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Short communication

Boron nutrition of tomato (*Lycopersicon esculentum* L.) grown in the laterite soils of southern Kerala

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Abstract

A pot culture experiment was conducted to study the effects of 0, 0.5, 1.0, and 1.5 kg B ha^{-1} with recommended doses of chemical fertilizers (75:40:25 kg N, P_2O_5, and K_2O ha^{-1}; RDF) and RDF+ farmyard manure (FYM; 25 tonnes ha^{-1}) on growth, yield, and quality of tomato as well as the B status of a lateritic soil in southern Kerala. B significantly increased plant height and number of primary branches. It also reduced the days to flowering and increased fruit set (12.5 to 20% more at the highest level) both with and without FYM. Benefit–cost ratio was 40% greater for the highest level of B when applied in conjunction with RDF compared with RDF alone (no B). Quality parameters like reducing sugars, total sugars, vitamin C, and lycopene concentrations also improved following B application. Nevertheless, B availability in these soils attained sufficiency levels (2 mg kg^{-1}) at 0.5 kg ha^{-1} of applied B, implying the need to exercise caution especially when applying higher doses.

Keywords: Boron availability, Fruit quality, Micronutrient fertilization, Recommended fertilizers.

Tomato (*Lycopersicon esculentum* L.) is India's most extensively grown vegetable crop after potato (*Solanum tuberosum* L.). It is cultivated over an area of 0.466 million ha with a production of 8.271 million tonnes, accounting for 7.95% of the world's tomato area and production (Chadha, 2002). Tomato is considered a heavy feeder of micronutrients and B in particular is important for its growth, fruit set, and disease resistance (Srinivasamurthy et al., 2003). Major soils of Kerala, derived from acid igneous rocks are, however, deficient in B (SSO, 2007). Moreover, being highly mobile in the soil (Tisdale et al., 1986), leaching losses further aggravate B insufficiency in the high rainfall zones of Kerala, frequently leading to development of deficiency symptoms in crop plants. Since the difference in concentration between sufficiency and toxicity levels of micronutrients being very narrow, blanket applications of B to correct deficiency is sometimes risky, as it would lead to environmental hazards. This paper reports an attempt to optimize the B requirement of tomato in the lateritic soils of southern Kerala and summarizes the impact of applied B on growth, yield, and quality of tomato, besides how the available soil B pool is altered following B additions.

A pot culture experiment was conducted from September 2004 to January 2005 at Vellayani using the surface soil collected in bulk from Thiruvallom (Vizhinjam Soil Series), nearby type location of laterite soil (Kandic Haplustult). The soil after drying under shade and sieving (2 mm) was filled in 32 earthen pots (50 cm diameter) at the rate of 8 kg per pot. The experimental variables (eight) were 0, 0.5, 1.0, and 1.5 kg ha^{-1} B supplied as borax in combination with the recommended doses of chemical fertilizers (RDF: 75:40:25 kg N, P_2O_5, and K_2O ha^{-1}, i.e., 0.3:0.17:0.1 g pot^{-1}; KAU, 2002) and RDF + farmyard manure (25 tonnes FYM ha^{-1}, i.e., 100 g pot^{-1}). There were four

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replications (pots) for each treatment. Full doses of N, P, K, and B were applied before transplanting and one seedling was planted per pot. Growth, yield characters, and yield were monitored. Quality parameters like sugars and vitamin C were determined titrimetrically and beta-carotene and lycopene by colorimetry. The data were statistically analyzed following the ANOVA technique and means compared using Duncan's multiple range test.

Results reveal that tomato responds to B application in the laterite soils of Kerala indicating that it is a limiting nutrient in these soils. Number of primary branches, percent fruit set, total dry matter production, and yield increased with increasing levels of B (Table 1). Increase in yield was 35 and 7% respectively when B was applied at 1.5 kg ha^{-1} without and with FYM, indicating that FYM meets B requirements of the crop partially. Reducing sugars, total sugars, and vitamin C, and lycopene concentrations also increased significantly with increasing levels of B, besides the B-C ratio (Table 1). Concurrent increase in sugar and vitamin C contents may indicate the catalytic function of B in converting sugars to vitamin C as suggested by Bergmann (1992). Furthermore, our results indicate that quality improvement was more prominent than yield when B was applied along with RDF and FYM while increase in yield and improvement in quality were equally prominent when it was applied along with RDF alone (no FYM). This suggests that B needs of the crop is only partially satisfied from the organic manures, but inorganic supplementation of B is warranted to meet the entire crop needs.

In deciding the optimal dose of micronutrient fertilizers, not only yield increase and quality improvement are important, but also the residual soil nutrient concentrations attained following nutrient addition is significant, especially to sustain soil health. The upper limit of the critical nutrient range for B sufficiency in soil is reported to be 2 mg kg^{-1} (Sillanappa, 1991). Our soil analysis showed that this level was reached when B was applied at 0.5 kg ha^{-1} (Table 1). Despite this, gains in fruit yield and quality continued up to 1.5 kg B ha^{-1}. Considering the critical range of micronutrient concentrations for sustaining soil health, application

Table 1. Effect of applied B on growth, yield, and quality of tomato and available B content in the laterite soils of Thiruvallom (Vizhinjam Soil Series) in southern Kerala.

Treatments	Primary branches	Days to flowering	Fruitset (%)	Yield per plant (g)	Total dry matter per plant (g)	B:C ratio	Total sugars (mg 100 g^{-1})	Vitamin C (mg 100 g^{-1})	Lycopene (mg 100 g^{-1})	Available soil B (ppm)
RDF (no B)	9.5^{a}	32.5^{a}	55.3^{a}	477.5^{a}	54.3^{a}	0.98^{a}	3.08^{a}	21.55^{a}	3.25^{a}	0.33^{a}
RDF + FYM (no B)	10.8^{b}	30.3^{b}	68.5^{b}	751.3^{b}	77.6^{b}	1.53^{b}	3.22^{b}	26.90^{b}	4.30^{b}	0.55^{b}
RDF + B (0.5 kg ha^{-1})	10.8^{a}	29.8^{a}	61.2^{a}	585.5^{a}	74.1^{a}	1.19^{a}	3.38^{a1}	26.75^{a}	4.15^{a}	1.84^{a}
RDF +B (1.0 kg ha^{-1})	11.3^{a}	29.3^{a}	62.5^{a}	624.0^{a}	78.5^{a}	1.27^{a}	3.49^{a}	28.70^{a}	4.40^{a}	2.27^{a}
RDF + B (1.5 kg ha^{-1})	11.8^{a}	29.5^{a}	66.3^{a}	643.3^{a}	78.6^{a}	1.29^{a}	3.57^{a}	30.07^{a}	4.58^{a}	2.53^{a}
RDF + FYM + B (0.5 kg ha^{-1})	11.0^{b}	29.3^{b}	71.3^{b}	759.8^{b}	79.5^{b}	1.55^{b}	3.62^{b}	30.72^{b}	4.30^{b}	2.00^{b}
RDF + FYM + B (1.0 kg ha^{-1})	11.8^{b}	28.5^{b}	73.5^{b}	786.8^{b}	80.7^{b}	1.57^{b}	3.67^{b}	31.67^{b}	4.41^{b}	2.58^{b}
RDF + FYM + B (1.5 kg ha^{-1})	12.3^{b}	28.3^{b}	76.0^{b}	803.5^{b}	81.1^{b}	1.60^{b}	3.73^{b}	32.82^{b}	4.73^{b}	2.86^{b}

RDF = Recommended dose of fertilizers (75:40:25 kg ha^{-1}), FYM = farmyard manure (25 tonnes ha^{-1}); means with same superscript do not differ significantly.

of B carriers, may be recommended at 0.5 kg B ha^{-1} along with RDF and FYM in the laterite soils of southern Kerala. However, the rate and periodicity of B application may be further evaluated by establishing more detailed field experiments.

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