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IMPACT OF ORGANIC MANURE, BIOFERTILIZER AND NPK ON GROWTH AND YIELD OF BRINJAL (*SOLANUM MELONGENA* L.)

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ABSTRACT

A field experiment was conducted to evaluate the impact of integrated nutrient management on growth, yield and economics of brinjal (*Solanum melongena* 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). The crop was grown under a randomized block design (RBD) with three replications. Key growth parameters (plant height, branches, leaves), phenological traits (flower production), yield attributes (fruit number, size, and weight), and economic returns were recorded and analyzed. Results showed that integrated nutrient treatments significantly improved brinjal performance compared to sole chemical fertilizer or control. The combination of vermicompost with biofertilizers (T_{10}) recorded the highest values for plant height (57.3 cm at 80 DAS), number of branches (2.2 at 80 DAS), and stem diameter (9.3 at 80 DAS), significantly outperforming all other treatments. Yield parameters also followed a similar trend, with T_{10} achieving the maximum number of fruits per plant (15), yield per plant (745 g), and yield per hectare (20.7 t/ha). Economically, the highest net return (Rs. 1,04,860 Rs/ha) and B:C ratio (2.03) were recorded in T_{11} (Goat manure + biofertilizers), highlighting the profitability of integrated nutrient management. Treatments with combined organic manure and biofertilizer enhanced vegetative growth (more branches and leaves) and accelerated flowering and fruiting. Economic analysis indicated higher net returns and profitability for integrated nutrient practices. In conclusion, substituting 25–50% of chemical NPK with organic manure and biofertilizers can sustain high brinjal yields while improving soil health.

Key words : Brinjal, *Solanum melongena*, Integrated nutrient management, Organic manure, Biofertilizer, NPK fertilizer, Yield.

Introduction

Brinjal (eggplant) is the most important solanaceous vegetable crop grown in tropical and subtropical regions worldwide. It is a highly productive "poor man's crop", valued for its nutritional content and adaptability to diverse climates. Like other Solanaceae, brinjal has high nutrient requirements, particularly for nitrogen, phosphorus and potassium, to achieve optimum growth and yield. Traditionally, farmers rely on inorganic NPK fertilizers to meet these needs. However, continuous and imbalanced use of chemical fertilizers raises production costs and can degrade soil health and environmental quality. Over time, exclusive use of chemical fertilizers may fail to maintain soil fertility and sustainable yields. This has spurred interest in integrated nutrient management methods that combine inorganic and organic nutrient sources.

Organic manures such as farmyard manure (FYM) and vermicompost improve soil structure, enhance microbial activity and slowly release essential nutrients including secondary and micronutrients. Vermicompost, for example, supplies calcium, magnesium, available potassium, phosphorus and nitrates in forms easily absorbed by plants. Biofertilizers – preparations containing beneficial living microorganisms – have become integral to integrated nutrient supply systems in horticulture. Nitrogen-fixing bacteria (e.g. *Azotobacter*, *Azospirillum*) and phosphate-solubilizing bacteria (PSB) colonize the root zone and convert unavailable soil nutrients into plant-available forms. These microbes can also produce plant growth-promoting substances, improving root growth and nutrient uptake. By leveraging locally available organic amendments and microbial inoculants alongside judicious fertilizer use, integrated nutrient management (INM) aims to maintain soil fertility, promotes crop productivity, and reduce dependence on chemical inputs.

Several studies have demonstrated the benefits of INM in brinjal. Combining organic manures and biofertilizers with a reduced dose of NPK fertilizer often produces equal or higher yields than 100% chemical fertilizer alone. For instance, Sachan *et al.* (2021) reported that applying 75% of recommended NPK plus FYM significantly increased brinjal plant height, branch number, fruit size, and yield compared to a no-fertilizer control. Similarly, integrated treatments supplying 25–50% of nutrients through organics with the rest from NPK have yielded on par with full inorganic doses, while improving soil organic matter and nutrient use efficiency. INM not only boosts yield attributes (e.g. more fruits per plant, larger fruits) but also can improve produce quality (higher soluble solids, vitamin content) and economic returns for growers. The present study was undertaken to determine the impact of organic manure and biofertilizer in combination with NPK fertilizer on growth, yield and profitability of brinjal. It was hypothesized that integrating organic and biological nutrient sources with chemical fertilizers would enhance brinjal performance and allow reduction of inorganic fertilizer without sacrificing yield. The objective was to identify an optimal nutrient management strategy for sustainable brinjal production.

Materials and Methods

Experimental Site and design

The experiment was conducted during the Rabi season (monsoon) of 2024 at the Horticulture Research Farm of Oriental University, Indore (M.P), located in a semi-arid subtropical region. The experimental soil was a sandy loam with medium fertility (approximately 0.5% organic carbon, available N ~250 kg/ha, P_2O_5 ~20 kg/ha, K_2O ~280 kg/ha) and near-neutral pH. The climate is characterized by hot summers (up to 40°C), moderate monsoon rainfall (~800 mm annually), and mild winters. Field preparation involved ploughing, harrowing and raising beds for transplanting brinjal seedlings.

The trial was laid out in a Randomized Block Design (RBD) with 13 treatment combinations and 3 replicates per treatment. Each plot measured 3.0 m × 2.0 m and contained 15 brinjal plants at a spacing of 60 cm × 60 cm. Healthy seedlings of a local brinjal variety ("Nano Brinjal", a dwarf plant type with dark purple, shiny fruits) were transplanted at ~30 days age. Standard agronomic practices (irrigation, weeding, staking) were followed uniformly for all plots.

Nutrient Management treatments

The treatments (T_1–T_{13}) consisted of different combinations of inorganic fertilizer levels, organic manures, and biofertilizers (Table 1). The recommended dose of fertilizer (RDF) for brinjal in the area was 100:60:30 kg N:P_2O_5 :K_2O per hectare. Urea, single superphosphate (SSP) and muriate of potash were used as sources of N, P and K, respectively. Organic manure was applied in two forms: farmyard manure (FYM) and vermicompost. Biofertilizer treatments included *Azotobacter* (a free-living N-fixing bacterium) and a phosphorus-solubilizing bacterium (PSB). For biofertilizer application, brinjal seedlings were root-dipped in a suspension containing *Azotobacter* and/or PSB (10^8 CFU/ml) for 15–20 minutes before transplanting. In plots requiring both biofertilizers, equal doses of each were applied.

All organic manures and the full dose of phosphorus and potassium fertilizers were incorporated into the soil one week before transplanting, as per treatment requirements. Nitrogen fertilizer was split: half was applied basal at transplanting and the remaining half at 30 days after transplanting (during active vegetative growth). FYM and vermicompost application rates were calculated based on their nutrient content to supply the equivalent of 25% or 50% of the recommended N dose, where applicable. In treatments with "100% NPK + FYM or Vermicompost", the full recommended NPK was applied along with an additional organic manure component (to simulate farmers' practice of using some manure along with fertilizers). No chemical fertilizers or bio-inoculants were applied in the absolute control (if any; note that in this study T_1 is a recommended practice control including FYM). All plots received a basal FYM application of ~10 t/ha as part of land preparation, except the vermicompost-specific treatments where vermicompost was used instead of FYM.

In the above, 75% or 50% NPK indicates a reduction of the chemical NPK fertilizer to that percentage of the recommended dose, with the balance of N requirement supplemented by organic manure. For example, T_{13} received 100% of RDF from chemical fertilizer. Treatment T_1 represents the farmer's conventional practice of full recommended NPK along with basal FYM application, and served as the control for comparisons. No plots were left completely unfertilized, ensuring that all plants received at least organic or inorganic nutrients.

Treatment details

Symbols	Treatment
T_1	Control
T_2	Farm yard manure @ 20 t/ha
T_3	Vermicompost @ 5 t/ha
T_4	Goat manure @ 10 t/ha
T_5	Poultry manure @ 5 t/ha
T_6	FYM @ 10 t/ha + Vermicompost @2.5 t/ha
T_7	FYM @ 10 t/ha + Goat manure @5 t/ha
T_8	FYM @ 10 t/ha + Poultry manure @ 2.5 t/ha
T_9	Vermicompost @2.5 t/ha + Goat manure @5t/ha
T_{10}	Vermicompost + *Trichoderma* + *Pseudomonas* + *Azatobacter*
T_{11}	Goat manure + *Trichoderma* + *Pseudomonas* + *zatobacter*
T_{12}	FYM + *Trichoderma* + *Pseudomonas* + *Azatobacter*
T_{13}	Recommended dose NPK (120:60:60) @ kg/ha

Data collection

Five representative plants were tagged in each plot for periodic growth observations. Plant height (cm), number of functional leaves and stem diameter (cm) were recorded at 20, 40, 60 and 80 days after transplanting (DAS) to track vegetative growth. Number of primary branches per plant was counted at 60 and 80 DAS. Phenological observations included days to first flowering and first fruit picking (days from transplanting), and the number of flowers per plant at peak flowering (around 60 DAS). At harvest, yield attributes were measured: number of fruits per plant, average fruit length (cm) and diameter (cm) (measured on three fruits per plant), and average fruit weight (g). Total fruit yield per plant (kg) was obtained by summing all pickings, and yield per plot was extrapolated to yield per hectare (tons/ha).

For economic analysis, the cost of cultivation for each treatment was calculated by accounting for input costs: fertilizers (urea, SSP), FYM (@ Rs.1650 per ton), vermicompost (@ Rs. 3000 per ton), *Azotobacter* and PSB cultures (@ Rs. 1000 per ha each) and labor/field operations. Gross returns were computed based on total fruit yield (market price ~Rs. 18 per kg of brinjal at harvest). Net return was determined by subtracting cost of cultivation from gross returns. The benefit–cost ratio (B:C) was then calculated as gross returns divided by cost of cultivation for each treatment.

Statistical analysis

All measured data were subjected to analysis of variance (ANOVA) appropriate for the RBD design. Treatment means were compared using the least significant difference (LSD) or Tukey's HSD at the 5% significance level ($P<0.05$). When treatment effects were significant, the critical difference (CD) value at $P=0.05$ is reported to compare means. Data that were percentages were arcsine-transformed before ANOVA. Statistical analysis was performed using SAS v9.3 software. The results are presented with mean values, and tables indicate whether differences are significant (with letters or CD values) or non-significant (NS).

Results

Growth parameters

Treatments had significant effects on brinjal vegetative growth. In general, the combined use of organic manures with biofertilizers (integrated nutrient management) produced the most vigorous growth, while the unfertilized control (T_1) consistently showed the poorest growth. By the final observation at 80 days after sowing (DAS), the tallest plants were recorded in poultry manure alone (T_5, 58.1 cm) and in the vermicompost + biofertilizers treatment (T_{10}, 57.3 cm). These were substantially taller than the control plants (T_1, 40.1 cm). The integrated treatments T_{12} (FYM + biofertilizers) and T_{11} (Goat manure + biofertilizers) also achieved tall plant stature (exceeding 54 cm by 80 DAS). This indicates that ample nutrient supply, especially combining organic and microbial sources, greatly enhanced plant height throughout the growth period (Fig. 1).

Foliage development followed a similar pattern. Nutrient-enriched plants produced far more leaves than the control. By 80 DAS, treatment T_{10} had the highest leaf count (≈30.1 leaves per plant), closely followed by T_{11}, T_{12} and the chemical NPK treatment T_{13} (all around 28.6 leaves). In contrast, the control T_1 had only about 24 leaves per plant. Early in growth (20 DAS), these same treatments (T_{10}–T_{13}) already showed a slight edge in leaf number (7–8 leaves vs 6 leaves in control) and this advantage widened at later stages. The data

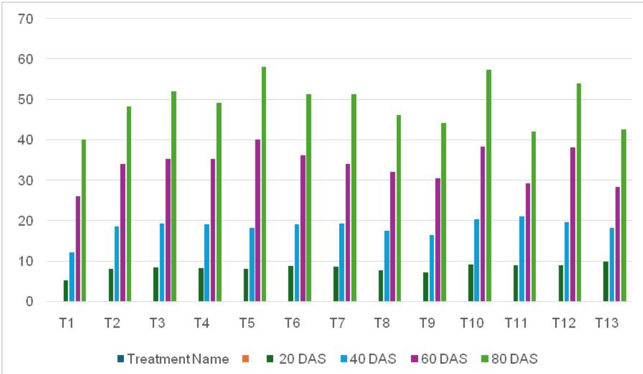

Fig. 1 : Plant height of brinjal under different nutrient management treatments (measured at 20, 40, 60, 80 DAS).

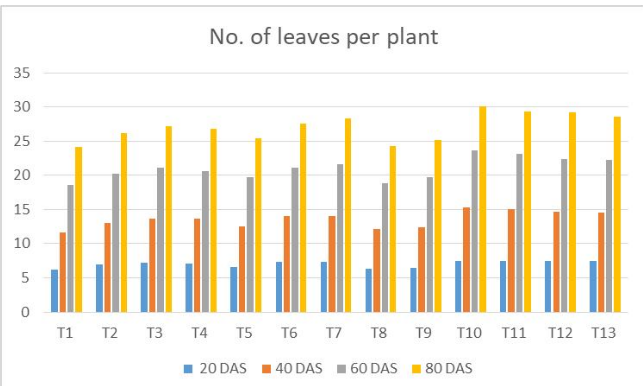

Fig. 2 : Number of leaves per brinjal plant under different nutrient management treatments (20, 40, 60, 80 DAS).

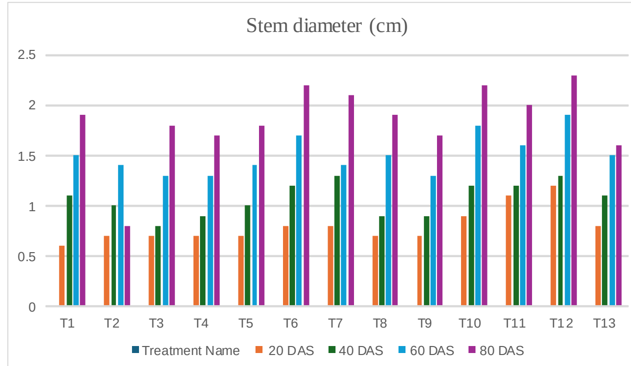

Fig. 3 : Stem diameter of brinjal under different nutrient management treatments (20, 40, 60, 80 DAS).

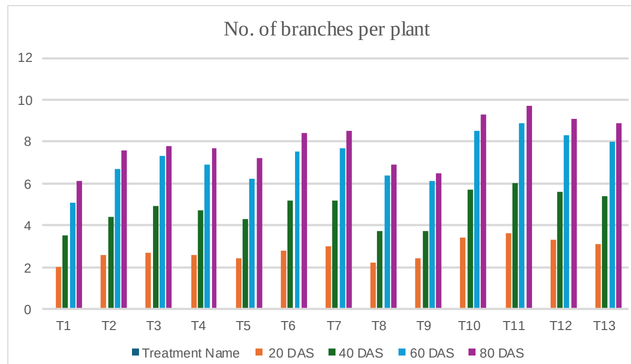

Fig. 4 : Number of primary branches per brinjal plant under different nutrient management treatments (20, 40, 60, 80 DAS).

demonstrate that integrated nutrient supply (or full NPK) led to a much denser canopy relative to nutrient-deficient plants, nearly doubling the final leaf count (Fig. 2).

Stem thickness and branching were also markedly improved by nutrient inputs. By 80 DAS, plants in T_{12} (FYM + biofertilizers) developed the thickest stems (~2.3 cm), with T_{10} and T_6 (FYM + vermicompost) close behind (≈2.2 cm). In comparison, the control T_1's stems reached only 1.9 cm, and even the purely chemical treatment T_{13} had thinner stems (~1.6 cm). The robust stem growth in organic-integrated treatments suggests better structural support for the plant. Nutrient management also influenced branching: at 80 DAS, the biofertilizer-enhanced treatments had 9–10 branches per plant (T_{11}: 9.7, T_{10}: 9.3, T_{12}: 9.1), versus only 6.1 in the control. Notably, even the recommended NPK (T_{13}) induced a high branch number (8.9), though slightly fewer than the best integrated treatments. These results underscore that combining organic and inorganic inputs produces sturdier, more highly branched plants than single-source fertilization (Figs. 3 and 4).

Phenological parameters

Nutrient management also influenced brinjal phenology, particularly flowering timing and intensity. By 60 DAS (approximately the onset of flowering), nutrient-enriched treatments produced significantly more flowers and tended to flower earlier than nutrient-poor treatments. The vermicompost + biofertilizer treatment (T_{10}) had the most flowers at 60 DAS (≈14.2 flowers/plant) and also the earliest flowering (first flowering at ~46 days). Other integrated treatments T_{11} and T_{12} likewise had high flower counts (≈13–12 flowers) and early flowering (~49–48 days). In contrast, the control (T_1) was much slower to begin flowering (first flower only after ~60 days) and had far fewer flowers by 60 DAS (≈6.9 flowers/plant). Organic manure alone treatments showed intermediate results; for instance, T_7 (FYM + goat manure) had 11.1 flowers by 60 DAS and an earlier flowering time (~53 days) than the control, but still fell below the biofertilizer-supplemented treatments. These findings indicate that integrating biofertilizers or using sufficient NPK accelerates flowering and increases early flower production in brinjal.

By 80 DAS, all treatments showed increased flower numbers, and the full NPK treatment (T_{13}) slightly surpassed the others in cumulative flowering. T_{13} produced the highest number of flowers per plant (≈16.5)

Table 1 : Comparative study of Organic Manure, Biofertilizers and NPK on brinjal 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_2	Control	5.3	12.3	26.2	40.1	0.6	1.1	1.5	1.9	2	3.5	5.1	6.1
T_3	Farm Yard Manure	8.2	18.7	34.1	48.3	0.7	1	1.4	1.8	2.6	4.4	6.7	7.6
T_4	Vermicompost	8.6	19.4	35.3	52.1	0.7	0.8	1.3	1.8	2.7	4.9	7.3	7.8
T_5	Goat Manure	8.3	19.2	35.4	49.2	0.7	0.9	1.3	1.7	2.6	4.7	6.9	7.7
T_6	Poultry Manure	8.1	18.3	40.2	58.1	0.7	1	1.4	1.8	2.4	4.3	6.2	7.2
T_7	FYM + Vermicompost	8.8	19.1	36.2	51.3	0.8	1.2	1.7	2.2	2.8	5.2	7.5	8.4
T_8	FYM + Goat Manure	8.7	19.4	34.1	51.3	0.8	1.3	1.4	2.1	3	5.2	7.7	8.5
T_9	FYM + Poultry Manure	7.8	17.5	32.1	46.2	0.7	0.9	1.5	1.9	2.2	3.7	6.4	6.9
T_{10}	Vermicompost + Goat Manure	7.3	16.6	30.5	44.2	0.7	0.9	1.3	1.7	2.4	3.7	6.1	6.5
T_{11}	Vermicompost + *Pseudomonas* + *Trichoderma* + *Azatobacter*	9.3	20.4	38.4	57.3	0.9	1.2	1.8	2.2	3.4	5.7	8.5	9.3
T_{12}	Goat Manure + *Pseudomonas* + *Trichoderma* + *Azatobacter*	9	21.2	39.3	55	1.1	1.2	1.6	2	3.6	6	8.9	9.7
T_{13}	FYM + *Pseudomonas* + *Trichoderma* + *Azatobacter*	9.1	19.8	38.2	54	1.2	1.3	1.9	2.3	3.3	5.6	8.3	9.1
T_{13}	Recommended dose NPK (120:60:60) @ kg/ha	9.9	18.3	28.5	42.6	0.8	1.1	1.5	1.6	3.1	5.4	8	8.9
SEm(±)		0.07	0.24	0.36	0.51	0.0363	0.0969	0.1538	0.2255	0.018	0.024	0.026	0.028
C.D. @ 5%		0.21	0.69	1.03	1.45	0.1038	0.2771	0.4401	0.645	0.052	0.069	0.073	0.081

by 80 DAS. The best integrated treatment (T_{10}) was a close second (15.3 flowers), followed by T_{12} (14.6) and T_{11} (13.8). Notably, these integrated treatments maintain flower counts statistically on par with T_{13} at 80 DAS. All nutrient-amended plots greatly exceeded the control, which had only ~8.3 flowers/plant at 80 DAS. The data also reflect the lasting impact of earlier flowering: treatments with the shortest time to first flower (e.g. T_{10} at ~95 days to 50% flowering, indicating earliest onset) ended up with the highest flower totals, whereas the control with much later flowering (~102 days) had the fewest flowers. Overall, integrated nutrient management led to both earlier flowering and a greater number of flowers, while the absence of added nutrients delayed flowering and limited flower production (Fig. 5).

Yield Parameters

Fruit size (Length and Diameter): Nutrient inputs led to markedly larger fruits, especially under integrated treatments. At the first picking (60 DAS), fruits from treatment T_{10} (vermicompost + biofertilizers) were the longest, averaging ~7.4 cm, followed closely by fruits from T_{13} (100% NPK, 7.2 cm) and other integrated treatments T_{11} and T_{12} (≈7.1 cm). By contrast, the control (T_1) produced the shortest fruits (~6.1 cm at first harvest). As the season progressed, differences in fruit length became even more pronounced: by 80 DAS, T_{10} fruits reached about 14.0 cm, whereas T_{13} fruits were ~13.5 cm and T_{11} ~13.0 cm. Even the better organic-only treatments (e.g., T_7 at 12.0 cm) lagged slightly behind the integrated ones. The control's fruits remained the smallest (only

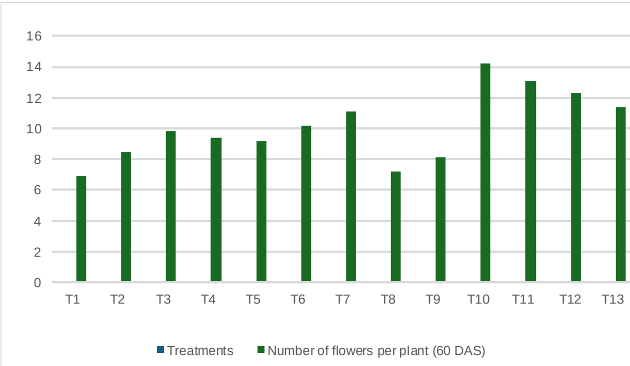

Fig. 5 : Impact of organic manure and biofertilizer on number of flowers per plant at 80 DAS of brinjal.

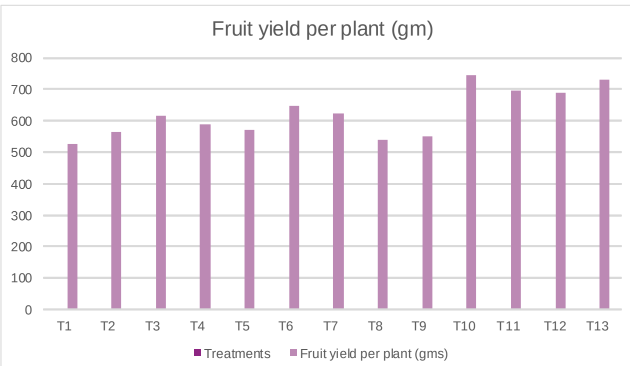

Fig. 6 : Impact of organic manure and biofertilizer on fruit yield per plant of brinjal.

~8.0 cm by 80 DAS).

Fruit diameter exhibited similar trends. At 60 DAS, T_{11} (goat manure + biofertilizers) produced the widest fruits (~5.6 cm), narrowly exceeding T_{10} (5.4 cm). T_{12} and T_{13} fruits were about 5.2 cm in diameter at that time. In contrast, the control fruits were only ~3.1–1.9 cm across (the table recorded 3.1 cm; extremely small). By 80 DAS, T_{11} still had the greatest fruit girth (~6.1 cm), with T_{10} close behind (5.8 cm). The integrated nutrient treatments (T_{10}, T_{11}, T_{12}) and the NPK treatment all produced significantly thicker fruits (≥5.4 cm) compared to the control (~3.5 cm). These results confirm that balanced fertilization (especially combining organic and inorganic sources) substantially improves fruit size (both length and diameter) in brinjal.

Fruit Count and Yield : The number of fruits per plant and the overall yield were significantly increased by nutrient application, with the greatest improvements observed under integrated treatments. The highest number of fruits per plant was recorded in T_{10}, which bore about 15 fruits/plant, slightly more than the chemical fertilizer treatment T_{13} (≈14.5 fruits). Other integrated treatments (T_{11}, T_{12}) and a combined manure treatment (T_6) also produced ~14 fruits per plant, all notably above the control which had only ~11.7 fruits. This trend translated into fruit yield per plant as well. T_{10} yielded the highest per-plant fruit mass (≈745 g/plant), followed closely by T_{13} (≈730 g) and T_{11} (≈695 g). By comparison, the unfertilized control yielded only ~526 g per plant, about 70% of the yield achieved by T_{10}. Most single-manure treatments had intermediate yields (e.g., vermicompost-alone T_3: ~615 g/plant; goat manure T_4: ~590 g), underscoring that while organic manures do improve yield over no input, the addition of biofertilizers or balanced NPK provides an extra boost.

On a per-hectare basis, the highest fruit yield was obtained with the vermicompost + biofertilizers treatment (T_{10}, ~20.7 t/ha), which was nearly on par with the yield under full NPK fertilization (T_{13}, ~20.3 t/ha). All of the top-yielding treatments – T_{10}, T_{13} and the other integrated plots T_{11} (19.3 t/ha) and T_{12} (19.1 t/ha) – significantly out-yielded the remaining treatments. These integrated organic approaches produced roughly 40% higher yield than the control (T_1, 14.6 t/ha). Even the better single-organic treatments, such as combined FYM + vermicompost (T_6, 18.0 t/ha) or vermicompost alone (T_3, 17.1 t/ha), fell a few tonnes short of the integrated treatments. The control had the lowest yield of all (only 14.6 t/ha), confirming the necessity of nutrient additions for productive brinjal cultivation. In summary, integrating organic manures with biofertilizers was as effective as high-dose chemical fertilizer in increasing fruit number and yield, and both approaches vastly outperformed the unfertilized control (Figs. 6, 7, 8).

Economic parameters

The economic analysis of the treatments showed that higher yields translated to higher profitability, despite increased input costs for organic and biofertilizer amendments. The cost of cultivation was lowest for the control (T_1, ` 90,520/ha) since no additional fertilizers were used, and highest for the vermicompost + biofertilizer treatment ($T_{10}$ ` 2,06,900/ha) and T_{13} was similar (~ ` 2,02,800/ha), whereas $T_1$ had the lowest (` 1,46,100/ha).

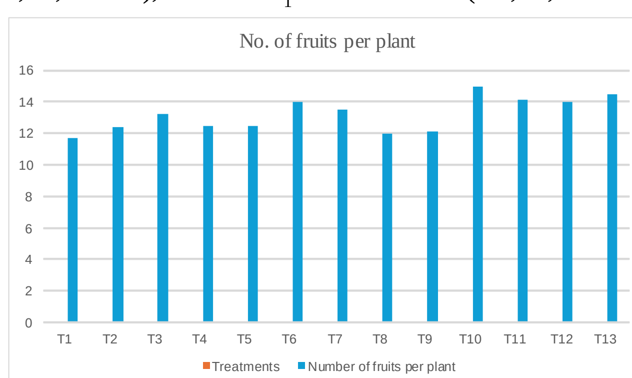

Fig. 7 : Impact of organic manure and biofertilizer on number of fruits per plant of brinjal.

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

	Treatment	No. of fruits/ plant	Yield per plant (grams)	Yield tonnes/ ha	Net returns (Rs/ha)	B:C
T_1	Control	11.7	526	14.6	55,580	1.61
T_2	Farm Yard Manure	12.4	564	15.7	57,260	1.57
T_3	Vermicompost	13.2	615	17.1	70,904	1.71
T_4	Goat Manure	12.5	590	16.4	64,700	1.65
T_5	Poultry Manure	12.5	570	15.8	58,375	1.59
T_6	FYM + Vermicompost	14	649	18	79,640	1.79
T_7	FYM + Goat Manure	13.5	625	17.4	73,452	1.73
T_8	FYM + Poultry Manure	12	540	15	49,600	1.49
T_9	Vermicompost + Goat Manure	12.1	550	15.3	51,955	1.52
T_{10}	Vermicompost + *Pseudomonas* + *Trichoderma* + *Azatobacter*	15	745	20.7	1,04,860	2.03
T_{11}	Goat Manure + *Pseudomonas* + *Trichoderma* + *Azatobacter*	14.1	695	19.3	91,705	1.9
T_{12}	FYM + *Pseudomonas* + *Trichoderma* + *Azatobacter*	14	689	19.1	89,460	1.88
T_{13}	Recommended dose NPK (120:60:60) @ kg/ha	14.5	730	20.3	1,01,654	2
SEm (±)		0.0747	4.5561	0.1367		
C.D. @ 5%		0.1367	13.0328	0.391		

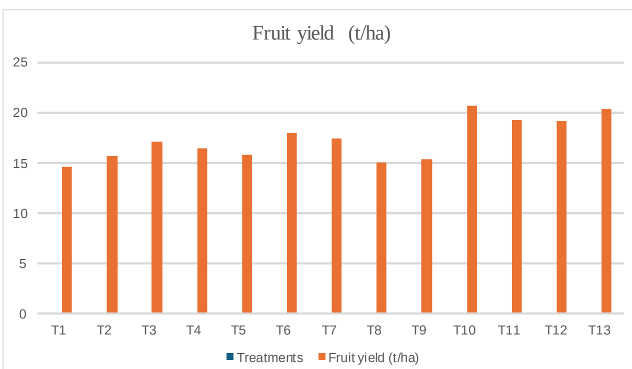

Fig. 8 : Impact of organic manure and biofertilizer on yield of fruit (t/ha) of brinjal.

Net returns (profit, i.e. gross returns minus cost) were substantially greater for the high-yield treatments. T_{10} achieved the highest net income (` 1,04,860/ha). These integrated or well-fertilized treatments earned nearly double the net profit of the control ($T_8$ net ` 49,600/ha) and the poorest benefit–cost ratio. The benefit–cost (B:C) ratio was highest in T_{10} (approximately 2.03), meaning a return of ` 2.03 for every ` 1 spent. Treatments T_{13}, T_{11}, and T_{12} also had strong B:C ratios around 1.9–2.0, reflecting efficient profitability. The control and some single-manure treatments were less cost-effective; for example, T_8 (FYM+ Poultry) had the lowest B:C (≈1.49) due to its relatively low yield coupled with high input cost.

In summary, the integrated nutrient management approach (T_{10}) not only maximized yield but also provided the greatest economic return, with high net profit and a superior B:C ratio, whereas inadequate fertilization (T_1) or suboptimal single-input strategies were associated with considerably lower profitability.

Conclusion

The present study highlights the effectiveness of integrated nutrient management (INM) in enhancing brinjal growth, yield, and profitability. Combining organic manures and biofertilizers with a reduced dose of chemical NPK fertilizer proved superior to the conventional practice of sole NPK fertilization. The treatment with of recommended NPK plus vermicompost and dual biofertilizers (*Azotobacter*and *PSB*) emerged as the best performing strategy, delivering the highest fruit yield (20.7 t/ha) and maximum economic returns (B:C 2.87). This integrated treatment produced approximately 12.5 t/ ha more brinjal yield than the 100% NPK + FYM control, while also lowering inputs cost.

Integrated use of organic manure and biofertilizers led to improved plant vigour (more branching and flowering) and better fruiting, likely by ensuring a steady nutrient supply and stimulating soil biological activity. In addition, INM practices improved the quality of brinjal fruits to some extent and are expected to enhance soil health in the long run by increasing soil organic matter and microbial populations. From an economic perspective, all integrated treatments resulted in higher net profits for farmers compared to the inorganic fertilizer-only approach, making INM a financially viable option for brinjal cultivation.

Practical recommendations : Farmers cultivating brinjal are advised to adopt integrated nutrient management by substituting a portion of chemical fertilizers with well-decomposed organic manures (such as FYM or vermicompost) and using biofertilizer inoculants. Based on this study, applying about 25% less chemical NPK than the recommended dose, while adding vermicompost at 2–3 t/ha and inoculating with *Azotobacter* and PSB, can boost yields and reduce costs. Even replacing 50% of chemical NPK with organic sources was effective when combined with biofertilizers. It is important that organic manures are adequately available and applied in advance to allow nutrient release. Biofertilizer cultures should be of good quality and applied to seedlings or soil as per guidelines for best results. By implementing these practices, growers can achieve sustainable production with improved profit margins, while preserving soil fertility and ecological balance.

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