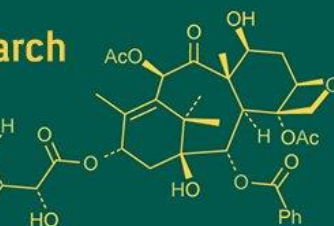
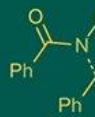


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; SP-10(8): 1665-1669
www.biochemjournal.com
Received: 03-06-2026
Accepted: 08-07-2026

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Impact of integrated nutrient management on growth, yield and quality of tomato (*Solanum lycopersicum* L.) under Balaghat region

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DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i8Sr.9644>

Abstract

The present investigation entitled “Impact of Integrated nutrient management on growth, yield and quality of tomato (*Solanum lycopersicum* L.)” was carried out with objectives to study the investigate the effect of various treatment on growth yield and quality of tomato., To work out the economics of different combination of INM of tomato cultivation. The experimental material consisted 08 treatments varieties Pusa Ruby. The experiment was conducted at Research farm of School of Agriculture Science Technology Research Sardar Patel University, Balaghat (M. P.). The sowing of experimental material was shown on 4th week of July, 2023 with Randomized Block Design (RBD) and 3 replications were used. The data were recorded on five randomly selected plants from each Variety for 15 characters. The data on all the characters were subjected to statistical analysis using statistical software OPSTAT. The overall results obtained from this present investigation clearly revealed that the application of T₆ ((50% RDF + 25%Azospirillum +25% vermicompost) showed the better performance for vegetative growth & Flowering (plant height, number of branch per plant, days to 1st flowering days to 50% flowering, Number of flowers per plant, Number of flowers per cluster, Number of clusters per plant, Number of fruits per plant), yield attributes [number of fruit per plant, fruit yield per plant (kg), fruit yield per plot (kg), fruit yield per hectare (t), and quality attribute TSS (^oBrix) ascorbic acid content (mg/100 gm) would be useful to enhance the productivity of tomato. The plant tomato sown in the field under the treatment with 50% RDF + 25% Azospirillum + 25% Vermicompost (T₆) recorded the maximum monetary advantage with the benefit cost ratio of 4.24, during the year of experimentation.

Keywords: Azospirillum, integrated nutrient, tomato vermicompost, yield

Introduction

Tomato (*Solanum lycopersicum* L.) is a popular vegetable crop grown around the world, with a high economic value in many nations. It belongs to the Solanaceae family and has 24 chromosomes. It is well-known for its nutritional value, since it is high in carotenoids, vitamin C, and pro-vitamin A. It also has a strong antioxidant profile that includes lycopene, ascorbic acid, phenolics, flavonoids, and vitamin E (Sen *et al.*, 2018) [16]. Tomatoes are an essential ingredient in various culinary creations, with many meals relying heavily on them. Their numerous nutritional and therapeutic advantages, as underlined by Dorais *et al.* (2008) [5], have earned them the position of protective food, valued for their important contribution to health and well-being. (Waheed *et al.* 2020) [23]. According to (Ugonna *et al.*, 2015) [22], ripe tomato fruits have a wide range of culinary applications, including salads, ketchup, sauces, pastes, and purees. In contrast, the use of immature fruits in pickling highlights their intrinsic worth. The tomato stands out as a wonderful crop, valued for its diverse range of high-demand value-added goods.

However, its cultivation is vulnerable to a variety of biotic and abiotic conditions, resulting in difficulties such as poor growth and yield loss, as emphasised by (Pugalendhi *et al.*, 2019) [14]. Tomatoes originated in the South American Andes mountains. Initially brought to Europe by Spanish conquistadors in the sixteenth century, it eventually expanded to southern and eastern Asia, Africa, and the Middle East. Tomato agriculture is widespread in India, with various states contributing significantly to the total output. Apart from Andhra Pradesh, states like Karnataka, Maharashtra, Madhya Pradesh, Uttar Pradesh, Chhattisgarh, Gujarat,

and Telangana are known for their extensive tomato farming. Vegetable output is expected to reach 204.61 million tonnes, up from 200.45 million tonnes in 2020-21. Tomato output is predicted to be 20.34 million tonnes, compared to 21.18 million tonnes in 2020-21.

Tomato production in India spanned 8.40 lakh hectares and produced 203.31 lakh metric tonnes. Nowadays, different nations face varied obstacles in providing chemical-free food to their rising populations. Vegetable output is declining as a result of the use of synthetic fertilisers. The use of synthetic fertilisers reduces soil fertility, kills important microorganisms, and interferes with natural ecosystems. A balanced nutrition supply can improve tomato productivity, fruit quality, fruit size, keeping quality, colour, and flavour (Shukla and Naik, 1993) [18]. The combined use of chemical fertilisers, FYM, vermicompost, and other organics shows tremendous potential in ensuring high crop output while simultaneously protecting soil health against degradation and pollution threats. Continuous use of high-level chemical fertilisers reduces plant nutrient absorption, resulting in stagnation or a decline in production. Continuous use of chemical fertilisers can lead to increased heavy metal concentrations in the soil, disrupting soil health and quality, making it unsuitable for long-term plant development. The combined use of chemical fertilisers, FYM, vermicompost, and other organics shows tremendous potential in ensuring high crop output while simultaneously protecting soil health against degradation and pollution threats. Continuous use of high-level chemical fertilisers reduces plant nutrient absorption, resulting in stagnation or a decline in production. Continuous use of chemical fertilisers can lead to increased heavy metal concentrations in the soil, disrupting soil health and quality, making it unsuitable for long-term plant development.

Vermicomposts are created when earthworms and microorganisms combine to break down organic waste (Edwards *et al.*, 2010) [6]. Vermicompost improves soil porosity, aeration, and water retention capacity. Vermicompost increases surface area, improves nutrient absorption and retention, and retains more nutrients for a longer length of time. It has been discovered that soil modified with vermicompost has much higher soil bulk density and does not become compacted (Martin, 1976) [27]. Vermicompost improves plant nutrient absorption by increasing the permeability of the root cell membrane, encouraging root development, and promoting root hair proliferation. It is also thought to be an excellent organic fertiliser and soil conditioner (Gajalakshmi and Abassi 2003) [7].

Biofertilizers are biologically active products that include certain strains of microorganisms. Among the principal nutrients, phosphatic fertilisers and organic phosphate found in soil are less soluble and are not easily absorbed by plants. Phosphorus solubilising bacteria (PSB) are helpful bacteria that can dissolve inorganic phosphorus from insoluble substances. Phosphate solubilising bacteria serve a crucial function in providing phosphorus to plants, enabling for the long-term utilisation of phosphate (Bhattacharya and Jain 2000) [26]. The use of integrated nutrient management concerned with the protection of soil productiveness and providing these nutrients to the cultivated plants at the most favourable level for sustaining the desired yield through optimisation of the benefits from all probable sources of

organic, inorganic, and biological ingredients in an integrated way (Prabhakar *et al.*, 2007; Sujatha *et al.*, 2008) [12, 25]. Soil's ability to produce agricultural crops is mostly governed by the environment it offers for root development. Roots absorb oxygen, water, nutrients, and ample area in order to grow.

Materials and Methods

The experiment was laid out in Randomized Block Design (RBD) with 08 treatments and three replications. For this purpose, 24 plots were made in Horticulture Research Farm, School of Agriculture Science Technology and Research, Sardar Patel University, Balaghat (M.P.) 481331, of M.P. during Late winter season academic year 2022-23. 100% RDF* (Recommended Dose of Fertilizer), 75% RDF + 25% Azospirillum, 50% RDF + 50% FYM, 50% RDF + 50% Vermicompost, 50% RDF + 25% Azospirillum + 25% FYM, 50% RDF + 25% Azospirillum + 25% Vermicompost, 50% RDF + 25% FYM + 25% Vermicompost and control. Balaghat District is located the south-eastern portion of the Satpura Range and the upper valley of the Wainganga River. The district extends from 21°19' to 22°24' north latitude and 79°31' to 81°30' east longitude. The plant height of five randomly selected plants was recorded from the base of the plants to the shoot tip at the final picking of the fruits and the average height per plant was calculated. The total numbers of branches of five randomly selected plants were counted and the average was worked out. Days to first flowering was noted in terms of days taken from the day of transplanting to first flowering appearance in each plot. The observation was taken on whole plot basis and the average of all the replications was calculated. Days to 50% flowering was noted in terms of days taken from the day of transplanting to 50% flowering appearance in each plot. The observations were made on a full plot basis, and the average of all replications was derived. The total number of flowers produced by each plant was counted and recorded as the number of clusters per plant for each treatment and replication. The captured data was then analysed. The total number of blooms in each cluster of five randomly selected plants was counted, and an average was determined. The quantity of flower clusters generated on each plant was counted and recorded for each treatment and replication. The captured data was then analysed. The number of fruits produced from each plant's blossoms was counted and recorded. The captured data was then analysed. The number of fruits produced by each plant's blossoms was counted and recorded for each treatment and replication. The captured data was then analysed. Five randomly selected fruits from each plant were weighed and categorised according to treatment and replication. This procedure was done for five randomly selected plants, and data were collected appropriately. The harvested fruits of individually randomly selected and tagged plants were weighed collectively, and the average weight was used to estimate the fruit output per plant, which was then classified by treatment and replication. The data was then analysed. The yield was estimated by weighing the entire fruit yield per plot and recording data for each harvest. According to Ranganna (1986), the vitamin C or ascorbic acid concentration of the pulp was determined using a 2, 6 dichlorophenol indophenol dye. The data collected during the experimental inquiry were subjected to statistical analysis using the "Analysis of variance" approach (Fisher and Yates, 1967) to make conclusions.

Results and Discussion

1. Plant height (cm) at 30, 60 and 90 DAT

The significant difference in the plant height was recorded due to application of different combinations of organic, inorganic fertilizer and biofertilizers. During the years maximum plant height at 30 DAT (38.48 cm). was recorded from T₆ treatment (50%RDF +25% Azospirillum +25% Vermicompost) followed by T₇ and T₁ while the minimum plant height at 30 DAT (36.90 cm and 33.91 cm) was recorded from T₀ control. The maximum plant height at 60 DAT i.e. 78.26 cm were noted by the application of T₆- (50%RDF +25% Azospirillum +25% Vermicompost) closely followed by T₄- (50% RDF + 50% vermicompost) i.e. 74.23 cm and T₇-50% RDF+ 25% FYM + 25% vermicompost i.e. 72.50 cm, respectively and this improvement was significantly highest then rest of the treatment, however, minimum values i.e. 58.65 cm were in control where plots were deprived off by the use of any organic, inorganic fertilizers and biofertilizers in the years. The maximum plant height at 90 DAT i.e. 108.15 cm were noted by the application of T₆- (50%RDF +25% Azospirillum +25% Vermicompost) closely followed by T₇- 50% RDF+ 25% FYM + 25% vermicompost i.e. 102.09 cm and T₁ - 100% RDF i.e. 100.73 cm during 2023-24 respectively and this improvement was significantly highest then rest of the treatment, however, minimum values i.e. 84.23 cm were in control where plots were deprived off by the use of any organic, inorganic fertilizers and biofertilizers in the years. Similar result was also reported that the Sudhakar and Purushotham 2008, Soumya *et al*, 2009, and Kumar *et al*, 2014^[21, 20, 10] in tomato.

2. Number of branches per plants

The maximum no. of branches per plant i.e. 36.90 were noted by the application of T₆-(50%RDF +25% Azospirillum +25% Vermicompost) closely followed by T₁-100% RDF i.e. 5.01 and T₂ -75%RDF + 25% Azospirillum% i.e. 34.80, while lowest number of branches per plant 30.14 were recorded with T₀ (control) during respectively and this improvement was significantly. Similar result was also reported that the Renuka and Sankar 2001, Prasad *et al*, 2002 and Prabhu *et al*, 2010^[13, 11] in tomato.

3. Days to first flowering

The days to 1st flowering i.e. 69.00 were noted by the application of T₇- (50%RDF +25% FYM +25% Vermicompost) closely followed by T₄- 50% RDF + 50% Vermicompost i.e. 62.67 and T₅ -50%RDF + 25% Azospirillum%+25% FYM i.e.62.00, while days to 1st flowering 59.00 were recorded with T₆ 50% RDF + 25% Azospirillum + +25% Vermicompost during respectively and this improvement was significantly. Similar result was also reported that the, Kumar *et al*, 2014 and Singh *et al*, 2014^[10, 19] in tomato.

4. Days to 50% flowering

The days to 50% flowering i.e. 78, 00 were noted by the application of T₇- (50%RDF +25% FYM +25% Vermicompost) closely followed by T₅- 50% RDF + Azospirillum +25% FYM i.e. 72.33 and T₄ -75%RDF + 50% Vermicompost i.e. 71.67, while lowest days to 50% flowering 70.00 were recorded with T₀ (control) during respectively and this improvement was significantly. Similar result was also reported that the Dev and Bhadana 2017, Islam *et al*, 2017 and Bindra *et al*, 2018^[3, 8, 1] in tomato.

5. Number of flowers per plant

The Number of flowers per Plant i.e. 73.84 were noted by the application of T₆- (50%RDF +25% Azospirillum +25% Vermicompost) closely followed by T₄- 50% RDF + 50% Vermicompost i.e. 73.46 and T₁ -100% RDF i.e. 62.52, while lowest days to 50% flowering 58.36 were recorded with T₀ (control) during respectively and this improvement was significantly. Similar result was also reported that the Dev and Bhandara 2017, Islam *et al*, 2017 and Bindra *et al*, 2018^[3, 8, 1] in tomato.

6. Number of clusters per plant

The Number of clusters per plant i.e. 9.93 were noted by the application of T₆- (50%RDF +25% Azospirillum +25% Vermicompost) closely followed by T₄- 50% RDF + 50% Vermicompost i.e. 7.73 and T₃ -50%RDF +50% FYM i.e.7.40, while lowest Number of flower per cluster 6.00 were recorded with T₀ (control) during respectively and this improvement was significantly. Similar result was also reported that the Soumya *et al*, 2009, Kumar *et al*, 2010 Islam *et al*, 2017^[20, 8] and Bindra *et al*, 2018^[1] in tomato.

7. Number of fruits per plant

The Number of fruits per Plant i.e. 41.53 were noted by the application of T₆- (50% RDF +25% Azospirillum +25% Vermicompost) closely followed by T₇- 50% RDF + +25% FYM + 25% Vermicompost i.e. 36.67 and T₅ -50%RDF +25% Azospirillum +25% FYM i.e.34.47, while lowest Number of fruits per Plant 30.93 were recorded with T₀ (control) during respectively and this improvement was significantly. Similar result was also reported that the Kumar *et al*, 2014 Singh *et al*, 2014, Kumar *et al*, 2017, Bindra *et al*, 2018^[10, 19, 1] in tomato.

8. Average fruit weight (g)

The Average fruit weight (gm) i.e. 84.32 gm were noted by the application of T₆- (50%RDF +25% Azospirillum +25% Vermicompost) closely followed by T₇- 50% RDF + +25% FYM + 25% Vermicompost i.e. 81.46 and T₃ -50%RDF +50% FYM i.e.80.38 gm, while lowest Number of fruit per Plant 65.00 gm. were recorded with T₀ (control) during respectively and this improvement was significantly. Similar result was also reported that the Kumar *et al*, 2014, Singh *et al*, 2014, Kumar *et al*, 2017, Bindra *et al*, 2018^[10, 19, 1] in tomato.

9. Fruit yield per plant (Kg/plant)

The Fruit yield per Plant (kg) /plant i.e. 3.77kg were noted by the application of T₆- (50%RDF +25% Azospirillum +25% Vermicompost) closely followed by T₇- 50% RDF + +25% FYM + 25% Vermicompost i.e. 3.09 and T₁ - 100%RDF i.e.3.07kg, while lowest Number of fruit per Plant 1.58 kg. Were recorded with T₀ (control) during respectively and this improvement was significantly. Similar result was also reported that the Kumar *et al*, 2014, Singh *et al*, 2014, Kumar *et al*, 2017, Bindra *et al*, 2018^[10, 19, 1] in tomato.

10. Fruit yield per hectare (t/ha)

The Fruit yield per ha.(t/ha.) i.e. 42.09 t/ha. were noted by the application of T₆- (50%RDF +25% Azospirillum +25% Vermicompost) closely followed by T₇ (50% RDF + 25% FYM +25% vermicompost) -i.e. 39.74 t/ha. and T₅ - 50%RDF + +25% Azospirillum + 25% FYM i.e.39.22 t/ha. while lowest Number of fruits per Plant 31.89 t/ha. Were recorded with T₀ (control) during respectively and this

improvement was significantly. Similar result was also reported that the Kumar *et al*, 2014, Singh *et al*, 2014, Kumar *et al*, 2017, Bindra *et al*, 2018^[10, 19, 1] in tomato.

11. Ascorbic acid (mg/100g)

The Ascorbic acid (mg/100gm) i.e. 21.97 were noted by the application of T₆- (50%RDF +25% Azospirillum +25% Vermicompost) closely followed by T₅ (50% RDF+ 25% Azospirillum +25% FYM) -i.e. 20.76 and T₁ -100% RDF i.e. 20.38, while lowest Ascorbic acid (mg/100gm) 17.77. Were recorded with T₀ (control) during respectively and this improvement was significantly. Similar result was also

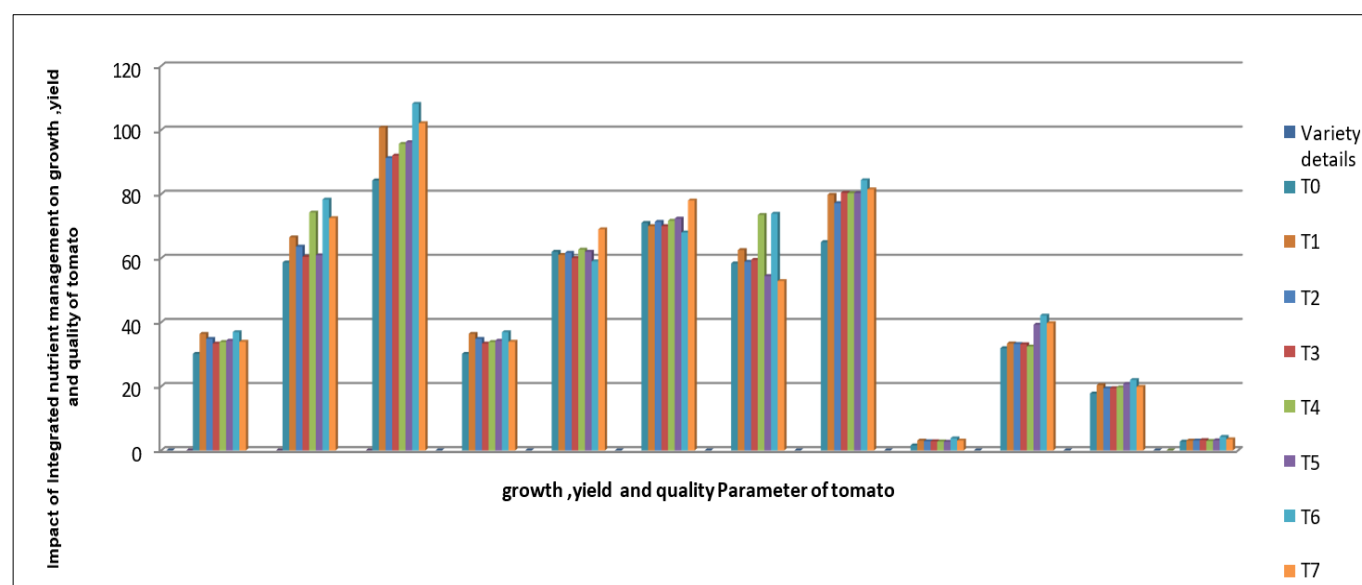
reported that the Prasad *et al*, 2002, Prabhu *et al*, 2010, and Singh 2014^[13, 11, 19] in tomato.

12. Economics Parameter

The plant tomato sown in the field under the treatment with 50% RDF + 25% Azospirillum + 25% Vermicompost (T₆) recorded the maximum monetary advantage with the benefit cost ratio of 4.25, during the year of experimentation The result of this study is in agreements with the finding of Yadav *et al*, 2004, Choudhary *et al*, 2008, Kondapa *et al*, 2009 and Sharma *et al*, 2023^[24, 2, 9, 17] in tomato.

Table 1: Impact of INM on growth, yield and quality of tomato

Variety Symbols	Variety details	Plant Height (cm)			No of branches per Plants	Days to 1st Flowering	Days to 50% Flowering	No of flowers per plant	Average fruit Weight (gm)	Fruit yield per Plant (Kg)/Plant	Fruit Yield Per hectare (t/ha)	Asco rbic acid (mg/100gm)	B:C ratio
		30 DAT	60 DAT	90 DAT									
T ₀	Control	30.14	58.65	84.23	30.14	62.00	71.00	58.36	65.00	1.58	31.89	17.77	2.75
T ₁	100% RDF	36.35	66.49	100.73	36.35	61.00	70.00	62.52	79.76	3.07	33.39	20.38	3.08
T ₂	75% RDF + 25% Azospirillum	34.80	63.59	91.23	34.80	61.67	71.33	58.86	77.16	2.87	33.22	19.38	3.10
T ₃	50% RDF + 50% FYM	33.36	60.42	92.00	33.36	60.00	70.00	59.46	80.38	2.87	33.14	19.42	3.23
T ₄	50% RDF + 50% Vermicompost	33.82	74.23	95.63	33.82	62.67	71.67	73.46	80.23	2.80	32.43	19.67	2.96
T ₅	50% RDF + 25% Azospirillum + 25% FYM	34.23	60.90	96.16	34.23	62.00	72.33	54.41	80.29	2.73	39.22	20.76	3.16
T ₆	50% RDF + 25% Azospirillum + 25% Vermicompost	36.90	78.26	108.15	36.90	59.00	68.00	73.84	84.32	3.77	42.09	21.97	4.24
T ₇	50% RDF + 25% FYM + 25% Vermicompost	33.91	72.50	102.09	33.91	69.00	78.00	52.87	81.46	3.09	39.74	19.86	3.48
	t												
	CD 0.05	0.70	0.42	0.13	2.06	1.97	1.83	1.25	2.45	0.34	1.48	2.26	
	SE.m (±)	8.03	2.43	0.53	0.70	0.67	0.63	0.43	0.84	0.12	4.32	0.77	



T₀- Control, T₁- 100% RDF, T₂- 75% RDF + 25% Azospirillum, T₃- 50% RDF + 50% FYM, T₄- 50% RDF + 50% Vermicompost, T₅- 50% RDF + 25% Azospirillum + 25% FYM, T₆- 50% RDF + 25% Azospirillum + 25% Vermicompost T₇- 50% RDF + 25% FYM + 25% Vermicompost

Fig 1: Impact of Integrated nutrient management on growth, yield and quality of tomato

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