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IMPACT OF ORGANIC MANURE, BIOFERTILIZERS, AND NPK ON TOMATO (*LYCOPERSICON ESCULENTUM* L.) PLANT GROWTH AND PRODUCTIVITY

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ABSTRACT

The present study was conducted to evaluate the impact of various organic manures, biofertilizers, and NPK on the growth, yield, and economic performance of tomato *(Lycopersicon esculentum* L.). A total of thirteen treatments were tested, including T_1 – Control (no fertilizer), T_2 – Farm Yard Manure (FYM), T_3 – Vermicompost, T_4 – Goat Manure, and T_5 – Poultry Manure. Combined treatments included T_6 – FYM + Vermicompost, T_7 – FYM + Goat Manure, T_8 – FYM + Poultry Manure, and T_9 – Vermicompost + Goat Manure. Biofertilizer-integrated treatments were T_{10} – Vermicompost + *Pseudomonas* + *Trichoderma* + *Azotobacter*, T_{11} – Goat Manure + *Pseudomonas* +*Trichoderma* + *Azotobacter*, and T_{12}– FYM + *Pseudomonas* + *Trichoderma* + *Azotobacter*. T_{13}consisted of the recommended dose of chemical fertilizer (NPK at 120:60:60 kg/ha). Among all treatments, the combination of vermicompost with biofertilizers (T_{10}) recorded the highest values for plant height (92.60 cm at 80 DAS), number of branches (13.04 at 80 DAS), and stem diameter (3.45 cm at 80 DAS), significantly outperforming all other treatments. Yield parameters also followed a similar trend, with T10 achieving the maximum number of fruits per plant (35.07), yield per plant (2.00 kg), and yield per hectare (63.47 t/ha). Economically, the highest net return (Rs. 532,660/ha) and B:C ratio (5.22) were recorded in T_{11} (Goat manure + biofertilizers), highlighting the profitability of integrated nutrient management. The study concludes that integrating organic manures, especially vermicompost or goat manure, with biofertilizers significantly enhances vegetative growth, yield potential, and economic returns in tomato cultivation, while also promoting sustainable and eco-friendly farming practices.

***Key words*:** Tomato, Growth, Yield, Return and BC ration).

Introduction

Tomato (*Lycopersicon esculentum* L.) is one of the most important vegetable crops cultivated worldwide, known for its nutritional value, economic importance, and versatility in culinary uses. Rich in vitamins A and C, antioxidants like lycopene, and essential minerals, tomato plays a significant role in promoting human health. It is cultivated in both open fields and protected environments and is a major income-generating crop for smallholder and commercial farmers alike. With increasing population and food demands, maximizing tomato yield while maintaining soil fertility has become a key focus in sustainable agriculture.

Fertilization is a critical component of modern agriculture, directly influencing plant growth, yield, and overall crop quality. Conventionally, synthetic fertilizers such as NPK (Nitrogen, Phosphorus, and Potassium) have been extensively used to meet the nutrient requirements of crops. While effective in boosting yield in the short term, over-reliance on chemical fertilizers can degrade soil health, lead to nutrient imbalances, and contribute to environmental pollution. This has prompted growing interest in more sustainable and eco-friendly nutrient management practices.

Organic manure, derived from animal waste, compost, or plant residues, is increasingly recognized for its role in improving soil structure, water retention, and microbial activity. Unlike chemical fertilizers, organic manure releases nutrients slowly, ensuring a more balanced nutrient uptake by plants. It also enhances the organic matter content of soil, which is crucial for long-term soil fertility and sustainable crop production. However, its nutrient content is typically lower and more variable than synthetic fertilizers, raising questions about its effectiveness in high-demand crops like tomato.

Biofertilizers, which contain living microorganisms such as nitrogen-fixing bacteria, phosphate-solubilizing bacteria, and mycorrhizal fungi, offer a biological route to improving soil fertility. These microorganisms enhance nutrient availability and promote plant growth through natural processes such as nitrogen fixation, solubilization of phosphorus, and production of growth-promoting substances. Biofertilizers not only reduce dependency on chemical inputs but also support environmental sustainability and soil health, making them a promising tool in integrated nutrient management.

Given the advantages and limitations of each fertilizer type, a comparative evaluation of organic manure, biofertilizers, and NPK fertilizers is essential to identify the most effective and sustainable strategy for tomato cultivation. This study aims to assess the individual and combined impacts of these fertilizers on tomato plant growth parameters, yield components, and overall productivity. By analyzing the response of tomato plants to different nutrient sources, the study seeks to recommend optimal fertilization practices that balance productivity with environmental sustainability.

Material and Methods

The present investigation was conducted during the *Rabi* season of 2024–2025 at the Experimental Research Farm of Oriental University, Indore (M.P.), situated at 22.7196° N latitude and 75.8577° E longitude with an altitude of 550 m. The soil was clayey in texture, slightly alkaline (pH 7.44), low in available nitrogen (182 kg/ha), medium in phosphorus (14.40 kg/ha), and high in potassium (520 kg/ha). The experiment was laid out in a Randomized Block Design (RBD) with 13 treatments and 3 replications. The treatments included: T_1 – Control (no fertilizer), T_2 – Farm Yard Manure (FYM), T_3 – Vermicompost, T_4 – Goat Manure, and T_5 – Poultry Manure. Combined treatments included T_6 – FYM + Vermicompost, T_7 – FYM + Goat Manure, T_8 – FYM + Poultry Manure, and T – Vermicompost + Goat Manure. Biofertilizer-integrated treatments were T_{10} – Vermicompost + *Pseudomonas* + *Trichoderma* + *Azotobacter*, T_{11} – Goat Manure + *Pseudomonas* + *Trichoderma* + *Azotobacter*, and T_{12} – FYM + *Pseudomonas* + *Trichoderma* + *Azotobacter*. T_{13} consisted of the recommended dose of chemical fertilizer (NPK at 120:60:60 kg/ha). These treatments were applied to evaluate their individual and synergistic effects on tomato plant performance under field conditions.The tomato variety 'Pankhuri' was used, and seedlings were raised in a nursery before being transplanted at a spacing of 30 cm × 60 cm. Standard agronomic practices and irrigation schedules were followed uniformly across all plots to assess the comparative effects of treatments on plant growth and yield.

Results

Growth Parameter

The growth parameters of tomato were significantly influenced by the application of various organic manures, biofertilizers, and NPK. Among the treatments, the combination of vermicompost with biofertilizers (T_{10}) recorded the highest plant height (30.65 cm at 20 DAS and 92.60 cm at 80 DAS), which was significantly superior to all other treatments, followed closely by FYM + biofertilizers (T_{12}) and goat manure + biofertilizers (T_{11}). The control treatment (T_1) consistently showed the lowest plant height throughout all stages.

In terms of the number of branches, T_{10} again

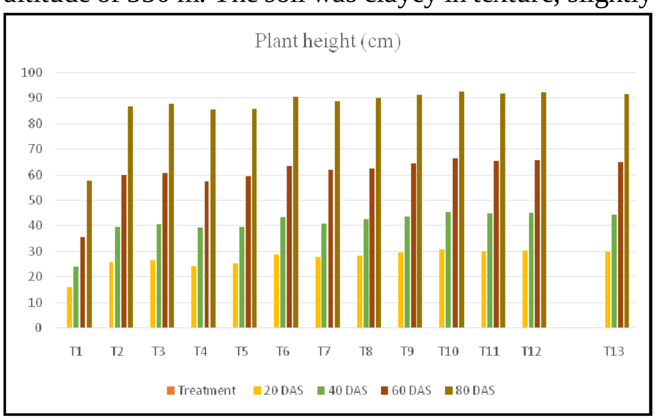

Fig. 1: Impact of organic manure and biofertilizer on plant height (cm) of tomato.

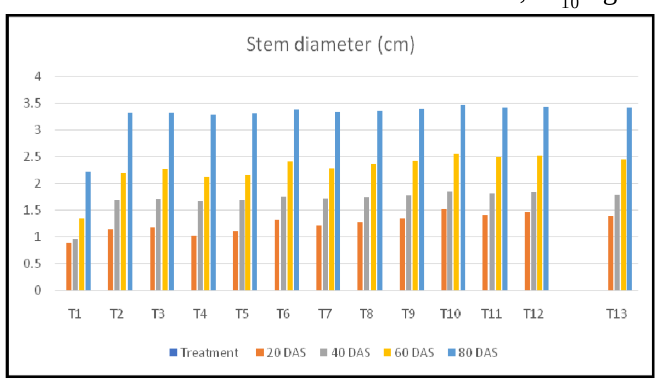

Fig. 2: Impact of organic manure and biofertilizer on stem diameter (cm) of tomato.

Table 1: Comparative study of organic manure, biofertilizers, and NPK on tomato plant growth.

Treatment		Plant height (cm)				Number of branches				Stem diameter (cm)			
		20 DAS	40 DAS	60 DAS	80 DAS	20 DAS	40 DAS	60 DAS	80 DAS	20 DAS	40 DAS	60 DAS	80 DAS
T_1	Control	16.12	24.07	35.52	57.70	0.51	2.36	4.21	7.46	0.89	0.95	1.35	2.22
T_2	Farm Yard Manure	25.91	39.79	60.09	86.55	1.05	2.89	5.73	12.30	1.13	1.69	2.19	3.31
T_3	Vermicompost	26.48	40.54	60.61	87.70	1.13	2.99	5.84	12.32	1.17	1.70	2.25	3.32
T_4	Goat Manure	24.39	39.29	57.44	85.26	0.78	2.66	5.20	12.18	1.02	1.65	2.11	3.29
T_5	Poultry Manure	25.52	39.56	59.35	85.82	0.89	2.79	5.48	12.26	1.10	1.68	2.16	3.3
T_6	FYM + Vermicompost	28.93	43.26	63.27	90.30	1.28	3.13	6.42	12.52	1.31	1.75	2.40	3.37
T_7	FYM + Goat Manure	27.87	41.00	61.65	88.65	1.19	3.03	6.10	12.38	1.20	1.71	2.27	3.33
T_8	FYM + Poultry Manure	28.44	42.77	62.49	89.93	1.23	3.10	6.29	12.47	1.27	1.73	2.36	3.36
T_9	Vermicompost + Goat Manure	29.52	43.71	64.35	90.93	1.31	3.27	6.55	12.58	1.34	1.77	2.42	3.39
T_{10}	Vermicompost + *Pseudomonas* + *Trichoderma* + *Azatobacter*	30.65	45.38	66.13	92.60	1.50	3.75	7.15	13.04	1.51	1.85	2.55	3.45
T_{11}	Goat Manure + *Pseudomonas* + *Trichoderma* + *Azatobacter*	30.08	44.80	65.37	91.73	1.41	3.57	6.96	12.76	1.40	1.80	2.49	3.42
T_{12}	FYM + *Pseudomonas* + *Trichoderma* + *Azatobacter*	30.31	45.13	65.78	92.25	1.44	3.63	7.05	12.85	1.46	1.83	2.51	3.43
T_{13}	Recommended dose NPK (120:60:60) @ kg/ha	29.8	44.43	64.80	91.45	1.37	3.45	6.77	12.64	1.38	1.78	2.44	3.41
SEm (±)		1.21	1.01	0.85	1.02	0.19	0.27	0.41	0.14	0.12	0.10	0.21	0.03
C.D. @ 5%		3.46	2.88	2.42	2.93	0.55	0.78	1.17	0.41	0.35	0.28	0.59	0.08

outperformed other treatments, reaching 13.04 branches per plant at 80 DAS, indicating enhanced vegetative growth under combined organic and microbial nutrient management. Treatments T_{11} and T_{12} also showed comparable performance, significantly higher than individual organic manures or the recommended NPK treatment (T_{13}), which produced 12.64 branches at 80 DAS.

Similarly, stem diameter followed the same trend, with T_{10} achieving the maximum stem thickness (3.45 cm at 80 DAS), which was significantly greater than the control (2.22 cm) and all other treatments. Notably, all biofertilizer-integrated treatments (T_{10}–T_{12}) and the combined organic treatments (T_6–T_9) showed superior growth attributes compared to the sole application of farmyard manure, vermicompost, goat manure, or poultry manure alone (T_2-T_5).

The overall effect of the integration of organic manures with biofertilizers showed a synergistic effect on the vegetative growth of tomato plants, with T_{10} being the most effective treatment in enhancing plant height, number of branches, and stem diameter across all growth stages. The recommended dose of NPK (T_{13}) also resulted in considerable growth but was statistically inferior to the best-performing organic + biofertilizer combinations.

Yield and Economic

The application of organic manures, biofertilizers, and NPK significantly influenced the yield parameters of tomato. The highest number of fruits per plant (35.07), yield per plant (2.00 kg), and maximum yield per hectare (63.47 t/ha) were recorded under T_{10} (Vermicompost + *Pseudomonas* + *Trichoderma* + *Azotobacter*), indicating the superior impact of integrated nutrient management on fruiting potential. This was closely followed by T_{12} (FYM + biofertilizers) and T_{11} (Goat manure + biofertilizers), which also exhibited excellent yield performance, each exceeding 62 t/ha.

Among the individual organic manures, vermicompost (T_3) and goat manure (T_4) outperformed FYM and poultry manure in yield efficiency, producing 60.50 and 57.80 t/ha, respectively. The recommended NPK treatment (T_{13}) also showed high productivity (62.67 t/ha), but was marginally inferior to biofertilizer-integrated organic treatments in yield enhancement.

Economic analysis revealed that the highest net returns (Rs 532,660/ha) and benefit-cost (B:C) ratio (5.22) were achieved under T_{11} (Goat manure + biofertilizers), followed closely by T_{12} and T_{13}, indicating strong profitability with integrated or conventional nutrient strategies. However, treatments combining organic and biological inputs consistently outperformed both individual manures and NPK alone in terms of economic returns and sustainability.

Overall, the findings suggest that integrating organic manures with biofertilizers, particularly goat manure or

Table 2: Comparative study of organic manure, biofertilizers, and NPK on tomato yield.

Treatment		No. of fruits/ plant	Yield per plant (kg)	Yield (tonnes/ ha)	Net returns (Rs/ha)	B:C
T_1	Control	20.25	1.12	46.52		
T_2	Farm Yard Manure	30.63	1.62	59.60	374680	4.13
T_3	Vermicompost	31.27	1.65	60.50	496260	4.97
T_4	Goat Manure	30.04	1.51	57.80	505070	5.05
T_5	Poultry Manure	30.27	1.58	58.50	478700	4.82
T_6	FYM + Vermicompost	32.57	1.74	62.08	485375	4.87
T_7	FYM + Goat Manure	31.72	1.67	60.98	520160	5.16
T_8	FYM + Poultry Manure	32.13	1.71	61.66	509640	5.08
T_9	Vermicompost + Goat Manure	32.93	1.78	62.40	516200	5.14
T_{10}	Vermicompost + *Pseudomonas* + *Trichoderma* + *Azatobacter*	35.07	2.00	63.47	523176	5.18
T_{11}	Goat Manure + *Pseudomonas* + *Trichoderma* + *Azatobacter*	33.8	1.88	62.85	532660	5.22
T_{12}	FYM + *Pseudomonas* + *Trichoderma* + *Azatobacter*	34.47	1.96	63.03	527148	5.20
T_{13}	Recommended dose NPK (120:60:60) @ kg/ha	33.26	1.82	62.67	528370	5.18
SEm(±)		0.35	0.03	0.81	525575	5.19
C.D. @ 5%		1.02	0.09	2.33		

vermicompost, significantly enhances tomato yield and profitability, offering a sustainable alternative to chemical fertilizers.

Discussion

Growth Parameter

The present study demonstrates that the vegetative growth parameters of tomato — including plant height, number of branches, and stem diameter — were significantly enhanced by the application of integrated nutrient management involving **vermicompost and biofertilizers (T_{10})**. This synergistic effect is supported by several earlier scientific findings that highlight the advantages of combining organic amendments with microbial inoculants.

The maximum plant height recorded under T_{10} (30.65/ cm at 20 DAS and 92.60/ cm at 80 DAS) can be attributed to the enhanced availability of macro and micronutrients from vermicompost, coupled with improved nutrient uptake efficiency facilitated by biofertilizers such as *Azotobacter*, *Pseudomonas*, and *Trichoderma*. These bioagents are known to produce growth-promoting substances like indole acetic acid (IAA) and gibberellins, which enhance cell division and elongation (Vessey, 2003; Glick, 1995). Vermicompost improves soil aeration and microbial activity, leading to better root development and nutrient absorption (Joshi and Vig, 2010; Atiyeh et al., 2000) and Nithya et al. (2024).

The significantly higher number of branches in T_{10} (13.04 at 80 DAS) compared to other treatments can be linked to the role of biofertilizers in improving nitrogen fixation and phytohormone production, which directly contribute to enhanced vegetative growth (Bhattarai et al., 2015). Additionally, vermicompost improves soil structure and organic matter content, creating a favorable environment for microbial proliferation and branching

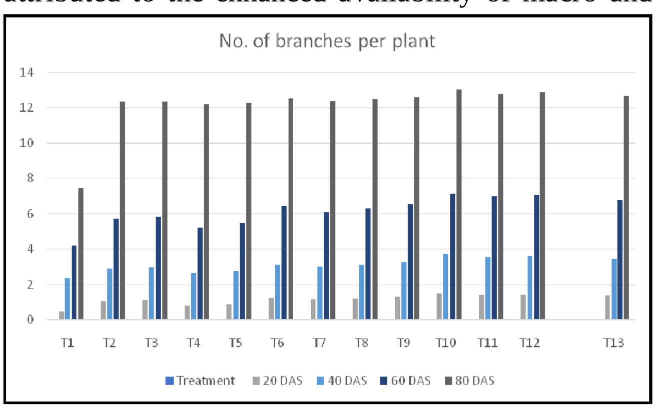

Fig. 3: Impact of organic manure and biofertilizer on number of branches per plant of tomato.

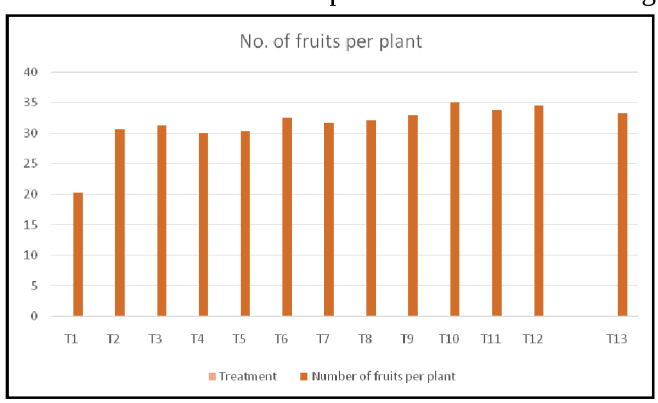

Fig. 4: Impact of organic manure and biofertilizer on number of fruits per plant of tomato.

(Kahem et al., 2015). Treatments T_{11} and T_{12} also showed similar trends, further validating the effectiveness of biofertilizer inclusion. The supporting references is El-Shazly et al. (2024).

Stem Diameter

T_{10} also resulted in the greatest stem thickness (3.45/cm at 80 DAS), reflecting stronger structural development due to optimal nutrient availability. Enhanced phosphorus solubilization by *Pseudomonas fluorescens* and *Trichoderma harzianum* leads to improved energy transfer and protein synthesis in plant tissues, promoting stem thickening (Verma *et al*., 2001). The observed trend supports the findings of Nithya *et al*., (2024), who reported that vermicompost integrated with microbial inoculants significantly improved tomato growth and stem girth.

Comparison with Other Treatments

The individual organic manure treatments (T_2–T_5) performed better than control (T_1) but were significantly inferior to combined treatments (T_6–T_9) and integrated organic + biofertilizer treatments (T_{10}–T_{12}). This suggests that while organic manures contribute to long-term soil fertility, the presence of biofertilizers accelerates nutrient mineralization and availability (Subbiah and Asija, 1956; Singh *et al*., 2011).

The recommended NPK dose (T_{13}), while yielding reasonably good growth (e.g., 12.64 branches at 80 DAS), was outperformed by T_{10}–T_{12}. Chemical fertilizers provide quick nutrient availability, especially nitrogen and phosphorus, but lack the beneficial microbial activity and soil health improvement associated with organic and biological amendments (Gosavi, 2005; Sharma *et al*., 2013).

Yield and Economic Analysis

The results clearly indicate that the integration of organic manures with biofertilizers significantly improved tomato yield and profitability compared to individual inputs or conventional NPK fertilization. Treatment T_{10}, which combined vermicompost with *Pseudomonas*, *Trichoderma*, and *Azotobacter*, recorded the highest yield (63.47 t/ha), number of fruits per plant (35.07), and yield per plant (2.00 kg). These findings are consistent with those reported by Chaurasia et al. (2005) and Singh *et al*.,(2011), who noted that vermicompost enhances soil biological activity and nutrient availability, while biofertilizers stimulate root growth and nutrient uptake through nitrogen fixation, phosphorus solubilization, and hormone production.

Treatments T_{11} (Goat manure + biofertilizers) and T_{12} (FYM + biofertilizers) also demonstrated high yield performance, producing over 62 t/ha each, which underscores the synergistic effects of organic and microbial inputs. The enhanced microbial colonization in the rhizosphere due to biofertilizers may have led to improved nutrient use efficiency and fruit setting, as supported by Nath *et al*., (2013) and Verma *et al*., (2015).

Among the individual organic sources, vermicompost (T_3) and goat manure (T_4) outperformed other treatments such as FYM and poultry manure, yielding 60.50 t/ha and 57.80 t/ha respectively. This superior performance could be attributed to the faster mineralization of nutrients from vermicompost and higher nutrient density in goat manure, as noted by Patil and Sheelavantar (2004) and Kale *et al*., (2006). Goat manure, in particular, is rich in nitrogen and micronutrients, making it highly effective in vegetable production.

Although the recommended NPK dose (T_{13}) yielded a relatively high output (62.67 t/ha), it was marginally less effective than biofertilizer-enriched organic treatments. This aligns with findings by Sharma *et al*., (2013), who observed that while NPK can provide quick nutrient supply, the long-term sustainability and soil health benefits are better achieved through integrated nutrient sources.

From an economic perspective, the highest net returns (Rs. 532,660/ha) and benefit-cost ratio (5.22) were

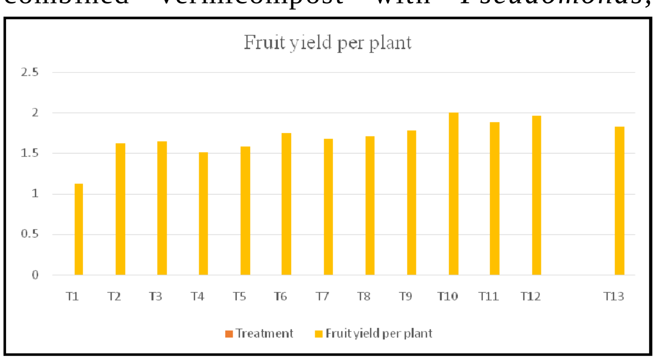

Fig. 5: Impact of organic manure and biofertilizer on fruit yield per plant of tomato.

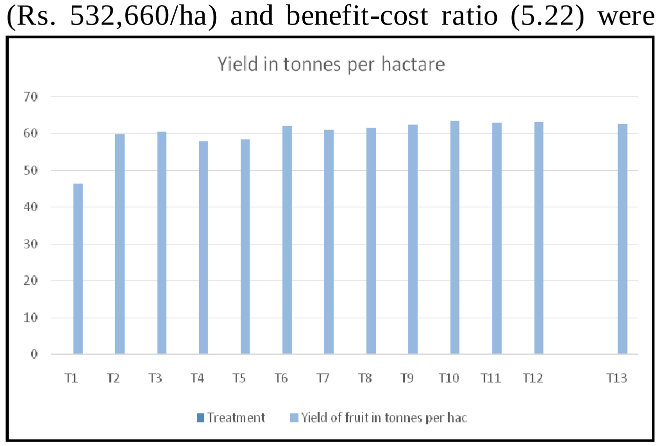

Fig. 6: Impact of organic manure and biofertilizer on yield of fruit in tonnes per hac of tomato.

observed in T_{11} (Goat manure + biofertilizers), slightly surpassing T_{12} and T_{13}. This suggests that while chemical fertilizers may still offer reasonable returns, the integration of organic and biological inputs ensures higher profitability along with environmental benefits, echoing the conclusions of Tomar *et al.*, (2010) and Ramesh *et al.*, (2009).

The better economic returns under biofertilizer-integrated treatments can be attributed to reduced input costs, improved yield, and sustainable soil health. Biofertilizers are often cheaper than synthetic inputs and contribute to long-term fertility management, making them more cost-effective in diversified farming systems (Yadav *et al.*, 2017).

Conclusion

Among all the treatments, the combination of vermicompost with biofertilizers (*Pseudomonas*, *Trichoderma*, and *Azotobacter*) (T_{10}) proved to be the most effective, recording the highest plant height, number of branches, stem diameter, fruit yield, and yield per hectare. This was closely followed by FYM + biofertilizers (T_{12}) and Goat manure + biofertilizers (T_{11}), which also produced excellent results across all growth and yield parameters. Thus, the study concludes that vermicompost or goat manure in combination with biofertilizers can be recommended as a viable and eco-friendly alternative to chemical fertilizers in tomato production. This approach not only maximizes yield and economic returns but also improves soil health, microbial activity, and long-term agricultural sustainability.

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