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Effect of rate and time of nitrogen application on growth and yield of turmeric (*Curcuma longa* L.)

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Abstract

An experiment was conducted to study the response of turmeric to rate and time of N application. The treatments consisted of three levels of nitrogen (60, 120 and 180 kg ha^{-1}) as main plot treatments and number of applications (nitrogen applied in equal splits of one, two, three, four and five) as sub-plot treatments. The results showed that 60 kg N ha^{-1} produced maximum fresh rhizome yield. Turmeric yield at 60, 120 and 180 kg N ha^{-1} did not differ significantly. Nitrogen applied in three equal splits produced maximum fresh rhizome yield and it was significantly superior to application of whole N at planting and in two splits. N content in leaf, rhizome and available nitrogen in soil increased with increase in the level of nitrogen and number of split application.

Key words: *Curcuma longa*, nitrogen, turmeric, yield

Introduction

Turmeric (*Curcuma longa* L.) is an important spice, valued for its characteristic yellow colour and flavour with varied uses in drug and cosmetic industry. India is the largest producer, consumer and exporter of turmeric. The major part of its production is consumed within the country. Since this spice is having a global demand and acceptance among importing countries, it is imperative to increase the productivity and upgrade its quality. The climatic and edaphic conditions of Punjab are quite suitable for its cultivation and this crop offers good scope for diversification of the existing cereal based cropping pattern of the State. The response of turmeric to nitrogen vary widely according to soil and climatic conditions. Nitrogen not only effects growth and yield of turmeric but also the quality of the produce. This necessitated to plan the present study.

Materials and methods

The field investigations were conducted at the Students' Farm, Department of Agronomy, Punjab Agricultural University, Ludhiana during *kharif* 1988 and 1999. The experimental field was sandy loam in texture, normal with respect to soil reaction and EC, low in organic carbon, low in available nitrogen (92 kg ha^{-1}) high in available phosphorus (34 kg ha^{-1}) and medium in available potassium (154 kg ha^{-1}). The experiment was laid out in split plot design with three levels of nitrogen (60, 120 and 180 kg ha^{-1}) as main plot treatments and time (number of split applications) of N application (T_1 – full nitrogen at planting; T_2 – two equal splits, at planting and 45 days after planting; T_3 – three equal splits, at planting, 45 and 75 days after planting; T_4 – four equal splits, at planting, 45, 75 and 105 days after planting and T_5 – five equal splits, at planting, 45, 75, 105 and 135 days after

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planting) as sub-plot treatments with four replications. Turmeric variety PCT-8 was sown in the last week of April in lines, 30 cm apart keeping plant to plant spacing of 20 cm. Phosphorus @ 30 kg P_2O_5 ha^{-1} was applied in the form of single super phosphate at planting and nitrogen in the form of urea was top dressed as per the treatments. To keep the weeds under control, four hoeings were given. Immediately after planting, irrigation was given. Light and frequent irrigations were given till the rhizomes sprouted. Thereafter, irrigation was given as per crop need.

At the time of harvest, samples of leaf (above ground part) and rhizomes from each plot were collected and analyzed for nitrogen (Piper 1966), phosphorus and potassium (Jackson 1967). The soil samples (0-15 cm) taken at harvest from each plot were analyzed for available nitrogen (Subbiah & Asija 1956), phosphorus (Olsen *et al.* 1954) and potassium (Hanwary & Heidal 1952). Curcumin content of processed rhizomes from each plot was determined following the method of Thimmaiah (1999). The data on yield and yield attributes were recorded at harvest.

Results and discussion

Application of 60 kg N ha^{-1}produced maximum fresh rhizome yield of 115 and 84 q ha^{-1} during 1998 and 1999, respectively. On the basis of pooled analysis, the differences in fresh rhizome yield due to differential levels of nitrogen were not significant and turmeric yield was maximum in 60 kg N ha^{-1}. Randhawa *et al.* (1984) had also reported non-significant increase in turmeric yield with increase in nitrogen from 0 to 225 kg ha^{-1}. The yield attributing characters namely, plant height, tillers per plant (during 1999), the number of leaves and primary fingers per plant and weight of fingers (Tables 1 and 2) decreased with increase in nitrogen level, though the differences were not significant. Number of leaves also decreased with increase in nitrogen level. Gill *et al.* (1999) had also reported that different nitrogen levels did not affect growth and yield of turmeric significantly.

Average yield of fresh rhizomes (101.6 q ha^{-1}) was obtained when nitrogen was applied in three equal splits, which was significantly higher than in the single and two split applications. Turmeric yields in three, four and five split applications of nitrogen were not statistically significant. Panigrahi *et al.* (1987) also reported beneficial effects of split doses of nitrogen. Curcumin content was not affected by different levels and also split application of nitrogen. However, higher curcumin content was recorded when nitrogen was applied in three splits (Table 2). The content of nitrogen in rhizome and leaf increased with increase in nitrogen level whereas no effect on P and K contents was observed. The higher rate of N

Table 1. Effect of rate and time of nitrogen application on growth and yield of turmeric

Treatment	Fresh rhizome yield (q ha^{-1})			Plant height (cm)		Tillers plant $^{-1}$		Leaves plant $^{-1}$	
	1998	1999	Mean	1998	1999	1998	1999	1998	1999
Nitrogen level (kg ha^{-1})									
60	115.9	84.2	100.0	25.7	49.6	1.82	2.32	5.39	6.39
180	93.5	78.1	85.8	26.6	44.7	2.90	1.96	5.06	6.25
CD 5 %	NS	NS	NS	NS	NS	NS	NS	NS	NS
Time of application									
T_1	91.6	74.5	83.0	26.0	43.8	1.76	2.13	5.18	5.98
T_2	99.2	77.0	88.1	26.2	47.3	2.00	2.13	5.33	6.20
T_3	121.9	81.3	101.6	26.6	49.0	1.93	2.04	5.28	6.29
T_4	104.6	80.7	92.6	26.1	48.3	1.86	1.91	5.06	6.51
T_5	108.5	87.8	98.1	26.4	47.5	1.86	2.27	5.33	6.40
CD 5 %	18.5	NS	9.6	NS	NS	NS	NS	NS	NS

Table 2. Effect of rate and time of nitrogen application on yield and curcumin of turmeric

Treatment	Primary fingers plant $^{-1}$		Secondary fingers plant $^{-1}$		Weight of fingers (g)		Curcumin (%)
	1998	1999	1998	1999	1998	1999	1998
Nitrogen level (kg ha^{-1})							
60	4.17	4.49	2.99	4.81	60.17	50.2	3.30
120	4.07	4.26	2.64	5.05	53.93	50.7	2.86
180	3.89	4.03	3.18	4.17	54.05	37.7	3.27
CD 5 %	NS	NS	NS	NS	NS	NS	NS
Time of application							
T_1	3.93	4.33	2.45	4.19	51.61	40.80	3.04
T_2	4.11	4.38	2.58	4.43	52.96	48.80	3.20
T_3	4.36	4.38	3.40	5.20	67.00	51.10	3.39
T_4	3.91	4.33	3.01	4.71	49.83	45.30	3.05
T_5	3.88	3.88	3.23	4.84	58.83	45.00	3.03
CD 5 %	NS	NS	NS	NS	11.08	NS	NS

application might have increased the nitrogen absorption by increasing the nutrient concentration in soil.

In general, the available N, P and K contents in soil after harvest declined from its initial status during 1998. The samples were taken during January and the temperature at that time was extremely low. This might have decreased the available nutrients in soil. The increase in nitrogen level increased the available nitrogen in soil significantly during 1998 and this indicated the low N requirement of turmeric. The available P and K contents decreased with increase in nitrogen level. The decline in the available P status with increase in N level might be due to increased P removal from soil as was evident from increase in P content of rhizome with increase in nitrogen level (Table 3). The K content in leaf and rhizome increased with increase in nitrogen

Table 3. N, P and K contents (%) in turmeric rhizome, leaf and available nutrients in soil as affected by different levels of nitrogen and time of application during 1998

Treatment	Rhizome			Leaf			Available nutrients (kg ha^{-1})		
	N	P	K	N	P	K	N	P	K
Nitrogen level (kg ha^{-1})									
60	2.81	0.050	0.42	1.08	0.41	0.88	82.40	26.80	142.0
120	2.95	0.053	0.45	1.14	0.39	0.91	89.20	24.40	136.0
180	3.02	0.054	0.49	1.23	0.37	1.01	93.20	21.80	120.0
CD 5 %	0.11	NS	NS	0.08	NS	NS	2.11	0.76	1.1
Time of application									
T_1	2.81	0.048	0.42	1.03	0.39	0.86	85.00	24.33	134.0
T_2	2.88	0.050	0.44	1.14	0.40	0.91	86.00	24.33	136.0
T_3	2.92	0.054	0.46	1.15	0.39	0.92	89.16	24.33	137.0
T_4	2.96	0.054	0.47	1.18	0.39	0.99	90.50	24.33	138.0
T_5	3.07	0.056	0.48	1.24	0.39	1.02	90.66	24.33	139.0
CD 5 %	NS	NS	NS	0.08	NS	NS	2.22	NS	2.0

level and this had resulted in the significant decrease in available K status of soil with increase in N level. The absence of K as a basal dose might have caused a still higher depletion of K from the native source.

The content of N and K in rhizome and leaf increased with increase in number of splits, though the differences were not significant. The increase in nitrogen splits had also increased the available nitrogen and potassium whereas there was no effect on available phosphorus during 1998. Due to split application of nitrogen, the higher concentration of nutrients/ nitrogen might have been maintained for longer period in soil and this had favourable effect on yield attributes of turmeric, content of N in leaf and rhizome and on the available nutrient status of soil.

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