



A Study on Effect of Nutrient Management on the Growth, Yield and Quality of Turmeric cv. Megha Turmeric-1

Jyoti Diwakar^{a++*} and Gyanendra Kumar Singh^{a#}

^a Department of Horticulture, Raja Balwant Singh College Bichpuri, Agra 283105, India.

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: <https://doi.org/10.9734/ijpss/2026/v38i106379>

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://pr.sdiarticle5.com/review-history/167803>

Original Research Article

Received: 20/07/2026

Accepted: 10/10/2026

Published: 17/10/2026

Abstract

Integrated nutrient management may improve turmeric productivity by combining readily available mineral nutrients with organic and biological nutrient sources. The present study evaluated the effects of different combinations of farmyard manure (FYM), compost, *Azospirillum*, and NPK fertiliser on the growth, yield, and quality of turmeric. The experiment was arranged in a randomised complete block design with nine treatments and three replications. Growth parameters were recorded during crop development, while rhizome yield components and quality parameters were assessed after harvest. The pooled results showed that T9, comprising FYM + *Azospirillum* + 100% NPK, recorded the highest plant height (101.82 cm), number of leaves per plant (13.11), number of tillers per clump (4.30), leaf length (47.58 cm), and leaf width (14.82 cm). The same treatment produced the highest pooled mother-rhizome weight (53.62 g), primary-rhizome weight (145.52 g), secondary-rhizome weight (233.17 g), and fresh rhizome yield (106.22 q ha⁻¹). T9 also recorded the highest curcumin content (6.64%) and oleoresin content (12.46%). In comparison, the treatment receiving 100% NPK alone generally recorded lower values for the measured growth, yield, and quality attributes. The findings indicate that combining FYM and *Azospirillum* with the full NPK treatment was associated with improved vegetative growth, rhizome production, and quality attributes under the conditions of the experiment.

Keywords: *Curcuma longa*; integrated nutrient management; farmyard manure; *Azospirillum*; NPK fertilisation; vegetative growth; rhizome yield; curcumin; oleoresin; soil fertility.

⁺⁺ Research Scholar; [#] Professor of Horticulture;

*Corresponding author: E-mail: diwakarjyoti16@gmail.com;

1. Introduction

Turmeric (*Curcuma longa* L.) is an ancient, highly valued, and culturally significant spice in India. It is a herbaceous perennial plant belonging to the family Zingiberaceae and is widely recognised for its nutritional, medicinal, and industrial importance. Turmeric rhizomes contain approximately 69.4% carbohydrates, 5.1% fats, 6.3% proteins, 3.5% minerals, 5.0–6.0% volatile oils, and 7.9–10.4% oleoresin (Srinivasan *et al.*, 2016). Historical evidence indicates that turmeric has been an integral part of Indian households for nearly 6,000 years, where it has traditionally been used as a culinary spice, medicinal ingredient, cosmetic aid, and natural dye. Its diverse applications and bioactive constituents have contributed to its continued importance in traditional practices as well as in modern food, pharmaceutical, cosmetic, and nutraceutical industries.

Turmeric has held a prominent position in the traditional Ayurvedic system of medicine and has been widely used for the management of various health disorders. In Ayurveda, turmeric has traditionally been recommended for digestive problems, skin disorders, fever, inflammation, wounds, infections, dysentery, arthritis, injuries, jaundice, and other liver-related ailments. Similarly, in Unani medicine, turmeric has been regarded as an important medicinal herb for maintaining healthy blood, owing to its traditionally recognised purifying, stimulating, and blood-building properties. Beyond its medicinal significance, turmeric is also an important nutrient-demanding crop that removes substantial quantities of nutrients from the soil. Therefore, maintaining an adequate and balanced supply of essential nutrients is critical for sustaining soil fertility and crop productivity. However, the continuous and excessive application of chemical fertilisers can adversely affect soil health, microbial activity, and the surrounding environment. Hence, the adoption of balanced and sustainable nutrient-management practices is essential for maintaining soil quality, improving turmeric productivity, and minimising environmental impacts.

The integrated application of organic and inorganic nutrient sources, commonly referred to as integrated nutrient management (INM), is an effective approach for improving crop productivity while maintaining soil health. INM enhances the physical, chemical, and biological properties of soil, thereby contributing to improved soil fertility, nutrient availability, productivity, and water-holding capacity. Organic sources play an important role in maintaining nutrient balance, improving soil structure, and supporting beneficial soil microorganisms, whereas inorganic fertilisers provide readily available nutrients that promote early crop establishment and vigorous vegetative growth. The complementary use of both nutrient sources ensures a more sustained and balanced supply of essential nutrients throughout the crop-growth period, ultimately promoting better growth, development, yield, and long-term soil fertility.

An increase in nitrogen application, whether supplied through organic manures or synthetic fertilisers, generally promotes vegetative growth, dry-matter accumulation, and yield in turmeric. Organic amendments such as compost and manure differ in their nutrient composition and generally contain comparatively lower concentrations of readily available nitrogen and potassium but may contribute substantial amounts of phosphorus and other nutrients. Their repeated application over time can enhance the availability and uptake of phosphorus, secondary nutrients, and micronutrients, thereby improving overall soil fertility and plant nutrition.

Different sources of organic manure can exert varying effects on the growth and yield of turmeric. The application of farmyard manure (FYM) has been reported to increase soil organic matter and provide a beneficial residual effect on soil fertility. Similarly, the combined application of organic amendments such as FYM and compost has been shown to positively influence the growth and yield of turmeric. Nitrogen fertilisation also plays a crucial role in enhancing plant height, number of leaves, and rhizome yield. Recent literature supports integrated nutrient management as a strategy for combining mineral, organic, and biological nutrient sources to sustain crop productivity and soil fertility across agricultural and horticultural systems (Yadav *et al.*, 2025; Ranjith & Rajeswari, 2026). In turmeric, recent studies have shown that nutrient-management regimes can influence yield, soil-quality indicators, rhizosphere processes, and crop response to fertiliser levels (Udhaya Nandhini *et al.*, 2023; Abraham *et al.*, 2026; Thombre *et al.*, 2026). However, the specific comparative response of FYM- and compost-based combinations with *Azospirillum* and graded NPK levels on turmeric growth, rhizome yield, and quality remains to be evaluated under the experimental conditions of the present study. Considering the importance of balanced nitrogen nutrition and the complementary roles of organic and inorganic nutrient sources, the present study was therefore undertaken to evaluate the effect of integrated nitrogen management on the growth and yield of turmeric.

2. Methods and Materials

The experiment was carried out at the Horticulture Farm of Raja Balwant Singh College, Bichpuri, Agra, Uttar Pradesh, India, during 2024–25. The experiment was laid out in a randomised complete block design with nine treatments, replicated three times. The following treatments were evaluated in turmeric cv. Salem.

- T1 – Control (NPK 100%)
- T2 – Compost + NPK (75%)
- T3 – Compost + NPK (100%)
- T4 – Compost + *Azospirillum* + NPK (75%)
- T5 – Compost + *Azospirillum* + NPK (100%)
- T6 – FYM + NPK (75%)
- T7 – FYM + NPK (100%)
- T8 – FYM + *Azospirillum* + NPK (75%)
- T9 – FYM + *Azospirillum* + NPK (100%)

The rhizomes were planted at a spacing of 45 cm × 30 cm. The required quantities of FYM, *Azospirillum*, NPK, and compost for the gross plot area were computed according to their N contents and applied to the respective plots as specified for each treatment.

Observations on growth parameters, including plant height, number of leaves per plant, number of tillers per clump, and leaf length and width, were recorded at 60, 120, and 180 days of crop growth. Yield parameters, including the number of mother rhizomes, primary rhizomes, and secondary rhizomes, as well as the weights of mother rhizomes, primary fingers, and secondary fingers per clump, were recorded at harvest (Singh & Dixit, 2010). Quality parameters were analysed after harvest and sun-drying (Parikh, 2020).

3. Results and Discussion

The results of the experiment involving supplementation with organic and inorganic nutrient sources revealed significant variation in the growth, yield, and quality attributes of turmeric cv. Salem. Plant height (101.82 cm), number of leaves per plant (13.11), number of tillers per clump (4.30), leaf length (47.58 cm), and leaf width (14.82 cm) showed the highest values at 180 DAP under FYM + *Azospirillum* + 100% NPK (T9). In contrast, the application of 100% NPK alone (T1) resulted in lower plant height (75.72 cm), number of leaves per plant (7.08), number of tillers per clump (2.04), leaf length (34.50 cm), and leaf width (9.08 cm) at 180 DAP. Observations were recorded at 60, 120, and 180 DAP (Tables 1 and 2). Plant height increased rapidly up to 180 days and thereafter slowed. This trend was in agreement with the explanation of Amala *et al.* (2019) in turmeric. The slower growth after 180 days might be attributed to rhizome and finger development associated with the source–sink relationship and the translocation of more photosynthates from the source (leaves) to the sink (fingers and rhizomes). The number of leaves per tiller was significantly enhanced by the organic, inorganic, and recommended-dose INM treatments (Das *et al.*, 2020). Fresh rhizome yield was significantly highest under T9 (106.22 q ha⁻¹), whereas T1 recorded a lower fresh rhizome yield of 40.92 q ha⁻¹. Based on the reported pooled CD value, T2 and T4 were not statistically on par with T9 for fresh rhizome yield. The greater plant height, number of leaves per plant, number of tillers per clump, and leaf length and width observed under T9 may have contributed to its higher rhizome yield. Another important yield attribute in turmeric is the number of tillers, which can influence yield and mother-rhizome development, as reported by Amala *et al.* (2022). The findings of Das *et al.* (2020) and Choudhary *et al.* (2018) are also consistent with the present results. Treatment T9 also resulted in the significantly highest weights of mother rhizomes (53.62 g), primary fingers (145.52 g), and secondary fingers per clump (233.17 g). However, application of 100% RDF (T1) resulted in the significantly lowest mother-rhizome weight (32.72 g) and primary- and secondary-rhizome weights per clump (89.25 g and 198.36 g, respectively). T9 was followed by T8 and T7 for these parameters (Tables 2, 3, and 4).

Table 1. Effect of Integrated Nutrient management on Plant height and Numbers of tillers

Treatments	Plant height (cm)			Number of Tillers		
	2024-25	2025-26	Pooled	2024-25	2025-26	Pooled
T ₁ .	72.76	78.69	75.72	1.79	2.30	2.04
T ₂ .	78.26	87.23	82.74	2.09	2.88	2.48
T ₃ .	82.66	88.51	85.58	2.39	2.90	2.65
T ₄ .	85.04	87.00	86.02	2.88	3.06	2.97
T ₅ .	87.28	89.23	88.25	3.01	3.21	3.11
T ₆ .	81.84	85.94	83.89	2.36	2.79	2.58
T ₇ .	84.07	86.86	85.47	2.43	2.81	2.62
T ₈ .	86.83	95.55	91.19	3.18	3.34	3.26
T ₉ .	97.22	106.43	101.82	4.18	4.42	4.30
Sem±	1.60	3.13	1.48	0.25	0.28	0.10
CD at 0.5%	4.82	9.40	4.85	0.75	0.74	0.33

Table 2. Effect of Integrated Nutrient management on Numbers of leaves and length of leaf (cm)

Treatments	Number of Leaves			Length Of Leaf (cm)		
	2024-25	2025-26	Pooled	2024-25	2025-26	Pooled
T ₁ .	6.50	7.66	7.08	34.19	34.82	34.50
T ₂ .	7.98	8.47	8.25	37.12	38.94	38.03
T ₃ .	8.59	8.84	8.71	37.64	39.83	38.74
T ₄ .	9.22	10.16	9.69	40.30	40.41	40.35
T ₅ .	10.03	10.47	10.25	41.28	42.54	41.91
T ₆ .	7.91	8.61	8.26	39.12	39.46	39.29
T ₇ .	9.06	9.11	9.08	40.99	41.23	41.11
T ₈ .	10.55	10.92	10.74	42.79	44.30	43.54
T ₉ .	12.96	13.27	13.11	46.09	49.08	47.58
Sem±	0.34	0.51	0.17	2.67	1.45	0.49
CD at 0.5%	1.04	1.51	0.57	3.68	3.47	1.61

The significantly highest fresh rhizome yield observed under T9 may be associated with the higher weights of mother rhizomes, primary fingers, and secondary fingers per clump, as well as the nutrient status associated with the combination of RDF, farmyard manure, and *Azospirillum*. Nitrogen and potassium are particularly important nutrients for improving the growth, yield, and quality of turmeric. Nitrogen is involved in chlorophyll synthesis and influences stomatal conductance and photosynthetic efficiency. Nitrogen is responsible for 26–41% of crop yields. Potassium (K) plays stimulatory roles in plants rather than becoming an integral part of plant components. It influences cell-wall permeability and the activities of various mineral elements, as well as neutralising physiologically important organic acids. Hu (2025) and Sagwal *et al.* (2025) reported that increases in potassium levels were

associated with increases in growth, leaf number, tiller number, and rhizome yield. The numbers of mother, primary, and secondary rhizomes can directly influence the weight and yield of fresh rhizomes. Early emergence of rhizomes through the soil after planting generally favours higher turmeric yield and may have contributed to the maximum fresh rhizome yield under T9. It has also been observed that the application of RDN through varied combinations of organic and inorganic sources, including vermicompost, neem cake, and pongamia cake, can result in comparatively higher rhizome yield through improvements in growth and yield parameters. The application of organic manures increased nutrient availability, improved the physical condition of the soil, and increased yield (Sahoo *et al.*, 2020; Kadam & Kamble, 2020). Plant height, number of green leaves, finger weight, and turmeric yield were influenced by nitrogen application, and all yield-contributing parameters increased progressively with increasing N levels (Bulbula, 2021). The pronounced yield improvement under organic treatments might be due to the sustained availability of nitrogen throughout the growing phase and to enhanced production and translocation of photosynthates to the sink, i.e., the rhizome, whereas plants at lower fertility levels remained stunted, resulting in reduced yield. Beneficial effects of organic inputs have been reported in many crops (Kadam & Kamble, 2020).

Table 3. Effect of Integrated Nutrient management on width of leaf (cm) and weight of mother rhizome(g)

Treatments	Width of leaf (cm)			Weight of mother rhizome (g)		
	2024-25	2025-26	Pooled	2024-25	2025-26	Pooled
T ₁ .	8.89	9.27	9.08	31.55	33.89	32.72
T ₂ .	10.3	11.27	10.78	39.06	40.83	39.94
T ₃ .	10.17	11.49	10.83	39.48	43.81	41.64
T ₄ .	11.25	11.54	11.39	40.67	44.12	42.39
T ₅ .	11.70	12.2	11.95	41.65	46.50	44.07
T ₆ .	9.79	10.01	9.90	40.46	44.74	42.60
T ₇ .	9.81	10.13	9.97	41.18	45.52	43.35
T ₈ .	11.74	13.06	12.4	43.40	47.21	45.31
T ₉ .	13.73	15.90	14.82	52.37	54.87	53.62
Sem±	0.57	0.59	0.33	2.23	1.58	0.53
CD at 0.5%	1.71	1.78	1.08	6.68	4.75	1.57

Table 4. Effect of Integrated Nutrient management on weight of primary fingers and secondary fingers (g)

Treatments	Weight of Primary rhizomes (g)			Weight of Secondary rhizomes (g)		
	2024-25	2025-26	Pooled	2024-25	2025-26	Pooled
T ₁ .	78.22	100.28	89.25	197.08	199.65	198.36
T ₂ .	92.34	117.41	104.87	207.53	209.43	208.48
T ₃ .	96.55	118.50	107.52	216.63	219.19	217.91
T ₄ .	104.18	125.23	114.71	219.93	221.83	220.88
T ₅ .	106.01	128.44	117.23	220.69	222.59	221.64
T ₆ .	101.15	120.24	110.69	218.01	219.91	218.96
T ₇ .	103.68	121.56	112.62	218.72	220.62	219.67
T ₈ .	112.61	145.10	128.85	224.53	227.09	225.81
T ₉ .	128.75	162.28	145.52	231.88	234.45	233.17
Sem±	5.89	5.06	2.76	1.75	2.02	0.17
CD at 0.5%	17.66	15.17	9.02	5.25	6.07	0.57

3.1 Growth Attributes

The superior plant height, leaf number, tiller number, and leaf dimensions under T9 suggest that the combined application of FYM, *Azospirillum*, and full NPK may have provided a more continuous nutrient supply and a biologically active rhizosphere than mineral fertiliser alone. Comparable responses have been reported in turmeric, where integrated combinations of organic manures, biofertilisers, and NPK improved plant height, tillering, and leaf production (Mondal & Hore, 2026), while field comparisons showed that both recommended NPK and organic nutrient sources enhanced vegetative growth relative to an unfertilised control (Sunuwar *et al.*, 2024). Compost-based nutrient management has also been associated with improved turmeric growth and nutrient status, indicating that organic inputs can complement mineral nutrition by supporting nutrient availability and soil conditions (Soliman *et al.*, 2023). These findings support interpreting the T9 response as an outcome of balanced nutrient management rather than attributing the observed growth improvement to a single nutrient source.

3.2 Yield and Rhizome Attributes

The higher pooled rhizome yield and rhizome weights under T9 are consistent with the improvement in vegetative growth, which can increase assimilate production and subsequent partitioning to developing rhizomes. Sunuwar *et al.* (2024) observed fertiliser-dependent increases in fresh rhizome yield together with increases in plant height, leaf number, tiller number, and rhizome components. In a three-year organic nutrient-management study, Mandi *et al.* (2025) reported that FYM combined with a microbial consortium produced fresh rhizome yield comparable to the recommended fertiliser dose, showing that organic and microbial inputs can sustain yield when nutrient supply is adequate. Likewise, Sil and Hore (2026) found that integrated macro- and micronutrient management improved clump weight and plot yield in turmeric. Collectively, these studies are consistent with the present pattern in

which FYM, *Azospirillum*, and NPK in T9 produced the highest yield-related values; however, direct comparisons should account for differences in cultivar, environment, and nutrient rate among studies.

3.3 Quality Attributes

Treatment T9 also recorded the highest pooled curcumin (6.64%) and oleoresin (12.46%) contents, indicating that the nutrient-management response extended beyond vegetative growth and rhizome yield to quality traits. Mondal and Hore (2026) reported higher curcumin and oleoresin contents under an integrated treatment combining organic manure, NPK, and biofertilisers. Mandi *et al.* (2025) similarly observed that vermicompost or FYM combined with a microbial consortium improved curcumin content under organic nutrient management, while Sil and Hore (2026) found that integrated nutrient strategies influenced both curcumin and oleoresin concentrations. Thus, the higher curcumin and oleoresin values under T9 may be associated with improved nutrient availability and crop physiological performance, although genotype, environment, and management conditions remain important sources of variation in turmeric quality.

Table 5. Effect of Integrated Nutrient management on yield kg/plot and q/hectare

Treatments	Yield (kg/plot)			Yield (q/ha)		
	2024-25	2025-26	Pooled	2024-25	2025-26	Pooled
T ₁ .	4.97	5.63	5.30	38.34	43.49	40.92
T ₂ .	7.91	8.08	8.00	61.09	62.38	61.74
T ₃ .	8.17	8.84	8.50	63.07	68.22	65.65
T ₄ .	8.66	9.89	9.28	66.85	76.37	71.61
T ₅ .	9.52	10.39	9.95	73.48	80.16	76.82
T ₆ .	8.36	9.36	8.86	64.54	72.26	68.40
T ₇ .	8.36	9.03	8.7	64.57	69.70	67.12
T ₈ .	10.61	11.15	10.88	81.91	86.03	83.97
T ₉ .	13.09	14.43	13.76	101.07	111.36	106.22
Sem±	0.71	0.69	0.18	5.51	5.34	1.39
CD at 0.5%	2.14	2.07	0.58	16.58	16.01	4.54

Table. 6. Effect of Integrated Nutrient management on curcumin and oleoresin content

Treatments	Curcumin (%)			Oleoresin (%)		
	2024-25	2025-26	Pooled	2024-25	2025-26	Pooled
T ₁ .	3.59	4.06	3.82	7.73	8.40	8.07
T ₂ .	4.69	5.03	4.86	9.38	9.71	9.54
T ₃ .	4.72	5.17	4.94	9.50	9.80	9.65
T ₄ .	4.92	5.28	5.10	10.30	10.50	10.40
T ₅ .	5.50	5.42	5.46	10.66	10.83	10.75
T ₆ .	4.72	5.18	4.95	9.80	10.16	9.98
T ₇ .	5.22	5.19	5.20	10.56	10.63	10.60
T ₈ .	5.09	6.03	5.56	10.77	11.10	10.93
T ₉ .	6.08	7.21	6.64	11.96	12.96	12.46
Sem±	0.27	0.37	0.19	0.66	0.67	0.14
CD at 0.5%	0.82	1.12	0.64	1.98	2.02	0.46

4. Conclusions

The nutrient-management treatments produced distinct responses in turmeric growth, yield, and quality. Among the nine treatments, FYM + *Azospirillum* + 100% NPK (T9) recorded the highest pooled values for the principal vegetative characteristics, rhizome component weights, fresh rhizome yield, curcumin content, and oleoresin content. The response of T9 was therefore consistent across the measured growth, yield, and quality attributes. In comparison, the 100% NPK treatment alone generally recorded lower values for these traits. Under the conditions of the experiment, the results indicate that combining farmyard manure and *Azospirillum* with the full NPK treatment can provide favourable conditions for turmeric growth and rhizome development. The findings support further evaluation of this integrated nutrient-management combination as a potential agronomic option for improving turmeric productivity and quality. Validation under different soil, climatic, and management conditions is required to determine the consistency of the observed responses and to establish the extent to which the treatment can be recommended beyond the present experimental setting.

5. Limitation

The findings are specific to the experimental conditions and nutrient-management combinations evaluated in this study. Treatment responses may vary with cultivar, soil properties, climate, nutrient availability, and crop-management conditions. Therefore, the observed advantages of T9 should not be generalised beyond the study setting without further validation. Multi-location and multi-season evaluation would help determine the stability of the growth, yield, and quality responses and support broader agronomic recommendations.

Declaration of AI Use

This manuscript was prepared through the intellectual contributions of the author(s) to the study design, data analysis, interpretation of results, and scholarly content. Grammarly and ChatGPT were used solely to assist with grammatical refinement and reference formatting during manuscript revision. The author(s) accept full responsibility for the accuracy, integrity, and final content of the manuscript.

Competing Interests

Authors have declared that no competing interests exist.

References

- Abraham, A., Sarathambal, C., Srinivasan, V., & Thankamani, C. K. (2026). Long-term nutrient management regimes alter root exudation and rhizosphere fungal community structure in turmeric (*Curcuma longa* L.). *Rhizosphere*, 37, Article 101265. <https://doi.org/10.1016/j.rhisph.2026.101265>
- Amala, D., Prabhakar, B. N., Padma, M., & Triveni, S. (2019). Effect of integrated nutrient management on yield, yield attributing characters and economics of turmeric (*Curcuma longa* L.) var. IISR Pragathi. *The Journal of Research, PJTSAU*, 47(3), 51–54. <https://epubs.icar.org.in/index.php/TJRP/article/view/97469>
- Amala, D., Prabhakar, B. N., Padma, M., & Triveni, S. (2022). Effect of integrated nutrient management on growth parameters and yield of turmeric (*Curcuma longa* L.) var. IISR Pragathi. *The Pharma Innovation Journal*, 11(3), 1492–1495. <https://www.thepharmajournal.com/archives/2022/vol11issue3/PartT/10-10-69-467.pdf>
- Bulbula, D. D. (2021). Comprehensive review on turmeric (*Curcuma longa* L.) as medicinal plant and its nutraceutical quality to human. *Cancer Therapy & Oncology International Journal*, 18(3), Article 555990. <https://doi.org/10.19080/CTOIJ.2021.18.555990>
- Choudhary, A. K., & Rahi, S. (2018). Organic cultivation of high yielding turmeric (*Curcuma longa* L.) cultivars: A viable alternative to enhance rhizome productivity, profitability, quality and resource-use efficiency in monkey–menace areas of north-western Himalayas. *Industrial Crops and Products*, 124, 495–504. <https://doi.org/10.1016/j.indcrop.2018.07.069>
- Das, A., Layek, J., Babu, S., Kumar, M., Yadav, G. S., Patel, D. P., Idapuganti, R. G., Lal, R., & Buragohain, J. (2020). Influence of land configuration and organic sources of nutrient supply on productivity and quality of ginger (*Zingiber officinale* Rosc.) grown in Eastern Himalayas, India. *Environmental Sustainability*, 3(1), 59–67. <https://doi.org/10.1007/s42398-020-00098-x>
- Hu, X. (2025). Effect of integrated nutrient management on curcumin content and yield of turmeric cultivars. *International Journal of Research in Agronomy*, 8(7), 68–71. <https://doi.org/10.33545/2618060X.2025.v8.i7a.5154>
- Kadam, J. H., & Kamble, B. M. (2020). Effect of organic manures on growth, yield and quality of turmeric (*Curcuma longa* L.). *Journal of Applied and Natural Science*, 12(2), 91–97. <https://doi.org/10.31018/jans.vi.2249>
- Mandi, S., Saha, P., Saha, N. D., Bindu, J. P., Reddy, D. D., Krishna, S. K., Barman, J. K. R., Nambari, R., Dam, S. K., & Satyanarayana, K. (2025). Standardization of organic cultivation practice for enhancing yield and quality of turmeric (*Curcuma longa* L.) in terai region of West Bengal. *Current Horticulture*, 13(4), 78–81. <https://doi.org/10.5958/2455-7560.2025.00060.0>
- Mondal, R., & Hore, J. K. (2026). Studies on the impact of integrated nutrient management on growth and quality parameters of turmeric. *Agricultural Science Digest*, 46(3), 452–457. <https://doi.org/10.18805/ag.D-5688>
- Parikh, R. P. (2020). *Effect of foliar application of organic liquid sources on growth, yield and quality of turmeric cv. GNT-2* [Master's thesis, Navsari Agricultural University].
- Ranjith, R. K., & Rajeswari, R. (2026). Enhancing growth and flowering through integrated nutrient management (INM) in pomegranate (*Punica granatum* L.) cv. Bhagwa during Ambe bahar. *Plant Cell Biotechnology and Molecular Biology*, 27(1–2), 165–172. <https://doi.org/10.56557/pcbmb/2026/v27i1-210267>
- Sagwal, V., Bora, L., Thakur, S., Ketan, Sharma, S., & Bhagta, T. (2025). Influence of integrated nutrient management on growth attributes, yield and soil chemical parameters of turmeric (*Curcuma longa* L.). *International Journal of Plant & Soil Science*, 37(9), 37–47. <https://doi.org/10.9734/ijpss/2025/v37i95683>
- Sahoo, B. B., Dalei, B. B., Phonglosa, A., & Senapati, N. (2020). Aptitude of vermicompost and bio-fertilizers on crop growth, yield and economics of turmeric (*Curcuma longa* L.). *International Journal of Current Microbiology and Applied Sciences*, 9(6), 138–146. <https://doi.org/10.20546/ijcmas.2020.906.018>
- Sil, A., & Hore, J. K. (2026). Integrated nano formulated macro and micro nutrient management enhances yield and quality of turmeric (*Curcuma longa* L.). *Indian Journal of Horticulture*, 83(2), 184–188. <https://doi.org/10.58993/ijh/2026.83.2.8>
- Singh, D., & Dixit, S. P. (2010). Effect of integrated nutrient management on quality parameters of turmeric in an acid Alfisol of Himachal Pradesh. *Indian Journal of Horticulture*, 67(Special Issue), 288–291. <https://journal.iahs.org.in/index.php/ijh/article/view/2178>
- Soliman, Y. M., Soliman, W. S., & Abbas, A. M. (2023). Alley cropping and organic compost: An efficient and sustainable agro-ecological strategy for improving turmeric (*Curcuma longa* L.) growth and attributes. *Agriculture*, 13(1), Article 149. <https://doi.org/10.3390/agriculture13010149>
- Srinivasan, V., Thankamani, C. K., Dinesh, R., Kandianan, K., Zachariah, T. J., Leela, N. K., Hamza, S., Shajina, O., & Ansha, O. (2016). Nutrient management systems in turmeric: Effects on soil quality, rhizome yield and quality. *Industrial Crops and Products*, 85, 241–250. <https://doi.org/10.1016/j.indcrop.2016.03.027>
- Sunuwar, C., Koirala, S., Acharya, R., Chaudhary, N., Bhandari, U. D., Rai, M., Niraula, S., & Mehta, R. K. (2024). Sustainable methods for growing turmeric: Evaluating the effects of synthetic and organic fertilizers on vegetative and reproductive attributes. *Turkish Journal of Food and Agriculture Sciences*, 6(1), 96–105. <https://doi.org/10.53663/turjfas.1468528>

- Thombre, S. V., Asewar, B. V., Baig, M. I. A., & Khatri, N. (2026). Optimizing turmeric productivity: Integrating intercropping systems, fertilizer regimes, and normalized difference vegetation index-based remote sensing for precision agriculture. *Industrial Crops and Products*, 250, Article 123903. <https://doi.org/10.1016/j.indcrop.2026.123903>
- Udhaya Nandhini, D., Janaki, P., Venkatesan, S., Senthilraja, K., Somasundaram, E., & Meena, S. (2023). Assessing changes in soil quality indicators, turmeric (*Curcuma longa* L.) yield, and monetary returns under different years of organic nutrient management. *Organic Agriculture*, 13(3), 443–460. <https://doi.org/10.1007/s13165-023-00438-1>
- Yadav, K. K., Singh, A. K., Chaturvedi, S. K., Singh, S. N., Kumar, V., Gupta, P., & Gupta, S. (2025). Integrated nutrient management in sustainable agriculture: Advances and challenges. *International Journal of Plant & Soil Science*, 37(9), 314–327. <https://doi.org/10.9734/ijpss/2025/v37i95710>

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of the publisher and/or the editor(s). This publisher and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.

© Copyright (2026): Author(s). The licensee is the journal publisher. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here: <https://pr.sdiarticle5.com/review-history/167803>