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Productivity and quality of Turmeric (*Curcuma longa* L) under different nutritional level supplemented through organic and inorganic sources

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ABSTRACT

A field experiment was conducted on Turmeric (Curcuma longa L)with a variety of AZAD HALDI-1 during 2011-12 and 2012-13 on sandy loam soil at HRC of SardarVallabhbhai Patel University of Agriculture and Technology, Meerut. The experiment aimed to evaluating the effect of different sources of nutrients (organic and inorganic) on the productivity andquality (essential oil and curcumin %) of turmeric.The experiment was laid out in the randomized block design with 10 treatments and 3 replications. The treatments comprised the T_1-(Control) , T_2 -(100% RDF NPK) , T_3- (125 % N + RDF PK), T_4- (125 % P + RDF NK) , T_5-(125 % K + RDF NP), T_6-(125 % NPK) , T_7-(100% NPK + FYM @ 20 tha^{-1}) , T_8-(75%NPK + FYM @ 30 tha^{-1}),T_9-(50% NPK + FYM @ 50 tha^{-1})and T_{10}-((25% NPK + FYM @ 80 tha^{-1}). The study indicated that turmeric showed better response of the application of 125 % NPK or 100 % NPK + FYM @ 20 tha^{-1} on yield attributes like primary fingers, secondary fingers, mother rhizomes over control as a results significantly higher yield was noticed under these treatments. Impact of different sources (Organic and inorganic) of nutrients were also studied on quality parameters like essential oil and curcumin percent and it was found that more essential oil and cur cumin was noticed in these treatments over control. The study thus suggests that application of balance mineral fertilizer @ 125 % NPK of RDF or in combination with FYM i.e. 100 % NPK + FYM @ 20 tha^{-1}gave higher crop production and more essential oil and curcumin under sandy loam soil.

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INTRODUCTION

Turmeric (*Curcuma longa* L.), the ancient and sacred spice of India is known as 'Indian saffron" because of its deep yellow-orange color'. It is used in diversified forms as a condiment, flavoring and coloring agent and as a principal ingredient in Indian culinary as curry powder. It has anticancer and antiviral action and hence finds use in the drug and cosmetic industry. Turmeric is a powerful medicine that has long been used in the Chinese and Indian systems of medicine as an anti-inflammatory agent to treat a wide variety of conditions, including flatulence, jaundice, menstrual difficulties, bloody urine, hemorrhage, toothache, bruises, chest pain, and colic. Curcumin is thought to be the primary pharmacological agent in turmeric. Turmeric is an excellent source of both iron and manganese. It is also a good source of vitamin B6, dietary fiber and potassium. The increasing demand for natural products as food additives makes turmeric as ideal produce as a food colorant.

India is the largest producer, consumer and exporter of turmeric in the world. India is the global leader in value added products of turmeric and exports.It can grow well in a variety of soils provided with better irrigation and drainage facilities. It can be grown in partial shade of orchards where other crops cannot be grown.Better yields are obtained at neutral pH of the soil. Turmeric needs heavy manuring. The productivity of turmeric in India is very low which can be increased ten times. Therefore, technologies are to be generate for different soil and climatic condition. Among the various factors, type of soil, levels and sources of nutrients, cultural practices, methods of planting and post harvest management practices are the important factors, which are responsible for increasing the productivity and quality specially oil content and curcumin in turmeric. The factors affecting the productivity and quality are to be studied in length as no much information is available on effect of

different nutritional level supplemented through organic and inorganic sources on Productivity and quality of Turmeric (*Curcuma longa* L).

METHODOLOGY

The present study entitled, "Productivity and quality of Turmeric (*Curcuma longa* L) under different nutritional level supplemented through organic and inorganic sources" was carried out at Horticulture Research Center located from 29°04' N latitude and 77°42' E longitude at an altitude of 237 meter above the mean sea level (MSL) of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, UP, Indiaon sandy loam soil low in organic carbon, nitrogen and phosphorus and medium in available potassium.

Study area enjoys sub tropical and semi arid climate with hot desiccating summers and cold winters. High rainfall and wide temperature variations (Maximum temperatures exceed even 42° C during the hot summer and minimum temperature occasionally touches 3°C during winter) are the characteristics features of this region. A field experiment was conducted on Turmeric (*Curcuma longa* L)with a variety of AZAD HALDI-1 during 2011-12 and 2012-13 on sandy loam soil at HRC of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut. The experiment aimed to evaluating the effect of different sources of nutrients (organic and inorganic) on the productivity and quality (essential oil and curcumin %) of turmeric.The experiment was laid out in the randomized block design with 10 treatments and 3 replications. The treatments comprised the T_1-(Control), T_2 -(100% RDF NPK), T_3- (125 % N + RDF PK), T_4- (125 % P + RDF NK), T_5-(125 % K + RDF NP), T_6-(125 % NPK), T_7- (100% NPK + FYM @ 20 tha^{-1}), T_8-(75%NPK + FYM @ 30 tha^{-1}),T_9-(50% NPK + FYM @ 50 tha^{-1})and T_{10}-((25% NPK + FYM @ 80 tha^{-1}). Mother, primary and secondary rhizomes were separated and weighed separately from each randomly selected five plant for the purpose. Fresh weight of each rhizome was recorded and their average values were expressed in tha^{-1}. curcumin content was measured by adopting standard methods and the curcumin percentage was calculated by the procedure suggested by **Manjunath*et al.* (1991)**. Similarly, essential oil from turmeric was extracted using steam distillation method and converted in percent by using following formula Essential oil % = Oil (g) x 100/1000

RESULTS

Yield and Yield attributes

Effects of different sources of nutrients (organic and inorganic) on wet weight of primary, secondary fingers and mother rhizomes (tha^{-1}) and wet rhizomes of Turmeric are presented in table 1.

Primary fingers are important yield parameter because their number provides bulk to the rhizome. They are responsible for about 8 % of total yield increase in the present study. The amount of fingers expected to have a direct bearing on yield. In the present study primary fingers were significantly affected by different treatments (Table-1). The lowest value was observed in control (1.93t ha^{-1}) while the highest value (5.33 t ha^{-1}) in 125% NPK (188: 75: 135 $kgha^{-1}$)T6 which was closely followed by 100% NPK + FYM @20tha^{-1}. The differences were significant amongst different treatments. The weight of primary fingers in T6 was about 2.7 times higher than control. The effect of nutrients was therefore clearly demonstrative. This might be due to augmented supply of nutrients and brisk metabolic activity in the plant thereupon. Several studies have reported such results. (Nath and Korla 2000, Khalil *et al.* 2002)

Secondary fingers are important as yield attributing component because they have a share of more than 41 % towards to total yield. In the present study different levels of nutrients had significant effect on increasing the weight of secondary fingers which was in direct proportion to the increasing levels of nutrients, both singly and conjointly applied with FYM (Table-1). The lowest (9.6t ha^{-1}) and highest (15.35t ha^{-1}) values of secondary fingers were observed in control (T_1) and T_6 (125% NPK (188: 75: 135 kg ha^{-1}), respectively T_7(100% NPK + FYM @20tha^{-1}) was also at par with T_6. It was evident from the study that 125% NPK (RDF) was the best treatment in respect of secondary finger yield. However, similar results could be obtained in combination with 100 % NPK + FYM @20tha^{-1}. Since the organic manures have some valuable extra nutritional functions in soil, this treatment might have some sustainability value. 125 % NPK might be the appropriate need for optimising the finger yield. Similar results have been found by other investigators. (Rao *et al.* 2004, Jadhao*et al.* 2005, Agrawal *et al*. 2007).

The highest yield contributing character with about 45 % share in total yield is mother rhizomes which is most important character. It varied from 7.93 to 18.8tha^{-1}. Minimum and maximum values were given by control (T_1) and T_6 (125% NPK (188: 75: 135 kg ha^{-1}) , respectively(Table-1). T_7(100% NPK + FYM @20tha^{-1}) was not significantly different from T_6. Thus combination of 20 t FYM with 100 % NPK is able to give a yield level of 125 % NPK. Since the use of organic manures conjointly is useful for soil life, incorporation of organic manure commands high value as evident from the present results. Since mother rhizomes have a major share in total yield of turmeric, increase in the yield of mother rhizomes is useful.

Many other investigators have also reported the similar results in their studies. (Rao *et al.* 2004, Jadhao*et al.* 2005, Agrawal *et al*. 2007).

Turmeric is an exhaustive crop with very high yield and admittedly a high nutrient mining crop. In the accompanying study for two years rhizome fresh weight ranged from 19.48 to 39.49tha^{-1}. The lowest and the highest values were recorded with in control (T_1) and T_6 (125% NPK (188: 75: 135 kg ha^{-1}), respectively. Among NPK fertilisers the next highest yield was given by 125 % N+ RDF PK (T_3). Thus the role of nitrogen in rhizome bulking was evident. T_7 100 % NPK + FYM @ 20 tha^{-1} gave the next highest value during both the years. It was indicated that FYM as a multi nutrient source in replacement of 25 % fertilisers was also a feasible practice because the organic manures function as sustainability factor in soil and plant. It is thus explicit that incorporation of 20 tha^{-1} of FYM along with 100 % RDF NPK fertiliser is of special significance. However, further increasing FYM level with equivalent decrease in fertilisers might not be helpful in maximising the yield because FYM takes long time in decomposition, mineralisation, and absorption stages of nutrient dynamics. Incorporation of inorganic fertilisers with FYM might be able to accelerate the microbial activity due to narrowing of C: N ratio and might proved beneficial in future.

Similar results have been reported by other investigators. (Sanyal and Dhar 2008, Singh *et al.* 2008, Velmurgan*et al.* 2008).

Quality parameters

Effect of different sources of nutrients (organic and inorganic) on essential oil (%) and curcumin (%) at harvest of Turmeric is presented in table 2.

Data presented in table 2 clearly shows that well define value addition can be achieve by the use of balance nutrition for production and quality in turmeric. In turmeric curcumin and essential oils are much appreciated products. Within genetic confines, the improvement can be brought upon by use of organic and inorganic fertilisers.

The essential oil content is a genetic property but sufficient improvement could be obtained with the use of different nutrients in proper balance. In the present study the essential oil % varied from 1.85 to 3.20 %. The best treatment T_7(100 % NPK + FYM @ 20 t ha^{-1}) gave about 1.7 times higher essential oil content over control, indicating that much improvement can be obtained by addition of organic manures and inorganic fertilisers. 100 % NPK with FYM @ 20 t ha^{-1} gave better results than 125% NPK indicating that addition of manure has greater role in increase in the percentage of essential oil. The variations due to different treatments over control and also within the treatments was significant. Several investigators have reported the increase in essential oil content due to balanced use of NPK with FYM. The present findings are in consonance with those workers. (Dixit and Singh 2010, Jadhao*et al.* 2005, Padampriya*et al.* 2008).

Curcumin is another valuable product obtainable from turmeric. Any increase in curcumin content will be a practice of value addition to the crop, with consequently economic gain to the farmer. With this objective the curcumin was analysed in turmeric and for quantification the harvest of curcumin tha^{-1} was also workout.

The results indicated that different treatments had significant increasing effect on curcumin content. The curcumin content varied from 3.96 to 6.46 percent during 2011-12 and 2012-13. Minimum and maximum content was found in T_1 and T_6, respectively. The next highest value with non significance difference was obtained in T_7. Approximately 63 % increase in curcumin in T_6 was found due to addition of 125% NPK over control. The results were significant over control and within different treatments. The next highest treatment T_7 gave 58 % higher curcumin percent than control.However there was no significance difference observed in curcumin content in T_6& T_7. Thus it was clear that increase in nutrient levels resulted in proportionate increase in curcumin content of turmeric and much improvement cab be brought about in the curcumin content by the proper nutrient management.

CONCLUSION

Result so obtained from the study may be concluded that economically better yield of turmeric may be obtained with the addition of 25 % extra NPK over RDF or 100 % NPK with 20 t ha-^{1} FYM. These two treatments distinctly showed the improvements in OC %, availability of N, P and K in soil at all the stages of samplings and found superior over control. Uptake of N, P and K by turmeric under these treatments was found significantly higher than control. Hence ,the study indicated that turmeric showed better response of the application of 125 % NPK or 100 % NPK + FYM @ 20 t ha^{-1} on yield attributes like primary fingers , secondary fingers , mother rhizomes over control as a results significantly higher yield was noticed under these treatments. As far as quality parameters are concern, it was also found that more essential oil and curcumin was noticed in these treatments over control. The study thus suggests that application of balance mineral fertilizer @ 125 % NPK of RDF (188: 75:135 Kg NPK ha^{-1}) or in

combination with FYM i.e. 100 % NPK + FYM @ 20t ha^{-1} sustain a better higher crop production and more essential oil and cur cumin under sandy loam soil.

Table 1 Effects of different sources of nutrients (organic and inorganic) on wet weight ofPrimary, secondary fingers and mother rhizomes (tha^{-1}) and wet rhizomes of Turmeric.

Treatment	Primary Fingers		Secondary Fingers		Mother rhizomes		Wet rhizomes	
	2011-12	2012-13	2011-12	2011-12	2011-12	2012-13	2011-12	2012-13
T_1 Control	1.9	1.96	9.46	9.75	7.83	8.07	19.18	19.78
T_2 100% NPK	3.8	4.01	12.83	13.5	14.78	15.56	31.41	33.07
T_3 125% N+RDF PK	4.32	4.55	14.25	15	15.75	16.58	34.32	36.13
T_4 125% P+RDF NK	4.14	4.36	14.01	14.75	15.03	15.82	33.18	34.93
T_5 125% K+RDF NP	4.77	5.02	13.42	14.12	15.73	16.56	33.92	35.7
T_6 125% NPK	5.19	5.47	14.96	15.75	18.32	19.28	38.48	40.5
T_7 100% NPK + FYM @20tha^{-1}	4.97	5.23	14.86	15.6	17.68	18.61	37.61	39.59
T_8 75% NPK + FYM @30tha^{-1}	4.24	4.46	13.66	14.38	15.45	16.26	33.35	35.1
T_9 50% NPK + FYM @50tha^{-1}	3.38	3.56	13.18	13.88	13.13	13.82	29.7	31.26
T_{10} 25% NPK + FYM @80tha^{-1}	3.14	3.3	12.47	13.13	12.4	13.06	28.01	29.48
SE (m) ±	0.09	0.1	0.62	0.76	0.77	0.77	0.16	0.17
CD (p= 0.05)	0.2	0.21	1.33	1.6	1.62	1.61	0.47	0.51

Table 2 Effects of different sources of nutrients (organic and inorganic) on essential oil (%) and curcumin (%) at harvest of Turmeric.

Treatment	Essential oil %		Curcumin %	
	2011-12	2012-13	2011-12	2012-13
T_1 Control	1.83	1.88	3.85	4.08
T_2 100% NPK	2.75	2.85	4.85	5.6
T_3 125% N+RDF PK	2.78	3.01	5.15	5.86
T_4 125% P+RDF NK	2.76	3.1	4.95	5.56
T_5 125% K+RDF NP	2.66	3.21	5.14	5.55
T_6 125% NPK	3.1	3.21	6.2	6.73
T_7 100% NPK + FYM @20tha^{-1}	3.15	3.26	6.0	6.5
T_8 75% NPK + FYM @30tha^{-1}	2.87	3.08	5.68	6.16
T_9 50% NPK + FYM @50tha^{-1}	2.42	2.66	5.22	5.62
T_{10} 25% NPK + FYM @80tha^{-1}	2.2	2.29	4.83	5.18
SE (m) ±	0.06	0.06	0.11	0.13
CD (p= 0.05)	0.13	0.14	0.24	0.26

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