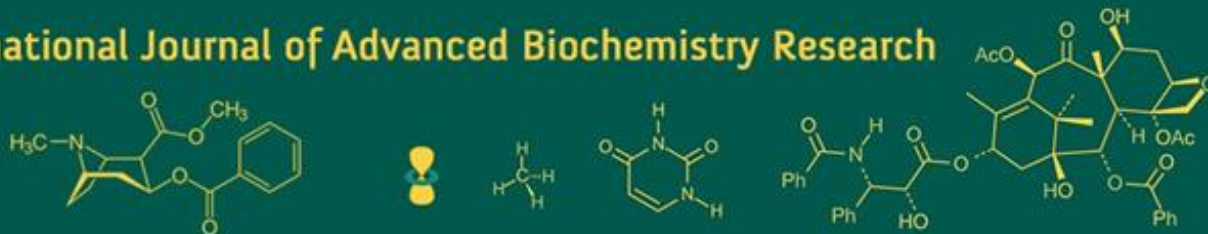


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Varun Kumar
 Department of Horticulture,
 School of Agriculture Science,
 Technology & Research,
 Sardar Patel University,
 Balaghat, Madhya Pradesh,
 India

Avadhesh Singh Choudhary
 Department of Horticulture,
 School of Agriculture Science,
 Technology & Research,
 Sardar Patel University,
 Balaghat, Madhya Pradesh,
 India

Mohd Wamiq
 Department of Horticulture,
 School of Agriculture Science,
 Technology & Research,
 Sardar Patel University,
 Balaghat, Madhya Pradesh,
 India

Pallavi Verma
 Department of Horticulture,
 School of Agriculture Science,
 Technology & Research,
 Sardar Patel University,
 Balaghat, Madhya Pradesh,
 India

Prakash Ghodeswar
 Department of Horticulture,
 School of Agriculture Science,
 Technology & Research,
 Sardar Patel University,
 Balaghat, Madhya Pradesh,
 India

Corresponding Author:
Mohd Wamiq
 Department of Horticulture,
 School of Agriculture Science,
 Technology & Research,
 Sardar Patel University,
 Balaghat, Madhya Pradesh,
 India

Impact of integrated nutrient management on growth, yield and fruit quality of tomato (*Solanum lycopersicum* L.) var. Pusa Ruby

Varun Kumar, Avadhesh Singh Choudhary, Mohd Wamiq, Pallavi Verma and Prakash Ghodeswar

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Abstract

A field experiment entitled "Impact of Integrated Nutrient Management on Growth, Yield and Fruit Quality of Tomato (*Solanum lycopersicum* L.)" was conducted during the Rabi season of 2024–25 at the Research Farm of the Department of Horticulture (Vegetable Science), School of Agriculture Science, Technology and Research, Sardar Patel University, Balaghat (Madhya Pradesh). The experiment was laid out in a Randomized Block Design (RBD) with twelve treatments and three replications to evaluate the effect of different combinations of inorganic fertilizers, vermicompost, farmyard manure (FYM), biofertilizers (Azotobacter and phosphate-solubilizing bacteria) and boron on the growth, yield and fruit quality of tomato. The results revealed significant differences among the treatments for all the parameters studied. Treatment T₁₁ (25% NPK @ 30:15:15 kg ha⁻¹ + Vermicompost @ 6 t ha⁻¹ + Borax @ 5 kg ha⁻¹) recorded the highest plant height (79.14 cm), number of leaves per plant (49.32), branches per plant (6.30), number of fruits per plant (42.51), fruit diameter (5.67 cm), fruit yield per plant (17.91 kg), total fruit yield (222.97 q ha⁻¹) and total soluble solids (4.37°Brix). The same treatment also resulted in the earliest flowering, requiring only 41.71 days for first flowering and 54.30 days for 50 per cent flowering. In contrast, the control treatment (T₀) recorded the lowest values for growth, yield and quality attributes. The findings indicate that integrated application of reduced chemical fertilizers along with vermicompost and boron substantially enhanced nutrient use efficiency, resulting in improved vegetative growth, early flowering, higher fruit yield and better fruit quality. Therefore, integrated nutrient management offers an effective and sustainable approach for increasing tomato productivity while maintaining soil fertility under the agro-climatic conditions of Balaghat, Madhya Pradesh.

Keywords: Tomato, integrated nutrient management, vermicompost, boron, yield, fruit quality

Introduction

Tomato (*Solanum lycopersicum* L.) is one of the most important vegetable crops cultivated throughout the world owing to its high economic value, nutritional significance and wide adaptability under diverse agro-climatic conditions. It belongs to the family Solanaceae and is native to South America, although it is now cultivated extensively in tropical, subtropical and temperate regions. India is the second-largest producer of tomato after China, contributing substantially to global production. Tomato occupies a prominent place in Indian vegetable cultivation because of its year-round demand, versatility in culinary use and profitability for farmers. The fruits are consumed in fresh as well as processed forms such as ketchup, puree, sauces, soups, juices and dehydrated products, making tomato an indispensable component of the food processing industry (FAOSTAT, 2024; NHB, 2024) [1, 2].

Tomato fruits are recognized as an excellent source of essential nutrients, including vitamins A, C, E and K, dietary fiber, minerals such as potassium, calcium, phosphorus and iron, along with several bioactive compounds. Among these, lycopene, β -carotene, phenolic compounds and flavonoids exhibit strong antioxidant properties that help reduce oxidative stress and lower the risk of cardiovascular diseases, certain cancers, diabetes and age-related disorders. Regular consumption of tomato contributes significantly to human nutrition and food security, emphasizing the need for sustainable production systems that improve both yield and fruit quality (Rai et al., 2021; Bhandari et al., 2022) [3, 4].

The productivity and quality of tomato are greatly influenced by nutrient management.

Tomato is considered a heavy feeder crop because of its rapid vegetative growth, prolonged fruiting period and high nutrient extraction from the soil. Balanced and adequate nutrition is therefore essential for optimum plant growth, flowering, fruit set, fruit development and quality improvement. Conventional farming practices often depend heavily on chemical fertilizers to maximize production. Although mineral fertilizers supply nutrients in readily available forms and increase crop productivity, their continuous and indiscriminate use has resulted in declining soil fertility, nutrient imbalance, deterioration of soil physical properties, reduced microbial activity and increased environmental pollution. Excessive reliance on inorganic fertilizers also increases production costs and adversely affects long-term sustainability of vegetable cultivation (Singh *et al.*, 2020; Kumar *et al.*, 2022) ^[5, 6].

Integrated Nutrient Management (INM) has emerged as an environmentally sound and economically viable strategy to achieve sustainable agricultural production. The concept of INM involves the judicious and balanced use of inorganic fertilizers, organic manures, biofertilizers and micronutrients to maintain soil fertility while ensuring optimum crop productivity. Organic sources such as farmyard manure (FYM) and vermicompost improve soil structure, enhance water-holding capacity, increase organic carbon content and stimulate beneficial microbial activity. These organic amendments also facilitate gradual nutrient release, reduce nutrient losses through leaching and improve nutrient use efficiency. Consequently, integration of organic manures with recommended fertilizer doses has been found to improve plant growth, yield attributes, fruit quality and soil health simultaneously (Choudhary *et al.*, 2021; Meena *et al.*, 2023) ^[7, 8].

Among organic nutrient sources, vermicompost has gained considerable importance because of its rich nutrient composition and biological activity. Vermicompost contains readily available macro and micronutrients, humic substances, beneficial microorganisms, vitamins, enzymes and plant growth-promoting substances such as auxins, gibberellins and cytokinins. Application of vermicompost improves root development, nutrient uptake, chlorophyll synthesis, photosynthetic efficiency and microbial diversity in the rhizosphere. Similarly, farmyard manure contributes substantial amounts of organic matter, enhances soil aggregation, improves cation exchange capacity and supports sustained nutrient availability throughout the crop growth period. Numerous studies have demonstrated that the combined application of vermicompost and FYM with reduced doses of chemical fertilizers significantly enhances tomato growth, yield and fruit quality while improving soil biological properties (Sharma *et al.*, 2021; Patel *et al.*, 2023) ^[9, 10].

Biofertilizers play an equally important role in integrated nutrient management. *Azotobacter* is a free-living nitrogen-fixing bacterium capable of fixing atmospheric nitrogen and producing various plant growth-promoting substances including indole acetic acid (IAA), gibberellins, cytokinins, vitamins and siderophores. These compounds stimulate root proliferation, enhance nutrient absorption, improve chlorophyll formation and increase resistance against abiotic stresses.

Likewise, phosphate-solubilizing bacteria (PSB) convert insoluble forms of phosphorus into plant-available forms through the secretion of organic acids and phosphatase enzymes. Enhanced phosphorus availability promotes root growth, flowering, fruit set and fruit development. Integration of *Azotobacter* and PSB with reduced doses of chemical fertilizers has been reported to improve fertilizer use efficiency, reduce dependency on synthetic fertilizers and increase tomato productivity under different agro-climatic conditions (Verma *et al.*, 2020; Sahu *et al.*, 2022) ^[11, 12].

Micronutrients are indispensable for normal plant metabolism despite being required in relatively small quantities. Among them, boron plays a critical role in cell wall formation, membrane integrity, carbohydrate translocation, pollen viability, fertilization, fruit set and seed development. Boron deficiency is frequently observed in tomato-growing regions, resulting in poor flowering, reduced fruit set, fruit cracking, internal browning, malformed fruits and lower marketable yield. Appropriate boron application along with integrated nutrient management improves reproductive efficiency, fruit firmness, shelf life, total soluble solids (TSS), vitamin C content and overall fruit quality. Therefore, inclusion of boron in integrated nutrient management practices offers considerable scope for enhancing both productivity and nutritional quality of tomato fruits (Khan *et al.*, 2023; Yadav *et al.*, 2024) ^[13].

Recent investigations have consistently shown that integrated application of inorganic fertilizers, organic manures, biofertilizers and micronutrients significantly improves vegetative growth parameters such as plant height, number of branches, leaf area, chlorophyll content and dry matter accumulation. Improved vegetative growth subsequently translates into better flowering, higher fruit set, increased fruit weight, greater number of fruits per plant, enhanced marketable yield and superior fruit quality characteristics including TSS, ascorbic acid, lycopene, acidity and shelf life. Furthermore, INM contributes to improved soil microbial biomass, nutrient availability, carbon sequestration and long-term soil productivity, making it an indispensable component of sustainable vegetable production systems (Rathore *et al.*, 2022; Kumari *et al.*, 2024) ^[14, 15, 16].

In view of the increasing concerns regarding soil degradation, escalating fertilizer prices and the growing demand for safe, nutritious vegetables, optimization of integrated nutrient management practices has become a priority for sustainable tomato cultivation. Therefore, the present investigation entitled "Impact of Integrated Nutrient Management on Growth, Yield and Fruit Quality of Tomato (*Solanum lycopersicum* L.)" was undertaken to evaluate different combinations of inorganic fertilizers, vermicompost, farmyard manure, biofertilizers (*Azotobacter* and phosphate-solubilizing bacteria) and boron on growth, yield and fruit quality parameters of tomato.

Materials and Methods

Experimental site

The present investigation entitled "Impact of Integrated Nutrient Management on Growth, Yield and Fruit Quality of Tomato (*Solanum lycopersicum* L.)" was conducted during the Rabi season of 2024–25 at the Research Farm of the Department of Horticulture (Vegetable Science), School of Agriculture Science, Technology and Research, Sardar Patel University, Balaghat, Madhya Pradesh, India. The experimental farm is situated at Dongariya, approximately 9.7 km from Balaghat city. Before laying out the experiment, representative soil samples were collected from different locations of the field at a depth of 0–30 cm and analyzed for their physico-chemical properties. The soil was slightly alkaline in reaction (pH 7.81), low in available nitrogen and organic carbon, medium in available phosphorus and fairly rich in available potassium, indicating moderate fertility status suitable for evaluating integrated nutrient management practices.

Experimental design and crop management

The experiment was laid out in a Randomized Block Design (RBD) comprising twelve treatments with three replications. Nitrogen was applied in split doses, while the full doses of phosphorus and potassium were applied as basal. Biofertilizers (*Azotobacter* and phosphate-solubilizing bacteria) were applied

as per treatment recommendations and borax was incorporated into the soil before transplanting wherever specified. The experiment consisted of twelve nutrient management treatments involving different combinations of inorganic fertilizers, organic manures, biofertilizers and boron to evaluate their influence on tomato growth, yield and fruit quality. Treatment T₀ served as the absolute control without nutrient application. T₁ comprised the recommended dose of fertilizers (100% NPK @ 120:60:60 kg ha⁻¹). Treatments T₂ and T₃ included 75% of the recommended NPK dose (90:45:45 kg ha⁻¹) integrated with vermicompost @ 25 t ha⁻¹ and farmyard manure (FYM) @ 25 t ha⁻¹, respectively. Treatments T₄ and T₅ consisted of 75% recommended NPK combined with *Azotobacter* @ 2 kg ha⁻¹ and phosphate-solubilizing bacteria (PSB) @ 2 kg ha⁻¹, respectively. Treatment T₆ received 50% NPK (60:30:30 kg ha⁻¹) together with vermicompost @ 12.5 t ha⁻¹ and FYM @ 12.5 t ha⁻¹. Treatment T₇ comprised 50% NPK along with vermicompost @ 12.5 t ha⁻¹ and *Azotobacter* @ 2 kg ha⁻¹, whereas T₈ received 50% NPK combined with FYM @ 12.5 t ha⁻¹ and *Azotobacter* @ 2 kg ha⁻¹. Treatment T₉ consisted of 25% NPK (30:15:15 kg ha⁻¹) integrated with vermicompost @ 6 t ha⁻¹ and FYM @ 25 t ha⁻¹. Treatment T₁₀ included 25% NPK supplemented with vermicompost @ 6 t ha⁻¹, PSB @ 2 kg ha⁻¹ and borax @ 10 kg ha⁻¹, while T₁₁ received 25% NPK together with vermicompost @ 6 t ha⁻¹ and borax @ 5 kg ha⁻¹. These treatment combinations were designed to compare the individual and integrated effects of

chemical fertilizers, organic nutrient sources, biofertilizers and boron on tomato productivity and fruit quality.

Observations recorded

Observations on growth, flowering, yield and fruit quality were recorded from five randomly selected and tagged plants in each experimental plot, excluding border plants and the average values were used for statistical analysis. Growth observations included plant height (cm), number of leaves per plant and number of branches per plant at different growth stages. Flowering parameters comprised days to first flowering and days to 50 per cent flowering. Yield attributes were recorded in terms of number of fruits per plant, average fruit weight (g), fruit diameter (cm), fruit yield per plant (kg) and total fruit yield (q ha⁻¹). Fruit quality was assessed by determining total soluble solids (TSS, °Brix) using a hand refractometer.

Statistical analysis

The experimental data recorded from different growth, yield and quality parameters were subjected to statistical analysis using the analysis of variance (ANOVA) appropriate for Randomized Block Design as described by Gomez and Gomez (1984). The significance of treatment effects was tested at the 5 per cent level of probability. Standard Error of Mean (SEm ±) and Critical Difference (CD) values were calculated for comparing treatment means wherever the F-test was found significant.

Results and Discussion

Table 1: Impact on Integrated Nutrient Management on Growth of Tomato (*Solanum lycopersicum* L.) var. Pusa Ruby

Treatment No.	Plant height (cm)				Number of leaves per plant				Number of Branches per plant at 60 DAS
	15 DAS	30 DAS	45 DAS	60 DAS	15 DAS	30 DAS	45 DAS	60 DAS	
T0	25.26	31.08	36.1	60.32	3.96	7.41	13.41	36.87	5.04
T1	26.14	32.15	37.34	62.4	4.14	7.75	14.03	38.57	5.15
T2	27.56	33.9	39.37	65.8	4.27	7.98	14.44	39.7	5.37
T3	26.94	33.13	38.49	64.32	4.21	7.86	14.23	39.14	5.24
T4	28.46	35.01	40.66	67.95	4.35	8.13	14.71	40.46	5.45
T5	29.66	36.48	42.38	70.82	4.52	8.46	15.31	42.11	5.75
T6	28.75	35.36	41.08	68.64	4.41	8.24	14.92	41.02	5.63
T7	29.86	36.73	42.67	71.3	4.57	8.54	15.47	42.53	5.87
T8	32.75	40.28	46.79	78.18	5.15	9.62	17.42	47.91	6.23
T9	31.99	39.35	45.71	76.39	5.01	9.36	16.94	46.59	6.13
T10	31.59	38.86	45.14	75.43	4.78	8.94	16.19	44.51	5.98
T11	33.15	40.77	47.36	79.14	5.3	9.91	17.94	49.32	6.3
S.Em ±	0.66	0.86	1.5	1.73	0.17	0.33	0.44	1.04	0.17
CD (P=0.05)	1.92	2.52	4.39	5.05	0.49	0.98	1.28	3.03	0.49

Table 2: Impact on Integrated Nutrient Management on Yield and Fruit Quality of Tomato (*Solanum lycopersicum* L.) var. Pusa Ruby

Treatment No.	Days to first flowering	Days to 50 % flowering g	Number of fruits per plant	Diameter of fruit (cm)	Yield per plant (g)	Yield (q/ha)	Total soluble solids
T0	46.54	59.13	30.75	4.1	12.73	158.53	3.18
T1	46.18	58.77	31.21	4.16	13.23	164.74	3.35
T2	45.11	57.70	33.02	4.4	13.58	169.01	3.7
T3	45.54	58.13	31.81	4.24	13.42	167.07	3.52
T4	44.50	57.09	34.22	4.56	13.94	173.54	3.83
T5	43.52	56.11	36.86	4.91	14.53	180.91	4.03
T6	44.00	56.59	35.43	4.72	14.21	176.9	3.93
T7	43.30	55.89	37.85	5.05	14.99	186.61	4.12
T8	42.37	54.96	41.38	5.52	17.31	215.47	4.34
T9	42.62	55.21	40.03	5.34	16.44	204.73	4.27
T10	42.90	55.49	38.67	5.16	15.49	192.82	4.2
T11	41.71	54.30	42.51	5.67	17.91	222.97	4.37
S.Em±	0.17	0.93	1.42	0.17	0.64	7.34	0.17
CD (P=0.05)	0.49	2.71	4.13	0.49	1.88	21.43	0.49

Plant height (cm)

Plant height increased progressively with crop growth under all integrated nutrient management treatments. At 60 DAS, the maximum plant height (79.14 cm) was recorded in T₁₁ (25 % NPK+

Vermicompost @ 6 t ha⁻¹+ Borax textcircleda5kg ha⁻¹), which was statistically at par with T₈ (78.18cm) and significantly superior to the remaining treatments. The minimum plant height (60.32 cm) was observed in the control (T₀). The enhanced plant height under T₁₁ may be attributed to the balanced supply of nutrients through inorganic fertilizers and vermicompost along with boron, which improved cell division, nutrient uptake and photosynthetic activity. Similar findings have been reported by Sharma *et al.* (2021)^[9], Meena *et al.* (2023)^[8] and Kumar *et al.* (2022)^[6].

Number of leaves per plant

The number of leaves per plant was significantly influenced by different nutrient management treatments. The highest number of leaves at 60 DAS (49.32) was recorded under T₁₁, followed by T₈ (47.91), whereas the lowest value (36.87) was recorded in the control. The improvement in leaf production may be due to the combined effect of vermicompost and boron, which enhanced nutrient availability and chlorophyll synthesis, resulting in vigorous vegetative growth. Similar observations were reported by Patel *et al.* (2023)^[10] and Verma *et al.* (2020)^[11].

Number of branches per plant

Among the treatments, T₁₁ produced the maximum number of branches per plant (6.30), closely followed by T₈ (6.23), while the minimum number of branches (5.04) was recorded in the untreated control. Increased branching under integrated nutrient management may be attributed to improved nutrient availability and enhanced metabolic activity resulting from the combined application of organic and inorganic nutrient sources. Similar results were reported by Sahu *et al.* (2022)^[12].

Days to first flowering

Significant variation was observed in days to first flowering. The earliest flowering (41.71 days) was recorded in T₁₁; followed by T₈ (42.37 days), whereas the control required the maximum time (46.54 days). Earlier flowering under integrated nutrient management might be due to balanced nutrition, which accelerated physiological activities and promoted early reproductive development. Similar findings were reported by Singh *et al.* (2020)^[5] and Meena *et al.* (2023)^[8].

Days to 50% flowering

The minimum number of days required for 50% flowering (54.30 days) was recorded under T₁₁, followed by T₈ (54.96 days), whereas the maximum (59.13 days) was observed in the control. The integration of vermicompost with boron probably enhanced nutrient uptake and hormonal balance, resulting in earlier flowering. These findings corroborate those of Kumar *et al.* (2022)^[6].

Number of fruits per plant

The highest number of fruits per plant (42.51) was obtained with T₁₁, followed by T₈ (41.38), while the control recorded the lowest number of fruits (30.75). Better fruit set under integrated nutrient management may be due to continuous nutrient availability and improved pollen viability through

boron application. Similar results have been reported by Khan *et al.* (2023)^[13] and Patel *et al.* (2023)^[10].

Fruit diameter (cm)

Fruit diameter was significantly improved by integrated nutrient management. The maximum fruit diameter (5.67 cm) was recorded under T₁₁, followed by T₈ (5.52 cm), whereas the minimum (4.10 cm) was observed in the control. Adequate nutrient supply through integrated sources promoted better cell enlargement and fruit development, thereby increasing fruit size. Similar observations were reported by Sharma *et al.* (2021)^[9].

Fruit yield per plant (kg)

The highest fruit yield per plant (17.91 kg) was recorded in T₁₁, followed by T₈ (17.31 kg), while the lowest yield (12.73 kg) was observed in the control. Higher fruit yield under T₁₁ may be attributed to enhanced vegetative growth, improved flowering, higher fruit set and efficient translocation of photosynthates due to the combined effect of vermicompost and boron. Similar findings were reported by Verma *et al.* (2020)^[11], Meena *et al.* (2023)^[8] and Kumari *et al.* (2024)^[15].

Fruit yield (q ha⁻¹)

Fruit yield per hectare differed significantly among treatments. T₁₁ recorded the highest yield (222.97 q ha⁻¹), closely followed by T₈ (215.47 q ha⁻¹) and T₉ (204.73 q ha⁻¹). The minimum yield (158.53 q ha⁻¹) was recorded under the control. The superior yield under T₁₁ indicates that integrated application of reduced chemical fertilizer with vermicompost and boron enhanced nutrient use efficiency and overall crop productivity. Similar results were reported by Rathore *et al.* (2022)^[14], Patel *et al.* (2023)^[10] and Sharma *et al.* (2021)^[9].

Total soluble solids (°Brix)

The quality parameter, total soluble solids (TSS), was significantly affected by nutrient management treatments. The highest TSS (4.37 °Brix) was observed in T₁₁, followed by T₈ (4.34 °Brix), whereas the lowest value (3.18 °Brix) was recorded in the control. The increase in TSS may be attributed to improved carbohydrate synthesis and translocation under integrated nutrient management, particularly due to the beneficial effect of vermicompost and boron on fruit maturation and sugar accumulation. Similar observations were reported by Khan *et al.* (2023)^[13] and Bhandari *et al.* (2022)^[4].

Conclusion

The present investigation clearly demonstrated that integrated nutrient management significantly influenced the growth, flowering, yield and fruit quality of tomato. Among all the nutrient combinations evaluated, T₁₁ (25% NPK @ 30:15:15 kg ha⁻¹ + Vermicompost @ 6 t ha⁻¹ + Borax @ 5 kg ha⁻¹) proved to be the most effective treatment by recording the maximum plant height, number of leaves, branches, fruits per plant, fruit diameter, fruit yield per plant, total yield and total soluble solids, while also producing the earliest flowering. The superior performance of this treatment may be attributed to the balanced and sustained supply of nutrients through the combined application of inorganic fertilizer, vermicompost and boron, which enhanced nutrient uptake, vegetative growth, reproductive development and fruit quality. The control treatment consistently recorded the poorest performance for all the characters studied. Based on the experimental findings, it may be concluded that the integrated application of 25%

recommended NPK along with vermicompost 6tha^{-1} and borax @ 5 kg ha^{-1} is an efficient and sustainable nutrient management strategy for tomato cultivation under the agro-climatic conditions of Balaghat, Madhya Pradesh. This nutrient combination not only improved crop productivity and fruit quality but also has the potential to reduce dependence on chemical fertilizers and promote sustainable soil health for long-term vegetable production.

under subtropical conditions. *Scientia Horticulturae*. 2024;329:113003.

16. Kumari S, Patel N, Sharma R. *Scientia Horticulturae*. 2024;329:113003.

References

1. FAOSTAT. Crops and livestock products database. Food and Agriculture Organization of the United Nations. 2024.
2. National Horticulture Board (NHB). Indian Horticulture Database 2023–24. Ministry of Agriculture & Farmers Welfare, Government of India. 2024.
3. Rai N, Singh P, Kumar V. Nutritional importance and health benefits of tomato: A review. *International Journal of Food Science and Nutrition*. 2021;6(3):98–105.
4. Bhandari HR, Sharma P, Singh R. Integrated nutrient management for sustainable vegetable production: A review. *Journal of Plant Nutrition*. 2022;45(16):2471–2490.
5. Singh D, Yadav R, Kumar P. Integrated nutrient management for improving soil fertility and crop productivity: A review. *International Journal of Current Microbiology and Applied Sciences*. 2020;9(8):2788–2801.
6. Kumar A, Singh V, Meena RK. Sustainable nutrient management strategies in vegetable production systems. *Agricultural Reviews*. 2022;43(3):241–250.
7. Choudhary M, Yadav BL, Kumar S. Effect of integrated nutrient management on growth, yield and quality of vegetable crops. *International Journal of Chemical Studies*. 2021;9(2):1278–1285.
8. Meena NK, Sharma S, Verma P. Organic manures and biofertilizers in integrated nutrient management for vegetable crops: A review. *Vegetos*. 2023;36(2):534–547.
9. Sharma V, Kumar S, Singh R. Effect of vermicompost and integrated nutrient management on growth and quality of tomato. *Journal of Pharmacognosy and Phytochemistry*. 2021;10(1):1018–1023.
10. Patel DK, Kumar M, Singh P. Effect of vermicompost and farmyard manure on growth, yield and soil fertility in tomato. *Journal of Applied Horticulture*. 2023;25(2):112–118.
11. Verma R, Gupta P, Meena K. Response of tomato to biofertilizers and integrated nutrient management. *International Journal of Chemical Studies*. 2020;8(6):1725–1731.
12. Sahu R, Verma S, Mishra A. Influence of Azotobacter and phosphate-solubilizing bacteria on growth and productivity of tomato under integrated nutrient management. *Biological Forum – An International Journal*. 2022;14(4):1543–1549.
13. Khan MA, Ali S, Ahmad R. Role of boron nutrition in improving fruit quality and yield of horticultural crops: A review. *Journal of Plant Nutrition*. 2023;46(11):2698–2716.
14. Rathore MS, Sharma A, Chouhan R. Integrated nutrient management improves yield, quality and soil health in vegetable crops. *Indian Journal of Agricultural Sciences*. 2022;92(11):1361–1368.
15. Kumari S, Patel N, Sharma R. Integrated nutrient management enhances productivity and quality of tomato