

Original Research Article

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Effect of Nutrient Sources and Mulching on Growth, Yield and Quality of Turmeric (*Curcuma longa* L.) under Partially Reclaimed Sodic Soil

B. R. Pandey*, A. Kumar and A. K. Pandey

Department of Soil science and Agricultural Chemistry, ANDUAT, Kumarganj,
Ayodhya, U.P-224229, India

*Corresponding author

ABSTRACT

A field experiment was conducted at the experimental site of Agronomy Research Farm of A.N.D. University of Agriculture and Technology, Kumarganj, Ayodhya, U.P., to evaluate the effect of different nutrient sources and mulching on vegetative growth, rhizome yield and quality of turmeric. The experiment consists of 12 treatments which were laid out in randomized block design with three replications. Results revealed that the application of paddy straw mulch @10t/ha significantly improved plant height, number of leaves and number of tillers. The data revealed that fresh rhizome yield increased significantly with mulch and sulphur combined application along with recommended dose of N, which was 18.7% and 18.6% higher over no mulch during 2017-18 and 2018-19, respectively. Upon analyzing the effect of different nutrient sources individually, it was observed that application of organic N sources in the form of FYM (T₂) and Vermicompost (T₃) resulted in significantly higher fresh rhizome yields during both seasons, 2017-18 (21.9 t/ha and 21.6 t/ha respectively) and 2018-19 (24.3 t/ha and 23.4 t/ha respectively). Curcumin content was significantly higher in the treatments receiving nutrients through organic sources as compared to inorganic nutrient sources. Hence, application of paddy straw mulch has beneficial effect on growth and yield of turmeric irrespective on nutrient sources. However quality parameter in terms of curcumin content showed positive response of organic sources over inorganic fertilizers but has no significant effect with the application of mulch.

Keywords

Farm yard manure,
Fresh rhizome
yield, Mulching,
Organic sources,
turmeric, Quality

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Introduction

Turmeric is a herbaceous, perennial plant which belongs to the family Zingiberaceae. It is an ancient, most prized and sacred spice of India. The global production of turmeric is approximately 11 lakh tonnes per annum. India rules the annual global production scenario of turmeric, contributing 78 %

followed by China (8%) and Myanmar (4%). In India, turmeric is cultivated under 2, 37, 960 hectare area with the production of 11, 32, 720 MT (NHB database, 2017-18). Turmeric has been in use from ancient times as a spice, food preservative, colouring agent, cosmetic, and as a component in religious ceremonies.

Turmeric can grow well in a variety of soils provided with better irrigation and drainage facilities. Turmeric is a long duration crop which extracts a lot of nutrients from the soil. It is, therefore necessary to replenish the soil with balanced fertilization for obtaining higher yield. Balanced fertilization implies improvement in the supply of nutrients while maintaining or improving the fertility of the soil through the use of all essential nutrients added to soil either through organic or inorganic sources to obtain higher yield and maintaining the fertility of the soil. The concept of balanced fertilization cannot be confined only to the N, P and K levels. Balanced fertilization includes the application of all the plant nutrients deficient in the soils and plants. The decline in factor productivity of intensive cropping over the years was associated with deficiencies of secondary and micronutrients. Among the three secondary nutrients, namely Ca, Mg & S, sulphur occupies a pivotal place and is now considered as the fourth major nutrient for Indian agriculture. The increasing incidence of sulphur deficiencies may be due to continuous use of sulphur-free high grade fertilizers like urea, DAP and practically no application of organic manures. Today, sulphur needs the same attention that was given to phosphorus in the early years of the "Green Revolution". Sulphur deficient plants had poor utilization of N, P and K and a significant reduction in activation of enzymes (Nasreen *et al.*, 2003).

In recent years, organic agriculture has been gaining considerable importance and many farmers are switching over to this traditional method of cultivation. Application of organic manures has various advantages like improving soil physical properties, water holding capacity and organic carbon content apart from supplying good quality of nutrients (Singh *et al.*, 2009). There is a great demand for organic spice products both in domestic

and international markets (ITC, 2004). Among the organic spice exported from India, turmeric holds the most important position next to chili. Different organic manures influence in a different way in terms of yield and quality of turmeric. Considering the economic importance of turmeric and environmental problems caused by chemical application, it is important to cultivate turmeric using organic fertilizers.

Mulch is used to cover soil surface around the plants to create a pleasant condition for the growth. Mulching is another important component in the management practices of turmeric production. Organic mulches are efficient in reduction of nitrate leaching, improve soil physical properties, prevent erosion, improve nitrogen balance, take part in the nutrient cycle through biological activity (Bhardwaj, 2011). After decomposition, organic mulches return organic matter and plant nutrients to the soil and improve its physical, chemical and biological properties after decomposition, which in turn increases the crop yield. Soil under the mulch remains loose, friable and leads to a suitable environment for root penetration. By providing a physical barrier, mulching decreases the germination and nutrition of many weeds. In view to this background, this study was aimed to evaluate the effect of nutrient sources and mulching on growth, yield and economics of turmeric.

Materials and Methods

Study site

The field experiment was conducted in experimental site of Agronomy Research Farm of A.N.D. University of Agriculture and Technology, Kumarganj, Ayodhya, U.P. The site is located at a distance of 42 km from Faizabad at Faizabad-Raibareli road (26.47^o, 82.12^o, 113 m above mean sea level). Climate

of the area is sub-tropical and sub-humid with an average annual rainfall of around 1040 mm. The rainfall is erratically distributed. Total annual precipitation of 848.6mm and 871.3 mm were received during the experimentation period of 2017-18 and 2018-19, respectively. The planting of turmeric (var. Narendra Haldi-1) was done in the 3rd week of March during both the years. The soil of the experimental field is alluvial, developed from the alluvium deposited by river, partially reclaimed sodic soil belongs to the order Inceptisol with silt loam texture.

Experimental site

The study was carried out during 2017-18 and 2018-19 in a randomized block design with 3 replications.

The experiment consists of 12 treatments viz. T₁ -100% NPK (RDF), T₂- 100% N (through FYM), T₃- 100% N(VC), T₄- 100% NPK + 40 kg S/ha, T₅- 100% N (FYM) +40 kg S/ha, T₆- 100% N(VC) + 40 kg S/ha, T₇- 100% NPK + mulch, T₈- 100% N (FYM) + mulch, T₉ - 100% N(VC) + mulch, T₁₀- 100% NPK + 40 kg S/ha + mulch, T₁₁- 100% N (FYM) + 40 kg S/ha+ mulch, T₁₂- 100% N(VC) + 40 kg S/ha + mulch. The recommended dose of fertilizer was 150-60-120 and paddy straw mulch was applied @ of 10 t/ha. The seed rhizomes of the turmeric (var. Narendrahaldi) were planted and maintained with 45×15 cm spacing between and within the rows at a depth of 5cm. The crop was planted in June and harvested in March in both the years when leaves turned yellow and started drying up.

Data collection and analysis

Observations on vegetative growth, viz. plant height (at180 DAP), no. of leaves per plant and no. of tillers per plant (both at 150 DAP) were recorded on five randomly selected

plants from each treatment at the time of maximum growth. The fresh rhizome yield (t/ha) were recorded separately from each treatment at harvesting stage. After proper drying the rhizome samples were polished and powdered to uniform mesh and were analyzed to find out the percentage of curcumin in the turmeric sample.

Results and Discussion

Influence on growth attributes

The growth parameters of turmeric crop are presented in Table 1 for 2017-18 and 2018-19. The data pertaining to plant height (180 DAP), no. of leaves per plant and no. of tillers per plant at 150 days of plant growth revealed that the application of different nutrient sources along with mulch resulted higher growth parameters over the other treatments tested during both the years.

In 2017-18, plant height ranged from 93.18-108.21cm under different treatments. The effect of organic sources and mulching was found significant on plant growth. Among different treatments, the maximum plant height (108.21cm) was found in T₁₁ receiving organic sources along with sulphur and mulch and minimum (93.18cm) in T₂. The effect of nutrient sources and mulching was also found significant over no mulch and sulphur treatments during second year. The height was slightly higher in second year as compared to first year. The significantly higher plant height was recorded in T₁₂ (110.20 cm) followed by T₁₁ (109.01cm) and lower (93.20cm) in T₁. In mulched condition due to less population of weed, the competition for nutrients between crops and weed may be less as a result, the plant height will be more under mulching. Turmeric growth in terms of number of leaves and number of tillers also showed similar trend as in case of plant height.

Table.1 Effect of different nutrient sources and mulching on growth characteristics of turmeric

Treatment	Plant height (cm) at 180 DAP		No. of leaves at 150 DAP		No. of tillers at 150 DAP	
	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
100% N NPK (150-60-120)	94.20	93.20	9.41	9.32	4.23	4.12
100% N (FYM)	93.18	95.18	9.63	9.51	4.27	4.23
100% N (VC)	93.38	97.03	9.52	9.69	4.24	4.18
100% NPK + 40 kg S/ha	95.20	94.41	9.68	9.73	4.26	4.20
100% N(FYM) + 40 kg S/ha	96.02	96.61	9.88	10.10	4.29	4.30
100% N(VC) + 40 kg S/ha	98.13	98.08	9.94	9.95	4.20	4.26
100% N NPK + paddy straw mulch @ 10t/ha	102.30	105.21	10.98	11.20	4.64	4.78
100% N (FYM) + paddy straw mulch @ 10t/ha	105.37	107.42	11.24	11.43	4.78	4.83
100% N (VC)+ paddy straw mulch @10t/ha	104.28	108.36	11.08	11.56	4.73	4.86
100% N NPK+ mulch + 40 kg S/ha	104.18	108.93	11.18	11.41	4.84	4.82
100% N (FYM) + mulch+40 kg S/ha	108.21	109.01	11.53	11.72	4.92	4.87
100% N (VC) + mulch+40 kg S/ha	106.12	110.20	11.38	12.00	4.86	4.92
SE (m) ±	2.31	2.25	0.26	0.27	0.15	0.16
CD	6.80	6.60	0.76	0.81	0.44	0.47

Table.2 Effect of different nutrient sources and mulching on fresh and dry rhizome yield of turmeric

Treatment	Fresh rhizome yield (t/ha)	
	2017-18	2018-19
100% N NPK (150-60-120)	19.9	21.6
100% N (FYM)	21.9	23.4
100% N (VC)	21.6	24.3
100% NPK + 40 kg S/ha	23.9	25.4
100% N(FYM) + 40 kg S/ha	24.6	27.0
100% N(VC) + 40 kg S/ha	25.2	26.7
100% N NPK + paddy straw mulch @ 10t/ha	26.1	27.4
100% N (FYM) + paddy straw mulch @ 10t/ha	28.5	30.8
100% N (VC)+ paddy straw mulch @ 10t/ha	27.3	29.7
100% N NPK+ mulch + 40 kg S/ha	27.3	29.1
100% N (FYM) + mulch+40 kg S/ha	29.7	31.8
100% N (VC) + mulch+40 kg S/ha	30.7	33.0
SE (m) ±	0.6	0.8
CD	1.92	2.41

Table.3 Effect of nutrient sources and mulching on curcumin content of turmeric

Treatment	Curcumin content (%)	
	2017-18	2018-19
100% N NPK (150-60-120)	5.10	5.07
100% N (FYM)	5.54	5.57
100% N (VC)	5.59	5.55
100% NPK + 40 kg S/ha	5.03	5.06
100% N(FYM) + 40 kg S/ha	5.64	5.60.
100% N(VC) + 40 kg S/ha	5.60	5.58
100% N NPK + paddy straw mulch @ 10t/ha	5.08	5.12
100% N (FYM) + paddy straw mulch @ 10t/ha	5.61	5.57
100% N (VC)+ paddy straw mulch @ 10t/h	5.63	5.67
100% N NPK+ mulch + 40 kg S/ha	5.13	5.09
100% N (FYM) + mulch+40 kg S/ha	5.59	5.63
100% N (VC) + mulch+40 kg S/ha	5.60	5.65
SE (m) ±	0.12	0.09
CD (p=0.05)	0.36	0.27

During both the years, number of leaves and number of tillers showed significant increase with treatments having organic sources and mulch along with sulphur. Also, the probable reason for increase in number of leaves might be due to improved soil properties and availability of plant nutrients which acted as growth enhancing factor for turmeric crop. The beneficial effects of mulch application on turmeric growth attributes have also been reported by various studies (Gill *et al.*, 1999, Manhas, 2009).

Influence on yield

The data pertaining to fresh rhizome yield of turmeric has been presented in Table 2. The data revealed that the fresh rhizome yield increased significantly with mulch and sulphur combined application, which was 18.7% and 18.6% higher over no mulch during 2017-18 and 2018-19, rhizome yield (19.9 t/ha and 21.6 t/ha) was obtained from the treatment T₁ receiving only recommended NPK through chemical fertilizers without sulphur or mulching during corresponding years.

The positive effect of mulch application on yield may be possible due to modification in soil environment viz. moderating soil temperature during early growth of the crop that conserves soil moisture, increases microbial activities and nutrient availability.

Upon analyzing the effect of different nutrient sources individually, it was observed that application of organic N sources in the form of FYM (T₂) and Vermicompost (T₃) resulted in significantly higher rhizome yields during both seasons, 2017-18 (21.9 t/ha and 21.6 t/ha respectively) and 2018-19 (24.3 t/ha and 23.4 t/ha respectively). Application of organic manures possibly reduced the nitrogen losses and enhanced the nutrient availability especially in long duration crops. The higher

doses of fertilizer nitrogen (urea) have also shown many adverse impacts on the beneficial soil micro-flora and fauna (Gosal *et al.*, 2012).

Curcumin content (%) in the rhizome

The curcumin content was significantly higher in the treatments receiving nutrients through organic sources as compared to inorganic nutrient sources. During 2017-2018, the highest curcumin content (5.64%) was found in T₇ whereas the lowest curcumin content (5.08%) was recorded in T₅. During 2018-19 the content was maximum (5.67%) in T₉ and minimum (5.07) in T₁.

The reason for decreased curcumin content under chemical fertilizer might be due to increase in weight and volume of rhizome without proper corresponding synthesis of curcumin as reported by Rao *et al.*, (1975). The quality parameter, *i.e.* curcumin content, which is a genetically governed trait, did not show significant difference with the different organic sources. The content of curcumin in rhizome was not affected with mulch application (Table 3).

It can be concluded that paddy straw mulching has beneficial effect on growth and yield of turmeric irrespective of other nutrient sources used. Mulching also has the potential to conserve moisture, reduce weed infestation and increase nutrient availability. This study shows that recommended dose of nitrogen (RDN) in turmeric can be managed by organic sources and proved to be more productive if mulching is done.

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