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Research Article

Role of UTPANN Fermented Organic Manure in Improving Growth Performance and Bulb Quality of Onion (*Allium cepa* L.)

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Abstract

A field experiment was conducted during the rabi season of 2024–25 under open field conditions in Banaskantha district of Gujarat to study the effect of fermented organic manure (UTPANN FOM) on growth, yield and quality of onion (*Allium cepa* L.). The experiment was laid out in a Randomized Block Design with two treatments, T1 control no nutrient input and T2 application of UTPANN FOM 10 kg/acre, replicated three times. The treatment receiving application of UTPANN Fermented Organic Manure (FOM) recorded a higher yield of 27.96 t/ha as compared to the control. Plant growth characteristics, such as plant height 56.78 cm, number of leaves per plant 9.21, and neck thickness 11.36 mm, were also improved bulb yield, as shown in higher yield parameters such as bulb diameter 6.18 cm and average bulb weight 102.36 g under UTPANN FOM application. Quality parameters showed higher values of total soluble solids 11.86 °Brix, dry matter content 14.67% and shelf life 68.5 days. The improvement in growth, yield and quality was associated with better nutrient availability, improved soil condition, enhanced microbial activity and balanced nutrient supply under fermented organic manure application.

Keyword: Bulb Yield; Field Experiment; Organic Manure; Growth Attributes; Onion; Quality Parameters; Rabi Season; Soil Fertility

Introduction

Onion (*Allium cepa L.*) is one of the most important vegetable crops worldwide. It is the second most important horticultural crop after tomatoes, with major consequences for world food security and the rural economies. It belongs to the genus *Allium*, which includes other economically important crops such as garlic, leek, and shallot. Onion is widely cultivated across diverse agro-climatic regions and is valued for its distinct flavour, nutritional richness, and medicinal [1,2]. The bulbs are rich in essential nutrients, including carbohydrates, vitamins (C, B6, and folic acid), and minerals such as calcium, phosphorus, iron, and magnesium. Additionally, onions contain bioactive compounds such as flavonoids (notably quercetin) and sulphur-containing compounds, which impart antioxidant, anti-inflammatory, and antimicrobial properties, thereby contributing to the prevention of chronic diseases. Consumer appetite for organic onions has increased as a direct consequence of these medicinal benefits, with health-conscious markets placing a higher priority on products free of artificial chemical residues [3].

Onion growth and productivity are primarily dependent on soil fertility and effective soil fertilizer management methods [4]. India is a major producer of onions, incorporating a substantial amount of global production. However, despite a large cultivation area, productivity in many regions remains relatively low due to insufficient nutrient management and decreasing soil fertility [5]. Efficient and balanced supply of nutrients is essential for managing plant physiological processes including as photosynthesis, root development, nutrient uptake, and biomass accumulation, which leads to increased bulb formation and crop yield [4]. The use of chemical fertilizers has increased substantially in agriculture, but their excessive and continuing application has resulted in several of environmental challenges, including soil deterioration, nutritional imbalance, a decrease in soil organic matter, and a decline in beneficial microbial populations [6]. Furthermore, onion is highly volatile, with losses following harvest in India estimated at 25-35% due to improper handling and storage, stressing the importance of strong cultivation practices that produce higher-quality, more resilient bulbs [7]. Long-term soil health and production for agriculture are severely impacted by these factors. The incorporation of organic manures has grown increasingly crucial in sustainable agriculture due to the concerns associated with chemical dependency [8].

In this context, organic nutrient management has gained considerable importance as a sustainable alternative to conventional fertilization practices. Organic supplements, such as farmyard manure (FYM) and compost, function as beneficial fertilizers by improving soil physical characteristics, increasing water-holding capacity, and increasing cation exchange capacity, which leads to improved nutrient retention and plant uptake [9,10]. These substances increase the availability of important micronutrients, specifically phosphorus, which is often chemically fixed in a number of soil types, and help in the mineralization of nutrients [11]. Organic improvements enhance beneficial microbial activity by increasing soil organic carbon (SOC) levels, which improves nutrient cycling and supports a more resilient rhizosphere for root development [12]. Plants cultivated in organic-enriched conditions frequently show higher vegetative development, nutrient assimilation, and resistance to environmental stress, ultimately leading to consistent and sustainable crop production [13].

Fermented organic manure (FOM) has emerged as a highly effective nutrition source due to its increased nutrient availability and biological activity. It is produced through controlled microbial fermentation, which reduces complex organic compounds to simpler, more accessible forms [14]. These fermented stimulants are enriched in beneficial microbial metabolites, enzymes, and natural plant growth-promoting chemicals such as phytohormone compounds (auxins and cytokinins), which promote rapid root development and improve nutrient uptake efficiency [15]. Recent research indicates that systemic biologicals and fermented products may substantially increase plant height and weight as compared to standard maintenance, primarily because FOM acts as a highly concentrated, environmentally safe biofertilizer that undergoes a particular decomposition process to get eliminate of diseases and weed seeds [16,17]. Nutrient partitioning. The synergistic effect of FOM improves the Nutrient partitioning in onion crops, promoting superior leaf development, increased neck thickness, and larger bulb diameters compared to conventional raw manures [18].

In the present research, the yield and sustainability of onions (*Allium cepa* L.) were determined by evaluating the effect of UTPANN Fermented Organic Manure (FOM) on growth, nutrient uptake, and bulb yield in typical field conditions. The objective of this research aims to provide mechanism for the transfer from synthetic components to bio-based fertilization, demonstrating that substantial commercial yields can be preserved and remaining sustainable for the environment.

Materials and Methods

Experimental site

The field experiment was conducted during the rabi season of 2024–25 under open field conditions in Banaskantha district of Gujarat, India. The experimental site illustrates a semi-arid agro-climatic region characterized by low to moderate rainfall, high evapotranspiration, and sandy loam soil conditions, which are suitable for onion cultivation under irrigated farming systems.

Soil analysis

Before initiation of the experiment, composite soil samples were collected from a depth of 0–15 cm from different locations of the experimental field to obtain a representative sample. The collected samples were air-dried, processed, and analyzed using standard laboratory procedures. The physico-chemical properties of the experimental field is mentioned in Table 1.

Experimental design and treatments

The experiment was laid out in a Randomized Block Design (RBD) to minimize field variability and to ensure reliable comparison between treatments. The field was divided into uniform blocks, and each treatment was randomly distributed within each block to reduce experimental error and improve statistical accuracy. The study consisted of two treatments with

Parameter	Value
pH	7.42
EC (dS/m)	0.38
Organic Carbon (%)	0.54
Available Nitrogen (kg/ha)	268.5
Available Phosphorus (kg/ha)	32.6
Available Potassium (kg/ha)	214.8

Table 1: Initial soil physico-chemical properties of the experimental field.

three replications as follows: T_1- Control no nutrient or fertilizer application T_2- UTPANN Fermented Organic Manure (FOM) 10 kg/acre. Each treatment plot was maintained under uniform agronomic practices, with the exception of the applied treatments, to ensure an objective comparison of treatment effects.

Crop establishment and management

Onion seedlings which were uniform and healthy was transplanted at the appropriate space. All agronomic measures, including irrigation, weeding, and plant protection, were consistent across all treatments to provide optimum crop yield and treatment comparable results.

Application of treatment

UTPANN FOM was applied as a basal dose at transplanting 10 kg/acre and uniformly incorporated into the soil within the root zone. Irrigation was provided after application to ensure proper soil integration and activation of microbial activity.

Observations recorded and measurement procedures

Five sample plants were selected and identified in each replication. Observations were recorded at different growth stages and at harvest using standard procedures.

Growth parameters

Plant height (cm) was measured from soil surface to the tip of the longest leaf using a measuring scale at harvest. The number of leaves per plant was determined during the highest vegetative stage, including viable leaves. At harvest, the area around neck thickness (mm) was measured at the highest point between bulb and leaves by vernier caliper at harvest stage [19].

Yield parameters

Bulb diameter (cm) was measured at the widest portion using a vernier caliper. Average bulb weight (g) was recorded using a digital weighing balance from five bulbs per plot. Total yield (t/ha) was calculated from net plot yield and converted into hectare basis using standard formula:

$$\text{Yield (t/ha)} = \frac{\text{Plot yield (kg)}}{\text{net plot area (m}^2\text{)}} \times 10{,}000$$ [20].

Quality parameters

Total soluble solids (°Brix) were determined from fresh onion juice using a hand refractometer, while dry matter content (%) was estimated by oven-drying samples at 65–70°C until a constant weight was achieved, furthermore, shelf life (days), was measured by maintaining the bulbs at room temperature and observing every day when flowering or substantial degradation was observed [21].

Statistical analysis

The collected data were subjected to analysis of variance (ANOVA) appropriate for a Randomized Block Design. The significance of treatment effects was determined using the Critical Difference (CD) at the 5% level of significance ($P \leq 0.05$).

Result

Vegetative growth

Plant height

UTPANN Fermented Organic Manure (FOM) at the recommended dosage substantially increased plant height, with treated plants recorded 56.78 cm compared to 42.36 cm in the control (Table 2). This 34.04% increase was due to the continuous supply of essential nutrients, which promoted cell growth and apical development. As per earlier research, plant height increased 38.13 cm with the FYM treatment, above the control value of 31.00 cm, with improved nutrient availability and higher cell division and elongation, resulting in better vegetative growth in the onion [22].

Number of leaves per plant and Neck Thickness

As per show, the number of leaves per plant from 6.82 to 9.21. This expansion of the photosynthetic apparatus improved the net assimilation rate, providing a larger source-sink capacity. Furthermore, the neck thickness increased to 11.36 mm, indicating robust vascular development.

In another study, the combined application of organic and inorganic fertilizers for onion growth, where the highest treatment of 103.5 kg N/ha + 30 t FYM/ha recorded a maximum leaf number of 15.67 and neck thickness of 19.9 mm, while the lowest values of 9.20 and 7.8 mm, respectively, were observed in the control treatment. This improvement attributed to integrated nutrient management, in which nitrogen increased vegetative growth and photosynthesis, while FYM improved soil structure and nutrient availability, yielding improved root formation and more efficient nutrient uptake [23]. Similarly, chicken manure increased onion growth over the control. The treatment plots had the increased 15 leaves/plant and the highest bulb neck 1.6 cm, while the control plots have which was the lowest number 9 leaves/plant and the bulb neck thickness 0.9 cm [24].

Treatment	Plant height (cm)	No. of Leaves/ Plant	Neck Thickness(mm)
Control	42.36 ± 1.25	6.82 ± 0.32	8.14 ± 0.41
Treated	56.78 ± 1.48	9.21 ± 0.45	11.36 ± 0.52
CD (P ≤ 0.05)	3.12	0.84	1.27

Table 2: Effect of Fermented Organic Manure (UTPANN FOM) on Growth Parameters of Onion.

Yield attributes and biomass partitioning

Bulb diameter

Based on Table 3, bulb diameter was, treated plants compared to the control. The treated plants recorded a bulb diameter of 6.48 cm, whereas the control plants showed 4.65 cm**,** representing improved bulb development under the treatment. This increase is attributed to enhanced nutrient availability and better physiological growth conditions provided by the treatment. A comparable result was observed in the previous study, integrated organic manures improved polar diameter of onion bulbs, where the highest value was recorded in T4 poultry manure 3 t/ha- 5.36 cm, followed by vermicompost T3- 5.55 cm and FYM T2- 5.34 cm, while the lowest was observed in the control T1- 4.28 cm [25].

Average bulb weight

The average bulb weight 102.36 g, representing a 49.54% increase over the control. This indicates superior nutrient uptake efficiency and effective dry matter partitioning. A higher bulb weight of 50.38 g was recorded in plants treated with poultry manure(3 t/ha), compared to the 32.67 g found in the control group, this result improved nutritional availability and bulb growth with organic nutrition [26].

Yield (t/ha)

The total yield was 27.96 t/ha, an increase of 9.72 t/ha compared to the untreated control. This application of fermented organic manure, which improved soil–microbe interactions, improved nutrient availability, and increased productivity. As reported in previous research, the effect of chicken manure increased onion yield compared to the control under greenhouse conditions. The control treatment yielded 67.54 t/ha, and the 20 t/ha chicken manure treatment yielded 72.99 t/ha, indicating a substantial increase over untreated soil due to increased nutrient availability, soil biological activity, and nutrient mineralization [27].

Treatment	Bulb Diameter	Average bulb weight	Yield (t/ha)
Control	4.62 ± 0.21	68.45 ± 3.12	18.24 ± 0.85
Treated	6.18 ± 0.27	102.36 ± 4.25	27.96 ± 1.12
CD (P ≤ 0.05)	0.62	8.54	2.14

Table 3: Effect of Fermented Organic Manure (UTPANN FOM) on Yield Parameters of Onion.

Qualitative parameters and post-harvest longevity

TSS (°Brix)

The biochemical profile of the bulbs was enriched under the FOM treatment. The Total Soluble Solids (TSS) rose to 11.86 °Brix, reflecting a higher concentration of sugars and soluble minerals. Similarly results have been reported where, the application of organic nutrient sources based on FYM, compost, vermicompost, and oil cakes under treatments T1 and T2 increased total soluble solids (TSS) in onion up to 11.4% and 11.6%, enhanced synthesis and accumulation of soluble sugars, which improved the quality attributes and biochemical composition of the crop [28].

Dry matter (%)

Table 4 shows a substantial increase in dry matter percentage, from 11.24 ± 0.52% in control to 14.67 ± 0.61% in treated bulbs, demonstrating higher levels of dry matter concentration and bulb quality. Organic fertilizer treatment with farmyard manure and vermicompost (Treatment T9) improves onion bulb dry matter content to 14.01% after curing and 14.57% after 60 days of storage, which is higher than the 8.55% and 10.49% observed in control treatments [29].

Treatment	TSS (°Brix)	Dry matter (%)
Control	9.12 ± 0.38	52.3 ± 2.1
Treated	11.86 ± 0.44	68.5 ± 2.8
CD (P ≤ 0.05)	1.36	5.48

Table 4: Effect of Fermented Organic Manure (UTPANN FOM) on Quality Parameters of Onion.

Shelf life (days)

As shown in Figure 1, shelf life was recorded at 68.5 ± 2.8 days under treatment, compared to 52.3 ± 2.1 days in the control. This increase in shelf life was due to higher mineral balance (Ca and K) in bulb scales, which improved cell walls and reduced physiological weight and moisture depletion during storage. A comparable result was observed in a study on onion shelf life, where protein hydrolysate (biostimulants) treatments extended storage duration to 199.0 days compared with 183.3 days in the control, with the highest value reaching 228.0 days in a variety. This improvement was enhanced structural substantial growth and better physiological stability of bulbs under organic treatments, which reduced degradation and maintained post-harvest quality for a longer period [30].

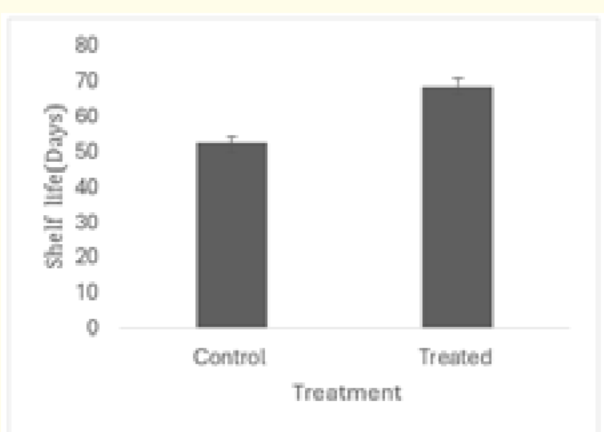

Figure 1: Effect of control vs Treated on Onion Shelf Life.

Conclusion

The study concludes that application of UTPANN FOM at the recommended dose improves onion growth, yield, and quality under field conditions. This treatment resulted in better vegetative growth, enhanced root development, and improved bulb development. Increased bulb weight, overall yield, and improved quality parameters such as shelf life all resulted to higher productivity and improved post-harvest results. The application of UTPANN FOM also has potential to improve soil health over time.

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