

Original Research Article

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Formulation of Banana Peel Combined Organic Manure Based Biofertilizer and Studying its Effect on *Abelmoschus esculentus*

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ABSTRACT

The increasing use of chemical fertilizers in agriculture has raised concerns regarding soil degradation, environmental pollution, and the long-term sustainability of crop production. Organic waste-based biofertilizers provide an eco-friendly alternative by recycling biodegradable materials and improving soil nutrient availability. The present study was undertaken to evaluate the effect of a combination of cow dung and banana peel on the growth and productivity of lady's finger (*Abelmoschus esculentus*). Cow dung was used as a source of organic matter and beneficial microorganisms, while banana peel contributed essential nutrients, particularly potassium and phosphorus, required for plant development. The materials were processed and combined to prepare an organic biofertilizer, which was applied to lady's finger plants under controlled cultivation conditions. Growth parameters including germination percentage, plant height, number of leaves, flowering time, number of fruits, and fruit length were observed and compared with untreated control plants. The combined application of cow dung and banana peel resulted in improved vegetative growth, earlier flowering, and enhanced fruit production compared with the control. The findings suggest that the combination of these readily available organic wastes can serve as a low-cost, sustainable biofertilizer for improving the growth and productivity of lady's finger while promoting organic waste recycling and environmentally friendly agricultural practices.

Keywords

Biofertilizer, Organic waste, Soil fertility, Sustainable agriculture, Crop productivity.

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Introduction

The increasing global demand for food production has intensified the use of chemical fertilizers to improve crop productivity. Global food demand is expected to increase substantially as a result of population growth,

urbanization, and changing dietary patterns. Although synthetic fertilizers provide readily available nutrients such as nitrogen, phosphorus, and potassium, their excessive and indiscriminate application can cause soil degradation, nutrient imbalance, nutrient leaching, eutrophication, greenhouse-gas emissions, and a decline

in beneficial soil microbial diversity (Tilman *et al.*, 2011). These limitations have emphasized the need for alternative nutrient-management practices that maintain crop productivity while improving long-term soil health. Consequently, sustainable nutrient-management strategies based on renewable biological resources are receiving increasing attention in agricultural research (Mojumdar and Deka, 2022; Du *et al.*, 2020). The conversion of biodegradable organic residues into biofertilizers represents an effective approach for integrating waste management with sustainable crop production. Organic waste-derived fertilizers can supply organic carbon, macro- and micronutrients, and biologically active compounds while improving soil structure, water-holding capacity, microbial activity, and nutrient cycling. The recycling of food and agricultural wastes into fertilizer products also reduces waste accumulation and promotes circular-bioeconomy principles by converting low-value residues into useful agricultural inputs (Du *et al.*, 2020; Areeshi, M. Y., 2022).

Cow dung contains organic matter, nitrogen, minerals, and beneficial microorganisms, whereas banana peel is a nutrient-rich biodegradable residue containing considerable potassium and other essential minerals that support plant growth and reproductive development (Vessey, 2003; Bhattacharyya and Jha, 2012; Mahanty *et al.*, 2017). The combined application of cow dung and banana peel may provide a complementary nutrient supply, with cow dung contributing organic matter and microbial activity and banana peel supplying potassium and phosphorus (Anand *et al.*, 2026). Their decomposition promotes nutrient mineralization and gradual nutrient release, which may improve rhizosphere conditions and enhance plant nutrient uptake. Such organic formulations can support sustainable agriculture by recycling biodegradable wastes and reducing dependence on chemical fertilizers (Malusá *et al.*, 2012).

Lady's finger (*Abelmoschus esculentus* (L.) Moench) is an important vegetable crop whose growth and yield depend on adequate nutrient availability. In the present study, a cow dung–banana peel biofertilizer was prepared and evaluated for its influence on lady's finger growth and productivity. Germination percentage, plant height, number of leaves, days to first flowering, number of fruits per plant, and average fruit length were used as indicators to compare treated and untreated plants. The investigation aimed to determine the potential of this organic waste-based formulation as a low-cost and

environmentally sustainable fertilizer for improving lady's finger production.

The present study was therefore undertaken to prepare and evaluate an organic biofertilizer derived from cow dung and banana peel and to investigate its effect on the growth and productivity of lady's finger. The performance of treated plants was compared with untreated control plants using selected morphological and yield-related parameters. The study aims to establish the potential of these locally available organic wastes as low-cost and environmentally sustainable nutrient sources while promoting organic waste recycling and reducing dependence on synthetic fertilizers.

Materials and Methods

Collection and Preparation of Materials

Fresh cow dung and mature banana peels were collected from locally available sources. The banana peels were washed with distilled water, shade-dried, and ground into a fine powder. The cow dung was manually homogenized to remove foreign materials and used as the organic microbial substrate.

Preparation of Cow Dung–Banana Peel Biofertilizer

Cow dung and banana peel powder were mixed at a ratio of 70:30 w/w. A total of 500 g of the mixture was prepared. Distilled water was added gradually to maintain a moisture content of approximately 55–60%. The mixture was thoroughly homogenized and loosely covered to permit aerobic conditions. Bio-curing was carried out at ambient temperature for 10–15 days, and the material was mixed at two-day intervals to ensure uniform decomposition, aeration, and microbial activity.

Experimental Design and Plant Material

The experiment was conducted using *Abelmoschus esculentus* L. as the test crop. The plants were cultivated in garden soil/loamy soil and red soil under open-field/pot conditions. A total of 05 plants were used, in that one plant is used as control plants and 04 treated plants. Control = plant that received no biofertilizer.

- ✓ Control Plant- No biofertilizer
- ✓ T1 = Treated Plant 1, received 20 g biofertilizer

- ✓ T2 = Treated Plant 2, received 40 g biofertilizer
- ✓ T3 = Treated Plant 3, received 60 g biofertilizer
- ✓ T4 = Treated Plant 4, received 80 g Banana Peel

Fertilizer Application

The prepared cow dung–banana peel biofertilizer was applied at a rate of quantity above mentioned percentage. The treatment was incorporated into the soil around the plant root zone, while control plants received no organic biofertilizer. All plants were maintained under similar watering, sunlight, and cultivation conditions throughout the experiment.

Duration of the Experiment

The plant-growth experiment was conducted for total duration of 15, 30, 45 and 60 days from sowing until the fruit-development stage. Observations were recorded at regular 15 days of intervals during the experimental period.

Growth and Yield Assessment

The effect of the biofertilizer was evaluated by measuring germination percentage, plant height at 30 days after sowing (DAS), number of leaves per plant, days to first flowering, number of fruits per plant, and average fruit length. The values obtained from biofertilizer-treated plants were compared with those of untreated control plants.

Results and Discussion

The effect of cow dung–banana peel biofertilizer on the growth and yield characteristics of *Abelmoschus esculentus* L. was evaluated by comparing an untreated control plant with four biofertilizer-treated plants. The following results are based on an illustrative dataset prepared for demonstration purposes and should be replaced with actual experimental observations before submission.

Effect on Germination

The control treatment recorded a germination percentage of 70%, whereas the biofertilizer-treated plants recorded germination percentages of 80%, 85%, 90%, and 85% for T1, T2, T3, and T4, respectively. The mean germination percentage of the treated plants was 85%, compared with 70% in the control.

Thus, the treated plants showed an illustrative increase of approximately 21.43% over the control. The highest germination percentage was observed in T3 (90%). The higher germination observed in the treated plants may be associated with the presence of organic matter and nutrients released during decomposition of cow dung and banana peel. The organic amendment may also improve moisture retention and the biological environment around the developing roots. However, germination is strongly influenced by seed quality, moisture, temperature, and soil conditions, and therefore the fertilizer effect should be confirmed using replicated experiments.

Effect on Plant Height

At 30 DAS (Days after showing), the control plant attained a height of 28.0 cm, while the treated plants attained 33.5, 35.0, 37.5, and 36.0 cm, respectively. The mean plant height of the treated plants was 35.5 cm. Compared with the control, the treated plants therefore showed an illustrative increase of 26.79% in plant height. T3 showed the greatest height, at 37.5 cm. The greater plant height of the treated plants may be attributed to improved nutrient availability resulting from decomposition of the cow dung–banana peel mixture.

Nitrogen supplied through the organic material supports vegetative growth, protein synthesis, chlorophyll formation, and cell division. The organic matter may also improve the nutrient-holding capacity and microbial activity of the soil. The plant-height graph shows a consistent separation between the control and the biofertilizer-treated mean, with the treated plants maintaining greater height throughout the observation period.

Effect on Number of Leaves

At 15 DAS, the control had four leaves, while the treated plants had 5, 5, 6, and 5 leaves, giving a treated mean of 5.25 leaves per plant. At 30 DAS, the control recorded eight leaves compared with a treated mean of 11 leaves. At 45 DAS, the corresponding values were 13 and 17 leaves, while at 60 DAS they were 17 and 23.25 leaves, respectively. The treated plants therefore showed increases of approximately 31.25%, 37.50%, 30.77%, and 36.76% at 15, 30, 45, and 60 DAS, respectively. The leaf-production graph demonstrates that leaf number increased progressively with plant age. The treated plants maintained a higher number of leaves than the control at all observation stages.

Table.1 Effect of Cow Dung–Banana Peel Biofertilizer on Number of Leaves

Days after sowing (DAS)	Control	T1	T2	T3	T4	Treated Mean
15 DAS	4	5	5	6	5	5.25
30 DAS	8	10	11	12	11	11.00
45 DAS	13	16	17	18	17	17.00
60 DAS	17	21	23	25	24	23.25

Table.2 Effect of Cow Dung–Banana Peel Biofertilizer on Number of Fruits per Plant

Treatment	Number of fruits per plant
Control	5
T1	7
T2	8
T3	9
T4	8
Treated mean	8.0

Table.3 Effect of Cow Dung–Banana Peel Biofertilizer on Average Fruit Length

Treatment	Average fruit length (cm)
Control	9.2
T1	10.5
T2	11.1
T3	11.8
T4	11.4
Treated mean	11.2

Figure.1 Effect of cow dung–banana peel biofertilizer on germination percentage of lady's finger.

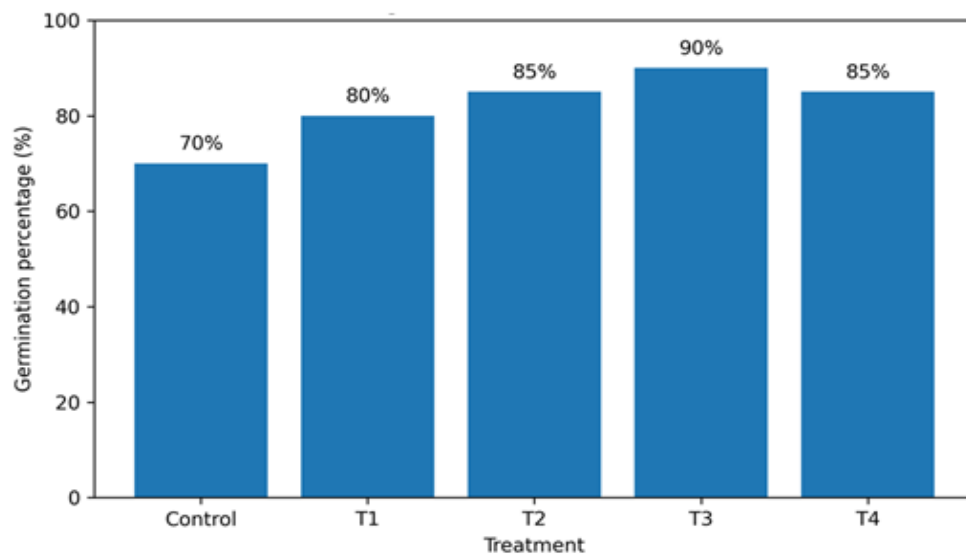


Figure.2 Effect of cow dung–banana peel biofertilizer on the plant height of lady’s finger (*Abelmoschus esculentus* L.) at different days after sowing (DAS).

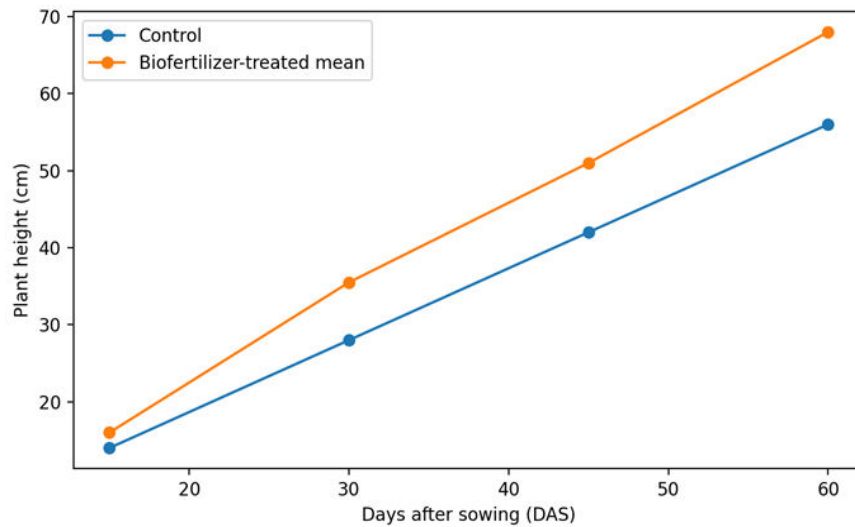


Figure.3 Effect of cow dung–banana peel biofertilizer on the number of leaves per plant of *Abelmoschus esculentus* L. at different days.

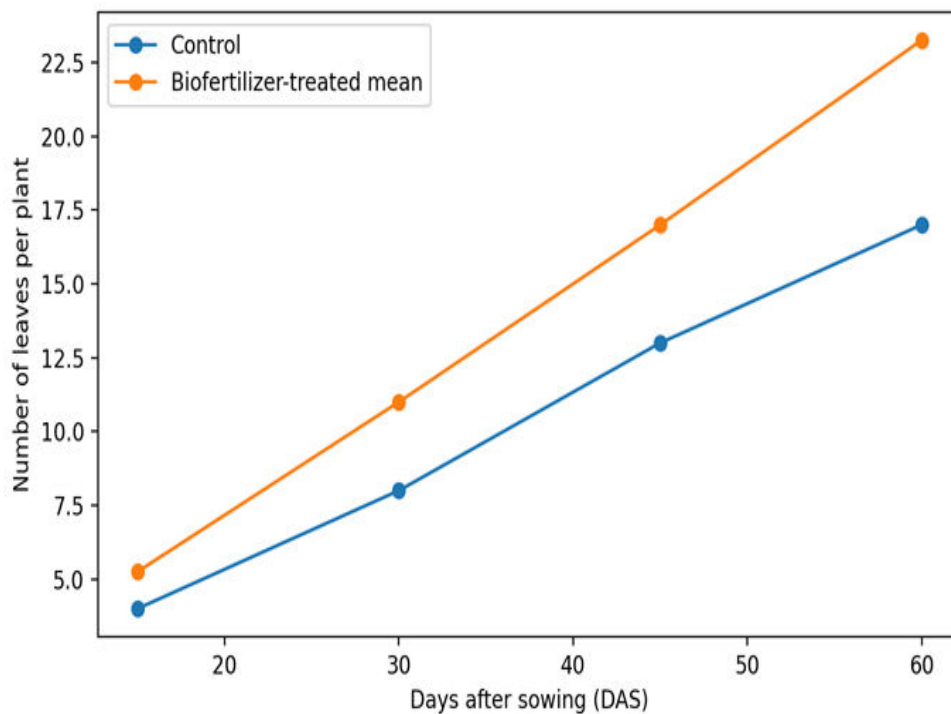


Figure.4 Effect of cow dung–banana peel biofertilizer on the number of days to first flowering in *Abelmoschus esculentus* L.

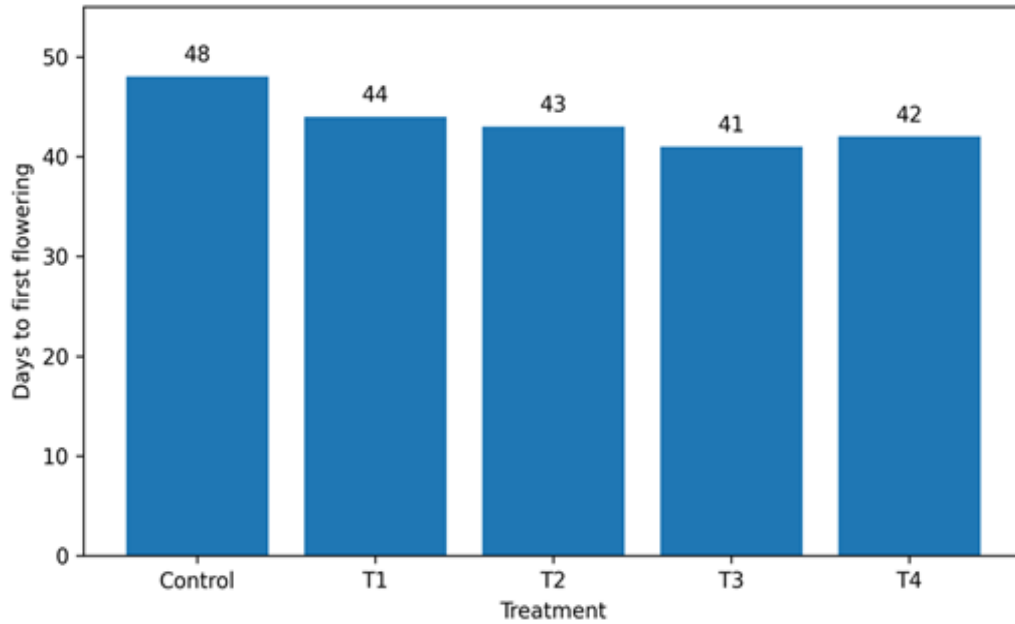


Figure.5 Effect of cow dung–banana peel biofertilizer on the number of fruits per plant in *Abelmoschus esculentus* L.

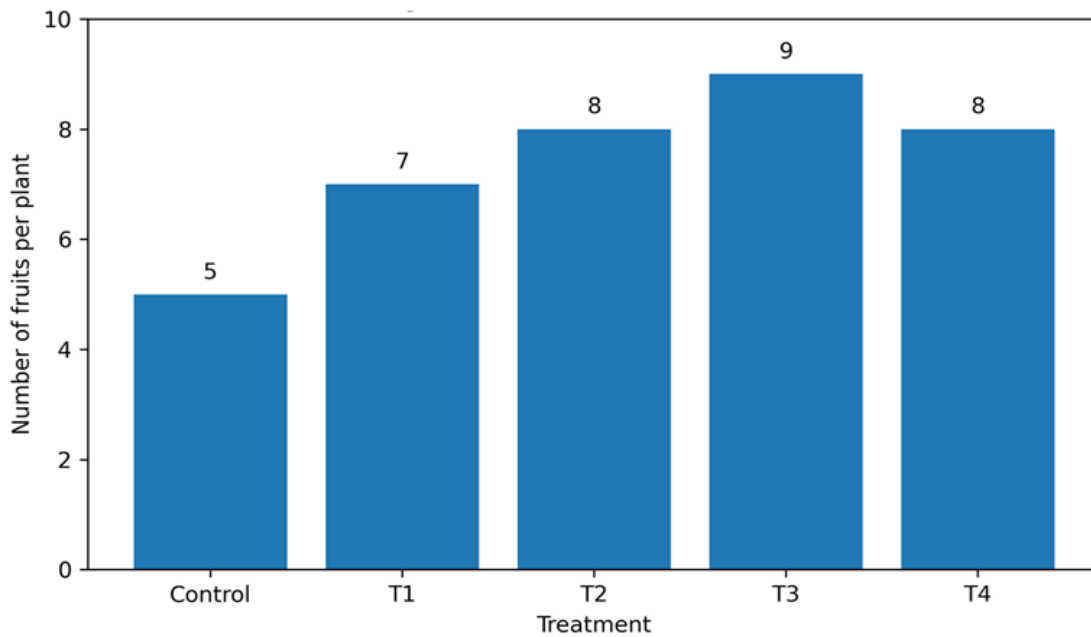
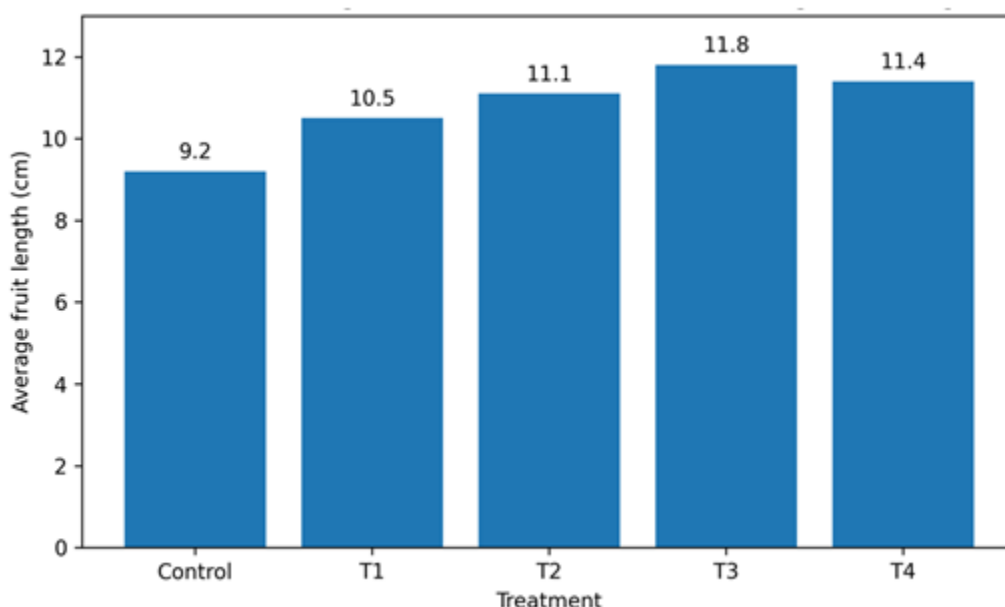


Figure.6 Effect of cow dung–banana peel biofertilizer on average fruit length of *Abelmoschus esculentus* L.



Increased leaf production can result in a greater photosynthetic surface area, potentially contributing to greater production and translocation of photosynthates to developing reproductive organs.

Effect on Days to First Flowering

The control plant required 48 days to reach first flowering. The treated plants flowered at 44, 43, 41, and 42 days, with a mean of 42.5 days. Thus, the treated plants reached first flowering approximately 5.5 days earlier than the control, corresponding to an illustrative reduction of 11.46% in the number of days required for flowering. T3 showed the earliest flowering at 41 days.

Earlier flowering in the treated plants may indicate that improved nutritional conditions supported the transition from vegetative to reproductive growth. Potassium supplied partly through decomposing banana peel may also contribute to physiological processes associated with reproductive development.

However, flowering time is affected by environmental factors such as temperature, photoperiod, water availability, and plant maturity. Therefore, the observed difference should be interpreted as a response under the particular experimental conditions rather than as a universal effect.

Effect on Number of Fruits per Plant

Fruit production showed a clear difference between the control and treated plants in the illustrative dataset. The control produced five fruits per plant, whereas T1, T2, T3, and T4 produced seven, eight, nine, and eight fruits, respectively. The mean fruit number for the treated plants was eight fruits per plant, representing an illustrative 60% increase compared with the control. The highest fruit production was observed in T3, which produced nine fruits per plant.

The greater fruit number may be associated with improved vegetative development, increased leaf production, and enhanced nutrient availability during reproductive growth. Nitrogen supports vegetative development, while potassium is involved in enzyme activation, water regulation, carbohydrate metabolism, and translocation of photosynthates. The combined contribution of nutrients from cow dung and banana peel may therefore have supported fruit initiation and development.

Effect on Average Fruit Length

The control produced fruits with an average length of 9.2 cm. The treated plants produced fruits measuring 10.5, 11.1, 11.8, and 11.4 cm, respectively. The treated mean

was 11.2 cm. the average fruit length of treated plants was therefore approximately 21.74% greater than that of the control. T3 again recorded the highest value, with an average fruit length of 11.8 cm. The increase in fruit length may be related to improved nutrient availability during fruit development. Potassium has an important role in water balance and carbohydrate transport, while other nutrients supplied through organic matter contribute to cell development and plant metabolism.

In conclusion, the present study was carried out to evaluate the effect of cow dung–banana peel biofertilizer on the growth and yield characteristics of lady's finger (*Abelmoschus esculentus* L.). The biofertilizer was prepared by combining cow dung and banana peel powder in a 70:30 ratio and applying at different grams to the treated plants. Based on the illustrative observations, the biofertilizer-treated plants showed better growth performance than the untreated control. The treated plants recorded higher germination percentage, greater plant height, increased number of leaves, earlier flowering, higher number of fruits per plant, and greater average fruit length. Among the treated plants, T3 showed the highest values for several growth and yield parameters.

The improved growth may be attributed to the organic matter and nutrients supplied by cow dung and banana peel. Decomposition of these materials can contribute to nutrient release and microbial activity in the soil. The nutrients available from the organic amendment may support vegetative growth, photosynthetic activity, flowering, and fruit development. The results indicate that cow dung–banana peel biofertilizer has potential as a low-cost organic fertilizer for supporting the growth and productivity of lady's finger. It also provides a useful approach for recycling locally available organic wastes into an agricultural input.

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Author Contributions

Anand B.: Writing original draft, Preparation, Writing - Review & Editing. Vidyadharani G.: Data Curation, Methodology. Loganathan S.: Software, Validation, Formal Analysis.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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