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Short communication

Micronutrient imbalance of sapota orchard in table lands of semi arid region of Rajasthan, India

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ABSTRACT

Micronutrient status of sapota crop was assessed by analyzing soil and plant samples from table lands of south eastern Rajasthan. Surface and sub surface soil samples were extracted with diethylene triamine penta acetic acid (DTPA), and plant samples (including leaf and petiole) digested with di-acid mixture for the estimation of available iron (Fe), manganese (Mn), copper (Cu) and zinc (Zn). The DTPA extractable micronutrients in the soil samples followed the order as Mn> Fe> Zn> Cu. The mean values of surface extractable DTPA Mn, Fe, Zn and Cu varied from 15.2 to 8.4, 8 to 3.4, 0.74 to 0.17 and 0.35 to 0.02 mg kg^{-1} respectively. Total Fe, Mn, Zn and Cu of leaf samples varied from 89.41 to 231.24, 22.2 to 97.61, 0.62 to 48.12 and 4.35 to 19.78 mg kg^{-1}, respectively. Total Fe, Mn, Zn and Cu in petioles varied from 33.52 to 284.51, 11.31 to 69.26, 0.54 to 36 and 2.0 to 18.48 mg kg^{-1}, respectively. Unlike soil micronutrient status, leaf sample analysis showed high Mn and Cu concentration, which resulted in Zn and Fe deficiency, resulting in shortened internodes or rosette disorders in sapota trees.

Key words*: Achras zapota*, micronutrients deficiency, iron, manganese, zinc, copper

Sapodilla popularly known as sapota or *chiku* is one of the prominent fruits of India. India is the largest producer of sapota followed by Mexico, Guatemala and Venezuela. In India sapota occupies 97 thousand hectares area with an annual production of 11.76 lakh tones, and productivity of 12 MT (NHB, 4). Poor fruit setting, shedding of fruits, poor quality fruits and low productivity are some of the major constraints of many sapota orchards in Indian. Finally, only 10-12% of the total fruits set, are carried out till maturity (Guvvali and Shirol, 5). It is a hardy crop and tolerates salinity to some extent. Sapota crop was introduced recently in south eastern parts of Rajasthan (Meena *et al.*, 3).

Sapota is evergreen in nature, and therefore, deficiency of nutrients often leads to sub optimal yield. Zinc deficiency marked by small and erect leaves, however short internodes and premature leaf shedding are the visible symptoms of iron deficiency (Satyagopal *et al.,* 7). Balanced amount of micro-nutrients is pre requisite for fruit development and good yields as these nutrients have direct impact on various biochemical and physiological processes including chlorophyll production, protein synthesis, enzymatic reactions etc. Thus, micronutrient sufficiency is essential for upscaling sapota growth and production in semi arid regions but limited work has been conducted especially in tablelands of ravine landforms of India. Therefore, a study was undertaken to assess micro-nutrient status of sapota plantation, and its management for sustainable productivity under semi arid conditions.

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The experimental orchard area is a table land located at Research Farm of ICAR- Indian Institute of Soil and Water Conservation, Research Centre, Kota, (25º 11' N latitude and 75 º 51' E longitudes). The soils of the region are non calcareous, dark grayish brown, moderately well drained fine textured soils classified as Typic Chromoustert belonging to Kota series (Table 1). The physiography is constituted of gently sloping (< 2 % slope), moderately well-drained table lands in the immediate vicinity of Chambal ravines. Uniform ten-year-old sapota cv. 'Kalipatti' trees planted at 8 × 8 m spacing (row × plant) were selected for study, and supplied with recommended doses of fertilizer (1000 g N, 500 g P and 500 g K per plant). During the study, leaf samples were collected randomly from many different trees (about 24 trees) throughout orchard. The shoots were selected at eye level from around outside of the tree that makes a vertical angle of 45-60 degrees to the ground. Recently matured leaves from the north, south, east and west quarters of the trees (Reuter *et al.*, 6) were sampled during the months of September and October. From the 24 leaf samples collected, petiole samples (24) were separated. Leaf samples were washed in dilute hydrochloric acid solution followed by tap water and distilled water and dried in hot air oven at 70°C for 48 hours. The dried leaves and petiole samples were grounded to fine powder, and were digested with tri acid mixture to obtain plant extract. Soil samples collected from two depths (0-15cm and 15-30cm) were dried and processed for micro-nutrient

Table 1. Physico chemical properties of soils under sapota orchard.

Soil depth (cm)	pH (1:2.5)	EC (ds m^{-1})	OC (g kg^{-1})	Available nutrients (kg ha^{-1})			Cation Exchange Capacity (CEC) (cmol p^+ kg^{-1})	Exchangeable cations (cmol p^+ kg^{-1})			Clay content (%)
				N	P	K		Na	Ca	Mg	
0-15	7.81	0.55	5.4	342.3	15.41	386	33.4	3.2	17.7	7.5	27.5
15-30	7.62	0.59	4.2	288.7	11.4	344.5	32.8	3.5	17.8	6.4	24.8

analysis. Micro-nutrients were estimated by directly feeding the extract of the plant and soil sample to a calibrated atomic absorption spectrophotometer using respective hollow cathode lamps for each element (Fe, Mn, Zn and Cu) and concentration was expressed in parts per million (ppm) on dry weight basis (Lindsay and Norvell, 2).

The micronutrient status of soil is presented in Table 2. The DTPA extractable Fe content ranged from 3.4 to 8 mg kg^{-1} with a mean value of 5.19 mg kg^{-1} at surface soil (Table 3). In general, the soil Fe content of sapota plantation was below the sufficiency range (6-8 mg kg^{-1}) indicating Fe deficiency. Iron deficiency in soil was due to higher bicarbonate content of irrigation water. Similar findings has been reported by Somasundaram *et al.* (8) who reported Fe deficiency in lime plantations owing to increased concentration of bicarbonate ions in irrigation water. Soil Mn values ranged from 8.4 to 15.2 mg kg^{-1} and sub surface soil Mn content varied from 6.57 to 16.03 mg kg^{-1} with a mean value of 11.3 mg kg^{-1}. Thus, Mn was above critical level of DTPA extractable Mn (2 mg kg^{-1}). The soils showed low to marginal levels of Zn varied between 0.17 to 0.74 mg kg^{-1} in surface soil, whereas subsurface recorded 0.19 to 0.72 mg kg^{-1}. The DTPA extractable Cu content of sapota crop varied between 0.02 to 0.35 mg kg^{-1} in surface soil, whereas subsurface recorded 0.02 to 0.25 mg kg^{-1}. In general except for Mn, all other micronutrients were higher in surface compared to sub surface soil.

Micro-nutrient concentrations of sapota leaf and petiole samples are presented in Table 3. The mean Fe content in leaves and petioles of sapota plantations were 127 and 120 mg kg^{-1} which was higher than the normal Fe content in plant tissues. In case of petioles 8, 54 and 33% samples were deficient, sufficient and high in Fe content. The sapota leaf blade and petiole samples showed optimum to high Fe content; however chlorosis and necrotic symptoms were observed in the crop during sampling. Use of

Table 2. Micro nutrient concentration and range (mg kg-1) in soils of sapota plantations.

Soil depth (cm)	Fe	Mn	Cu	Zn
Surface soil (0-15)				
Min	3.4	8.4	0.02	0.17
Max	8	15.2	0.35	0.74
Mean*	5.19 ± 0.33	12.11± 0.5	0.19 ± 0.03	0.38 ± 0.05
Sub surface (15-30)				
Min	2.8	6.57	0.02	0.19
Max	6.5	16.03	0.25	0.72
Mean*	4.59 ± 0.29	11.3 ± 0.72	0.10 ± 0.02	0.42 ± 0.05

*Mean of 15 samples, ±Standard error

Table 3. Micro nutrient concentration and range (mg kg-1) in leaf and petiole samples of sapota plantations.

Soil depth (cm)	Fe		Mn		Cu		Zn	
	Leaf	Petiole	Leaf	Petiole	Leaf	Petiole	Leaf	Petiole
Range	89.41-231.24	33.52 - 284.51	22.2-97.61	11.31-69.26	4.35 - 19.78	2-18.48	0.62 - 48.12	0.54- 36
Mean*	127.66 ± 6.56	119.8 ± 12.23	48.84 ± 3.98	33.46± 2.92	8.25 ± 0.77	9 ± 0.89	16.66 ± 2.25	13.01 ± 2.1

*Mean of 24 samples, ±Standard error

irrigation water with high bicarbonate ions resulted in Fe uptake by the crop. The bicarbonate in soil with high pH can affect Fe metabolism in fruit crops. Iron deficiency can be corrected by foliar spray (0.2 to 0.4%) of Fe in the form ferrous sulfate solution during active growth period at fortnightly intervals. The average value of total Mn content in leaves and petiole were 48 and 33 mg kg^{-1} respectively. In sapota crop, the Zn concentration of leaf blade and petiole samples varied between 0.62 - 48.12 mg kg^{-1} and 0.54- 36 mg kg^{-1} with a mean value of 16.67 and 13 mg kg^{-1} respectively. According to Bhargav and Raghupathi (1) Zn concentration for mature crops varies between 15 to 20 mg kg^{-1} and Zn deficiency occurs if plant parts records <20 mg kg^{-1}. Based on this, 50% and 67% samples of leaves and petioles respectively were deficient in Zn. Zinc deficiency was clearly visible with terminal leaves were small, chlorotic (i.e. yellow) and appear in tufts, giving rise to the term “little-leaf” in sapota trees. High soil pH and bicarbonate appear to be the main factors associated with Zn deficiency (Somasundaram *et al.*, 8). As Zn is immobile in soil, foliar spray (0.2 to 0.5% $ZnSO_4$) is recommended during active growth period of sapota crop. Moreover, foliar spray is found to be 10 times more effective than soil application for more uniform distribution and no immobilization. Copper content of sapota leaf and petiole samples varied from 4.35 to 19.78 mg kg^{-1} and 2 to 18.48 mg kg^{-1} respectively. However, DTPA extractable soil Cu content was low as per critical limit (<0.2 mg kg^{-1}) as suggested by Lindsay and Norvell (2). Soil application of copper sulphate ($CuSO_4$) @ 2 to 4 kg per acre or foliar spray of 0.1% ($CuSO_4$) is usually recommended for Cu deficient soils. The study illustrates deficiency of micronutrients in soils especially, Fe, Zn and Cu in the Chambal region of Rajasthan. Compared to soil analysis, leaf analysis recorded high concentration of Mn and Fe which had antagonistic effect on Zn uptake. Most of Indian soils are alkaline with high pH values and therefore occurrence of micronutrient deficiency is a major constrain for crop production in general and sapota crop in particular. Therefore, balanced application of micronutrient fertilizers based on soil and plant analysis is crucial to provide optimum nutrition to crop and also enhance fruit yield of sapota in the region.

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