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Effect of integrated nutrient management on growth and yield of turmeric (*Curcuma longa* L.) in an Acid Alfisol of Himachal Pradesh

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Abstract

The present study was conducted in the experimental farm of the Department of the Soil Science CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur during *kharif* 2004 and 2005. The eleven treatments on turmeric variety T-12 comprised of FYM application as soil incorporation and as soil mulch (both @ 20t ha^{-1}), 100% NPK, 100 % NPKS, 100 % NPKS in combination with 10, 15 and 20t FYM ha^{-1} (soil incorporation) and 100% NPKS in combination with same doses of FYM as soil mulch including an untreated check. The highest germination percentage (87.5), number of fingers rhizome^{-1} (5.95), turmeric rhizome yield per plant (151.3 g) and total rhizome yield (150.8 qha^{-1}) were recorded in 100% NPKS+20t FYM ha^{-1} as soil mulch. Maximum plant height of 112.8 cm and straw yield of 16.0 q ha^{-1} were recorded in integrated treatment of 100% NPKS + 20t FYM as soil incorporation. Highest N (0.76%) and K (1.29%) concentration in turmeric rhizome were registered in 100 % NPKS + 20 t FYM ha^{-1} as soil mulch whereas, maximum P (0.25%) and S (0.18%) concentration were recorded in 100 % NPKS + 20t FYM ha^{-1} as soil incorporation.

Key words: *Curcuma longa*, germination percentage, plant height, rhizome yield, nutrient concentration.

Introduction

Turmeric (*Curcuma longa* L.), a medicinal plant, belonging to family Zingiberaceae, is one of the most valuable spices all over the world and cultivated in the country since ancient times. The productivity of turmeric is low in acidic soil due to the presence of exchangeable aluminium and iron, fixation of phosphorus, leaching and runoff losses of nitrogen and potassium in high rainfall areas (Kamat *et al.*, 1982 and Singh *et al.*, 2001). Application of farmyard manure is useful in crops such as turmeric but its alone use is not sufficient to meet out the crop nutrient requirement. Similarly, use of inorganic fertilizers alone pose serious threat to the sustainability of the agricultural productivity. Therefore, the best substitute is integrated nutrient management for sustainable production and health of soil. Mulching with farmyard manure is a new practice in turmeric, which is becoming popular in Himachal Pradesh. It has a number of benefits viz. it increases the soil moisture, optimizes temperature, provides protective cover against rainfall, reduces weed infestation, enhances the germination percentage and ultimately growth and yield of the crop. Keeping these facts into consideration, present study was conducted to study the effect of alone application of FYM as incorporation and mulch, alone application of inorganic fertilizers and integrated application of FYM at varied doses along with inorganic fertilizers on the growth, yield and nutrient concentration of turmeric under Palampur condition in Himachal Pradesh.

Material and Methods

The experiment was conducted on Turmeric (*Curcuma longa* L.) variety T-12 at research farm of Department of Soil Science, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur (H.P) during *kharif* 2004 and 2005. The crop was sown in last week of May during both the years with row to row and plant to plant spacing of 30 x 20 cm, respectively. The soil of the experimental farm at the start of the experiment was silty clay loam in texture with pH 5.6, organic carbon- 11.8 gkg^{-1}, available nitrogen-264 kgha^{-1}, available phosphorus-16 kgha^{-1}, available potassium- 204 kg ha^{-1} and available sulphur- 12 kgha^{-1}. The experiments were laid out in the randomized block design comprising eleven treatments replicated thrice including an untreated check. The treatments were 20t FYM ha^{-1} as soil incorporation and as soil mulch, 100 % NPK, 100 % NPKS, 100 % NPKS in combination with 10, 15, 20t FYM ha^{-1} as soil incorporation and 100% NPKS with same doses of FYM as soil mulch.

Growth parameters *viz.* germination percentage was recorded at 45-50 days after sowing by counting the total germinated plants per plot in comparison to number of the rhizomes sown. The plant height was measured at maximum growth from ground to tip level at fortnightly intervals in the months of September and October. Number of fingers per rhizome was calculated by

averaging rhizome fingers of five plants per plot at the time of harvest. Total rhizome yield per plot and straw yield per hectare were calculated at the time of harvesting.

The concentration of nitrogen, phosphorus, potassium and sulphur were determined in rhizome and straw (leaf) following standard procedures. Total nitrogen content was determined by micro-kjeldahl's method (Jackson, 1967), total phosphorus content was determined by vando-molybdate phosphoric acid yellow colour method (Jackson, 1967), total potassium content was determined by flame photometric method (Chapman and Brown, 1950) and total sulphur content was determined by turbidimetric method (Chesin and Yien, 1950).

The data pertaining to different parameters were pooled for two *kharif* seasons i.e. 2004 and 2005.

Results and Discussion

Germination percentage (%)

The germination percentage increased significantly due to application of 100 % NPK and 100 % NPKS alone or in combination with farm yard manure as incorporation and mulch. Highest germination percentage (87.5) was recorded in 100% NPKS + 20t FYM ha^{-1} as soil mulch and lowest (52.6) in control (Table 1).

The treatment 100% NPKS + 20t FYM ha^{-1} as soil incorporation was statistically at par with 100 % NPKS + 20 t FYM ha^{-1} as soil mulch. The increase in the germination percentage of the crop might be due to hastening of germination due to improvement in hydrothermal regime, less weeds and more utilization of added nutrients. These results are in conformity with those of Sankhyan (1997).

Plant height (cm)

Maximum plant height (112.8 cm) was attained at 100% NPKS + 20t FYM ha^{-1} as soil incorporation which was found to be statistically at par with 100% NPKS + 20t FYM ha^{-1} as soil mulch (Table 1). However, the minimum (49.3 cm) was recorded in control. This may be due to the reason that farm yard manure in integration with NPKS caused a synergistic effect on availability of nutrients to the crop (Medda and Hore, 2003).

Fingers per rhizome

Highest number (5.95) was recorded in 100% NPKS + 20t FYM ha^{-1} as soil mulch and lowest (4.65) in control. In integrated nutrient management treatment, there may be more translocation of photosynthates from leaves to the sink *i.e* rhizome resulting into robust rhizomes and more number of fingers per rhizome (Jadho, 2005).

Table1.Effect of integrated nutrient management on growth parameters of turmeric (pooled data of *kharif* 2004 and 2005)

Treatments	Germination percentage (%)	Plant height (cm)	Fingers rhizome^{-1} (no.)
Control	52.6	49.3	4.65
20t FYM (I)	60.0	63.6	5.21
20t FYM (M)	66.5	71.6	5.28
100% NPK	69.1	82.5	5.39
100% NPKS	73.0	82.7	5.49
100% NPKS + 10t FYM (I)	75.8	93.7	5.65
100% NPKS + 15t FYM (I)	77.6	103.2	5.83
100% NPKS + 20t FYM (I)	85.2	112.8	5.89
100% NPKS + 10t FYM (M)	74.5	92.2	5.64
100% NPKS + 15t FYM (M)	82.5	104.5	5.84
100% NPKS + 20t FYM (M)	87.5	107.8	5.95
CD (P= 0.05)	5.7	9.4	0.07

I: Soil Incorporation, M: Mulch

Yield

Maximum rhizome yield (151.3 g plant^{-1}) was observed in 100% NPKS + 20t FYM ha^{-1} as soil mulch with an improvement of 133 per cent over untreated check (64.83 g plant^{-1}). Integrated treatment of 100% NPKS + 20t FYM ha^{-1} as soil incorporation (148.7 g pl^{-1}) was also found statistically at par with treatment comprising similar doses of NPKS and FYM as soil mulch . Likewise, total rhizome yield was highest (150.8 q ha^{-1}) in 100% NPKS + 20t FYM ha^{-1} as soil mulch being significantly superior over other treatments with an improvement of 134 per cent over untreated check (64.2 q ha^{-1}). It was followed by rhizome yield of 150.0 q ha^{-1} in 100% NPKS + 20t FYM ha^{-1} as incorporation, 145.5 q ha^{-1} in 100% NPKS + 15t FYM ha^{-1} as soil incorporation and 145.0 q ha^{-1} in 100% NPKS + 15t FYM ha^{-1} as soil mulch, all the three being statistically at par with one another. Similarly, highest straw yield of 16.0 q ha^{-1} was recorded in 100% NPKS + 20t FYM ha^{1} as soil incorporation and lowest (8.7 q ha^{-1}) in untreated check (Table 2). Straw yield obtained in 100% NPKS + 10t FYM ha^{-1} and 100% NPKS +

15t FYM ha^{-1} as soil incorporation (14.4 and 15.4 q ha^{-1}) and in 100% NPKS + 15 t FYM ha^{-1} and 100% NPKS + 20t FYM ha^{-1} as soil mulch (14.5 and 15.9 q ha^{-1}), respectively were statistically at par with highest level i.e. 100 % NPKS + 20t FYM ha^{-1}.

Better yield recorded in integrated treatment of 100% NPKS + 20t FYM ha^{-1} as soil mulch could be because of the fact that the combined application of organics (FYM) and inorganic fertilizers give availability of more nutrients to crop and improve the physical and microbiological condition of soil (Nandal, 2000; Dixit and Bhardwaj, 2006).

Nutrient concentration

Maximum N (0.79%) and K concentration (1.29%) in turmeric rhizome were recorded in 100% NPKS + 20t FYM ha^{-1} as soil mulch. Likewise, maximum P (0.25%) and S (0.18%) concentration in turmeric rhizome were recorded in 100% NPKS + 20t FYM ha^{-1} as soil incorporation and lowest in untreated check (Table 3). In case of straw, highest concentration of N (0.19%), P (0.090%) and K (0.23%) were observed in integrated treatment of 100 % NPKS + 20t FYM ha^{-1} as soil mulch, whereas, S (0.068%) concentration was maximum in 100% NPKS+ 20t FYM ha^{-1} as soil incorporation. The current results are in compliance with those of Medda and Hore (2003).

From the present study, it was observed that in turmeric, all the growth parameters *viz.* germination percentage, plant height, number of fingers per rhizome; yield parameters *viz.* rhizome yield per plant, total rhizome yield and straw yield per hectare and nutrient concentration in rhizome and straw were maximum either in the integrated treatment of 100% NPKS + 20t FYM ha^{-1} as soil mulch or 100% NPKS + 20t FYM ha^{-1} as soil incorporation and that too at higher doses of FYM rather than when these treatments were applied alone.

It is concluded that in turmeric, integrated application of farm yard manure either as incorporation or mulch with 100 % NPKS improved the nutrient concentration, growth parameters and eventually yield of the crop as compared to alone application of either organic (farm yard manure) or inorganic fertilizers (100 % NPK and 100 % NPKS).

Table 2. Effect of integrated nutrient management on yield per plant (g), rhizome yield (qha^{-1}) and straw yield (qha^{-1}) of turmeric (pooled data of *kharif* 2004 and 2005)

Treatments	Yield per plant^{-1} (g)	Rhizome yield q ha^{-1}	Straw yield q ha^{-1}
Control	64.8	64.2	8.7
20t FYM (I)	79.5	86.7	10.5
20t FYM (M)	83.2	92.8	12.6
100% NPK	110.0	113.7	12.9
100% NPKS	118.8	121.2	13.5
100% NPKS + 10t FYM (I)	126.4	135.3	14.4
100% NPKS + 15t FYM (I)	138.9	145.5	15.4
100% NPKS + 20t FYM (I)	148.7	150.0	16.0
100% NPKS + 10t FYM (M)	127.6	133.7	13.8
100% NPKS + 15t FYM (M)	141.2	145.0	14.5
100% NPKS + 20t FYM (M)	151.3	150.8	15.9
CD (P= 0.05)	8.7	8.4	1.87

I: Soil Incorporation, M: Mulch

Table 3. Effect of INM on nutrient concentration (%) in turmeric rhizome and straw (pooled data, *kharif* 2004 and 2005)

Treatments	Concentration in rhizome (%)				Concentration in straw (%)			
	N	P	K	S	N	P	K	S
Control	0.67	0.19	0.99	0.09	0.10	0.080	0.12	0.050
20t FYM (I)	0.68	0.21	1.06	0.11	0.11	0.083	0.15	0.059
20t FYM (M)	0.69	0.22	1.10	0.12	0.12	0.082	0.16	0.059
100% NPK	0.71	0.23	1.12	0.09	0.14	0.085	0.19	0.049
100% NPKS	0.73	0.23	1.16	0.14	0.15	0.086	0.18	0.063
100% NPKS + 10t FYM (I)	0.75	0.24	1.21	0.16	0.16	0.088	0.19	0.065
100% NPKS + 15t FYM (I)	0.76	0.25	1.20	0.17	0.18	0.088	0.22	0.066
100% NPKS + 20t FYM (I)	0.78	0.25	1.25	0.18	0.18	0.090	0.21	0.068
100% NPKS + 10t FYM (M)	0.74	0.22	1.21	0.15	0.15	0.088	0.19	0.061
100% NPKS + 15t FYM (M)	0.78	0.24	1.28	0.17	0.17	0.089	0.21	0.064
100% NPKS + 20t FYM (M)	0.79	0.25	1.29	0.18	0.19	0.090	0.23	0.065
CD (P= 0.05)	0.036	0.085	0.05	0.01	0.014	0.001	0.014	0.041

I: Soil Incorporation , M: Mulch

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