Original Research Article

Effect of micronutrients application on soil properties of sapota (*Achras sapota* L.) cv. Kalipatti

ABSTRACT

Field experiments were conducted to determine the effects of micronutrients application on soil properties of sapota (*Achras sapota* L.) cv. Kalipatti at Kittur Rani Chennamma College of Horticulture, Arabhavi, India, during the year 2015-2016. Zinc and iron sulphates were used for soil and foliar application, whereas the boron in the form of sodium tetraborate (Jai bore) for soil and solu-bore for foliar application were used. The results revealed that foliar application of 0.5% $ZnSO_4$+ 0.5% $FeSO_4$ + 0.3% B lead to maximum utilization of N, P and K by the plant which resulted into reduced concentration of (123.50 kg ha^{-1}), (11.59 kg ha^{-1}) and (103.50 kg ha^{-1}) as well as exchangeable micronutrient content boron (1.70 mg/kg) in the soil.

KEYWORDS: Soil properties, micronutrient, NPK and Sapota.

INTRODUCTION

The successful commercial cultivation of sapota depends on many factors such as climate, soil, irrigation, fertilizer, spacing and season of growing. Among the different management practices, nutrient management plays an important role in growth, yield and quality of fruits under high density planting (HDP) system. To obtain sustainable yield and quality it needs high amount of nutrients (Mishra, 2014).

The intensive and exploitative agriculture practices like, high yielding varieties and improved technologies are produces fruit. However, under high density planting where there is competition for water and nutrients, major nutrients usually supplied through straight fertilizers or mixture lead to the depletion of micronutrients (Dinesh *et al*., 2007). To sustain the yield and quality of fruit crops maintenance of micro and secondary nutrients becomes very pertinent to foresee the emerging nutrient deficiencies and to evolve suitable ameliorating technologies.

Sapota has the problem of low fruit setting and shedding of fruits. Only about 10-12 % of the total fruits set, and retains until maturity (Guvvali, 2016). Most of the fruit-drop occurs immediately after fruit setting. Increase in fruit set and retention are possible by spraying of boron (B), iron (Fe) promotes formation of chlorophyll pigments, acts as an oxygen carrier and reactions involving cell division and growth. Zinc (Zn) aids in regulating plant growth hormones and enzyme system, necessary for chlorophyll production, carbohydrate and starch formation. The element is also important for the formation and activity of chlorophyll and in the functioning of several enzymes and the growth hormone, auxin (Jeyakumar and Balamohan, 2013).

The foliar application of micro-nutrients have very important role in improving fruit setting, productivity and quality of fruits. It has also beneficial role in recovery of nutritional and physiological disorders in fruit trees. Various experiments have been conducted earlier on foliar spray of micro-nutrients in different fruit crops and shown significant response to improve nutrient up take (Baiea *et al*., 2015; Khan *et al.,* 2015).

The objective of this study was to determine the effects of both soil and foliar application of B, Fe and Zn on soil properties under sapota.

MATERIALS AND METHODS

Experiment site was located in northern dry zone of Karnataka State at latitude 16° 15' North and longitude 74° 45’ East at an altitude of 612.05 m above the mean sea level. The average annual rainfall of the area was 900 mm. The average maximum temperature of the location is 38 °C while the average minimum is 14 °C with relative humidity range from 60 to 90 %.

Experimental Details

Field experiments was conducted at Katter Rani Chennamma College of Horticulture, Arabhavi, Belagavi District, India, during 2015-2016. Experiment was laid out in Randomized Complete Block Design with three replications and eleven treatments- T1: control (no micronutrients), T2: (water foliar application), T3: $ZnSO_4$ (50 g/plant soil application), T4: $FeSO_4$ (40 g/plant soil application), T5: Boron (Jai Bore) 25 g/plant soil application, T6: $ZnSO_4$ (foliar application) at 0.5 %, T7: $FeSO_4$ (foliar application) at 0.5 %, T8: boron (solubor) foliar application at 0.3 %, T9: $ZnSO_4$ (50 g) + $FeSO_4$ (40 g) + boron (25 g) for soil application. T10: $ZnSO_4$ (0.5%) + $FeSO_4$ (0.5%) + boron (0.3%) for foliar application. micronutrients (foliar application) and T11: T9 + T10. Each treatment consists of three plant of uniform size and five years old were selected. These nutrients were applied two times as foliar i.e. 1st at 50 % flowering and another on fruits at pea size while the soils were applied once. The experiment was conducted in clay loam soil having pH of 8.3, 0.53% organic carbon, EC 0.15 dS/m, CEC 13.60 c molc /kg and NPK 235.4, 34.08 and 73.60 Kg per hectare, respectively.

Soil sampling and processing

The soil samples were collected before application of the treatment and at harvest of sapota fruits. Soils from each treatment were collected at 0-30 cm depth separately and dried under shade for five days. Then they were sieved by using 2 mm mesh and packed in polythene cover with proper labeling and stored in dried condition for analysis. The soil samples were analyzed for pH, electrical conductivity, organic carbon, available nitrogen, phosphorous, potassium, exchangeable zinc (Zn), iron (Fe) and boron (B) by following standard methods.

Soil pH

The soil pH was determined by potentiometric method in 1: 2.5 soil water suspension using pH meter having a glass-calomel combined electrode (Jackson, 1967).

Electrical conductivity (dS/m)

An electrical conductivity of soil samples was measured in soil water extract of 1:2.5 ratio using conductivity bridge (Jackson, 1967) and expressed in dS/m.

Organic carbon (%)

The soil organic carbon was determined by Walkey and Black's wet oxidation method by using potassium dichromate (Nelson and Sommers, 1996).

Available nitrogen (Kg/ha)

Available nitrogen (N) in soil was determined by alkaline potassium permanganate method as described by Subbaiah and Asija (1956). Available nitrogen was calculated by using formula

Available phosphorous (Kg/ha)

The available phosphorous (P) in soil was extracted by using Bray's extractant reagent. The ammonium molybdate solution and stannous chloride solution was added to this filtrate solution. The aliquot was taken and estimated by using spectrophotometer. Standard solutions of P with concentration of 0, 0.1, 0.2, 0.4, 0.6, 0.8 and 1.0 mg/kg were prepared by following the same procedure but without using soil sample.

Available potassium (Kg/ha)

The available potassium (K) was extracted from soil by using neutral normal ammonium acetate solution and the aliquot was fed to calibrated flame photometer for K estimation. 0, 10, 20, 30 and 40 mg/kg of K standard solution were pipetted out to volumetric flask (50 ml) from 100 mg/kg of potassium standard solution for calibration of instrument (Black, 1965). These samples were fed to to obtain flame photometer reading as graph.

RESULTS AND DISCUSSIONS

Soil pH

The results indicated that, the pH of the soil after harvest did not vary significantly among the treatments due to application of micronutrients on sapota cv. Kalipatti under HDP system (Table 1) which indicates that soil reaction was not change much with micronutrients application.

Electrical conductivity (dS/m)

Electrical conductivity in the soil after harvest did not vary significantly among the treatments due to application of micronutrients on sapota cv. Kalipatti under HDP system (Table 1) which indicates that soil reaction will not influence much with micronutrients application.

Cation exchange capacity (c molc/kg).

The results indicated that, the cation exchange capacity (CEC) of the soil after harvest was not significant among the treatments due to application of micronutrients on sapota cv. Kalipatti under HDP system. The CEC varied from 10.33 to 13.67 c molc/kg). Cation exchange capacity depends on the surrounding chemical conditions. As the soil pH increases, the hydrogen cations are stripped from the organic matter (OM) and leave a negative charge that will retain a soil cation. As the pH increases, the CEC (of the soil) increases; called pH-dependent charge (Silt loams 15 – 25 and Loams 10 -15 CEC c molc/kg) Mikkelsen, 2011. In this study CEC was statistically non significant, it vary from 10.33 to 13.67 which indicate that it might be there no significant change in OC % (Table 1).

Organic carbon (%)

The highest organic carbon (0.55 %) was recorded in T3 which was not statistically different from other treatments (Table 1). However, the lowest organic carbon (0.44 %) was observed in T5. This might be due to lesser uptake of nutrients. The lowest OC (0.44%) was observed in T_5 (soil application of 25g B per tree). This might be due to more mineralization and maximum uptake by the crop as influenced by sufficiency of required micronutrients to utilize available organic carbon.

Effect of micronutrients on availability of nutrients

Available nitrogen (kg/ha)

The maximum available nitrogen (162.67 and 161.17 kg/ha) was recorded in T_1 and T_2 (control and water spray respectively). This might be lesser crop uptake T_1 and T_2 and minimum available nitrogen in soil (123.50 and 125.81 kg/ha) after harvest was recorded in T_{10} and T_4 (foliar spray of $ZnSO_4$ (0.5%) + $FeSO_4$ (0.5%) + B (0.3%) per tree and soil application of 40 g $FeSO_4$ per tree respectively) (Table 2). It seems that the micronutrients enhanced the uptake of other nutrients like boron and zinc play important roles in nitrogen metabolism which enable other nutrients to be utilize efficiently. Similar results were noticed by Baiea *et al*. (2015).

Available phosphorous (kg/ha)

The results were indicated that, the maximum utilization of phosphorous was observed in soil application of 40 g $FeSO_4$ per tree (T_9) followed by T_{10} (11.59 kg/ha). Whereas maximum available phosphorous (18.97 kg/ha) was recorded in T_8 and T_3 (foliar spray of 0.3% B per tree and soil application of 50 g $ZnSO_4$ per tree) even after harvest. This might be attributed to lesser uptake and fixation of phosphorous in soil. Similarly, lower available phosphorous (9.42 kg/ha) was recorded in treatment with soil application of 40 g $FeSO_4$ per tree (Table 2). It seems that, the Fe as soil and combined micronutrients application enhanced uptake of phosphorus and as observed by Baiea *et al*. (2015) and Khan *et al.* (2015).

Available potassium (kg/ ha)

The maximum available potassium (159.98 kg/ha) was recorded in T_9 (soil application of $ZnSO_4$ (50 g) + $FeSO_4$ (40 g) + B (25 g) per tree) due to more fixation and lesser crop uptake. However the lower available potassium (103.50 kg/ha) was recorded in T_{10} (foliar application of $ZnSO_4$ (0.5%) + $FeSO_4$ (0.5%) + B (0.3%) per tree). It suggests that, the combined micronutrients foliar application might helped in enhanced uptake of potassium. The same reports were given by Baiea *et al*. (2015) and Khan *et al.* (2015).

Exchangeable zinc (mg/kg)

The maximum exchangeable zinc content (4.58 and 4.44 mg/kg) was recorded in T_9 [soil application of $ZnSO_4$ (50 g) + $FeSO_4$ (40 g) + B (25 g) per tree] and T_6 (foliar spray of 0.5% $ZnSO_4$ per tree) and the minimum amount of exchangeable zinc (2.27 mg/kg) was noticed in T_5

Table 1: Effect of micronutrients on organic carbon content, EC, pH, and CEC of soil of sapota

Treatments	OC (%)	EC (dS/m)	pH	CEC (c molc /kg)
T_1- Control (RDF)	0.53	0.15	8.29	13.67
T_2- RDF + Water spray	0.54	0.13	8.30	13.23
T_3- RDF + 50 g $ZnSO_4$ per tree (SA)	0.55	0.16	8.35	11.00
T_4- RDF + 40 g $FeSO_4$ per tree (SA)	0.50	0.15	8.35	10.33
T_5- RDF + 25 g B per tree (SA)	0.44	0.13	8.34	12.44.
T_6- RDF + 0.5% $ZnSO_4$ per tree (FA)	0.50	0.11	8.37	11.33
T_7- RDF + 0.5% $FeSO_4$ per tree (FA)	0.47	0.13	8.43	12.13
T_8- RDF + 0.3% B per tree (FA)	0.50	0.15	8.35	11.45
T_9- RDF + 50 g $ZnSO_4$+40 g $FeSO_4$+ 25 g B per tree (SA)	0.49	0.16	8.30	11.55
T_{10}- RDF + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ + 0.3% B per tree (FA)	0.47	0.13	8.40	11.75
T_{11}- T_9 + T_{10}	0.49	0.17	8.17	12.33
S. Em ±	**0.10**	**0.05**	**0.22**	**1.51**
C. D. at 5%	**NS**	**NS**	**NS**	**NS**

RDF – Recommended dose of fertilizer **SA** –Soil Application **FA** – Foliar Application **NS** – Not significant

Table 2: Availability of major and micronutrients in soil of sapota

Treatments	Available soil nutrients					
	N (kgha^{-1})	P (kgha^{-1})	K (kgha^{-1})	Exch. Zn (mg/kg)	Exch. Fe (mg/kg)	Exch. B (mg/kg)
T_1- Control (RDF)	161.17	12.81	146.67	2.37	9.50	3.10
T_2- RDF + Water spray	162.67	15.00	139.67	2.34	9.45	3.17
T_3- RDF + 50 g $ZnSO_4$ per tree (SA)	156.89	17.71	105.47	3.91	9.50	2.57
T_4- RDF + 40 g $FeSO_4$ per tree (SA)	125.81	9.42	108.11	2.40	10.40	2.50
T_5- RDF + 25 g B per tree (SA)	140.50	12.51	110.24	2.27	10.50	2.11
T_6- RDF + 0.5% $ZnSO_4$ per tree (FA)	152.68	14.24	135.67	4.44	9.03	2.20
T_7- RDF + 0.5% $FeSO_4$ per tree (FA)	141.51	11.38	125.00	2.57	9.80	1.85
T_8- RDF + 0.3% B per tree (FA)	131.24	18.97	114.67	2.99	9.45	2.00
T_9- RDF + 50 g $ZnSO_4$+40 g $FeSO_4$+ 25 g B per tree (SA)	151.28	15.39	159.98	4.58	9.05	1.94
T_{10}- RDF + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ + 0.3% B per tree (FA)	123.50	11.59	103.50	3.60	9.45	1.70
T_{11}- T_9 + T_{10}	160.75	13.64	153.33	4.05	11.33	2.47
S. Em ±	**2.27**	**0.45**	**2.04**	**0.08**	**0.11**	**0.06**
C. D. at 5%	**6.70**	**1.34**	**6.02**	**0.24**	**0.31**	**0.16**

RDF – Recommended dose of fertilizer **SA** –Soil Application **FA** – Foliar Application **NS** – Not significant.

(Soil application of 25 g B per tree) as shown in Table 2. It was found that zinc toxicity also causes chlorosis in the younger leaves, which can extend to older leaves after prolonged exposure to high soil Zn levels. Also the excess Zn give rise to manganese (Mn) and copper (Cu) deficiencies in plant shoots. Such deficiencies have been ascribed to a hindered transfer of these micronutrients from root to shoot. This hindrance is based on the fact that, the Fe and Mn concentrations in plants grown in Zn-rich media are greater in the root than in the shoot. Another typical effect of Zn toxicity is the appearance of a purplish-red colour in leaves, which is ascribed to phosphorus (P) deficiency (Lee *et al*., 1996) and Ebbs and Kochin (1997). The similar results proposed by Bhadur *et al.* (1998) and Paparnakis *et al.* (2013).

Exchangeable iron (mg/kg)

The amount of exchangeable iron was significantly reduced (9.03 mg/kg) in T_6 foliar spray of $ZnSO_4$ (0.5%) per tree. The maximum iron content in soil (11.33 mg/kg) was recorded in T_{11} (T_9+ T_{10}). It is due to fact that iron applied through soil is more efficient than the foliar application, which is supported by finding of Fang and Jaiwevi (2006).

Exchangeable boron (mg/kg)

The amount of exchangeable boron was significantly reduced (1.70 mg/kg) in T_{10} (foliar application of $ZnSO_4$ (0.5%) + $FeSO_4$ (0.5%) + B (0.3%) per tree). The maximum boron content in soil of 3.17 and 3.10 mg/kg were recorded in treatments with soil application of T_2 and T_1.respectively. This might be due to efficient utilization of micronutrients in the presence of all other essential elements and this was supported by findings of Sayed *et al.* (2012).

CONCLUSIONS

The result of this study revealed the role of micronutrients in mobilizing the nutrients from the soil of sapota cv. Kalipatti under HDP system. Foliar application of (0.5% $ZnSO_4$), iron (0.5% $FeSO_4$) and boron (0.3% B) helped in more utilization of both macro and micronutrients.

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