APPLICATION OF POTASSIUM AND MAGNESIUM ON TURMERIC *(Curcuma longa)* TO INCREASE PRODUCTIVITY IN INCEPTISOLS

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Introduction

Tamil Nadu having 6.63 million hectares of cultivated area spread over seven agro –climatic zones enjoy varied agro climatic situations. It has been estimated that in 2015, the projected population in Tamil Nadu would be 69.61 million, for them the projected requirement of food grain would be 126 lakh tones. Under these circumstances, more intensive cultivation is the only option available for the state to sustain production of food grains. This intensification has lead to the changes in the cropping systems viz; monoculture of (sugarcane, turmeric, banana.), Short duration crops were introduced for utilizing the available moisture present in the soil, as well as drought resistant crops like tapioca which can utilize the moisture and nutrients present at deeper depths were brought into cultivation. These changes such as introduction of input responsive high yielding varieties and hybrids demanding heavy nutrient inputs resulted in increased consumption of mineral fertilizers. Therefore proper nutrient management program based on the soil nutrient status, with emphasis on potassium, secondary nutrients and micronutrients is required to run the agriculture system in the state of Tamil Nadu (Karthikeyan., 2006).

Turmeric (*Curcuma longa)* is an important commercial crop grown for its aromatic rhizomes used for culinary and cosmetic purposes since antiquity. Currently India is the largest producer, exporter, and consumer of this commodity in the world. Other producers in Asia include Bangladesh, Pakistan, Sri Lanka, Taiwan, China, Burma (Myanmar), and Indonesia. Turmeric is also produced in the Caribbean and Latin America: Jamaica, Haiti, Costa Rica, Peru, and Brazil. The world trade in turmeric is around 37,000 t valued at US$40,160 million. The major importing countries are the Japan, Iran, United Arab Emirates (UAE), Bangladesh, Singapore, Netherlands, and Sri Lanka accounting for nearly 80% of turmeric traded the world over. (Ravindran *et al*., 2007). Turmeric is a tropical rhizomatous crop. Turmeric has a high demand for plant mineral nutrients and generally responds to increased soil fertility by raising yield production, the quantity of fertilizers (inorganic or organic) required by the crop depending on the variety selected as well as soil, and weather conditions prevailing during crop growth.(Karthikeyan.*et al.*,2009). The average cured rhizome yield of turmeric ranges from 3 to 5 mt ha^{-1} in the Erode district, of Tamil Nadu, (Selvarajan and Chezhiyan, 2001). In order to study the effect of potassium and magnesium on turmeric production and on its quality attributes of the crop under conditions of adequate supply of nitrogen and phosphorus, a pot experiment was carried out on the Irugur soil series (Inceptisols) in the western zone of Tamil Nadu.

Materials and Methods

The pot experiment was carried out on an Inceptisol (a soil with little horizon development) in the farmers` holdings at Arachalur, in the Erode District of Tamil Nadu, under the supervision of The Department of Soil Science and Agricultural Chemistry, Faculty of Agriculture, Annamalai University. Soil samples taken from the field experiment prior to treatment application, were analyzed for all important soil parameters adopting standard procedures. The available N (alkaline $KMnO_4$), P (Bray P), K (NH_4OAc) contents were 120, 8.8, 69 mg kg^{-1} respectively. The experimental design was a randomized block design with six treatments replicated threefold. The details of the treatments are given in Table 1.

Table 1: Experimental treatments (kg of K_2O ha^{-1} + kg MgSO4 ha^{-1})

K1	Control (No potash)
K2	40 + 4 (kg of K_2O ha^{-1} + kg $MgSO_4$ ha^{-1})
K3	80 + 8 (kg of K_2O ha^{-1} + kg $MgSO_4$ ha^{-1})
K4	120 +12 (kg of K_2O ha^{-1} + kg $MgSO_4$ ha^{-1})
K5	160 +16 (kg of K_2O ha^{-1} + kg $MgSO_4$ ha^{-1})
K6	200 +20 (kg of K_2O ha^{-1} + kg $MgSO_4$ ha^{-1})

120 kg of N ha^{-1}(urea), 50 kg P_2O_5 ha^{-1} (superphosphate), 5 kg $ZnSO_4$ ha^{-1}, and 5 kg Fe SO_4 ha^{-1} were applied to all the treatments. Farm yard manure at a rate of 25 mt ha^{-1}as well as 50 kg of P_2O_5 ha^{-1} and 5 kg of $ZnSO_4$ ha^{-1} and 5 kg of $FeSO_4$ ha^{-1} were applied as a basal treatment on all plots. The fertilizers, potassium (as muriate of potash KCl), magnesium as (magnesium sulphate), nitrogen (as urea) and phosphorus (as super phosphate) were applied in four equal splits. The first split was applied basally and the rest on 30, 60, and 90 days after planting. During crop growth, growth parameters viz., tiller count per plant and secondary rhizomes per plant were recorded. The crop was harvested 290 days after planting and the yield of fresh rhizomes was documented. The curcumin content of rhizome samples was estimated by the method suggested by (ASTA, 1968).

Results and Discussion

The positive response of turmeric to increased potassium and magnesium fertilization expressed itself by way of enhanced tillering coupled with increased yields (Table 2).

Table 2. Influence of potassium on the yield and quality of turmeric Cv. Erode local

Treatments	(Potash + Magnesium) application	No of tillers	Fresh turmeric yield	Curcumin content
	Kg ha^{-1}	*No./plant*	*g $plant^{-1}$*	*%*
K1	0 (control)	4.2	453	2.96
K2	(40+4*)	5.7	570	3.24
K3	(80+8*)	7.7	683	3.59
K4	(120+12*)	10.0	785	3.88
K5	(160+16*)	12.7	883	4.14
K6	(200+20*)	14.0	963	4.28
CD (P=0.05)		1.24	18.3	0.16

kg of K_2O ha^{-1} * kg of Mg SO_4 ha^{-1}

The data presented in Table 2 indicate that the number of tillers per plant increased significantly with increased rates of application of potassium and magnesium. The treatment which received 200 kg of K_2O $ha^{-1}$and 20 kg of $MgSO_4$ ha^{-1} (K6) recorded the highest tiller count (14 $plant^{-1}$) was statistically significant to all other treatments. The rhizome yield followed the similar trend and application of potassium at higher levels 200 kg of K_2O ha^{-1} and 20 kg of $MgSO_4$ ha^{-1} exhibited significant and synergistic effect over the other treatments which received less potassium. Singh *et al*., (1998) also showed that increasing rates of potassium application had a positive and significant effect on fresh rhizome yield.

Rhizome quality is judged on how much curcumin it contains. This important quality parameter of the rhizome, curcumin content i.e. concentration has been shown to increase significantly in response to potassium application (Singh *et al.*, 1992). Our results also confirmed this finding of significantly increased concentrations as a consequence of potassium and magnesium application. Magnesium has major physiological and molecular roles in plants, such as being a component of the chlorophyll molecule, a cofactor for many enzymatic processes associated with phosphorylation, dephosphorylation, and the hydrolysis of various compounds, and as a structural stabilizer for various nucleotides. The control recorded a value of 2.96 percent which was significantly lower than the other treatments (4.14- 4.28 percent). The highest curcumin content of 4.28 per cent was recorded in treatment (K6) 200 kg of K_2O $ha^{-1}$and 20 kg of $MgSO_4$ ha^{-1} followed by treatment K5 which recorded 4.14 per cent. In this experiment potassium application along with magnesium at the highest rate brought about a significant increase in yield of cured rhizomes, and curcumin content.

Conclusions

The influence of potassium and magnesium on growth, yield, and quality parameters of turmeric *Cv. Erode local* was assessed from a pot experiment on an Inceptisol low in available K, in Tamil Nadu, the major turmeric growing region of South India. Increasing the rate of application of potassium (200 kg K_2O ha^{-1}) in the form of KCl enhanced growth, nutrient uptake and utilization, increasing yield and quality of turmeric. This more than doubled cured rhizome yield and increased curcumin content by over 50 percent. These results suggest that the turmeric crop requires large amounts of potassium and magnesium for both yield and quality. Increased potassium fertilization or availability, relative to magnesium, will inhibit magnesium absorption and accumulation and vice versa. The degree of this antagonistic effect varies with potassium and magnesium fertilization rates, as well as the ratio of the two nutrients to one another (*Lasa et al.*, 2000).Further higher levels of potassium and magnesium should be incorporated and test verified for optimization of both potassium and magnesium levels in turmeric crop.

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