen and phosphorus required to sustain the higher rate of leaf growth required for a high-yielding photosynthetic source. This is the reason for this numerical improvement (a 45% increase in final leaf count) [20]. Comparable trend was observed in similar research, where the Amended-Mixed-NPK treatment showed the highest terminal leaf count of 14.0 leaves at flowering, which was substantially higher than the saline control, 8.2 leaves. The effect is due to increased nutrients and reduced salt stress, which prevents earlier leaf senescence and maintains a higher photosynthetic cover, which is essential for better bunch development and production [21].

Vegetative growth parameters of banana

Fruit bunch and finger development

As indicated in Table 2, the initial structural components of the fruit, such as the number of hands per bunch and the number of fingers per hand, showed relatively close values between the two groups. The treated plants produced 7.12 hands and 14.05 fingers, while the control group recorded 6.88 hands and 13.82 fingers, respectively. This suggests that while the organic treatment did not change the overall count of fruit segments, it established a strong

Treatment	Initial height (m)	Final height (m)	Mid trunk diameter (cm)	Number of suckers per mat	Initial number of leaves	Terminal number of leaves
Control	1.38 ± 0.03	4.72 ± 0.12	22.85 ± 0.65	3.10 ± 0.08	9.45 ± 0.18	8.20 ± 0.22
Treated	1.42 ± 0.04	5.48 ± 0.15	26.40 ± 0.78	3.85 ± 0.10	9.62 ± 0.21	9.35 ± 0.25
CD (P ≤0.05)	NS	0.22	1.40	0.18	NS	0.65

Table 1: Effect of treatment on growth parameters of banana.

foundation for the development of individual fruits.

Earlier study observation that the application of 75% RDNP (Recommended Dose of Nitrogen and Phosphorus) through inorganic fertilizer combined with 25% nitrogen through organic manure resulted in the number of hands per bunch 7.12 and fingers per hand 14.05, which remained numerically close to the control values of 6.88 hands and 13.82 fingers, respectively. The total nutrient management treatment has substantial effects on the physical count of fruit portions, it also provides an effective physiological support for further growth and weight of individual fruits. The reason for this stability is that these structural traits are frequently genetically determined early in the plant [21].

Finger dimensions and physical quality

The data in Table 2 show a difference in the physical size of the fruit. The length of fingers in the treated group reached 14.45 cm, the 12.20 cm observed in the control. Similarly, the diameter of the fingers increased to 3.72 cm, compared to 3.25 cm in the untreated plants. This expansion in both length and girth indicates that the nutrient-rich environment created by the UTPANN FOM allowed the plants to invest more energy into the filling and sizing of each individual fruit. In similar study observation on banana crop, treatment T11 (75% RDN + organic amendments) produced a finger length of 18.78 cm and a diameter of 12.44 cm, which result T1 control 14.24 cm length, 9.11 cm diameter. The improved performance is due to increased nutrient availability from the combination of FYM, vermicompost, and bio-fertilizers [23]. A similar trend has been observed in earlier studies, where integrated nutrient management enhanced fruit size. In those studies, fruit length reached 15.71 cm and diameter 11.20 cm, exceeding the control. This improvement is attributed to the continuous supply of essential nutrients such as potassium and phosphorus from organic amendments during bunch development, which supports efficient nutrient uptake and promotes better fruit filling, resulting in increased finger length and diameter [24].

Bunch productivity

The combined improvements in fruit size directly determined the final weight of the crop. According to Table 2, the weight of fruits per bunch reached 4.72 kg in the treated plots, while the control group averaged 3.95 kg. This increase in bunch weight is a direct outcome of the better finger dimensions previously noted. According to research, organic manure provides the essential potassium and minerals during the fruit growth stage, which results in bunches. A similar result was reported for treatment T11 (75% RDN + 20 kg FYM + 10 kg Vermicompost + 100g PSB + 100g *Azotobacter*), which produced a maximum average bunch weight of 20.35 kg, which was considerably greater than the control group (T1), which produced only 11.39 kg. This increase in bunch weight can be attributed to enhanced nutrient availability, microbial activity, and nutrient uptake efficiency as a result of the combined application of organic manures and biofertilizers [25].

Yield parameters

Individual plant productivity

The data presented in figure 1. show a substantial difference

Treatment	Number of hand per bunch	Number of finger per bunch	Length of fingers (cm)	Diameter of fingers (cm)	Weight of fruits per bunch (kg)
Control	6.88 ± 0.12	13.82 ± 0.18	12.20 ± 0.35	3.25 ± 0.08	3.95 ± 0.14
Treated	7.12 ± 0.15	14.05 ± 0.22	14.45 ± 0.42	3.72 ± 0.10	4.72 ± 0.18
CD (P ≤ 0.05)	NS	NS	0.85	0.18	0.32

Table 2: Effect of treatment on yield parameters of banana.

in the output of individual banana plants following the treatment. The plants supplied with UTPANN FOM produced a yield per plant of 13.00 kg, which effectively doubled the 6.83 kg observed in the control group. This indicates that the cumulative improvements in plant height, trunk diameter, and fruit weight directly resulted in a much more productive plant. Comparable results were observed in a previous study, the organic method improved the yield of a banana (cv. Nendran) to 9.60 kg/plant, up from 6.10 kg/plant in the control group. This result was due to a nutrition supply, photosynthetic capability through increased leaf area and chlorophyll, and enhanced soil biological health through biofertilizers and organic compounds [26].

Total farm yield per acre

When evaluating the broader impact on the farm, figure 1. shows that the higher individual productivity led to a much greater yield per acre. The treated plots reached a total of 7.22 tonnes, whereas the control plots produced 3.79 tonnes. This increase in total tonnage per acre is a direct result of the enhanced fruit-filling and overall plant health noted in the previous tables. It appears the 15–20 kg/acre dosage of UTPANN FOM successfully optimized the land's potential, making it a highly effective choice for increasing banana production in the Anand and Kheda regions. Similarly, a related study observed that the combination of biocompost, castor cake, and vermicompost results in a maximum banana yield of approximately 29.47 tons per acre. This is a 47.4% improvement over the control, which can be attributed to improved soil health and supply of nutrients for the plants [27].

Conclusion

The study concludes that application of UTPANN FOM 15-20 kg per acre improves banana growth, harvest production, and fruit quality in the field. This treatment also results in earlier

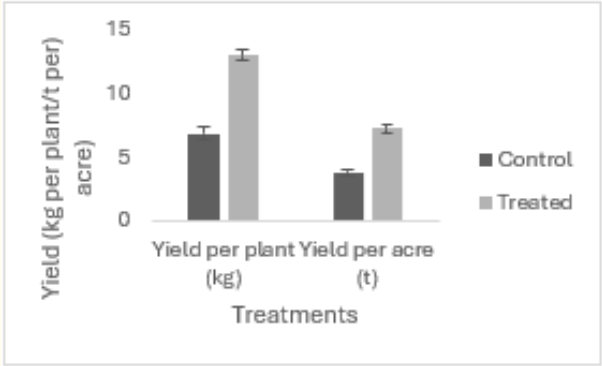

Figure 1: Effect of Fermented Organic Manure (FOM) Application on Yield Parameters of Banana.

shooting and a higher percentage of commercial fruits. Better vegetative development, heavier bunch weight, and more fingers per hand improve the total yield. Furthermore, its application has the potential to enhance soil health over time. The research results of the present study indicate that UTPANN FOM can boost productivity and improve sustainable banana farming, and

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