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Short communication

Critical limit of soil and plant magnesium in tomato-growing soils of South Karnataka

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ABSTRACT

Response of tomato to a blanket application of 50kg Mg ha^{-1} was studied at 20 locations on soil available Mg ranged from 40.6ppm to 172.4ppm. This range can be classified exchangeable Mg low to high status. These plots were selected from intensive tomato growing areas of southern Karnataka. The yield responses obtained from these plots were used to calculate the soil and plant Mg critical levels. Using scattered plot technique soil Mg limit of 74ppm is arrived as critical soil Mg for tomato crop. Similarly a plant critical limit of 0.39% was established to separate deficient plants from those having sufficient Magnesium.

Key words: Alfisols, calcium, critical limit, nutrient interaction, tomato

India produces 12.43 million tonnes of tomato from an area of 6.34 lakh hectares. The average productivity is 19.60 t ha^{-1}. Karnataka state is one of the leading producers of tomato having 0.483 lakh hectares with a production and productivity of 15.80 lakh tones and 32.70t ha^{-1}, respectively (Anon., 2010). Tomato farmers want to have high quality tomatoes for fetching better price in the market. This can be achieved through better crop production practices, which included balanced nutrition and better water management practices.

Tomato farmers use high inputs including fertilizers to attain high productivity. Many a times, a skilled application of NP fertilizers is a general rule rather than an exception. This has caused huge nutrient imbalances in tomato soils. As a result deficiencies of secondary and micronutrients are becoming common which affects both yield and quality. Recently magnesium deficiency is found to be one of the major constraints in obtaining high yields and quality of tomato. In many acid soils addition of dolomite lime stone in the crop rotation helps in alleviating Mg deficiency both through direct supply of Mg and through correction of pH of the soil.

The studies on different crops have shown that, Mg application in red soils of Karnataka, have increased the yields by 15- 20%. Crop response to applied Mg varied from 8 to 84%. The response depends on crop species, location and soil type. Further it has been observed that where the exchangeable Mg is lower than 0.5 [cmol(p+) kg^{-1}], application to soil responded well in all crops (Ganesha Murthy and Hegde, 1980), where in study was undertaken to assess the critical levels of Mg for tomato in soils of Karnataka.

Forty-eight soil samples were collected from tomato growing fields from Kolar, Chikkaballapura, Bangalore, Tumkur, Belgum and Hassan districts of Karnataka. These samples were analysed for available magnesium content using different extractants viz., 1N NH4OAC and 0.02 M $CaCl_2$. These samples were analyzed for available magnesium using atomic absorption spectrophotometer.

Simple fertilizer trials were conducted at 20 sites selected from the above 48 samples based on available Mg content ranging from low to high in the year 2009-10 in order to assess the critical limit of Mg in soil and plant. Two treatments were imposed in twenty locations. First treatment was recommended dose of fertilizers (180:150:120 NPK kg ha^{-1}) and second treatment was recommended dose of fertilizers (180:150:120 NPK kg ha^{-1}) + 50kg Mg ha^{-1}. Tomato hybrid Arka Ananya was used for this experiment with a spacing of 100cm x 60cm.

From these plots soil samples were drawn and available magnesium was estimated by using 1N NH4OAC and 0.05M$CaCl_2$ extracts. Soil analysis was done at three different stages of plant growth such as initial, flowering and harvesting stages.

Plant sample: whole plant samples were collected from each treatment for recording total biomass production. Five plants from each replication were also sampled for fruit, leaf and stem separately. The plant samples were partitioned into leaf, stem and fruit, washed. Weight of each plant was recorded separately after drying at 70°C in a hot air oven. Samples were powdered and processed for estimation of nutrients accumulated in plant. Nutrient estimated from the plant tissue included nitrogen, phosphorous, potassium, calcium and magnesium using standard procedures at different stage of initial, flowering and harvesting stage.

Statistical procedure: Cate and Nelson (1965) scatter plot technique was used to find out the critical limits of soil and plant magnesium in tomato growing belts of southern Karnataka. In this approach per cent yield value were obtained for a wide range in different location. Scattered plot diagram were drawn as percent yield (y axis) and soil test level (X axis). The Percent yield was calculated using the formula.

$$\text{Percent yield} = \frac{\text{Yield at 0 level of a nutrient}}{\text{Yield where all factors are adequate}}$$

Critical limit of soil magnesium: Data on available Mg in the 48 samples collected from different tomato growing districts are presented in Table 1. In Bengaluru Urban district, the available Mg ranged from 61.6 to 154.2ppm, whereas, in Tumkur and Bengaluru Rural, it varied from 61.6 to 70.6 and 64 to 73.6ppm, respectively. In Chikkaballapura district, the available Mg ranged from 67.2 to 71.2 ppm. These soils, being Alfisols, are inherently acidic and available soil Mg was in medium to low range. Asiegbu and Uzo, 1983 reported soil available Mg of 0.64mg/100g in Alfisols. Similar results were also reported by other authors. Response to applied Mg in simple fertilizer experiments conducted over 20 sites is presented in Table 2. The response varied from 77.3 to 102.4%. The degree of response was in proportion to the level of soil available Mg. Osman and Gerald, 1985 suggested that application of 56kgha^{-1} corrected Mg deficiency and yield was increased significantly in tomato crop. Response to applied Mg in Indian soils in various crops is reported by several workers. Deshbandhu *et al*, 2003 found that udic ustochrepts application of 60kg Mg ha^{-1} increased the mustard yield by 22-23%.

Table 1. Available soil Mg (ppm) extracted by two extractants in selected samples

Sample No.	Available soil Mg	
	$CaCl_2$	NH_4OAc
1	53	78.8
2	44.8	46.2
3	42.6	61.6
4	60.6	70.6
5	50.2	95.2
6	53.2	55.2
7	50	48.4
8	96	116
9	101.6	150.4
10	78.4	151.2
11	105.4	143.4
12	106.2	132.6
13	135.2	139.4
14	40.8	53.8
15	56	56.4
16	50.2	40.6
17	103.4	115
18	104.8	124.2
19	92.4	94.8
20	75.2	97.2
21	99.6	71.2
22	68.4	68.8
23	67.4	74.2
24	105.2	74.4
25	104.4	138.2
26	110.4	135.4
27	77.2	78.8
28	55.6	73.6
29	47.6	64
30	130	161.6
31	104.6	172.4
32	93.2	98
33	67.6	80.6
34	64.6	73.4
35	69.4	81.4
36	56	74.8
37	52.2	61.6
38	55.6	79.2
39	73	91.2
40	62.8	136.8
41	54.8	68.8
42	50.4	67.2
43	57.2	70.4
44	52.8	71.2
45	55.2	74.4
46	58	75.6
47	61.6	74
48	57.2	78.4

Soil critical-limit

Bray's per cent yield was plotted against soil available Mg (Fig 1). Using this scattered plot technique of Cate and Nelson (1965) a critical limit of 74 ppm soil Mg was estimated. Similarly the critical level was estimated using

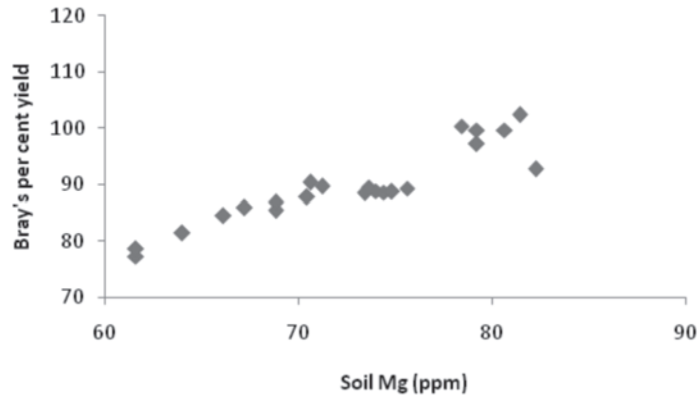

Fig1. Brays per cent yield v/s soil magnesium determining critical Mg concentration in soil.

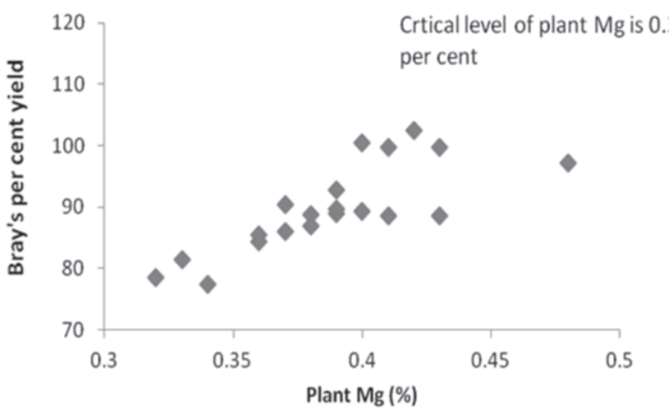

Fig. 2. Scatter plot between Bray's per cent yield v/s plant Mg concentration for determining the plant critical Mg

Table 2. Effect of magnesium on yield in tomato var. Arka Ananya in alfisols of South Karnataka

Location	Initial soil Mg (ppm) (NH_4 OAc)	Tomato Yield ($t\ ha^{-1}$)		Bray's per cent yield	Per cent increase	Response ($q\ ha^{-1}$)
		NPK+ $MgSO_4$	NPK			
1. (BU)	74	74.25	66.00	88.89	12.50	82.50
2. (BU)	78.4	67.25	67.50	100.37	-0.37	-2.50
3. (BU)	61.6	80.50	62.25	77.33	29.32	182.50
4. (BU)	154.2	73.00	71.25	97..60	2.46	17.50
5. (BU)	79.2	72.50	70.50	97.24	2.84	20.00
6. (BU)	79.2	72.00	71.75	99.65	0.35	2.50
7. (BU)	74.4	74.50	66.00	88.59	12.88	85.00
8 . (BU)	75.6	74.75	66.75	89.30	11.99	80.00
9. (BU)	80.6	72.75	72.50	99.66	0.34	2.50
10. (BU)	81.4	73.00	74.75	102.40	-2.34	-17.50
11. (BU)	73.4	71.75	63.50	88.50	12.99	82.50
12. (BU)	74.8	73.75	65.50	88.81	12.60	82.50
Mean	82.232	73.33	68.19	92.79	7.96	51.46
13. (TM)	70.6	72.25	65.25	90.31	10.73	70.00
14. (TM)	61.6	81.75	64.25	78.59	27.24	175.00
Mean	66.1	77.00	64.75	84.45	18.99	122.50
15. (BR)	73.6	72.20	64.50	89.58	11.63	75.00
16. (BR)	64	78.00	63.92	81.41	22.83	145.00
Mean	68.8	75.10	64.21	85.50	17.23	110.00
17. (CB)	68.8	72.50	63.00	86.90	15.08	95.00
18. (CB)	67.2	71.25	61.25	85.96	16.33	100.00
19. (CB)	70.4	71.75	63.00	87.80	13.89	87.50
20. (CB)	71.2	70.50	63.25	89.72	11.46	72.50
Mean	173.50	71.50	62.63	87.60	14.19	88.75

BU = Bengaluru Urban, TM = Tumkur, BR = Bengaluru Rural, and CB= Chikkaballapura

Nelson and Anderson's (1977) statistical method. The critical in both cases was found to be 74ppm. A soil Mg status of 0.64 meq/100g of soil was critical limit of soil magnesium in tomato crop as reported by Asiegbu and Uzo, 1983. These soils are very sandy and hence the CEC being very low the critical level was very low. The soils under present study are medium textured and good in CEC. Hence the critical level was high. Lin Qiming, 1985 reported a critical limit of soil available Mg in the soil was less than 26 ppm in soil which was derived from red earth and sandy paddy soils derived from alluvial deposit in rice.

Plant critical-limit

The plant Mg levels were significantly related to soil available Mg levels and the response to applied Mg was also related to plant Mg levels to work out the plant critical Mg level, similar to soil Mg, plant Mg content was plotted against Bray's per cent yield and presented in Fig 2. A critical limit of 0.39 to 0.41 per cent Mg were established using scatter plot and statistical procedure respectively. Schwartz and Bar-Yosef, 1983 observed that critical limit were 0.13 % in shoots of tomato crop where they used the whole plant of tomato instead of index leaves. Ward and Miller, (1969) reported that in green house tomato critical limit of Mg at tissue level was 0.30 %

Among the four locations, the response was highest in Tumkur districts (18.98 %) followed by Bangalore rural (17.23 %) Chikkaballapura district (14.19 %) and Bangalore urban (7.96 %). This indicated that Mg application to those soils having available Mg below critical limits can respond to applied Mg and farmers can get higher yields of tomato on these soils.

Using scattered plot technique a soil Mg limit of 74 ppm is arrived as critical soil Mg for tomato crop. Similarly a plant critical limit of 0.39 % was established to separate deficient plants from those having sufficient Magnesium.

Table 3. Effect of applied Mg on plant Mg content and yield in tomato

Location	Initial soil Mg (ppm) (NH_4OAc)	Mg Nutrient content of leaves (% DW)	Tomato Yield (t ha^{-1})		Bray's per cent yield	Per cent increase	Response (q ha^{-1})
			NPK+$MgSo_4$	NPK			
1. (BU)	74	0.39	74.25	66.00	88.89	12.50	82.50
2. (BU)	78.4	0.4	67.25	67.50	100.37	-0.37	-2.50
3. (BU)	61.6	0.34	80.50	62.25	77.33	29.32	182.50
4. (BU)	154.2	0.48	73.00	71.25	97..60	2.46	17.50
5. (BU)	79.2	0.43	72.50	70.50	97.24	2.84	20.00
6. (BU)	79.2	0.41	72.00	71.75	99.65	0.35	2.50
7. (BU)	74.4	0.4	74.50	66.00	88.59	12.88	85.00
8. (BU)	75.6	0.41	74.75	66.75	89.30	11.99	80.00
9. (BU)	80.6	0.42	72.75	72.50	99.66	0.34	2.50
10. (BU)	81.4	0.43	73.00	74.75	102.40	-2.34	-17.50
11. (BU)	73.4	0.38	71.75	63.50	88.50	12.99	82.50
12. (BU)	74.8	0.39	73.75	65.50	88.81	12.60	82.50
Mean	82.232	0.37	73.33	68.19	92.79	7.96	51.46
13. (TM)	70.6	0.32	72.25	65.25	90.31	10.73	70.00
14. (TM)	61.6	0.36	81.75	64.25	78.59	27.24	175.00
Mean	66.1	0.39	77.00	64.75	84.45	18.99	122.50
15. (BR)	73.6	0.33	72.00	64.50	89.58	11.63	75.00
16. (BR)	64	0.36	78.00	63.50	81.41	22.83	145.00
Mean	68.8	0.38	75.00	64.00	85.50	17.23	110.00
17. (CB)	68.8	0.37	72.50	63.00	86.90	15.08	95.00
18. (CB)	67.2	0.39	71.25	61.25	85.96	16.33	100.00
19. (CB)	70.4	0.4	71.75	63.00	87.80	13.89	87.50
20. (CB)	71.2	0.34	70.50	63.25	89.72	11.46	72.50
Mean	173.50	7.76	71.50	62.63	87.60	14.19	88.75

BU-Bengaluru Urban, TM-Tumkur, BR-Bengaluru Rural , and CB-Chikkaballpur

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