



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
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NAAS Rating (2026): 5.20
www.agronomyjournals.com
2026; 9(9): 324-329
Received: 11-06-2026
Accepted: 18-07-2026

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Influence of slow release fertilizer on leaf nutrient uptake and soil properties of turmeric

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DOI: <https://www.doi.org/10.33545/2618060X.2026.v9.i9e.6516>

Abstract

A field experiment was conducted during kharif 2025–26 at the farm of the Department of Vegetable Science, Dr. Panjabrao Deshmukh Krishi Vidhyapeeth, Akola, Maharashtra, to study the influence of slow-release fertilizer on leaf nutrient content and soil properties in at harvest of turmeric (*Curcuma longa* L.). The variety of turmeric is PDKV Waigaon. The experiment was laid out in a randomized block design with seven treatments and three replications, including 100% RDF + FYM @ 20 t ha⁻¹ and 75% NPK with 5, 15 and 25% N through slow-release fertilizer (SRF). The results revealed that 100% RDF + FYM @ 20 t ha⁻¹ (T₄) recorded the significantly highest N, P, K and S contents and uptake in turmeric leaves at 80 DAP, 140 DAP and harvest, and was statistically at par with 75% NPK + 25% N through SRF. Post-harvest soil an improvement and reduction in pH, while soil organic carbon increased from 5.37 g kg⁻¹ in the control to 6.36 g kg⁻¹ under T₄. Available N, P, K and S were also improved by integrated nutrient management, with the highest overall availability under 100% RDF + FYM @ 20 t ha⁻¹. Among the SRF treatments, 75% NPK + 25% N through SRF (T₇) consistently performed better than 75% NPK + 5% N through SRF and 75% NPK + 15% N through SRF in maintaining leaf nutrient content and soil nutrient availability. Overall, 100% RDF + FYM @ 20 t ha⁻¹ was the most effective treatment, while 75% NPK + 25% N through SRF showed considerable potential as an SRF-based nutrient management practice for improving turmeric nutrition and soil fertility.

Keywords: SRF, Biochar, FYM, Turmeric, Leaf nutrient content & uptake, Soil fertility, leaves dry matter yield

Introduction

India is popularly known as the “Spice Bowl of the World” and “Home of Spices” because of its wide diversity and long history of spice cultivation. Among the important spices, turmeric (*Curcuma longa* L.) has special economic, cultural and medicinal importance and is popularly known as the “Golden Spice.” Turmeric is known as the “Ayurvedic Treasure”, “Golden Spice of Life” and “Nature’s Precious Gift” due to its multiple applications. It is widely used in traditional medicine, pharmaceutical formulations, cosmetic products, food processing, dye manufacture and numerous other industrial applications. The dried rhizomes generally contain 4-8 per cent of curcumin and are rich in valuable mineral nutrients such as iron, phosphorus, calcium and potassium and thus have a good nutritional value. Its characteristic yellow colour is mainly due to curcumin, the principal bioactive compound responsible for many of its biological and pharmacological properties. Turmeric is widely used in Indian cooking, traditional medicine, pharmaceutical and cosmetic products, food processing, natural colouring and religious and cultural practices. India is the world’s largest producer, consumer and exporter of turmeric, which speaks volumes about the country’s dominance in the global spice industry. During 2025-26 the country exported around 1.51 lakh tonnes of turmeric. Maharashtra had the largest area under cultivation with 0.87 lakh hectares (2.15 lakh acres) among the turmeric-growing states, followed by Odisha (0.34 lakh ha), Tamil Nadu (0.27 lakh ha), Madhya Pradesh (0.26 lakh ha), Andhra Pradesh (0.22 lakh ha) and West Bengal (0.19 lakh ha).

Slow release fertilizer prepared using biochar and urea may therefore improve the synchronisation between nitrogen supply and crop demand, resulting in better nutrient uptake and fertilizer-use efficiency. Previous studies have shown that biochar-based nitrogen fertilizers can reduce nitrogen losses, increase nitrogen retention in soil and improve crop performance compared with conventional urea.

In turmeric, nutrient management practices have also been found to influence soil available nutrients and rhizome yield, while the addition of organic sources can help maintain soil fertility. However, limited information is available on the use of biochar-urea slow-release fertilizer in turmeric, particularly its combined effect on rhizome yield and soil properties. Hence, the present study was undertaken to assess the effect of biochar-based slow-release urea fertilizer on turmeric yield and important soil properties after harvest.

Integrated application of organic and inorganic nutrient sources has been reported to improve nutrient availability, crop growth and productivity in turmeric. Studies have also shown that appropriate fertilizer and organic manure combinations can improve soil organic carbon, available N, P, K and S along with turmeric rhizome yield. Slow-release fertilisers (SRFs) are of great importance in crop nutrition due to their ability to supply nutrients slowly, at rates more closely matching plant uptake and requirements (An *et al.*, 2020) [2]. The release of nutrients from coated fertilisers generally occurs in three consecutive phases, which include permeation of water thru the coating, dissolution of fertiliser within the coated structure, and subsequent diffusion of dissolved nutrients thru the coating into the surrounding soil (Ye *et al.*, 2019) [17]. Different formulations of SRFs have been developed with polymer-based materials to control nutrient availability for a longer time (Guo *et al.*, 2005) [7].

In recent years, biochar has emerged as a carbon source and an amendment, along with chemical fertilizers and hold a promise in improving the yield of crops without causing hazards to soil and the environment. Biochar, which is produced by the process of pyrolysis, is the thermal decomposition of organic compounds at a temperature range of 300-800° C under limited or no supply of oxygen. The use of biochar in agriculture can be a modern agro-technology that can help in reducing greenhouse gas emissions, enhancing soil carbon sequestration, and ultimately increasing crop yield. Agricultural and forestry residues are a potential source of biomass to soil, but these residues undergo faster decomposition and will adversely affect soil organic carbon stores and soil fertility. Slow release fertilisers are produced in several forms, including coated fertilisers such as sulphur-coated and gypsum-coated products and chemically modified fertilisers such as urea-form and polyform compounds that are intended to release one or more nutrients slowly over time. More recently, Fertilisers and Chemicals Travancore Limited (FACT), Kochi, India, have developed slow-release fertiliser formulations such as tablets, fertiliser mixtures and tar-coated ammonium phosphate containing the three major plant nutrients. These fertiliser sources have been evaluated for their usefulness in improving nutrient management. Turmeric, being a long-duration crop, requires heavy nutrients throughout the growth period and hence continuous and balanced supply of nutrients is necessary for sustaining optimum growth and realising higher yields. The slow-release fertilisers provide nutrients gradually, which is more in line with the demand of the crops, thus improving the fertiliser use efficiency and reducing the loss of nutrients. Turmeric is an important commercial crop, but little research has been done on the use of slow-release fertilisers in turmeric. Therefore, a systematic evaluation of these fertiliser sources is needed to determine their efficacy in improving nutrient uptake, crop productivity and sustainable turmeric cultivation.

Materials and Methods

The field experiment was conducted during kharif 2025-26 at the farm of the Department of Vegetable Science, Dr. Panjabrao Deshmukh Krishi Vidhyapeeth, Akola, Maharashtra, India. Geographically, the region is located at 20°42' 01.13" North and 77°03' 47.93" East, at an elevation of 307.8 meters above Mean Sea Level (MSL). It has a semi-arid climate with three well-

defined seasons. These are a hot, dry summer from March to May, a warm, rainy monsoon from June to October, and a mild, cold winter from November to February. The average annual precipitation is 711.1 mm. The soil of the experimental site was deep, clayey black soil. The soil pH was moderately alkaline (8.05), non-saline (0.33 dS m⁻¹), medium in organic carbon (5.41 g kg⁻¹), available nitrogen was low (175.20 kg ha⁻¹), very low in available phosphorus (15.69 kg ha⁻¹), moderately high in available potassium (295.90 kg ha⁻¹). Moderately in available Sulphur (11.06 mg ha⁻¹). The experiment was laid out in a Randomized Block Design (RBD) with seven treatments and three replications. Twenty-one plots. Seven treatments are Absolute control (T₁), 75%RDF (T₂), 100%RDF (T₃), 100% RDF + FYM @ 20 t ha⁻¹ (T₄), 75%NPK + 5% N through SRF (T₅), 75%NPK + 15% N through SRF (T₆), And 75%NPK + 25% N through SRF (T₇). The variety of turmeric PDKV waigaon was rhizome planted at a 25-q ha⁻¹ planting by the Dibbling (Small rhizomes) method at a spacing of 30 x 30 x 90cm (Two row system). Plot Gross size - 4.80 x 3.90 m and Net size - 4.20 x 3.30 m, respectively. The recommended dose of fertilizer (RDF) for turmeric was 200:100:100 kg N, P₂O₅, and K₂O per hectare (ha⁻¹). The doses of N, P, and K, as per treatments, was applied basally at sowing; 50% P and K at rhizome planting, 50% N, P and K at 30-35 Day after planting (DAP). 25% N at 60 DAP. Remaining 25% N at 90 DAP. And Slow release fertilizer application 50% SRF at the time of rhizome planting, Remaining 50% at the time of 60 DAP. FYM (on an oven-dry-weight basis) was applied before sowing.

At harvest, turmeric fresh rhizome yields were recorded plot-wise and expressed as q/ha. Various soil parameters were analysed using the methods and the results were used for field application. pH and EC were determined using pH and conductivity meter as described by Jackson (1973) [8], Organic carbon was determined by wet oxidation method (Walkley and black, 1934). Available Nitrogen was determined by the alkaline permanganate method (Subbiah and Asija, 1956) [15]. Available Phosphorus was determined by Olsen's method using 0.5 M sodium bicarbonate as an extractant using UV based double beam spectrophotometer (Watanabe and Olsen, 1965) [16]. Available Sulphur was determined by Turbidimetric method using a flame photometer (Chesnin and Yien, 1950) [3]. The neutral normal ammonium acetate method was used to measure available Potassium using a flame photometer (Jackson 1973) [8]. The recorded data on yield and soil properties were statistically analysed using analysis of variance (ANOVA) for a Randomized Block Design, as described by Gomez and Gomez (1984) [6]. Treatment means were compared using the critical difference (CD) at the 5 per cent level of significance.

Results

The result shows that the slow release fertilizer effect on nutrient content in leaves at different growth stages and soil properties after harvesting of turmeric.

Leaves Dry Matter Yield of Turmeric at Various Days

The data indicate that the application of various slow release fertilizer treatments significantly affected the dry matter production of turmeric leaves at different stages of crop growth. These results are presented in Table 01.

Dry matter accumulation in turmeric leaves increased from 80 to 140 DAP and declined at harvest, indicating maximum vegetative growth during the active growth period. At 80 DAP, the highest leaves dry matter was recorded under 100% RDF + FYM @ 20 t ha⁻¹ at 8.28 q ha⁻¹, which was statistically at par with 75% NPK + 25% N through SRF at 8.19 q ha⁻¹. At 140 DAP, 100% RDF + FYM @ 20 t ha⁻¹ recorded the highest leaf dry matter (20.93 q ha⁻¹), comparable with 75% NPK + 25% N through SRF (20.25 q ha⁻¹), whereas the lowest values were observed under the absolute

control. 100% RDF + FYM @ 20 t ha⁻¹ increased leaf dry matter by 51.65% at 80 DAP and 58.56% at 140 DAP over the control. Among SRF treatments, leaf dry matter progressively increased with increasing proportion of N supplied through SRF. The improved biomass accumulation may be attributed to better nutrient availability from gradual nutrient release, supporting sustained vegetative growth. The application of organic manures significantly improved the dry biomass of turmeric compared with the control (Kamal and Yousuf 2012) [10]. However, slow-

release NPK tablets improved shoot dry matter production of turmeric compared with several other fertilizer sources (Jagadeeswaran *et al.* 2005) [9]. The nitrogen fertilization enhanced dry biomass accumulation compared with the control throughout crop growth. biochar- embedded slow- release N fertilizers gave higher biomass of turmeric at later stages due to sustained N availability and improved N uptake (Liao *et al.* 2020) [11].

Table 1: Effect of slow release fertilizer on leaves yield of turmeric at various days (q ha⁻¹)

Treatments	Leaves dry matter yield (q ha ⁻¹)	
	80 DAP	140 DAP
T ₁ - Absolute control	5.46	13.20
T ₂ - 75% RDF	6.65	14.53
T ₃ - 100% RDF	7.85	17.68
T ₄ - 100% RDF+FYM @ 20 t ha ⁻¹	8.28	20.93
T ₅ - 75% NPK + 5% N through SRF	6.92	16.67
T ₆ - 75% NPK + 15% N through SRF	7.55	18.60
T ₇ - 75% NPK + 25% N through SRF	8.19	20.25
SE(m) ±	0.51	0.36
CD at 5%	1.49	1.06

Nutrient content (NPKS)

Content and uptake of N, P, K, S in leaves of turmeric at 80 DAP

The nutrient content in turmeric leaves at 80 DAP was influenced by the different nutrient management treatments. The considerably highest concentrations of N (1.05%), P (0.423%), K (1.097%) and S (0.380%) in turmeric leaves recorded with 100% RDF + FYM @ 20 t ha⁻¹, which was statistically at par in application 75% NPK + 25% N through SRF while the lowest values were observed under absolute control. The integrated application of RDF along with FYM resulted in better nutrient

concentration in leaves, probably due to improved nutrient availability and uptake by the crop. Among the slow-release fertilizer treatments, nutrient concentration generally increased with increasing N contribution through SRF, with 75% NPK + 25% N through SRF recording higher N, P, K and S contents than 75%NPK + 15% N and 75%NPK + 5% N through SRF. The results indicate that integrated nutrient application through RDF, FYM and slow-release fertilizer improved the nutritional status of turmeric leaves compared with the unfertilized control. These results are presented in fig. 01.

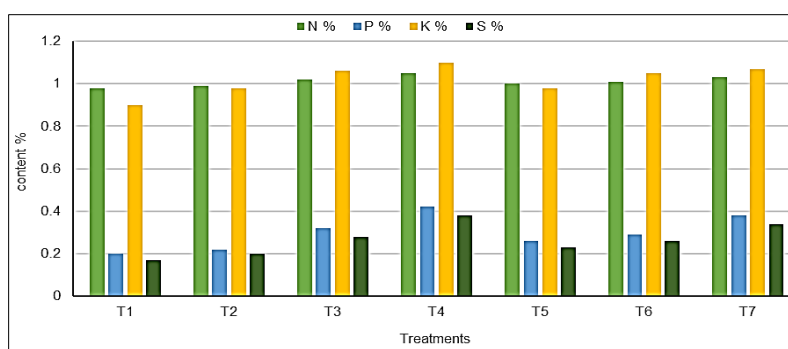


Fig 1: Effect of slow release fertilizer on content of N, P, K, S in leaves of turmeric at 80 DAP

Same as the highest uptake by leaves of turmeric was recorded under 100% RDF + FYM @ 20 t ha⁻¹ (100% RDF + FYM @ 20 t ha⁻¹). N uptake ranged from 5.34 to 8.69 kg ha⁻¹, while P, K and S uptake ranged from 1.11-3.52, 4.92-9.08 and 0.95-3.15 kg ha⁻¹, respectively. 100% RDF + FYM @ 20 t ha⁻¹ recorded the highest N (8.69), P (3.52), K (9.08) and S (3.15 kg ha⁻¹) uptake and remained statistically at par with 75% NPK + 25% N through SRF. The improved uptake under 100% RDF + FYM @ 20 t ha⁻¹

may be attributed to better nutrient availability and greater leaf biomass, whereas the progressive response under SRF treatments indicates improved nutrient utilization with increasing SRF-N contribution. The absolute control recorded the lowest uptake of all nutrients, confirming the positive response of nutrient application on turmeric leaf nutrient uptake. These results are presented in Table 02.

Table 2: Effect of slow release fertilizer on uptake of N, P, K, S in leaves of turmeric at 80 DAP

Treatments	Leaves nutrient uptake			
	N	P	K	S
	(kg ha ⁻¹)			
T ₁ - Absolute control	5.34	1.11	4.92	0.95
T ₂ - 75% RDF	6.59	1.48	6.54	1.30
T ₃ - 100% RDF	7.99	2.53	8.28	2.32

T ₄ - 100% RDF+FYM @ 20 t ha ⁻¹	8.69	3.52	9.08	3.15
T ₅ - 75% NPK + 5% N through SRF	6.90	1.77	6.83	1.59
T ₆ - 75% NPK + 15% N through SRF	7.61	2.17	7.91	2.00
T ₇ - 75% NPK + 25% N through SRF	8.44	3.14	8.79	2.77
S.E.m. ±	0.54	0.18	0.54	0.17
CD at 5%	1.59	0.53	1.59	0.51

Content and uptake of N, P, K, S in leaves of turmeric at 140 DAP

At 140 DAP, nutrient management treatments resulted in noticeable differences in the concentration of N, P, K and S in turmeric leaves. The significantly highest contents of N (1.080%), P (0.397%), K (1.120%) and S (0.247%) were recorded under 100% RDF + FYM @ 20 t ha⁻¹, which was statistically on par with 75% NPK + 25% N through SRF and found better over rest of treatments and absolute control. Whereas the lowest values were observed under absolute control. The combined application

of RDF and FYM appeared to maintain a better nutrient supply to the crop, resulting in higher nutrient concentration in the leaves. Among the SRF treatments, nutrient content showed a gradual increase as the proportion of N supplied through SRF increased, with 75% NPK + 25% N through SRF consistently recording higher N, P, K and S contents than 75%NPK + 5% N through SRF and 75%NPK + 15% N through SRF. Overall, the results suggest that integrated nutrient management through RDF, FYM and SRF improved the nutrient status of turmeric leaves compared with the unfertilized control. These results are presented in fig. 02

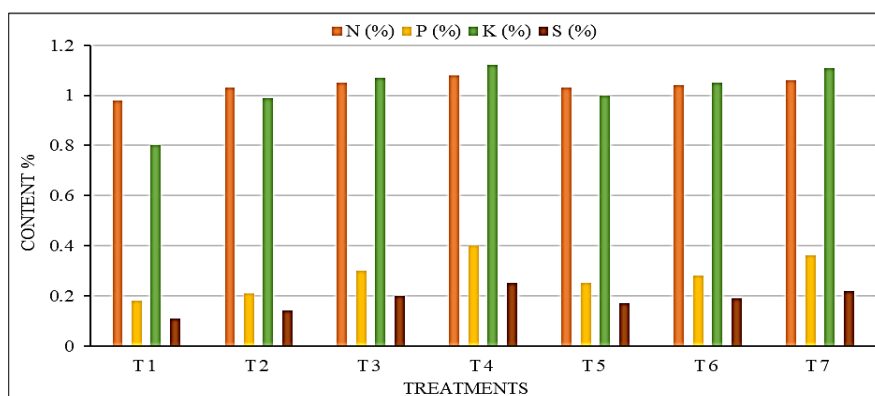


Fig 2: Effect of slow release fertilizer on content of N, P, K, S in leaves of turmeric at 140 DAP

N, P, K and S uptake by turmeric leaves at 140 DAP was markedly influenced by nutrient application, with 100% RDF + FYM @ 20 t ha⁻¹ recording the highest uptake of all nutrients. N uptake ranged from 12.92-22.58 kg ha⁻¹, P from 2.39-8.32 kg ha⁻¹, K from 10.62-23.43 kg ha⁻¹ and S from 1.40-5.17 kg ha⁻¹. 100% RDF + FYM @ 20 t ha⁻¹ recorded the highest N (22.58), P (8.32), K (23.43) and S (5.17 kg ha⁻¹) uptake, which was statistically at par with 75% NPK + 25% N through SRF. The absolute control recorded the lowest uptake of all nutrients, indicating the beneficial effect of nutrient application on leaf nutrient

accumulation. Among the SRF treatments, uptake increased with increasing SRF-N proportion, with 75% NPK + 25% N through SRF showing better nutrient uptake than 75% NPK + 15% N through SRF and 75% NPK + 5%N through SRF. The higher uptake under 100% RDF + FYM @ 20 t ha⁻¹ may be attributed to improved nutrient availability and greater leaf biomass, while the response under SRF treatments indicates improved nutrient utilization with increasing SRF-N contribution. These results are presented in Table 03.

Table 3: Effect of slow release fertilizer on uptake of N, P, K, S in leaves of turmeric at 140 DAP

Treatments	Leaves nutrient uptake			
	N	P	K	S
	(kg ha ⁻¹)			
T ₁ - Absolute control	12.92	2.39	10.62	1.40
T ₂ - 75% RDF	14.97	3.00	14.42	1.99
T ₃ - 100% RDF	18.62	5.36	18.98	3.47
T ₄ - 100% RDF + FYM @ 20 t ha ⁻¹	22.58	8.32	23.43	5.17
T ₅ - 75% NPK + 5%N through SRF	17.21	4.21	16.60	2.77
T ₆ - 75% NPK + 15% N through SRF	19.41	5.20	19.53	3.55
T ₇ - 75% NPK + 25% N through SRF	21.54	7.23	22.42	4.40
S.E.m. ±	0.35	0.30	0.46	0.26
CD at 5%	1.02	0.87	1.37	0.77

Content and uptake of N, P, K, S in leaves of turmeric at harvest

At harvest, the concentration of major nutrients in turmeric leaves varied considerably among the nutrient management treatments. Nitrogen content in turmeric leaves was highest in application 100% RDF + FYM @ 20 t ha⁻¹, reaching 1.082%, which was statistically at par 75% NPK + 25% N through SRF while the

lowest value of 0.993% was recorded under absolute control, indicating the beneficial effect of nutrient application on N accumulation. A similar response was observed for phosphorus, with leaf P content ranging from 0.173 to 0.380%, the significantly higher recorded in 100% RDF + FYM @ 20 t ha⁻¹ and the lowest in absolute control. Potassium concentration also responded positively to nutrient management and varied from

0.793 to 1.113%, with better values under the fertilized treatments. Sulphur content followed the same general pattern, ranging from 0.100 to 0.230%, with the higher concentration associated with the nutrient-supplied treatments. Overall, the results showed that integrated nutrient management, particularly the combination of 100% RDF + FYM @ 20 t ha⁻¹, maintained higher nutrient concentrations in turmeric leaves at harvest than the absolute control. In FYM-based nutrient management that

nitrogen, phosphorus and potassium contents in leaves and rhizomes improved with farmyard manure application (Gill *et al.*, 2004) [5]. The combining inorganic fertilizers with FYM improved nutrient availability, nutrient assimilation, crop yield and quality compared with fertilizer application alone (Aiholli *et al.*, 2025). The sulphur uptake by sweet corn increased significantly with the combined application of compost and biochar (Sofyan and Sara, 2026) [14].

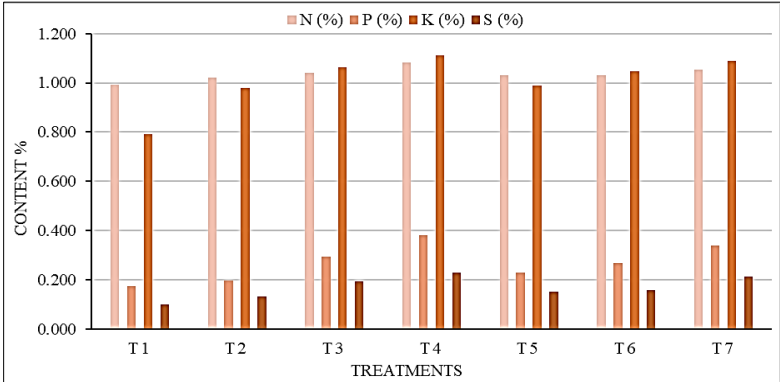


Fig 3: Effect of slow release fertilizer on content of N, P, K, S in leaves of turmeric at harvest

At the time of harvest of turmeric N, P, K and S uptake by leaves was markedly influenced by the different nutrient treatments. Nitrogen uptake ranged from 9.50 to 15.16 kg ha⁻¹, with the highest value recorded under 100% RDF + FYM @ 20 t ha⁻¹ (15.16 kg ha⁻¹), which was statistically similar to 75% NPK + 25% N through SRF (15.08 kg ha⁻¹). Same as P uptake ranged from 1.66 to 5.34 kg ha⁻¹, while K uptake varied from 7.61 to 15.64 kg ha⁻¹, with the highest values recorded under 100% RDF + FYM @ 20 t ha⁻¹ and comparable values under 75% NPK + 25% N through SRF. Sulphur uptake ranged from 0.96 to 3.23 kg ha⁻¹, with 100% RDF + FYM @ 20 t ha⁻¹ recording the maximum (3.23 kg ha⁻¹), statistically similar to 75% NPK + 25% N through SRF (2.96 kg ha⁻¹). The absolute control recorded the lowest uptake of N, P, K and S. Overall, increasing N contribution through SRF improved nutrient uptake by turmeric leaves, with 75% NPK + 25% N through SRF showing a response comparable to the highest treatment. These results are presented in Table 04.

Table 4: Effect of slow release fertilizer on uptake of N, P, K, S in leaves of turmeric at harvest

Treatments	Leaves nutrient uptake			
	N	P	K	S
	(kg ha ⁻¹)			
T ₁ - Absolute control	9.50	1.66	7.61	0.96
T ₂ - 75% RDF	11.85	2.32	11.56	1.53
T ₃ - 100% RDF	12.77	3.61	13.11	2.38
T ₄ - 100% RDF +FYM @ 20 t ha ⁻¹	15.16	5.34	15.64	3.23
T ₅ - 75% NPK + 5%N through SRF	13.36	2.99	12.87	1.95
T ₆ - 75% NPK + 15% N through SRF	13.84	3.60	14.13	2.11
T ₇ - 75% NPK + 25% N through SRF	15.08	4.69	15.12	2.96
S.Em. ±	0.28	0.23	0.28	0.18
CD at 5%	0.83	0.66	0.81	0.52

Soil properties

Post-harvest soil properties responded differently to the nutrient management treatments. the application of RDF, FYM, slow release fertilizer resulted in a slight decrease in soil pH. Soil pH remained within a narrow range of 7.90-8.03 and the treatment differences were non-significant, with the highest value under absolute control and the lowest under 100% RDF + FYM @ 20 t

ha⁻¹, indicating only a slight shift in soil reaction following nutrient application. Soil EC varied from 0.30 to 0.36 dS m⁻¹, with comparatively higher values under the SRF treatments, particularly 75% NPK + 15% N through SRF and 75% NPK + 25% N through SRF, while the control recorded a lower EC. In contrast, soil organic carbon showed a clear improvement with nutrient management, increasing from 5.37 g kg⁻¹ under absolute control to 6.36 g kg⁻¹ under. The SRF treatments also maintained higher organic carbon, reaching 6.16 and 6.10 g kg⁻¹ under 75%NPK + 25% N through SRF and 75%NPK + 15% N through SRF, respectively. The improvement in organic carbon under 100% RDF + FYM @ 20 t ha⁻¹ was mainly associated with the addition of FYM, whereas the higher values under SRF treatments may have resulted from greater biomass production and subsequent incorporation of crop residues. Overall, FYM-based integrated nutrient management was more effective in improving soil organic carbon, while soil pH remained relatively stable after harvest. The combined use of FYM and biochar showed the greatest reduction in soil pH, while organic amendments with the untreated soil (Dotaniya *et al.*, 2024) [4]. biochar generally increases soil electrical conductivity because it contains soluble mineral constituents released after application. (Pandian *et al.*,2024) [12]. The influence of biochar, farmyard manure (FYM), and press mud on the chemical properties of saline soil. The improvement was attributed to enhanced organic carbon content and better nutrient dynamics within the soil (Dotaniya *et al.*, 2024) [4]. Soil nutrient status was improved by the different nutrient management practices, with 100% RDF + FYM @ 20 t ha⁻¹ generally recording the highest availability of N, P, K and S. Available N increased from 173.11 kg ha⁻¹ under absolute control to 206.56 kg ha⁻¹ under 100% RDF + FYM @ 20 t ha⁻¹. A similar pattern was observed for available K, which ranged from 293.61 kg ha⁻¹ in absolute control to 352.03 kg ha⁻¹ in 100% RDF + FYM @ 20 t ha⁻¹, with 75% NPK + 25% N through SRF (333.75) and 75% NPK + 15% N through SRF (320.57 kg ha⁻¹) occupying the next positions. Available P ranged from 16.12 to 20.85 kg ha⁻¹, with the higher under 100% RDF + FYM @ 20 t ha⁻¹, followed by 75% NPK + 15% N through SRF, 100% RDF, 75% NPK + 5% N through SRF, 75% RDF and absolute control; however, the value reported for 75% NPK + 25% N through SRF (14.67 kg ha⁻¹) is lower than the stated range and should be checked against

the original table before publication. Available S showed the widest treatment response, increasing from 11.27 mg ha⁻¹ under absolute control to 28.41 mg ha⁻¹ under 100% RDF + FYM @ 20 t ha⁻¹. The improvement in available nutrients under 100% RDF + FYM @ 20 t ha⁻¹ may be related to the combined contribution of inorganic fertilizers and FYM, while the relatively higher nutrient availability under 75% NPK + 15% N through SRF and 75% NPK + 25% N through SRF suggests that the gradual nutrient release from SRF helped sustain nutrient supply in the soil. Overall, integrated application of 100% RDF + FYM @ 20 t ha⁻¹ was most effective in improving post-harvest soil nutrient

availability, with higher SRF-N treatments also showing a favourable response over the absolute control. The application of NPK fertilizers based on STCR along with FYM @ 5 t ha⁻¹ resulted in higher soil organic carbon and available N, P, K and S compared with conventional fertilization practices (Shubham and Dixit, 2020) ^[13]. The enriched biochar combined with recommended fertilizer dose and farmyard manure improved nutrient availability and synchronized nutrient release, resulting in better vegetative growth of turmeric (Amulya *et al.*, 2025) ^[1].

Table 5: Effect of slow release fertilizer on available nutrients of soil at harvest of turmeric

Treatments	Available nutrients			
	N	P	K	S
	(kg ha ⁻¹)			(mg kg ⁻¹)
T ₁ - Absolute control	173.11	16.12	293.61	11.27
T ₂ - 75% RDF	176.04	17.78	301.94	15.05
T ₃ - 100% RDF	180.21	20.53	312.70	20.51
T ₄ - 100% RDF + FYM @ 20 t ha ⁻¹	206.56	25.85	352.03	28.41
T ₅ - 75% NPK + 5% N through SRF	179.24	18.53	308.65	18.82
T ₆ - 75% NPK + 15% N through SRF	196.52	21.61	320.57	19.88
T ₇ - 75% NPK + 25% N through SRF	202.79	24.67	333.75	24.84
SE(m) ±	9.05	2.26	12.65	1.32
CD at 5%	26.71	6.68	37.33	3.88

Conclusion

It can be concluded that, the application of 100 % RDF + FYM @ 20 t ha⁻¹ and slow release fertiliser containing 75 % NPK + 25 % N through SRF showed mutually benefited for substantially higher N, P, K and S content and uptake at 80 DAP, 140 DAP and at harvest in leaves of turmeric with improving soil fertility status.

Acknowledgments

The authors acknowledge the Department of Soil Science, Dr. Panjabrao Deshmukh Krishi Vidhyapeeth, Akola, Maharashtra, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh. Indian Council of Agriculture Research (ICAR).

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