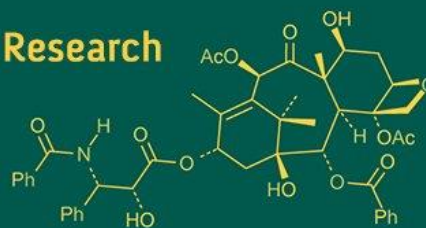
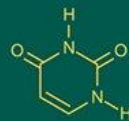
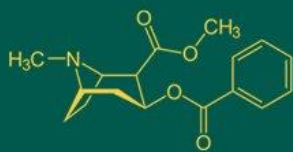


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Productivity and profitability of turmeric (*Curcuma longa* L.) as influenced by integrated nutrient management

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Abstract

Turmeric (*Curcuma longa* L.) is a perennial herb native to Southeast Asia, known for its rhizomatous growth. The combined use of organic and inorganic fertilizer known as Integrated Nutrient Management can improve soil fertility, increase crop yield and reduce the negative impact of chemical fertilizers on environment. Vermicompost is rich in beneficial microorganisms and nutrients, making it an excellent organic fertilizer for cultivating turmeric. This study was carried out at research farm of the department of vegetable science, regional research station, Karnal during summer season of 2022-23 in Randomized-block Design. The results showed that no of primary and secondary rhizomes per plant (4.10 and 8.43), weight of mother, primary and secondary rhizomes (70.12, 108.68 and 64.18 g) and yield (182.80 q/ha) were recorded highest with application of 75% recommended dose of fertilizer (RDF) + vermicompost @ 5 t/ha, whereas, available potassium (186.81 kg/ha) was recorded highest with application of 75% recommended dose of fertilizer (RDF) + FYM @ 25 t/ha. Highest gross returns (Rs 3,65,600) were observed with application of 75% recommended dose of fertilizer (RDF) + vermicompost @ 5 t/ha. The highest gross return (Rs. 3,65,600) was also recorded with 75% Recommended dose of fertilizer (RDF) + vermicompost @ 5 t/ha., whereas highest net income (Rs 2,30,449) with B:C ratio (1.90) was observed in Recommended dose of fertilizer (N:P:K-100:50:50).

Keywords: Fertilizer, vermicompost, FYM, turmeric

Introduction

Turmeric (*Curcuma longa* L.) is a perennial herb native to Southeast Asia and widely cultivated in tropical regions for its medicinal and culinary value. India is the world's leading producer, with major cultivation in states like Maharashtra, Telangana and Andhra Pradesh. Turmeric thrives in well-drained, slightly acidic soils and requires balanced nutrition for optimal growth. The plant is valued for its bioactive compounds, especially curcuminoids, which offer antioxidant, anti-inflammatory and antimicrobial benefits. However, intensive turmeric farming has led to soil degradation and reduced productivity due to excessive reliance on chemical inputs.

To promote sustainable cultivation, integrated nutrient management (INM)-combining organic (like FYM and vermicompost) and inorganic fertilizers-has emerged as a viable approach. INM improves soil health, enhances crop yield and quality and minimizes environmental harm. Research supports its effectiveness in meeting turmeric's nutrient needs while maintaining long-term soil fertility. Organic inputs like farmyard manure (FYM) and vermicompost play a vital role. FYM enriches the soil with essential nutrients and improves structure and microbial activity. Studies show that applying FYM at 10 t/ha significantly boosts turmeric yield (Jena *et al.*, 2016) [5]. Vermicompost, rich in nutrients and beneficial microbes, has also proven effective, with applications of 5-10 t/ha improving both yield and quality (Sharma *et al.*, 2017 and Hosseini *et al.*, 2020) [13, 4]. Optimal fertilizer use is essential for turmeric. Research recommends applying 120 kg N, 80 kg P and 60 kg K per hectare, though actual needs may vary by soil and climate (Kumar *et al.*, 2019) [7]. A balanced nutrient strategy-chemical, organic or integrated-can close the yield gap, enhance rhizome quality, and reduce the negative effects of over-fertilization.

Materials and Methods

To evaluate the effect of integrated nutrient management on turmeric production and profitability, a field experiment was conducted at the Research Farm of the Department of Vegetable Science, Regional Research Station, Karnal situated at latitude of 29° 43' north, longitude of 76° 58' east and at an elevation of 245 metre above mean sea level during the cropping season of 2022-2023 (June-March). The climate of village Uchani, Karnal is semi-arid and sub-tropical with dry and hot winds during summer months, warm and humid in monsoon and dry and cold weather in winter. Both, summers & winters are generally harsh to hold. The mean minimum and maximum temperature show wide range. A maximum temperature ranging 44-48 °C during summer and temperature plunging as low as to freezing point accompanied with chill frost in winter is a normal event. A large portion of the precipitation is received during the long periods of July to September and few showers during December to pre-summer. Soil of the study area was clay-loam and near neutral with average in organic carbon, low in available nitrogen, medium in available phosphorus and potassium. The field experiment was laid out in a randomized complete block design with ten treatments replicated thrice: T₁-Control, T₂-Recommended Dose Fertilizer (N:P:K-100:50:50), T₃-50% Recommended Dose Fertilizer, T₄-75% Recommended Dose Fertilizer, T₅-FYM @ 25 t/ha, T₆-50% Recommended Dose Fertilizer + FYM @ 25 t/ha, T₇-75% Recommended Dose Fertilizer + FYM @ 25 t/ha, T₈-Vermicompost @ 5 t/ha, T₉-50% Recommended Dose Fertilizer + Vermicompost @ 5 t/ha and T₁₀-75% Recommended Dose Fertilizer + Vermicompost @ 5 t/ha. The turmeric variety Punjab Haldi-1 was planted on 1st June, 2022 in 4.2 m x 3.0 m plot at a spacing of 60 cm x 15 cm. One-third of dose of nitrogen along with full doses of P₂O₅ and K₂O were applied at the time of planting. Remaining two-third of nitrogen was applied at an interval of one month. All other agronomic practices like earthing up, weeding (manual), etc., were done during the crop growth. The crop was harvested on

12th March, 2023 and data on primary and secondary rhizome were recorded.

Economic evaluation

- The cost of cultivation was calculated by adding all the expenditures incurred as per prevailing market rates.
- Gross returns were calculated by multiplying the economic yield with market price of turmeric.
- Net returns were worked out for each treatment after deducting the corresponding cost of cultivation from gross returns.
- Benefit-cost ratio was worked out by dividing net return with cost of cultivation.

Statistical analysis

The data generated were statistically analyzed following the technique of analysis of variance for randomized block design as suggested by Gomez and Gomez (1984) [3].

Results and Discussion

Number of mother, primary and secondary rhizomes per plant

The data on the number of mother rhizomes, number of primary rhizomes and number of secondary rhizomes per plant are presented in Table 1. Here number of mother rhizomes, number of primary rhizomes and number of secondary rhizomes revealed the significant difference among the treatments, as influenced by the different manures and fertilizer treatments. Application of 75% Recommended dose of fertilizer (RDF) + FYM @ 25 t/ha had resulted in significantly higher number of mother rhizomes (1.68). In case of number of primary and secondary rhizomes the maximum number of primary and secondary rhizomes was noted in T₁₀: 75% Recommended dose of fertilizer (RDF) + vermicompost @ 5 t/ha, i.e., 4.10 and 8.43 respectively. The minimum number of mother, primary and secondary rhizomes per plant was observed in T₁: Control i.e., 1.22, 3.04 and 6.11 respectively.

Table 1: Effect of integrated nutrient management on number of mother, primary and secondary rhizomes per plant

Treatment	Number of mother rhizomes per plant	Number of primary rhizomes per plant	Number of secondary rhizomes per plant
T ₁ : Control	1.22	3.04	6.11
T ₂ : Recommended dose of fertilizer (N:P:K-100:50:50)	1.34	4.00	7.61
T ₃ : 50% Recommended dose of fertilizer (RDF)	1.55	3.66	7.01
T ₄ : 75% Recommended dose of fertilizer (RDF)	1.34	3.86	7.22
T ₅ : FYM @ 25 t/ha	1.60	3.22	6.43
T ₆ : 50%Recommended dose of fertilizer (RDF) + FYM @ 25 t/ha	1.51	3.68	7.89
T ₇ : 75%Recommended dose of fertilizer (RDF) + FYM @ 25 t/ha	1.68	3.94	8.24
T ₈ : Vermicompost @ 5 t/ha	1.42	3.39	6.81
T ₉ : 50% Recommended dose of fertilizer (RDF) + vermicompost @ 5 t/ha	1.31	3.76	8.04
T ₁₀ : 75% Recommended dose of fertilizer (RDF) + vermicompost @ 5 t/ha	1.44	4.10	8.43
C.D.at 5% level of significance	0.11	0.30	0.61

Weight of mother, primary and secondary rhizomes per plant (g)

The integrated nutrient management influenced significantly the weight of the rhizomes per plant, such as weight of mother rhizomes, weight of primary rhizomes and weight of secondary rhizomes and are presented in Table 2.

The significantly superior weight of mother rhizomes, weight of primary rhizomes and weight of secondary rhizomes was reported in T₁₀: 75% recommended dose of

fertilizer (RDF) + vermicompost @ 5 t/ha, i.e., 70.12, 108.68 and 64.18, respectively and which was statistically at par with T₇: 75% recommended dose of fertilizer (RDF) + FYM @ 25 t/ha. The minimum weight of mother rhizomes, weight of primary rhizomes and weight of secondary rhizomes was noted in T₁: Control, i.e., 51.54, 80.33 and 41.14, respectively. These results are in conformity with Khalil *et al.* (2002) [6], Painkra *et al.* (2020) [11] and Bhat and Tandel (2023) [2].

Table 2: Effect of integrated nutrient management on weight of mother, primary and secondary rhizomes per plant

Treatment	Weight of mother rhizomes per plant (g)	Weight of primary rhizomes per plant (g)	Weight of secondary rhizomes per plant (g)
T ₁ : Control	51.54	80.33	41.14
T ₂ : Recommended dose of fertilizer (N:P:K-100:50:50)	63.4	93.88	53.16
T ₃ : 50% Recommended dose of fertilizer (RDF)	60.11	86.49	47.18
T ₄ : 75% Recommended dose of fertilizer (RDF)	60.98	90.41	49.43
T ₅ : FYM @ 25 t/ha	54.51	81.48	44.13
T ₆ : 50%Recommended dose of fertilizer (RDF) + FYM @ 25 t/ha	65.71	96.39	57.11
T ₇ : 75%Recommended dose of fertilizer (RDF) + FYM @ 25 t/ha	68.9	104.56	60.01
T ₈ : Vermicompost @ 5 t/ha	56.14	83.38	45.97
T ₉ : 50% Recommended dose of fertilizer (RDF) + vermicompost @ 5 t/ha	66.87	99.01	59.13
T ₁₀ : 75% Recommended dose of fertilizer (RDF) + vermicompost @ 5 t/ha	70.12	108.68	64.18
C.D.at 5% level of significance	5.13	7.74	4.41

Total yield

The data concerning to yield per hectare (q) have been demonstrated in table 3. The data on yield per hectare revealed that there was significant difference among treatments of integrated nutrient management.

Among the various treatments, the maximum yield per hectare was observed in T₁₀: 75% Recommended dose of fertilizer (RDF) + vermicompost @ 5 t/ha which was statistically at par with T₂: recommended dose of fertilizer (N:P:K-100:50:50) (175.93 q), T₆: 50% recommended dose

of fertilizer (RDF) + FYM @ 25 t/ha (164.29 q), T₇: 75% recommended dose of fertilizer (RDF) + FYM @ 25 t/ha (168.25 q) and T₉: 50% recommended dose of fertilizer (RDF) + vermicompost @ 5 t/ha. (178.31 q). The significantly lowest yield per hectare (135.71 q) was observed in T₁: Control. These results are supported with the investigations of Nirmalatha *et al.* (2010) ^[10], Tripathi *et al.* (2021) ^[15], Amala *et al.* (2022) ^[1], Khedkar *et al.* (2024) ^[16] and Kumar *et al.* (2024) ^[9].

Table 3: Effect of integrated nutrient management on yield of turmeric

Treatments	Yield(q/ha)
T ₁ : Control	135.71
T ₂ : Recommended dose of fertilizer (N:P:K-100:50:50)	175.93
T ₃ : 50% Recommended dose of fertilizer (RDF)	155.29
T ₄ : 75% Recommended dose of fertilizer (RDF)	162.70
T ₅ : FYM @ 25 t/ha	144.18
T ₆ : 50%Recommended dose of fertilizer (RDF) + FYM @ 25 t/ha	164.29
T ₇ : 75%Recommended dose of fertilizer (RDF) + FYM @ 25 t/ha	168.25
T ₈ : Vermicompost @ 5 t/ha	151.33
T ₉ : 50% Recommended dose of fertilizer (RDF) + vermicompost @ 5 t/ha	178.31
T ₁₀ : 75% Recommended dose of fertilizer (RDF) + vermicompost @ 5 t/ha	182.80
C.D.at 5% level of significance	19.30

Economics

The data concerning to economic analysis have been demonstrated in Table 4. The data revealed that the highest gross returns (Rs. 3,65,600) were registered in the T₁₀: 75% Recommended dose of fertilizer (RDF) + vermicompost @ 5 t/ha whereas the lowest gross return were observed in T₁: Control (Rs. 2,71,420). The maximum net returns (Rs

2,30,449) and highest B:C ratio (1.90) was observed in T₂: Recommended dose of fertilizer (N:P:K-100:50:50) whereas the lowest net return (Rs 1,52,620) and B:C ratio (1.28) was observed in T₅: FYM @ 25 t/ha. The outcomes of present study are similar to the results of Sarma *et al.* (2015) ^[12], Singh (2015) ^[14], Kumar *et al.* (2016) ^[8] and Khedkar *et al.* (2024) ^[16].

Table 4: Effect of integrated nutrient management on economics of turmeric

Treatments	Total cost (Rs.)	Gross returns (Rs.)	Net returns (Rs.)	B:C ratio
	(ha ⁻¹)			
T ₁ : Control	118800	271420	152620	1.28
T ₂ : Recommended dose of fertilizer (N:P:K-100:50:50)	121411	351860	230449	1.90
T ₃ : 50% Recommended dose of fertilizer (RDF)	120106	310580	190474	1.59
T ₄ : 75% Recommended dose of fertilizer (RDF)	120758	325400	204642	1.69
T ₅ : FYM @ 25 t/ha	128800	288360	159560	1.24
T ₆ : 50%Recommended dose of fertilizer (RDF) + FYM @ 25 t/ha	130106	328580	198474	1.53
T ₇ : 75%Recommended dose of fertilizer (RDF) + FYM @ 25 t/ha	130758	336500	205742	1.57
T ₈ : Vermicompost @ 5 t/ha	143800	302660	158860	1.10
T ₉ : 50% Recommended dose of fertilizer (RDF) + vermicompost @ 5 t/ha	145106	356620	211514	1.46
T ₁₀ : 75% Recommended dose of fertilizer (RDF) + vermicompost @ 5 t/ha	145758	365600	219842	1.51

Conclusion

On the basis of present experiment, it may be concluded that in turmeric crop integrated application of T₁₀: 75% Recommended dose of fertilizer (N:P:K-100:50:50) + vermicompost @ 5 t/ha (84.66%) gave highest yield (182.80 q/ha) with highest gross return (Rs. 3,65,600), whereas highest net income (Rs. 2,30,449) with B:C ratio (1.90) was observed in T₂: Recommended dose of fertilizer (N:P:K-100:50:50). Thus, it can be concluded that combined application of organic and inorganic nutrient sources not only boosts yield performance but also reduces dependency on chemical fertilizers and enhance gross return.

Conflict of Interest: The authors have no conflict of interest

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