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Effect of Nitrogen and Potassium on Yield and Quality of Turmeric under Terai Zone of West Bengal

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ABSTRACT

A field experiment was conducted during 2016-17 and 2017-18 to study the effect of different Nitrogen and Potassium levels on yield, quality and benefit cost ratio in turmeric (*Curcuma longa* L.) at UBKV, Pundibari, Cooch Behar, West Bengal. The experimental results revealed that the application of 120 kg N/ha (N_4) resulted in highest fresh yield (26.07 t/ha) and dry yield (6.44 t/ha) conversely, the maximum dry recovery (26.58%) was obtained from treatments devoid of nitrogen i.e., 0 kg N/ha (N_1), while highest curcumin content (5.62%) was reported from the treatment with 160 kg N/ha (N_5). Likewise, among varied levels of Potassium, the application of 180 kg K_2O/ha (K_4) recorded the highest fresh yield (22.42 t/ha) and dry yield (5.66 t/ha) while, the maximum dry recovery (25.52%) and curcumin content (5.23%) was obtained in the treatment consisted of 240 kg K_2O /ha (K_5). The maximum gross monetary returns (Rs 383320/ha), net monetary returns (Rs 227425/ha) and B:C ratio (2.46) were recorded under treatment combination of N_4K_4 (120 kg N/ha and 180 Kg K_2O/ha). In brief, considering the yield and economic perspective for terai zone of West Bengal the treatment combination of N_4K_4 (120 kg N/ha and 180 kg K_2O/ha) might be suitable.

Kerwords Nitrogen, Potassium, Turmeric, Terai zone, Yield.

INTRODUCTION

Turmeric (*Curcuma longa* L.) is a tropical perennial rhizomatous crop which belongs to the family of Zingiberaceae. It is one of the most important ancient spice crop hence often referred to as the "Golden Spice" or the "Spice of life". Turmeric is an integral part of every Indian cuisine for its typical color and flavor. Besides, it also holds a medicinal significance and has been a part and parcel of traditional as well as of modern medicines. Curcumin has been a center of attraction which is a main coloring substance of turmeric and the value of the turmeric products is based on their curcuminoid content (Kulkarni *et al*. 2012). It is a potential treatment for an array of diseases, including allergies, arthritis alzheimer, cancer, diabetes, and other chronic illnesses.

Turmeric is one of the important export oriented

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crop of India. It holds fifth rank in area and third position in production (Verma *et al*. 2019). It is cultivated in the area of 1.95 lakh hectare (ha) with the production of 9.99 lakh tonnes. In West Bengal, 15.8 thousand ha is occupied by turmeric cultivation from where production of 42 thousand tonnes is achieved. Productivity of turmeric in West Bengal is quite low (2.66 tonnes/ha) as compared to national average (5.11 tonnes/ha). The main reason for low productivity may be due to the use of low yielding cultivars and poor management practice.

Turmeric being a long duration (8-9 months) and exhaustive crop it demands a heavy nutrition for getting higher yield and quality (Mekonnen and Garedew 2019). The quantity of fertilizers required by the crop depends on the soil and weather conditions prevailing during crop growth (Karthikeyan *et al*. 2009). Among the different nutrient, nitrogen (N) and potassium (K) are the most important nutrient and proper fertilizer management is important for increasing yield and quality of any plant species. Nitrogen is important for protein production. It plays a pivotal role in many critical functions in a plant. Modupeola and Olaniyi (2015) reported the significant improvement in rhizome yield of turmeric with increasing level of nitrogen. Next to nitrogen and phosphorus Potassium is the third major plant nutrient. The spice crops like turmeric and ginger shows high vulnerability to potassium deficiency and requires a large amount of available soil K. Potassium improves the utilization of nitrogen and protein formation, improves size, weight, color.

However, very scanty information is available in the terai zone of West Bengal. In this region most of the farmers grow turmeric in homestead areas with subsistence level of management without applying any inorganic fertilizer or by applying of small quantity of inorganic nutrients. With keeping this view, the present experiment was undertaken with an objective to study the effects of different levels of nitrogen and potassium on growth, yield and quality of turmeric under terai zone of West Bengal.

MATERIALS AND METHODS

Field experiment was carried out in the Department of Vegetable and Spice Crops, Faculty of Horticulture, UBKV, Pundibari, Cooch Behar, West Bengal during 2016-17 and 2017-18. The plots followed Factorial Randomized Complete Block Design (FRCBD) and were replicated three times. The treatment comprised five different levels of nitrogen,viz.,N_1 (0 kg N/ha), N_2 (40 kg N/ha), N_3 (80 kg N/ha), N_4 (120 kg N/ha), N_5 (160 kg N/ha) and five different levels of potassium viz., K_1 (0 kg K_2O/ha), K_2 (60 kg K_2O/ha), K_3 (120 kg K_2O/ha), K_4 (180 kg K_2O/ha) and K_5 (240 kg K_2O/ha). N, P_2O_5 and K_2O were applied in the chemical form of urea (46% N) and muriate of potash (60% K_2O). Farm Yard Manure (FYM) @ 15 t ha^{-1} was applied at the field where the variety Suranjana (TCP-2) was transplanted at 30 cm X 20 cm spacing during the 1st fortnight of February. Transplanting was done during evening hours and light irrigation was given immediately after transplanting. All other recommended agronomic package and practices were followed to grow a successful crop. From each treatment five plants were selected at random for recording yield parameters (Fresh yield in t/ha, Dry recovery in %, Dry yield in t/ha), Curcumin content (%) and benefit cost ratio was worked out. The data were statistically analyzed (Gomez and Gomez 1984). Fisher and Snedecor's 'F' test with probability at 0.05% was used to test the significance of the different sources of variation and least significance difference was tested at 5% level of significance (Fisher and Yates 1963).

RESULTS AND DISCUSSION

Effect of N and K on yield

The data of two year and pooled values pertaining to yield as influenced by different level of treatment is presented in Tables 1 and 2.

The fresh yield was significantly influenced by the levels of nitrogen (N). The highest fresh yield of 26.07 t/ha was obtained in N_4 (120 kg/ha). It was observed that above and beyond nitrogen dose of 120 kg/ha (N_4) there was a slight decrement in fresh yield. Hence, for this location and environment dose N_4 could be fitting. Verma *et al*. (2019) also recorded the increase in fresh yield with increasing N level and 120 kg N/ha produced highest yield thereafter it reduced. Haque *et al*. (2007) confirmed the present results and reported that rhizome yield increases with inclusion of more N fertilizer. Nitrogen is one of the major essential plant nutrients and takes part in a various physiological processes. It gives plants their green color, enhances the growth of leaves, stem and other vegetative part's (Leghari *et al*. 2016). Hence, the improvement in vegetative growth also encourages the production and storage of photosynthates in rhizomes ultimately leading to higher yield.

Different levels of potassium (K) also exhibited significant difference in the fresh yield of turmeric. The highest fresh yield of 22.42 t/ha was recorded from treatment K_4 (180 kg/ha). The fresh yield escalated from lower dose K_1 (20.86 t/ha in 0 kg K/ha) to higher dose K_4 (22.42 t/ha in 180 kg K/ha) then it decreased again in treatment K_5 (22.11 t/ha in 240 Kg K/ha). Noor *et al*. (2014) and Karthikeyan *et al*. (2009) also suggested that the addition of K fertilizer gradually increases the yield of turmeric from low dose to high dose. Adequate supply of K nutrition enhances the uptake of nutrients which results in improved growth and production of metabolites for rhizome development, thereby improving the yield. In general, K nutrition improves the yields and disease resistance of roots and tubers (Noor *et al*. 2014).

The perusal of data (Table 1) revealed that the dry recovery percentage of turmeric was significantly affected by various levels of nitrogen (N). The maximum dry recovery (%) for both the year and in pooled value (22.65 %) was found with the lowest dose of nitrogen (N_1=0 kg/ha). In reverse the highest dose of nitrogen (N_5=160 kg/ha) ensued lowest dry recovery (%).

As for the different level of potassium there was a significant effect on the dry recovery (%) of turmeric during first year however, it showed no significant difference during the second year. Among the various potassium levels the highest dose of 240 kg/ha(K_5) attained the highest dry recovery percentage of 25.52%. With the decreasing dose of potassium (K) the dry recovery percentage also decreased and lowest of 24.98% was found with 0 Kg/ha (K_1). Verma *et al*. (2019) also reported that the level of dry recovery % increased with increase in K fertilizer level.

The results from the study (Table 2) shows that, the maximum dry yield of 6.44 t/ha in turmeric was recorded from nitrogen dose of 120 kg/ha (N_4) followed by 5.90 t/ha in dose of 160 kg N/ha (N_5). The dry yield increased up to dose of 120 kg/ha and then decreased when the dose was further increased. During the effective crop growth period the availability of N at optimum quantity is indispensable hence

Table 1. Effect of nitrogen and potassium on fresh yield and dry recovery per cent (%) of turmeric (t/ha).

Treatments	Fresh yield (t/ha)			Dry recovery (%)		
5 levels of nitrogen (N)	Year 1	Year 2	Pooled	Year 1	Year 2	Pooled
N_1 (0 kg/ha)	15.30	15.73	15.52	26.58	26.57	26.58
N_2 (40 kg/ha)	19.66	19.74	19.70	26.01	26.04	26.02
N_3 (80 kg/ha)	22.55	22.98	22.73	24.91	25.16	25.03
N_4 (120 kg/ha)	25.83	26.32	26.07	24.57	24.80	24.68
N_5 (160 kg/ha)	24.35	24.76	24.56	23.95	24.09	24.02
SEm±	0.11	0.12	0.05	0.04	0.04	0.02
CD (P=0.05)	0.31	0.34	0.14	0.13	0.12	0.05
5 levels of potassium (K)						
K_1 (0 kg/ha)	20.68	21.03	20.86	24.88	25.06	24.98
K_2 (60 kg/ha)	21.15	21.55	21.35	25.07	25.25	25.16
K_3 (120 kg/ha)	21.64	22.05	21.85	25.24	25.35	25.30
K_4 (180 kg/ha)	22.23	22.67	22.42	25.33	25.44	25.39
K_5 (240 kg/ha)	21.99	22.23	22.11	25.50	25.55	25.52
SEm±	0.11	0.12	0.08	0.04	0.04	0.03
CD (P=0.05)	0.31	0.34	0.22	0.13	0.12	0.08
Interaction						
SEm±	0.25	0.27	0.11	0.10	0.09	0.04
CD (P=0.05)	0.70	0.77	NS	0.28	NS	0.12

Table 2. Effect of nitrogen and potassium on dry yield (t/ha) and curcumin content (%) in dry form of turmeric.

Treatments	Dry yield (t/ha)			Curcumin content (%)		
5 levels of nitrogen (N)	Year 1	Year 2	Pooled	Year 1	Year 2	Pooled
N_1 (0 kg/ha)	4.07	4.18	4.12	4.71	4.76	4.74
N_2 (40 kg/ha)	5.12	5.14	5.13	4.93	4.96	4.94
N_3 (80 kg/ha)	5.62	5.78	5.52	5.20	5.16	5.18
N_4 (120 kg/ha)	6.35	6.53	6.44	5.47	5.35	5.41
N_5 (160 kg/ha)	5.83	5.96	5.90	5.66	5.57	5.62
SEm±	0.03	0.03	0.02	0.02	0.02	0.01
CD (P=0.05)	0.08	0.08	0.05	0.05	0.05	0.02
5 levels of potassium (K)						
K_1 (0 kg/ha)	5.11	5.24	5.18	5.14	5.11	5.12
K_2 (60 kg/ha)	5.27	5.41	5.34	5.16	5.14	5.15
K_3 (120 kg/ha)	5.43	5.56	5.49	5.20	5.17	5.18
K_4 (180 kg/ha)	5.60	5.74	5.66	5.22	5.17	5.20
K_5 (240 kg/ha)	5.57	5.65	5.44	5.25	5.21	5.23
SEm±	0.03	0.03	0.03	0.02	0.02	0.01
CD (P=0.05)	0.08	0.08	0.08	0.05	0.05	0.02
Interaction						
SEm±	0.06	0.06	0.04	0.04	0.04	0.02
CD (P=0.05)	0.18	0.18	0.11	0.11	NS	0.05

supplement of N at optimum dose will construct the appropriate soil nutrient status which will increase the assimilation and translocation of photosynthates (Ojikpong and Undie 2019). Therefore, this might have lead to the improved growth and dry yield at 120 kg N/ha.

The dry yield of turmeric showed significant influence due to effect of varying level of K fertilizer (Table 2). The maximum dry yield of 5.66 t/ha was achieved in treatment K_4 (180 kg K/ha) followed by 5.49 t/ha in K_3 (120 kg/ha). Certainly the dry yield was reduced to 5.18 t/ha when K fertilizer was not incorporated in the treatment (K_1: 0 kg K/ha).

Curcumin content (%) as response to different levels of nitrogen and potassium are depicted in Table 2. The result indicated that highest curcumin content was detected in turmeric supplemented with highest level of nitrogen i.e., 160 kg N/ha (N_5) followed by 120 kg N/ha (N_4) and it lessened as the level of nitrogen lowered. Curcumin content was significantly different between the treatments due to the varying level of nitrogen doses in this present experiment.

From Table 2 it is apparent that there was a consistent trend of increasing level of curcumin with increasing level of potassium. The maximum content of curcumin (5.23%) was recorded from the turmeric treated with 240 kg K/ha (K_5) followed by 180 kg K/ha (K_4) and the lowest curcumin content of 5.12 % was from turmeric bereft of K fertilizer i.e., K_1 (0 kg K/ha). Karthikeyan *et al*. (2009) also reported that higher dose of K helps to improve the curcumin content in turmeric. According to Akamine *et al*. (2007) Potassium is the principal element involved in curcumin formation in turmeric followed by phosphorus.

Effect of varying level of nitrogen and potassium on cost benefit ratio

Table 3 delineates the economics of cultivation of turmeric under different levels of nitrogen and potassium. Among the various treatment combinations, highest gross returns of Rs 383320/ha, net return of Rs 227425/ha and benefit cost ratio 2.46 was obtained from N_4K_4 (120 kg N/ha along with 180 kg K_2O/ha) combination. It was followed by N_5K_4 (160 kg N/ha along with 180 kg K_2O/ha) with gross returns of Rs 374500 /ha and net return of Rs 216290 /ha wherein benefit cost ratio 2.39 was achieved in N_3K_4 (80 kg N/ha along with 180 kg K_2O/ha). The least gross returns of Rs 207060 /ha, net return of Rs 55060 / ha and benefit cost ratio of 1.36 was obtained from treatment combination N_1K_1 (without N and K_2O).

Table 3. Economics of cultivation of turmeric under different levels of nitrogen and potassium. N_1 (0 kg nitrogen /ha), N_2 (40 kg nitrogen /ha), N_3 (80 kg nitrogen /ha), N_4 (120 kg nitrogen /ha), N_5 (160 kg nitrogen /ha) and K_1 (0 kg potassium /ha), K_2 (60 kg potassium /ha), K_3 (120 kg potassium /ha), K_4 (180 kg potassium /ha), K_5 (240 kg potassium /ha).

Treatment combinations	Rhizome yield (t/ha)	Cost of cultivation (Rs)	Gross return benefit (Rs)	Net return (Rs)	Benefit : Cost
N_1K_1	14.79	152000	207060	55060	1.36
N_1K_2	18.70	155150	261800	106650	1.69
N_1K_3	22.15	155800	310100	154300	1.99
N_1K_4	24.70	156450	345800	189350	2.21
N_1K_5	22.93	157100	321020	163920	2.04
N_2K_1	15.12	149315	211680	62365	1.42
N_2K_2	19.24	149965	269360	119395	1.80
N_2K_3	22.58	150615	316120	165505	2.10
N_2K_4	25.40	151265	355600	204335	2.35
N_2K_5	24.39	151915	341460	189545	2.25
N_3K_1	15.51	151630	217140	65510	1.43
N_3K_2	19.90	152280	278600	126320	1.83
N_3K_3	22.75	152930	318500	165570	2.08
N_3K_4	26.18	153580	366520	212940	2.39
N_3K_5	24.89	154230	348460	194230	2.26
N_4K_1	16.04	153505	224560	71055	1.46
N_4K_2	20.42	154595	285880	131285	1.85
N_4K_3	23.80	155245	333200	177955	2.15
N_4K_4	27.38	155895	383320	227425	2.46
N_4K_5	25.13	156545	351820	195275	2.25
N_5K_1	16.12	155820	225680	69860	1.45
N_5K_2	20.22	156910	283080	126170	1.80
N_5K_3	23.02	157560	322280	164720	2.05
N_5K_4	26.75	158210	374500	216290	2.37
N_5K_5	24.44	158860	342160	183300	2.15

CONCLUSION

From the present study it can be concluded that the combination of 120 kg Nitrogen/ha and 180 kg Potassium/ha (N_4K_4) was beneficial to get maximum yield per hectare and the highest benefit cost ratio under the terai zone of West Bengal.

REFERENCES

Akamine H, Hossain MA, Ishimine Y, Yogi K, Hokama K, Iraha Y, Aniya Y (2007) Effects of application of N, P and K alone or in combination on growth, yield and curcumin content of turmeric (*Curcuma longa* L.). Plant production science 10(1): 151-154.

Fisher SRA, Yates F (1963) Statistical Tables for Biological, Agricultural and Medical Research. 6th edn. Oliver and Boyd, Edinburgh Tweedale Court, London.

Gomez KA, Gomez AA (1984) Statistical Procedures for Agricultural Research. 2nd edn. John Wiley and sons Inc., Hoboken: 680.

Haque MM, Rahman AKMM, Ahmed M, Masud MM, Sarker MMR (2007) Effect of nitrogen and potassium on the yield and quality of turmeric in hill slope. *Int J Sustain Crop Prod* 2(6): 10-14.

Karthikeyan PK, Ravichandran M, Imas P, Assaraf M (2009) The effect of potassium on the yield and quality of turmeric (*Curcuma longa*). Research Findings: e-ifc, pp 21.

Kulkarni SJ, Maske KN, Budre MP, Mahajan RP(2012) Extraction and purification of curcuminoids from Turmeric (*Curcuma longa* L.). *Int J Pharmacol Pharmaceutical Technol* (IJPPT) 1(2): 81-84.

Leghari SJ, Wahocho NA, Laghari GM, HafeezLaghari A, MustafaBhabhan G, HussainTalpur K, Bhutto TA, Wahocho SA, Lashari AA (2016) Role of nitrogen for plant growth and development: A review. *Adv Environ Biol* 10(9):209-219.

Modupeola TO, Olaniyi JO (2015) Effects of nitrogen (N) fertilizer and plant spacing on the growth and rhizome yield of turmeric (*Curcuma Longa* L.) in Ibadan South-West Nigeria. *Int J Pl Sci Ecol* 1(4): 149-154.

Mekonnen B, Garedew W (2019) Nitrogen fertilizer rate and time of application affected yield and quality of turmeric (*Curcuma longa* L) at tepi, Southwestern ethiopia. *World J Agric Soil Sci* 2(3): 1-6.

Noor S, Akhter S, Islam MS, Hasan T, Hamidullah ATM (2014) Response of turmeric (*Curcuma longa*) to potassium fertilization on K deficient soil in Northern Bangladesh. Research Findings: e-ifc, pp 37.

Ojikpong TO, Undie UL(2019) Growth, yield and quality of turmeric (*Curcuma longa* linn.) as influenced by nitrogen fertilizer rates and nitrogen split application in obubra, south-south Nigeria. *Europ J Agric For Res* 7(4):1-13.

Verma PPS, Padalia RC, Singh VR, Kumar A, Agri BK (2019) Effect of nitrogen, phosphorus and potassium levels on growth and yield of turmeric (*Curcuma longa* L.). Under the Katyur valley of western Himalayan region of Uttarakhand. *J Med Pl* 7: 117-122.