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Drip fertigation and mulching regulate post-harvest soil nutrient dynamics in turmeric (*Curcuma longa* L.) cv. Pragati

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Abstract

A field experiment was conducted during the 2024 - season at Dr. YSRHU - College of Horticulture, Anantharajupeta, Andhra Pradesh, India, to evaluate the effect of fertigation levels and mulching practices on post-harvest soil available nitrogen (N), phosphorus (P₂O₅) and potassium (K₂O) in turmeric (*Curcuma longa* L.) cv. Pragati. The experiment consisted of 15 treatment combinations arranged in a split-plot design with three replications. Fertigation treatments included flood irrigation with 100% RDF, drip irrigation with 100% RDF through soil application, drip fertigation with 100% RDF, drip fertigation with 75% RDF and drip fertigation with 50% RDF, while mulching treatments comprised no mulch, silver-black polyethylene mulch and organic mulch. Post-harvest soil available N, P₂O₅ and K₂O were significantly influenced by fertigation and mulching. The highest residual nutrient contents were recorded under F₅ (drip fertigation + 50% RDF) with 234.73 kg ha⁻¹ N, 40.65 kg ha⁻¹ P₂O₅ and 220.53 kg ha⁻¹ K₂O, whereas the lowest values were observed under F₃ (drip fertigation + 100% RDF). Among mulches, no mulch recorded the highest residual nutrient status, while organic mulch recorded the lowest values. The study indicated that drip fertigation with 100% RDF enhanced nutrient uptake and utilization by turmeric, resulting in lower residual soil nutrient levels after harvest.

Keywords: Fertigation, mulching, post-harvest soil fertility, nutrient use efficiency, residual soil nutrients

Introduction

Turmeric (*Curcuma longa* L.), a perennial rhizomatous spice crop belonging to the family Zingiberaceae, is believed to have originated in Southeast Asia. It is a sterile triploid species (2n = 3x = 63) propagated through underground rhizomes and is popularly known as the “golden spice” owing to its culinary, medicinal, cosmetic and industrial importance. Turmeric (*Curcuma longa* L.) is an important spice crop of India and many other Asian countries. The rhizomes are widely used in traditional Indian systems of medicine (Ayurveda, Unani and Siddha), primarily due to the presence of curcumin, which possesses antioxidant, anti-inflammatory, antimicrobial, antiviral, hypoglycaemic and anticancer properties (Julie, 2009). Turmeric grows well in Andhra Pradesh, Maharashtra, Orissa, Tamil Nadu, Karnataka, Kerala and some parts of North East India including Assam. Turmeric is widely cultivated mainly for its rhizomes. It is used both as spice and as a raw material for dye making and cosmetic industries. Turmeric rhizome contains around 3% curcumin, 2.2% α -phellandrene, 1.5% terpinolene and other essential oils. These essential oils/alkaloids have very good medicinal properties (Khanna, 1999)^[4]. Curcumin, the primary pigment of turmeric, is generally used in various food industries as a food colourant. Turmeric is a long-duration and nutrient-exhaustive crop that requires a continuous supply of water and nutrients for sustained productivity (Syed *et al.*, 2010). Fertigation improves nutrient availability and minimizes nutrient losses, while mulching conserves soil moisture and enhances nutrient retention in the root zone (Jagadeeswaran *et al.*, 2004)^[2]. These practices influence not only crop growth and yield but also the residual soil fertility status. Therefore, assessment of post-harvest soil available nitrogen (N), phosphorus (P₂O₅) and potassium (K₂O) is important for understanding nutrient uptake, nutrient use efficiency and the sustainability of turmeric cultivation. Hence, the present study was undertaken to evaluate the effect of different fertigation levels and mulching practices on post-harvest soil available N, P₂O₅ and K₂O in turmeric.

Material and methods

A field experiment was conducted during 2024–25 at Dr. YSRHU–College of Horticulture, Anantharajupeta, Andhra Pradesh, India (13.98° N, 79.40° E). The experiment consisted of 15 treatment combinations arranged in a split-plot design with three replications to study the effect of fertigation levels and mulching practices on post-harvest soil available N, P₂O₅ and K₂O in turmeric (*Curcuma longa* L.) cv. Pragati. The main-plot treatments were F₁ – flood irrigation + 100% RDF through soil application, F₂ – drip irrigation + 100% RDF through soil application, F₃ – drip fertigation + 100% RDF, F₄ – drip fertigation + 75% RDF and F₅ – drip fertigation + 50% RDF. The sub-plot treatments were M₁ – no mulch, M₂ – silver-black polyethylene mulch and M₃ – organic mulch. Soil samples were collected before planting and after harvest (0–30 cm depth) and analyzed for available N, P₂O₅ and K₂O. The data were subjected to analysis of variance appropriate to a split-plot design.

Results

Available nitrogen (kg ha⁻¹)

Post-harvest soil available nitrogen was significantly influenced by fertigation levels and mulching practices. Among the fertigation treatments, F₅ (drip fertigation + 50% RDF) recorded the highest available nitrogen content (234.73 kg ha⁻¹), followed by F₁ (flood irrigation + 100% RDF through soil application) with 220.80 kg ha⁻¹. The lowest available nitrogen content was observed under F₃ (drip fertigation + 100% RDF) with 188.17 kg ha⁻¹. Among the mulching treatments, M₁ (no mulch) recorded the highest mean available nitrogen (213.72 kg ha⁻¹), whereas M₃ (organic mulch) recorded the lowest value (207.54 kg ha⁻¹). The

interaction between fertigation and mulching was non-significant. Numerically, the highest available nitrogen content (235.60 kg ha⁻¹) was recorded under F₅M₃, while the lowest value (183.10 kg ha⁻¹) was observed under F₃M₃.

Available phosphorus (P₂O₅) (kg ha⁻¹)

Post-harvest soil available phosphorus differed significantly among fertigation and mulching treatments. The highest available phosphorus content was recorded under F₅ (40.65 kg ha⁻¹), followed by F₁ (37.25 kg ha⁻¹), whereas the lowest value was observed under F₃ (27.43 kg ha⁻¹). Among the mulches, M₁ recorded the highest mean phosphorus content (35.12 kg ha⁻¹), followed by M₂ (34.50 kg ha⁻¹) and M₃ (33.22 kg ha⁻¹). The interaction effect was non-significant. The maximum phosphorus content (41.50 kg ha⁻¹) was observed under F₅M₁, while the minimum value (26.33 kg ha⁻¹) was recorded under F₃M₃.

Available potassium (K₂O) (kg ha⁻¹)

Significant variation in post-harvest soil available potassium was observed due to fertigation levels and mulching practices. The highest available potassium content was recorded under F₅ (220.53 kg ha⁻¹), followed by F₁ (199.05 kg ha⁻¹), while the lowest value was recorded under F₃ (164.65 kg ha⁻¹). Among the mulching treatments, M₁ recorded the highest mean potassium content (195.70 kg ha⁻¹), whereas M₃ recorded the lowest value (186.43 kg ha⁻¹). The interaction effect was non-significant. Numerically, the highest potassium content (223.14 kg ha⁻¹) was obtained under F₅M₁, while the lowest value (155.35 kg ha⁻¹) was recorded under F₃M₃.

Table 1: Initial soil available nitrogen (N), phosphorus (P₂O₅) and potassium (K₂O) status of the experimental field

Initial Soil N content (kg ha ⁻¹)	Initial Soil Phosphorus content (kg ha ⁻¹)	Initial Soil potassium content(kg ha ⁻¹)
192.7	34.0	205.6

Table 2: Post-harvest soil available N, P₂O₅ and K₂O as influenced by fertigation and mulching in turmeric cv. Pragati

Fertigati on doses	Mulches											
	Available Nitrogen				Available phosphorus				Available potassium			
	M ₁	M ₂	M ₃	Mean(M)	M ₁	M ₂	M ₃	Mean (M)	M ₁	M ₂	M ₃	Mean (M)
F ₁	224.10	219.30	219.00	220.80	37.90	37.46	36.40	37.25	202.10	200.85	194.20	199.05
F ₂	217.20	214.80	204.60	212.20	34.56	34.28	33.56	34.13	193.20	191.45	189.60	191.42
F ₃	191.20	190.20	183.10	188.17	28.45	27.50	26.33	27.43	174.00	164.60	155.35	164.65
F ₄	202.88	201.90	195.40	200.06	33.19	32.36	30.24	31.93	186.05	180.30	174.85	180.40
F ₅	233.20	235.40	235.60	234.73	41.50	40.90	39.57	40.65	223.14	220.31	218.15	220.53
Mean	213.72	212.32	207.54		35.12	34.50	33.22		195.70	191.50	186.43	
Factors	SE(m)		C.D.		SE(m)		C.D.		SE(m)		C.D.	
F	1.02		7.02		1.52		5.04		1.84		6.09	
M	1.25		3.25		1.43		4.24		1.53		4.54	
M x F	1.77		NS		2.64		NS		3.19		NS	
F x M	2.50		NS		3.02		NS		3.34		NS	

Main plots: Fertigation doses (5)

F₁ - Flood irrigation +100% Recommended dose of NPK through soil application
 F₂ - Drip irrigation + 100% Recommended dose of NPK through soil application
 F₃ - Drip irrigation + 100 % Recommended dose of NPK through fertigation
 F₄ - Drip irrigation + 75 % Recommended dose of NPK through fertigation
 F₅ - Drip irrigation + 50 % recommended dose of NPK through fertigation

Subplots: Mulches (3)

M₁ - No mulch
 M₂ - Silver black mulch (25microns)
 M₃ - Organic mulch

Discussion

Post-harvest soil available N, P₂O₅ and K₂O were significantly influenced by fertigation levels and mulching practices. The lower residual nutrient status observed under F₃ (drip fertigation + 100% RDF) indicates greater nutrient uptake by turmeric under optimum fertigation. Similar findings were reported by Krishnamoorthy *et al.* (2012) [5], who observed reduced post-

harvest soil available N, P and K under 100% fertigation with water-soluble fertilizers due to enhanced nutrient uptake and higher rhizome yield. Among the mulching treatments, M₃ (organic mulch) recorded lower residual N, P₂O₅ and K₂O than M₁ and M₂, suggesting greater nutrient utilization by the crop under improved soil moisture and rhizosphere conditions. Enhanced nutrient uptake and crop performance under organic mulch in

turmeric were also reported by Manhas *et al.* (2011)^[6]. Similarly, Anshuman *et al.* (2021)^[1] observed significant changes in soil available N, P and K under mulched turmeric plots. The similar trend observed for N, P₂O₅ and K₂O across fertigation treatments suggests a uniform response of soil nutrients to moisture and nutrient management. Comparable parallel responses of soil N, P and K under fertigation were reported by Krishnamoorthy *et al.* (2012)^[5].

Conclusion

Fertigation with 100% RDF (F₃) enhanced nutrient uptake and utilization in turmeric cv. Pragati, resulting in lower post-harvest soil available N, P₂O₅ and K₂O. Organic mulch further improved nutrient utilization, indicating better nutrient use efficiency and sustainability of turmeric cultivation under fertigation and mulching practices.

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