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Efficiency of organic and inorganic fertilizers on growth, yield and quality of tomato (*Solanum lycopersicum* L.)

¹Adarsh Kumar, ²Jitendra Kumar, ³Vinod Joseph Silas and ⁴Vinod Kumar

¹M.Sc. (Ag.) Horticulture (Vegetable Science), Faculty of Agricultural Sciences and Allied Industries, Rama University, Kanpur, Uttar Pradesh, India

²Assistant Professor, Horticulture (Vegetable Science), Faculty of Agricultural Sciences and Allied Industries, Rama University, Kanpur, Uttar Pradesh, India

³Assistant Professor, Horticulture (Fruit Science), Faculty of Agricultural Sciences and Allied Industries, Rama University, Kanpur, Uttar Pradesh, India

⁴Assistant Professor, Horticulture (Fruit Science), Bhavdiya Educational Institute, Ayodhya, Uttar Pradesh, India

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Corresponding Author: Jitendra Kumar

Abstract

The present investigation titled “Influence of Organic and Inorganic Fertilizers on Growth, Yield and Quality of Tomato (*Solanum lycopersicum* L.)” was conducted at the Agricultural Research Field, Rama University, Mandhana, Kanpur (Uttar Pradesh) during the *rabi* season of 2025-26. The experiment was arranged in a Randomized Block Design with eight treatments and three replications. Treatments consisted of various combinations of inorganic fertilizers (recommended dose of fertilizers, RDF: 120:80:60 kg NPK ha⁻¹) and organic manures (vermicompost, farmyard manure, poultry manure, and neem cake) applied on a nutrient-equivalent substitution basis. The popular indeterminate tomato variety ‘Pusa Ruby’ was used.

Integrated nutrient management significantly affected growth, yield, and quality traits of tomato. Treatment T₄ (75% RDF + 25% poultry manure) recorded the highest plant height (102.6 cm at 90 DAT), number of fruits per plant (55.7), fruit length (6.15 cm), fruit diameter (6.68 cm), fruit volume (156.4 cm³), and maximum fruit yield (114.4 t ha⁻¹). This treatment was statistically at par with T₇ for most yield-related characters. The control (T₀) consistently gave the lowest values for all parameters. For quality traits, T₇ (25% RDF + 25% each of poultry manure, neem cake, and FYM) performed best, registering the highest total soluble solids (5.8 °Brix), ascorbic acid content (28.9 mg/100 g), sugar:acid ratio (17.06), and lowest titratable acidity (0.34%). Economically, T₄ was the most profitable, with the highest gross return (₹6,86,400 ha⁻¹), net return (₹4,86,400 ha⁻¹), and benefit-cost ratio (3.43), followed by T₇ (B:C ratio 3.17). The study concludes that integration of 75% RDF with 25% poultry manure (T₄) is the most effective and economically viable nutrient management strategy for achieving higher yield and profitability in tomato under the Middle Gangetic Plain conditions of Uttar Pradesh. When the focus is on improving fruit quality, higher organic manure integration (T₇) can be adopted.

Keywords: Tomato, integrated nutrient management (INM), poultry manure, vermicompost, yield, quality, economics

Introduction

Tomato (*Solanum lycopersicum* L.) belongs to the Solanaceae family and has a somatic chromosome number of 2n = 24. It is predominantly a self-pollinated crop with its primary centre of origin in the Peru-Ecuador belt of South America. Portuguese traders introduced the crop to India, where it has become one of the most important vegetables for both fresh consumption and industrial processing. The plant grows best between 10 °C and 30 °C, with an optimum range of 20-24 °C for vigorous vegetative growth, fruit set, and lycopene biosynthesis, the pigment responsible for the bright red colour of ripe fruits. Tomato is highly sensitive to frost and waterlogging and performs best in well-aerated, fertile soils with a pH of 6.0-7.0.

Often described as a “protective food,” tomato plays a vital role in human nutrition and provides livelihood security to many small and marginal farmers. On a fresh-weight basis, 100 g of edible portion contains about 94.1 g water, 1 g

protein, 0.3 g fat, and 4 g carbohydrates. It is rich in ascorbic acid (vitamin C), provitamin A, thiamine (vitamin B1), riboflavin (vitamin B2), and essential minerals such as potassium, phosphorus, magnesium, calcium, iron, zinc, manganese, and copper. The fruit also contains 2.5-4.5% total sugars, 0.6-1.2% starch, and health-promoting organic acids (citric, malic, and acetic). These bioactive compounds impart strong antioxidant properties that help combat oxidative stress.

Globally, tomato is one of the leading vegetable crops, with annual production around 190 million tonnes. In India, horticultural production continues to expand, and tomato constitutes a significant portion of the vegetable basket. As per the final estimates for 2024-25, national tomato production reached approximately 20.60 million tonnes. Uttar Pradesh contributed around 0.94 million tonnes during the same period.

However, intensive farming systems that rely heavily on chemical fertilizers have caused soil nutrient depletion, macro- and micronutrient imbalances, deterioration of soil biological health, and rising environmental concerns. These issues have shifted scientific focus toward Integrated Nutrient Management (INM) approaches. INM involves the judicious combination of organic manures, inorganic fertilizers, and microbial inoculants to ensure balanced nutrient supply, higher productivity, and long-term soil fertility restoration.

Among organic amendments, vermicompost is valued for its readily available macro- and micronutrients, humic and fulvic acids, and naturally occurring plant growth regulators. Farmyard manure (FYM) is the most accessible traditional organic source that improves soil structure and water-holding capacity. Poultry manure provides concentrated nutrients with relatively fast mineralization rates, while neem cake supplies moderate amounts of N, P, and K along with natural pest-repellent properties due to its favourable carbon-to-nitrogen ratio. When these organic resources are integrated with reduced doses of chemical fertilizers, they help minimise dependence on synthetic inputs without compromising yield or quality.

The present investigation was therefore undertaken to generate practical, environmentally sound, and economically viable nutrient management recommendations for tomato cultivation in the Middle Gangetic Plains of Uttar Pradesh and similar agro-ecological zones.

Research methodology

The experiment was conducted at the Agricultural Research Field, Rama University, Mandhana, Kanpur (Uttar Pradesh) during the *rabi* season of 2025-26. The soil was sandy loam in texture, slightly alkaline (pH 7.6-7.9), low in organic carbon (0.38-0.52%), and medium in available N (185-210 kg ha⁻¹), P (18-25 kg ha⁻¹), and K (210-245 kg ha⁻¹). The popular indeterminate tomato variety 'Pusa Ruby' was used. Seeds were sown on 5 October 2025 and 30-day-old seedlings were transplanted on 5 November 2025.

The experiment was laid out in a Randomized Block Design (RBD) with eight treatments and three replications. Each plot measured 1.44 m² (1.2 m × 1.2 m) with 60 cm × 60 cm spacing (4 plants per plot). The recommended dose of fertilizers (RDF) was 120:80:60 kg NPK ha⁻¹. Organic manures were applied on a nutrient-equivalent substitution basis as a basal dose. Inorganic fertilizers were applied in

split doses (half N + full P and K as basal; remaining N at 30-40 DAT).

Treatments:

- T₀: Control (no fertilizer/manure)
- T₁: 100% RDF
- T₂: 75% RDF + 25% Vermicompost
- T₃: 50% RDF + 25% Vermicompost + 25% FYM
- T₄: 75% RDF + 25% Poultry manure
- T₅: 50% RDF + 25% Poultry manure + 25% Neem cake
- T₆: 25% RDF + 25% FYM + 25% Vermicompost + 25% Neem cake
- T₇: 25% RDF + 25% Poultry manure + 25% Neem cake + 25% FYM

Standard cultural practices (irrigation, weeding, staking, and plant protection) were followed uniformly. Data on growth, fruit characters, yield, and quality parameters were recorded. All observations were statistically analysed using ANOVA suitable for RBD. Treatment means were compared by Critical Difference (CD) at 5% probability level. Standard error of mean (SE_m±) and coefficient of variation (CV %) are presented in the tables.

Results and Discussion

The results clearly showed that integrated nutrient management through a balanced combination of inorganic fertilizers and organic manures significantly influenced growth, yield, and quality attributes of tomato. Treatment effects were statistically significant as revealed by the analysis of variance.

Growth parameters

Plant height: Combined application of organic and inorganic sources markedly improved plant height at all stages (Table 1). The maximum plant height at 90 DAT (102.6 cm) was recorded in T₄ (75% RDF + 25% poultry manure), which was statistically at par with T₇ (99.2 cm) and significantly superior to all other treatments. The control (T₀) recorded the minimum height (68.4 cm). The superiority of T₄ was due to the readily available nutrients from poultry manure combined with inorganic fertilizers, which ensured continuous supply of major nutrients (N, P, K) during the active vegetative phase, leading to enhanced cell division and elongation.

Table 1: Influence of organic and inorganic fertilizers on plant height (cm) of tomato at 30, 60 and 90 DAT

Treatment	30 DAT	60 DAT	90 DAT
T ₀ (Control)	28.4	48.6	68.4
T ₁ (100% RDF)	35.2	62.4	85.6
T ₂ (75% RDF + 25% VC)	37.8	68.2	91.4
T ₃ (50% RDF + 25% VC + 25% FYM)	36.5	65.8	88.7
T ₄ (75% RDF + 25% PM)	39.6	72.5	102.6
T ₅ (50% RDF + 25% PM + 25% NC)	38.4	70.1	96.3
T ₆ (25% RDF + 25% each FYM+VC+NC)	34.9	64.3	87.9
T ₇ (25% RDF + 25% each PM+NC+FYM)	38.7	71.8	99.2
SE _m ±	0.61	0.89	1.07
CD (p=0.05)	1.82	2.64	3.15
CV (%)	4.85	3.92	3.18

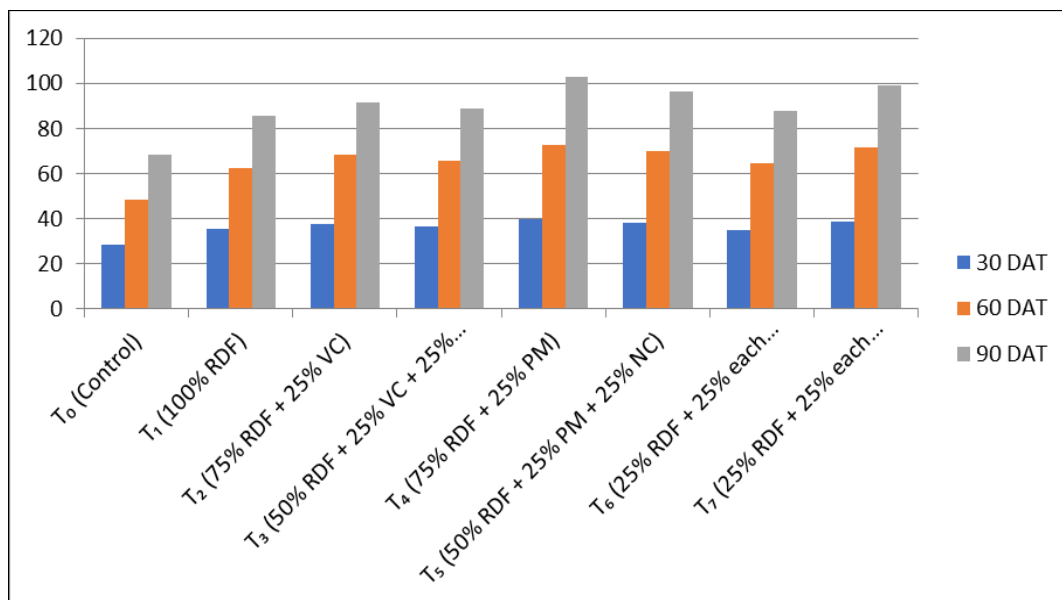


Fig 1: Influence of organic and inorganic fertilizers on plant height (cm) of tomato at 30, 60 and 90 DAT

Days to first picking of marketable fruits: The earliest picking (81 days) was recorded in T₄, followed by T₇ (82 days), while the control took the longest (98 days) (Table 2).

Faster reproductive development in T₄ resulted from balanced nutrition that promoted early flowering and fruit set.

Table 2: Influence of organic and inorganic fertilizers on days to first picking of marketable fruits

Treatment	Days to first picking
T ₀	98
T ₁	86
T ₂	84
T ₃	85
T ₄	81
T ₅	83
T ₆	87
T ₇	82
SEm±	0.95
CD (p=0.05)	2.80
CV (%)	3.45

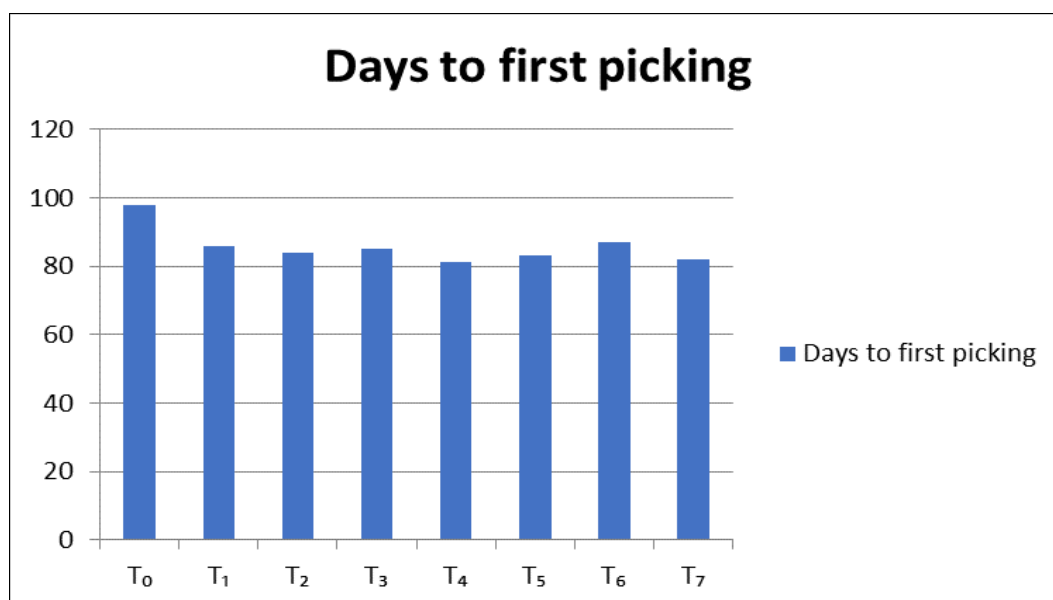


Fig 2: Influence of organic and inorganic fertilizers on days to first picking of marketable fruits

4.2 Fruit Characters

Fruit length, equatorial diameter, volume and number of locules: Treatment T₄ produced significantly longer (6.15 cm), thicker (6.68 cm), and larger-volume fruits (156.4 cm³) with a higher number of locules (5.4) (Table 3). T₇ was at

par with T₄ for most characters. The control recorded the poorest fruit size. Improved assimilate translocation and cell enlargement under balanced nutrition from poultry manure were responsible for better fruit physical characters.

Table 3: Influence of organic and inorganic fertilizers on fruit length (cm), equatorial diameter (cm), volume (cm³) and number of locules

Treatment	Fruit length (cm)	Equatorial diameter (cm)	Fruit volume (cm ³)	Locules/fruit
T ₀	4.82	5.14	98.6	3.8
T ₁	5.64	6.12	132.4	4.6
T ₂	5.89	6.38	141.2	4.9
T ₃	5.76	6.25	137.8	4.7
T ₄	6.15	6.68	156.4	5.4
T ₅	6.02	6.51	149.8	5.1
T ₆	5.71	6.19	135.6	4.5
T ₇	6.08	6.59	152.9	5.2
SEm±	0.07	0.06	1.62	0.11
CD (p=0.05)	0.21	0.19	4.82	0.32
CV (%)	3.65	2.95	3.48	6.85

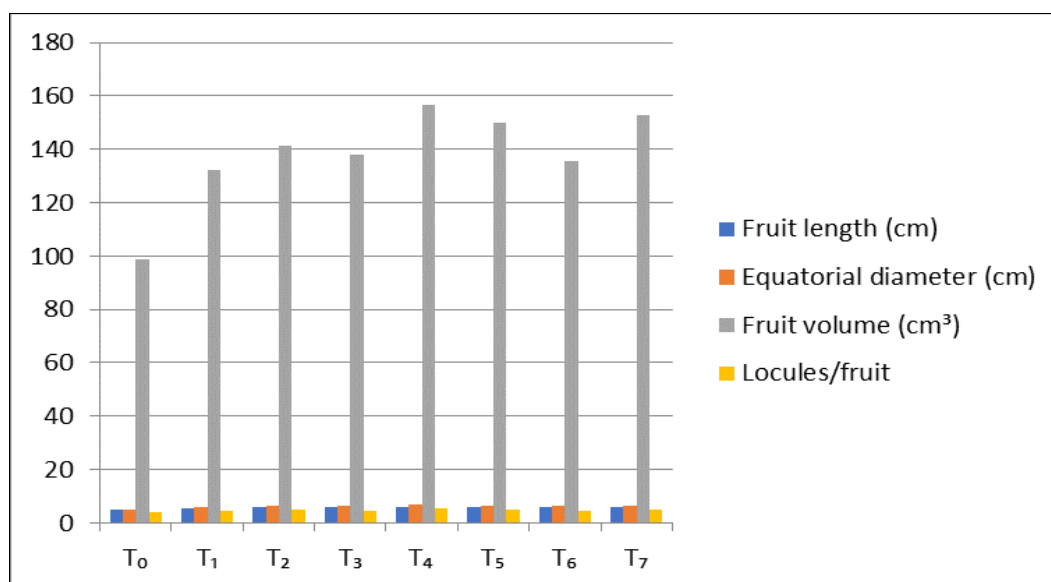


Fig 3: Influence of organic and inorganic fertilizers on fruit length (cm), equatorial diameter (cm), volume (cm³) and number of locules

Yield Parameters

Fruit yield: The highest fruit yield per plant (4.12 kg), per plot (16.48 kg), and per hectare (114.4 t ha⁻¹) was obtained with T₄, which was statistically at par with T₇ (109.7 t ha⁻¹) and significantly superior to the rest of the treatments (Table

4). The control gave the lowest yield (51.4 t ha⁻¹). The remarkable yield advantage in T₄ resulted from cumulative improvement in growth and yield-attributing characters due to the synergistic effect of inorganic fertilizers and poultry manure.

Table 4: Influence of organic and inorganic fertilizers on fruit yield per plant (kg), per plot (kg) and per hectare (t ha⁻¹)

Treatment	Yield/plant (kg)	Yield/plot (kg)	Yield/ha (t ha ⁻¹)
T ₀	1.85	7.40	51.4
T ₁	3.12	12.48	86.7
T ₂	3.48	13.92	96.7
T ₃	3.35	13.40	93.1
T ₄	4.12	16.48	114.4
T ₅	3.89	15.56	108.1
T ₆	3.21	12.84	89.2
T ₇	3.95	15.80	109.7
SEm±	0.08	0.32	2.25
CD (p=0.05)	0.24	0.96	6.72
CV (%)	6.15	6.10	6.45

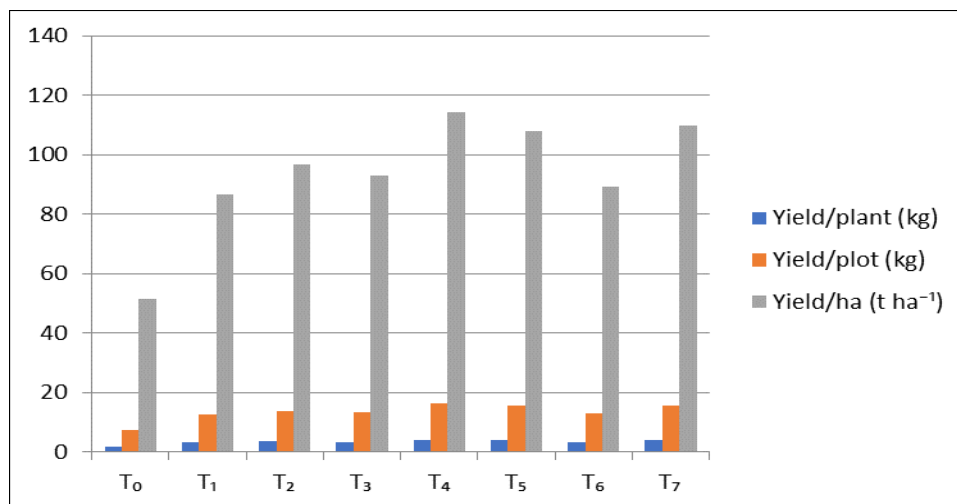


Fig 4: Influence of organic and inorganic fertilizers on fruit yield per plant (kg), per plot (kg) and per hectare (t ha⁻¹)

Quality Parameters

Quality attributes: Treatment T₇ recorded the highest total soluble solids (5.8 °Brix), ascorbic acid content (28.9 mg/100 g), sugar:acid ratio (17.06), and lowest titratable acidity (0.34%) (Table 5). T₄ ranked next best for most quality traits. The control registered the poorest quality. The

improvement in quality under higher organic substitution (T₇) resulted from slow and steady nutrient release, enhanced microbial activity, better soil organic carbon status, and reduced nitrate accumulation, leading to higher synthesis of sugars, vitamins, and organic acids.

Table 5: Influence of organic and inorganic fertilizers on quality parameters of tomato fruits

Treatment	TSS (°Brix)	Titratable acidity (%)	Ascorbic acid (mg/100 g)	Sugar:acid ratio	pH
T ₀	4.2	0.48	18.4	8.75	4.42
T ₁	4.8	0.41	22.6	11.71	4.31
T ₂	5.3	0.37	25.8	14.32	4.26
T ₃	5.4	0.36	26.4	15.00	4.24
T ₄	5.5	0.35	27.2	15.71	4.22
T ₅	5.6	0.35	27.8	16.00	4.20
T ₆	5.7	0.34	28.4	16.76	4.19
T ₇	5.8	0.34	28.9	17.06	4.18
SEm±	0.06	0.007	0.38	0.29	0.013
CD (p=0.05)	0.18	0.02	1.12	0.85	0.04
CV (%)	3.35	5.85	4.25	5.60	0.92

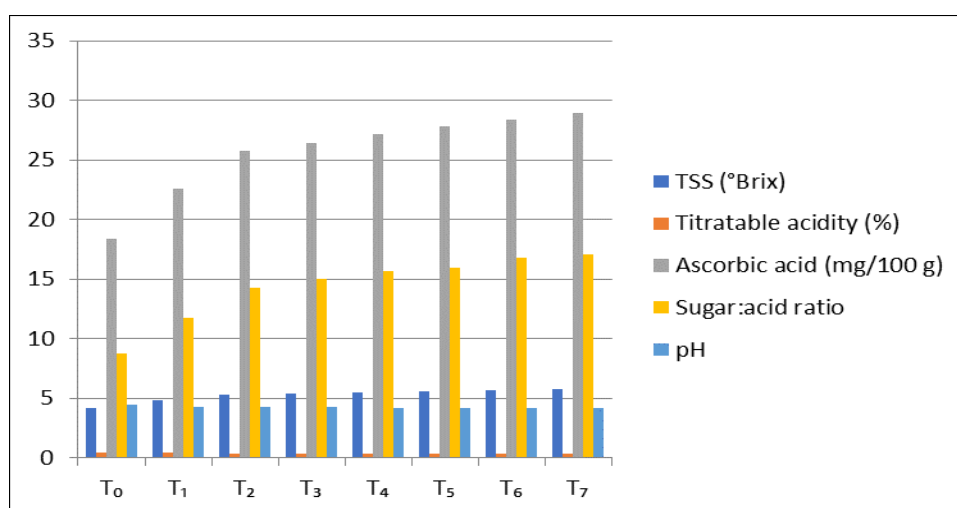


Fig 5: Influence of organic and inorganic fertilizers on quality parameters of tomato fruits

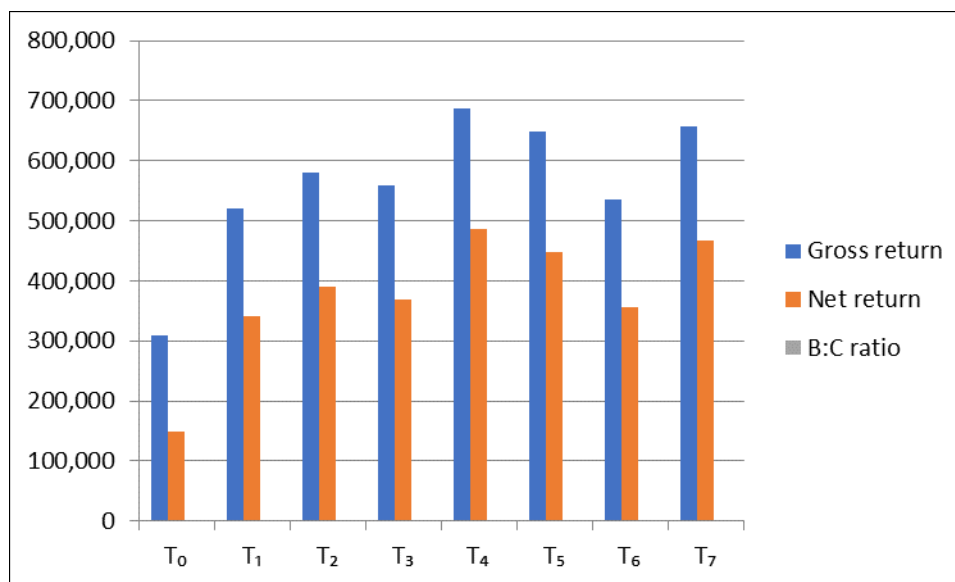
Economic analysis

Economics of production: Treatment T₄ recorded the highest gross return (₹6,86,400 ha⁻¹), net return (₹4,86,400 ha⁻¹), and benefit-cost ratio (3.43), followed by T₇ (B:C

ratio 3.17) (Table 6). The control gave the lowest returns. The economic superiority of T₄ was mainly due to maximum fruit yield with moderate cost of cultivation.

Table 6: Effect of different treatments on economics of tomato production (₹ ha⁻¹)

Treatment	Gross return	Net return	B:C ratio
T ₀	3,08,400	1,48,400	1.93
T ₁	5,20,200	3,40,200	2.89
T ₂	5,80,200	3,90,200	3.06
T ₃	5,58,600	3,68,600	2.94
T ₄	6,86,400	4,86,400	3.43
T ₅	6,48,600	4,48,600	3.25
T ₆	5,35,200	3,55,200	2.98
T ₇	6,58,200	4,68,200	3.17
SEm±	12,650	9,820	0.09
CD (p=0.05)	37,450	29,100	0.26
CV (%)	5.85	6.75	7.15

**Fig 6:** Effect of different treatments on economics of tomato production (₹ ha⁻¹)

The overall results conclusively indicated that substitution of 25% RDF through poultry manure (T₄) is the most effective and economically viable practice for achieving higher growth, yield, and profitability in tomato under Middle Gangetic Plain conditions of Uttar Pradesh. When the emphasis is on improving fruit quality parameters (TSS, ascorbic acid, and sugar:acid ratio), higher organic integration (T₇) can be adopted without much reduction in yield. These INM strategies not only sustain soil fertility but also reduce dependence on costly chemical fertilizers.

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