Short communication

Effect of S, Ca and Mg on fresh rhizome yield of turmeric (*Curcuma longa* L.)

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Abstract

The effect of the secondary elements, viz., sulphur, calcium and magnesium on the yield of turmeric (*Curcuma longa* L.) was studied at the Department of Agronomy, College of Horticulture, Vellanikkara from 2013-2014. Ten treatments were evaluated which included 25 kg ha^{-1} each of sulphur, calcium and magnesium applied separately and in combination at 30 and 60 days after planting along with recommended dose of manures and fertilizers for turmeric as per package of practices recommendations of the Kerala Agricultural University. The experiment was laid out in randomized block design with three replications. Application of calcium @ 25 kg ha^{-1}, 60 days after planting and magnesium @ 25 kg ha^{-1}, 30 days after planting along with package of practices recommendation of Kerala Agricultural University significantly enhanced dry matter production at 6 months after planting and fresh rhizome yield. A yield increase of 33.77 percent and 29.27 percent were recorded in the above treatments over the recommended package of practices of Kerala Agricultural University. Highest yields were associated with highest calcium contents in shoots at six months after planting.

Key words : Secondary nutrients; Rhizome yield; Turmeric; Sulphur; Calcium; Magnesium

Turmeric (*Curcuma longa* L.) is a very important spice crop, widely used in medicines, drug, cosmetic, and food industries. The rhizome also has an important role in indigenous medicine. The climatic and soil conditions prevailing in Kerala are optimally suited for the cultivation of the crop. Turmeric is a soil exhausting crop, and application of N, P and K are recommended for its economical cultivation. Secondary nutrients do not find a place in the nutrient recommendations. However, high rhizome yields in turmeric with increasing concentrations of foliar sprays of magnesium sulphate in the acidic soils of Meghalaya have been reported (Chandra et al., 1997). Bose et al. (2008) reported that inclusion of S and Mg in the fertilization schedule greatly improved the fresh yields of turmeric in the depleted red lateritic soils of West Bengal. Similarly, Kavitha (2012) revealed that in the rhizomatous crop kacholam (*Kaempferia galanga* L.), top dressing of sulphur and magnesium resulted in higher rhizome yields. Hence, an experiment was taken up to study the effect of S, Ca and Mg along with recommended dose of manures and fertilizers for turmeric as per package of practices recommendations of the Kerala Agricultural University on the yield of turmeric.

The experiment was carried out in the farm of the Department of Agronomy, College of Horticulture, Vellanikkara from June 2013 to January 2014. The soil of the experiment site was sandy loam in texture, with a pH of 5.3. Available N, P, K, S, Ca and Mg contents in the soil were 593.74, 9.50, 386.77, 25.10, 382.60 and 20.90 kg/ha respectively. The experiment was laid out in randomized block design with ten treatments and three replications. The treatment details are as follows:

T_1: POP + 25 kg S ha^{-1} applied 30 days after planting (DAP)
T_2: POP + 25 kg S ha^{-1} applied 60 DAP
T_3: POP + 25 kg Ca ha^{-1} applied 30 DAP
T_4: POP + 25 kg Ca ha^{-1} applied 60 DAP
T_5: POP + 25 kg Mg ha^{-1} applied 30 DAP
T_6: POP + 25 kg Mg ha^{-1} applied 60 DAP

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T_7: POP + 25 kg S ha^{-1} + 25 kg Ca ha^{-1} + 25 kg Mg ha^{-1} applied 30 DAP
T_8: POP + 25 kg S ha^{-1} + 25 kg Ca ha^{-1} +25 kg Mg ha^{-1} applied 60 DAP
T_9: Control - POP (Package of practices recommendations of Kerala Agricultural University) viz., 40 t/ha FYM and 30:30:60 kg N, P_2O_5 and K_2O/ ha; FYM 40 t , 30 kg P_2O_5 plus 30 kg K_2O as basal dose, 20 kg N at 30 DAP, 10 kg N plus 30 kg K_2O at 60 DAP.
T_{10}: Absolute control (no manures or fertilizers)
The nitrogen, phosphorus and potassium were applied in the form of urea, ammonium sulphate, rock phosphate and muriate of potash as per treatment requirements. Sulphur was applied in the form of ammonium sulphate, while Ca and Mg were applied as calcium oxide and magnesium oxide.

Rhizome bits of variety Sobha weighing 20g each were planted in raised beds of dimensions 2 m x 1 m at a spacing of 25cm x 25 cm. The cultural operations in the field were carried out following the recommended package of practices of Kerala Agricultural University (KAU, 2011). Observations were recorded on the available N, P and K status of soil, dry matter production, fresh rhizome yield and primary and secondary nutrient contents of shoots of turmeric. The dry matter accumulation at 3 months after planting (MAP) and 6 MAP were recorded from each plot by randomly selecting five plants. Fresh yield was calculated by harvesting rhizomes from the net plot area separately for each treatment and was expressed on per hectare basis. Rhizomes were cut into small pieces and dried to constant weight at 70°C in a hot air oven. The dried and powdered rhizomes were analyzed for primary and secondary nutrient contents. The procedures detailed by Jackson (1958) were followed for estimating N, P and K. S was estimated turbidimetrically using a spectrophotometer (Williams and Steinberg, 1959). Ca and Mg contents were estimated by the atomic absorption spectrophotometer (Page, 1982). The data was analyzed using the statistical package MSTAT-C (Freed, 1986). Duncan's Multiple Range Test (DMRT) was used to compare means (Duncan, 1955; Gomez and Gomez, 1984).

Data on dry matter accumulation recorded at 3 and 6 months after planting and fresh rhizome yield are presented in Table 1. At 3 months stage, application of calcium 60 DAP along with POP recommendation (treatment T_4) resulted in highest dry matter production, *i.e*., 2069 kg ha^{-1}. However, all the treatments were on par with this treatment except for T_6, T_8 and T_{10}. At 6 months after planting, treatments were significantly different. Treatment receiving calcium at 60 DAP along with POP (T_4) recorded highest dry matter production of 9237 kg ha^{-1}. This was on par with T_5, where Mg was top dressed at 30 DAP along with POP (8897 kg ha^{-1}) and T_8, where combination of secondary nutrients were applied along with POP at 60 DAP (8751 kg ha^{-1}). Absolute control produced the lowest value both at 3 and 6 months stage (829 and 6387 kg ha^{-1} respectively).

Significant difference was observed between treatments with respect to fresh rhizome yields. Calcium (T_4) and magnesium (T_5) @ 25 kg ha^{-1} each top dressed at 60 DAP and 30 DAP respectively along with POP produced significantly higher rhizome yield (30.58 Mg ha^{-1} and 29.55 Mg ha^{-1} respectively) compared to control, T_9 (22.86 Mg ha^{-1}). Thus the application of calcium or magnesium along with POP could produce 33.77 per cent and 29.27 per cent increase in yield over the recommended package of practices recommendation of Kerala Agricultural University (control).

The treatments POP + sulphur @ 25 kg ha^{-1} applied at 30DAP (T_1), POP + calcium @ 25 kg ha^{-1} applied at 30 DAP (T_3), POP + calcium @ 25 kg ha^{-1} applied at 60DAP (T_4) and POP + Mg @ 25 kg ha^{-1} applied at 30 DAP (T_5) were on par. Enhanced productivity levels in rhizomatous and tuber forming crops through the application of Ca and S have been obtained by several researchers. Simmons and Kelling (1987) reported that highest tuber yield in potato was obtained when Ca was applied through

Table 1. Effect of treatments on dry matter production and fresh rhizome yield

Treatment No.	Treatments	Dry matter production (kg ha^{-1}) 3 MAP	Dry matter production (kg ha^{-1}) 6 MAP	Rhizome yield (Mg ha^{-1})
T_1	POP + S-30 DAP	1716^{abc*}	8022^{d}	26.29^{abc}
T_2	POP + S-60 DAP	1699^{abc}	8110^{cd}	23.63^{cd}
T_3	POP + Ca-30 DAP	1817^{ab}	8312^{bcd}	25.92^{abcd}
T_4	POP + Ca-60 DAP	2069^{a}	9237^{a}	30.58^{a}
T_5	POP + Mg-30 DAP	1827^{ab}	8897^{ab}	29.55^{ab}
T_6	POP + Mg-60 DAP	1153^{cd}	7958^{d}	24.78^{bcd}
T_7	POP + S + Ca + Mg-30 DAP	1639^{abc}	8273^{bcd}	23.26^{cd}
T_8	POP+ S + Ca + Mg-60 DAP	1418^{bc}	8751^{abc}	21.36^{d}
T_9	POP (Control)	1575^{abc}	8492^{bcd}	22.86^{cd}
T_{10}	Absolute control	829^{d}	6387^{e}	10.42^{e}
S.E.		172.62	202.05	1.626
CD(0.05)		517.877	606.175	4.878

*In a column, means with the same superscript do not differ significantly at 5% level
DAP - days after planting; POP - Package of practices recommendations of Kerala Agricultural University

Ca $(NO_3)_2$ in combination with $CaSO_4$. Singh and Dwivedi (1993) also reported highest tuber yields in potato when S was applied through gypsum.

Rhizome yield of turmeric was found to increase with increasing concentrations of foliar sprays of magnesium sulphate in the acidic soils of Meghalaya (Chandra et al., 1997). Gangadharan and Menon (2003) discussed improvement in quantitative yield development in kacholam by application of $MgSO_4$ one month after planting. 20 kg S ha^{-1} is one of the recommendations for fertilizers for ginger in Bangladesh (Halder et al., 2007), confirming the positive effect of S on the productivity of rhizomatous crops. Application of high rates of Mg (22 kg ha^{-1}) along with sulphur (44 kg ha^{-1}) and recommended dose of NPK, improved the yield and quality of turmeric (Bose et al., 2008). Kavitha and Menon (2013) reported the role of secondary nutrients in improving both quantitative and qualitative yields in kacholam

Nutrient contents of shoots at 6 MAP are given in Table 2. Both major and secondary nutrient contents were analyzed at this stage. All the treatments were on par except for absolute control (T_{10}) with regard to N content. However, package of practices recommendations of Kerala Agricultural University (KAU, 2011) gave the highest value (1.57%). P content, was superior in T_4 where calcium was applied at 60 DAP along with POP. K content was highest in T_3, where calcium was applied in addition to POP at 30 DAP and was on par with T_2, where suphur was top dressed at 60 DAP. Content of sulphur was highest in the treatment where earlier application (30 DAP) of sulphur was done T_1. The treatment where calcium was applied at 60 DAP registered highest content of calcium and it was on par with T_3, T_7, T_1, T_9, T_8 and T_5. Highest content of 0.37% Mg was noticed in T_5, where magnesium was top dressed at 30 DAP and in T_7, where combination of treatments were applied at 30 DAP. T_6 and T_1 were on par with this. In short, higher contents of S, Ca and Mg in plants were recorded in the treatments where these nutrients were applied. The higher yielding treatments were associated with higher contents of Ca in the shoots. This may be related to the role of calcium in translocation of carbohydrates and nutrients. Decreased carbohydrate content of stems and roots and impaired root function because of low energy supply occurs due to Ca stress (Havlin et al., 2006). Higher rhizome yield was obtained when later application of Ca was done *i.e.,* 60 DAP. Ca being generally immobile in the plant, a continuous supply available for root absorption would support better growth and

Table 2. Effect of treatments on primary and secondary nutrient contents in turmeric shoots at 6 MAP

TreatmentNo.	Treatments	N (%)	P (%)	K (%)	S (%)	Ca (%)	Mg (%)
T_1	POP + S-30 DAP	1.16^{abc*}	0.057^{h}	1.39^{cd}	0.45^{a}	0.68^{abc}	0.27^{cde}
T_2	POP + S-60 DAP	1.16^{abc}	0.067^{f}	2.17^{ab}	0.34^{bc}	0.58^{bcd}	0.24^{ef}
T_3	POP + Ca-30 DAP	1.10^{bc}	0.092^{d}	2.26^{a}	0.27^{de}	0.74^{ab}	0.30^{bcde}
T_4	POP + Ca-60 DAP	1.45^{ab}	0.130^{a}	1.37^{cd}	0.30^{cde}	0.76^{a}	0.25^{de}
T_5	POP + Mg-30 DAP	1.33^{ab}	0.107^{b}	1.91^{b}	0.27^{ef}	0.61^{abcd}	0.37^{a}
T_6	POP + Mg-60 DAP	1.28^{abc}	0.097^{c}	1.39^{cd}	0.26^{ef}	0.54^{cd}	0.33^{ab}
T_7	POP + S + Ca + Mg-30 DAP	1.28^{abc}	0.086^{e}	1.18^{cd}	0.33^{bcd}	0.74^{ab}	0.37^{a}
T_8	POP+ S + Ca + Mg-60 DAP	1.23^{abc}	0.092^{d}	1.47^{c}	0.38^{b}	0.62^{abcd}	0.31^{bcd}
T_9	POP (Control)	1.57^{a*}	0.062^{g}	1.17^{cd}	0.28^{cde}	0.67^{abc}	0.32^{abc}
T_{10}	Absolute control	0.87^{c}	0.037^{i}	1.12^{d}	0.21^{f}	0.47^{d}	0.19^{f}
S.E.		0.1328	0.0114	0.1066	0.0177	0.0510	0.0146
CD(0.05)		0.401	0.034	0.317	0.053	0.152	0.043

***** In a column, means with the same superscript do not differ significantly at 5% level

DAP - days after planting; POP - Package of practices recommendations of Kerala Agricultural University

yield. It can be speculated that further application of Ca, beyond 60 DAP, may have produced still better results.

The present experiment could prove that integrating calcium @ 25 kg ha^{-1}, 60 days after planting or magnesium @ 25 kg ha^{-1}, 30 days after planting along with recommended dose of manures and fertilizers as per package of practices recommendation of Kerala Agricultural University could substantially enhance the yield of turmeric.

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