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Effect of bioinoculant on growth, yield and quality of mango (*Mangifera indica* L.) cv Kesar

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Abstract
A field experiment titled "Effect of bioinoculant on growth, yield and quality of mango *(Mangifera indica* L.) cv. Kesar" was carried out during 2024-25 at the College of Agriculture, Badnapur, in collaboration with Mahyco Company at their research field in Jalna. The study included various treatments using biofertilizers (Azotobacter and PSB) along with vermicompost and was arranged in a Randomized Block Design (RBD).
Among all the treatments, T_9, which consisted of Azotobacter (50 g per plant) + PSB (50 g per plant) combined with 3 kg of vermicompost per plant, proved to be significantly superior in several growth and development parameters, including percent increase in leaf length (9.64%) and fruit weight (356.00 g).
For other parameters, the highest plant height (11.83%) and maximum leaf area increase (9.69%) were recorded in the control treatment (T_{10}). The shortest duration for achieving 50% flowering (11.78%) and the fastest transition from flower bud initiation to fruit set (36.14%) were observed in T_9. The highest number of flowers per panicle (2666.67) occurred in T_1, while the maximum number of fruits at the marble stage (8.62) was recorded in the control (T_{10}).
Treatment T_3 produced the greatest number of fruits at harvest (333.33) and also recorded the minimum fruit drop (82.00), along with the highest increase in fruit retention (8.33%). The longest fruits (13.26 cm) were obtained from T_7, and the largest fruit diameter (9.93 cm) from T_1. The highest average fruit yield per tree (45.96 kg) was observed in T_8, whereas the maximum juice percentage (52.6%) was found in the control (T_{10}).
Additionally, the control treatment (T_{10}) recorded the highest values for TSS (24.4 °Brix), acidity (0.55%), and total sugar content (13.64%).

Keywords: Azatobacter, PSB, vermicompost, bioinoculant, Kesar

Introduction

Mango (*Mangifera indica* L.) is one of the most important and commercially cultivated fruit crops in India and is recognized as the national fruit. It belongs to the family Anacardiaceae and is native to the Indo-Burma region. Mango grows well in tropical and subtropical climates and can be cultivated from sea level up to an elevation of about 1100 meters. The optimum temperature for growth ranges from 24 °C to 27 °C, although the crop can tolerate temperatures as high as 48 °C with adequate irrigation.
Mango adapts to a wide variety of soils under diverse agro-climatic conditions, ranging from alluvial to lateritic soils. It performs best in slightly acidic soils, particularly those with a pH below 7.5.
India dominates global mango production, contributing nearly 50% of the world's supply, with an annual output of around 20 million tonnes. Nationally, mango is cultivated on 2.3 million hectares, with major producing states including Uttar Pradesh, Andhra Pradesh, and Maharashtra. Maharashtra, known for premium varieties like Alphonso and Kesar, produces approximately 1.2 million tonnes annually (Anonymous, 2020-22). India is also a leading producer and exporter of Kesar mangoes, especially from Gujarat, exporting to markets such as the United States, European Union, Middle East, and Southeast Asia.
Biofertilizers are natural inputs containing beneficial microorganisms such as nitrogen-fixing and phosphate-solubilizing bacteria. When applied to soil, these microbes enhance nutrient availability, improve nutrient uptake, and protect plants from soil-borne diseases. Being eco-

friendly, they help maintain soil health and reduce the negative impacts associated with excessive chemical fertilizer use. Their application increases the population of useful soil microbes, which in turn release nutrients in plant-available forms, promoting healthier and more vigorous growth.

The combined use of biofertilizers and vermicompost is a sustainable approach to reducing production costs while maintaining high productivity in fruit crops like Kesar mango. Commonly used biofertilizers in fruit cultivation include Azotobacter and Phosphate-Solubilizing Bacteria (PSB). These microbial inoculants release nutrients gradually and improve the plant's nutrient absorption efficiency, helping maintain a balanced internal nutrient status. The present study was undertaken to evaluate the effectiveness of biofertilizers in enhancing the growth and quality of Kesar mango and to explore their potential as an alternative to chemical fertilizers.

Materials and Methods

The investigation entitled “Effect of bioinoculant on growth, yield, and quality of mango cv. Kesar” was carried out during 2024-25 at the College of Agriculture, Badnapur, in collaboration with the MAHYCO Company Research Project at Jalna. The following section outlines the experimental materials and techniques used.

Applications of biofertilizer treatments were carried out during the first week of October 2024 on seven-year-old mango plants. The treatment combinations included:

Serial no	Treatment no	Treatment details
1.	T_1	RDF(100 g N + 50 g P + 100 g K)
2.	T_2	Azotobacter 25 g + Verm 3 kg per plant
3.	T_3	Azotobacter 50 g + Verm 3 kg per plant
4.	T_4	Phosphorus Solubilizing Bacteria (PSB) 25 g + Verm 3k g per plant
5.	T_5	Phosphorus Solubilizing Bacteria (PSB) 50 g + Verm 3kg per plant
6.	T_6	Azotobacter 25 gT_7 + PSB 25 g + Verm 3kg per plant
7.	T_7	Azotobacter 25 g + PSB 50 g + Verm 3k g per plant
8.	T_8	Azotobacter 50 g + PSB 25g + Verm 3k g per plant
9.	T_9	Azotobacter 50 g + PSB 50g + Verm 3 kg per plant
10.	T_{10}	Control

The experiment was conducted using a Randomized Block Design (RBD) with three replications. Uniform, newly planted mango plants of cv. Kesar were selected from the research farm in Jalna. A total of 60 plants exhibiting similar growth and vigor were chosen in October 2024 for the study.

All treatments were applied during the first week of October 2024. No biofertilizers were used in the control treatment (T0). In T_1, the Recommended Dose of Fertilizers (RDF) was applied, while in treatments T_2 to T_9, the respective biofertilizer and vermicompost dosages were applied individually to each plant within the canopy area. The biofertilizers Azotobacter (AZB) and Phosphate-Solubilizing Bacteria (PSB) were sourced from the Department of Soil Science, Badnapur, and high-quality vermicompost was obtained from Krishi Vigyan Kendra, Badnapur.

Observations on growth and developmental parameters—such as percent increase in plant height, leaf length, leaf width, initiation of flower bud to fruit set, and number of flowers per plant—were recorded at monthly intervals from October 2024 to March 2025. Plant growth measurements were taken at the end of each month.

Biofertilizers were applied by drenching in a ring 1.5 m away from the tree trunk, followed by incorporation into well-decomposed FYM. One week later, half the dose of nitrogen was applied before the pea stage. The bioinoculants were sprayed using a foot sprayer as per the treatment requirements.

Mature, uniform-sized mango fruits were harvested and brought to the laboratory. From each treatment, five mature fruits were randomly selected for recording physical and biochemical parameters under ambient storage conditions. Total Soluble Solids (TSS) were measured in °Brix using a hand refractometer. Sugar content and vitamin A levels were determined following the methods described by Ranganna (1979) and Mishra and Gupta (1998), respectively.

The data for each parameter were statistically analyzed. To determine the overall effectiveness of the treatments, a pooled analysis was also performed following the procedure suggested by Gomez and Gomez (1976).

Results and Discussion

Plant height(cm)

The application of various biofertilizer treatments had a noticeable effect on plant height. During March 2025, the highest percentage increase in plant height (11.83%) was recorded in the T_{10} treatment, which was found to be significantly superior to all other treatments. In contrast, the lowest increase in plant height (7.75%) was observed in the control treatment.

Plant spread (m)

The percentage increase in East-West canopy spread varied significantly among the treatments. During March 2025, the maximum increase in East-West spread (18.56%) was recorded in the T_{10} treatment, which was significantly superior to all other treatments. In contrast, the minimum increase (1%) in East-West spread was observed in the control treatment.

leaf length (cm)

The percentage increase in leaf length differed significantly among the treatments. During March 2025, the highest increase in leaf length (9.64%) was recorded in the T_9 treatment, which proved significantly superior to all other treatments. Conversely, the lowest increase in leaf length (4.90%) was observed in the control treatment.

leaf width (cm)

The percentage increase in leaf width varied significantly among the treatments. During March 2025, the maximum increase in leaf width (13.48%) was recorded in the T_{10} treatment, which was statistically at par with T_8, and both were significantly superior to the remaining treatments. The lowest increase (9.18%) in leaf width was observed in the control treatment.

leaf area (cm)

The percentage increase in leaf perimeter showed noticeable variation among treatments, with the highest increase recorded in the T_9 treatment. However, during March 2025, the maximum increase in leaf area (9.69%) was observed in the T_{10} treatment, which was significantly superior to all other treatments. In contrast, the lowest increase in leaf area (6.71%) occurred in the control treatment.

Total number of flowers per panicle in mango

The combined application of vermicompost, biofertilizers, and inorganic fertilizers resulted in a significant increase in the total number of flowers per panicle. Treatment T_1 recorded the highest number of flowers per panicle (2666.67), which was statistically at par with T_2, followed by T_7 with 2485.66 flowers. In contrast, T_5 produced the lowest number of flowers per panicle (340.87). This variation may be attributed to differences in nutrient availability and uptake efficiency among the treatments.

Table 1: Effect of biofertilizers sources on percent increase total number of flowers per panicle in mango.

Tr.no	Tratment details	Total number of flowers per panical
T_1	[RDF(100gN + 50g P+ 100 K)/plant]	2666.67
T_2	Azotobacter 25 g + Verm 3kg/plant	2429.37
T_3	Azotobacter 50 g + Verm 3kg/plant	2413.00
T_4	PSB 50g + Vermicompost 3kg/plant	2125.00
T_5	PSB 50g + Vermicompost 3kg/plant	2244.33
T_6	Azatobacter 25g + PSB 25g +verm 3kg/plant	2012.33
T_7	Azatobacter 25g + PSB 50g + verm 3kg/plant	2485.66
T_8	Azatobacter 50g + PSB 25g + verm 3kg/plant	2226.00
T_9	Azatobacter 50g + PSB 25g + verm 3kg/plant	2118.33
T_{10}	Control	2307.00
SEm (±)		139.07
CD (5%)		289.95

Total number of fruits per panicle in mango

The total number of fruits per panicle in Kesar mango showed significant variation across the different treatments. The highest number of fruits per panicle (12.13) was observed in Treatment T_9, followed by T_{10} (11.63), T_5 (11.00), and T_8 (10.80), indicating that these treatments had a favorable influence on fruit set. The lowest number of fruits per panicle (7.70) was recorded in T_3.

Fruit drop (%)

The lowest fruit drop percentage (82.00%) was recorded in the treatment receiving Azotobacter 50 g + Vermicompost 3 kg per plant (T_3), identifying it as the most effective treatment in reducing fruit drop. Treatments T_4, T_5, and T_2 also exhibited comparatively lower fruit drop percentages of 83.00%, 85.33%, and 82.00%, respectively, and these treatments were statistically at par. In contrast, the highest fruit drop (87.00%) was observed in the RDF treatment (T_1).

Table 2: Effect of biofertilizers sources on percent increase in fruit drop of mango.

Tr.no	Treatment details	Fruit drop
T_1	[RDF(100gN + 50g P+ 100 K)/plant]	87.00
T_2	Azotobacter 25 g + Verm 3kg/plant	84.00
T_3	Azotobacter 50 g + Verm 3kg/plant	82.00
T_4	PSB 50g + Vermicompost 3kg/plant	83.00
T_5	PSB 50g + Vermicompost 3kg/plant	85.33
T_6	Azatobacter 25g + PSB 25g + verm 3kg/plant	84.66
T_7	Azatobacter 25g + PSB 50g + verm 3kg/plant	84.32
T_8	Azatobacter 50g + PSB 25g + verm 3kg/plant	84.33
T_9	Azatobacter 50g + PSB 25g + verm 3kg/plant	83.33
T_{10}	Control	86.66
SEm (±)		2.04
CD (5%)		4.25

Weight of fruit (gm)

The highest fruit weight (356.00 g) was recorded in Treatment T_9, followed by T_7 (348.33 g) and T_3 (345.70 g). These treatments, along with T_6 (337.00 g), were statistically at par with one another. In contrast, the lowest fruit weight (217.00 g) was observed in the control treatment (T_{10}). The enhanced fruit weight under treatments containing Azotobacter may be attributed to improved nitrogen fixation and hormone synthesis, which support cell enlargement and overall fruit development.

Average number fruits per plant of mango

The application of bioinoculants had a significant impact on fruit yield in mango cv. Kesar. Among the treatments, T_7 produced the highest number of fruits per tree (161.00), reflecting the positive effect of integrated biofertilizer use. This was followed by T_5 (158.33 fruits) and T_6 (151.66 fruits) per tree. In contrast, the lowest fruit count (140.66) was recorded in the control treatment (T_{10}), indicating that untreated plants yielded significantly fewer fruits.

TSS (°B) of mango

The highest TSS value (24.4°B) was recorded in the control treatment (T_{10}), indicating that untreated plants produced the sweetest fruits. Among the treated plots, T_9 showed the highest TSS (23.6°B), followed by T_8 (23.1°B), T_7 (22.5°B), and T_6 (21.6°B), all of which included various combinations of Azotobacter, PSB, and vermicompost. The lowest TSS (17.6°B) was observed in T_1, suggesting that the integrated use of biofertilizers and organic manures was more effective in improving fruit quality than the application of chemical fertilizers alone.

Table 3: Effect of biofertilizers sources on percent increase in TSS (°B) of mango kesar

Tr.no	Treatment details	TSS (°B)
T_1	[RDF(100gN + 50g P+ 100 K)/plant]	17.6
T_2	Azotobacter 25 g + Verm 3kg/plant	18.3
T_3	Azotobacter 50 g + Verm 3kg/plant	19.1
T_4	PSB 50g + Vermicompost 3kg/plant	20.0
T_5	PSB 50g + Vermicompost 3kg/plant	20.9
T_6	Azatobacter 25g + PSB 25g +verm 3kg/plant	21.6
T_7	Azatobacter 25g + PSB 50g + verm 3kg/plant	22.5
T_8	Azatobacter 50g + PSB 25g + verm 3kg/plant	23.1
T_9	Azatobacter 50g + PSB 25g + verm 3kg/plant	23.6
T_{10}	Control	24.4
SEm (±)		0.44
CD (5%)		24.4

Acidity (%) of mango

The highest acidity (0.55%) was recorded in the control treatment (T_{10}), followed by T_2 (0.54%) and T_3 (0.50%). In contrast, the lowest acidity (0.30%) was observed in T_9, indicating that the application of biofertilizers and vermicompost contributed to a reduction in fruit acidity.

Total sugar (%) of mango

The highest total sugar percentage (13.64%) was recorded in the control treatment (T_{10}), followed by T_9 (13.08%), T_8 (12.56%), and T_7 (12.04%), all of which were statistically at par with one another. In contrast, the lowest total sugar content (9.06%) was observed in T_1. The higher sugar levels in treatments involving biofertilizers may be attributed to their role in enhancing photosynthesis, delaying leaf senescence, regulating sugar metabolism, improving stress tolerance, and influencing plant hormone activity.

Conclusion

The results of this study demonstrate that various treatment such as azatobacter, phosphate solubilizing bacteria, vermicompost improves the all parameters like plant height, plant spread, leaf length, leaf width, leaf area, total number of flowers per panicle in mango, fruit drop, weight of fruit, average no fruits, TSS, acidity, total sugar in mango cv. Kesar

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