Original Research Article

Effect of micronutrients application on soil properties of sapota cv. Kalipatti under high density planting

ABSTRACT

The field experiment was conducted to know the effect of micronutrients application on soil properties of sapota cv. Kalipatti under high density planting at Kittur Rani Chennamma College of Horticulture, Arabhavi during the year 2015-2016. Zinc and iron sulphates were used for soil and foliar application, while boron in the form of sodium tetraborate (Jai bore) for soil application and for the foliar application solubor was used. The results revealed that foliar application 0.5% $ZnSO_4$+ 0.5% $FeSO_4$ + 0.3% B lead to maximum utilization and relatively lower amounts of macro nutrients like nitrogen (123.50 kg ha^{-1}), phosphorous (11.59 kg ha^{-1}) potassium (103.50 kg ha^{-1}) in soil and optimum exchangeable micronutrient contents of zinc (3.60 mg/kg), iron (9.45 mg/kg) and boron (1.70 mg/kg) was recorded in the soil. By the above treatment low soil macro nutrients (resulting of maximum utilization) content, optimum zinc, iron and boron might be favors increase yield and quality of fruits.

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 perform sustainable yield and quality it needs high amount of nutrients (Mishra, 2014).

The intensive and exploitative agriculture with high inputs, high yielding varieties and improved technologies which was helped better fruit production. But, 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; resulting the loss in yield and quality (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 per cent 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. Zinc is an 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 set, 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 yield and quality of fruits (Kumar and Verma, 2004 and Dhinesh *et al.* (2005).

Therefore, based on the possible benefits of zinc, iron and boron, The objective of present study was to determine the effect of soil and foliar application on the planned to know the response of soil and foliar application micro nutrients on the following objective. To study the soil properties and soil nutrient content in sapota as result of micronutrients application.

MATERIALS AND METHODS

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

Experimental Details

Field experiments were conducted at Kittur Rani Chennamma College of Horticulture, Arabhavi, Belagavi District during 2015-2016. Experiments were laid out in Randomized Complete Block Design with eleven treatments *viz.,* T1: control (no micronutrients), T2:

(water foliar application), T3: ZnSO4 (50 g/plant soil application), T4: FeSO4 (40 g/plant soil application), T5: Boron (Jai Bore) 25 g/plant soil application, T6: ZnSO4 (foliar application) with 0.5 per cent, T7: FeSO4 (foliar application) with 0.5 per cent, T8: boron (solubor) foliar application at with 0.3 per cent, T9: ZnSO4 (50 g) + FeSO4 (40 g) + boron (25 g) for soil application. T10: ZnSO4 (0.5%) + FeSO4 (0.5%) + boron (0.3%) for foliar application. micronutrients (foliar application) and T11: T9 + T10. These nutrients are applied in two times as foliar i.e. 1st at 50 per cent flowering and another on fruits at pea size. For soil application micronutrients applied along with recommended dose of fertilizers..

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 are 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.

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 was 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 flame photometer to obtain flame photometer reading as graph mg/kg.

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 will not influence 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 this might be there no significant change in OC % (Table 1).

Organic carbon (%)

The highest organic carbon (0.55 %) was recorded in T3 which was statistically on at par with all treatment (Table 1). However, the lowest organic carbon (0.44 %) was observed in T5. The organic carbon content in soil did not varied significantly among the different treatments. The highest organic carbon content in soil after fruit harvest (0.55 %) was recorded in T_3 (soil application of 50 g $ZnSO_4$ per tree). This might be due to lesser uptake of nutrients and fruit yield of crop. Whereas, the lowest OC (0.44%) 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 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 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 micronutrients enhanced uptake of phosphorus and these 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 suggest that, the micronutrients 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) 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 iron applied through soil more efficient than the foliar application these findings can be supported by 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 (3.17 and 3.10 mg/kg) was recorded in treatment with soil application of T_2 and T_1. This might be due to efficient utilization of micronutrients in presence all 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 and thus resulted in obtaining more yield and quality of sapota.

REFERENCES

Bahadur, L., Malhi, C. S. and Singh, Z., 1998. Effect of foliar and soil applications of zinc sulphate on zinc uptake, tree size, and yield and fruit quality of mango. *J. Pl. Nutir.*, **21**(3): 589-600.

Baiea, M. H. M., El-Badawy, H. E. M. and El-Gioushy, S. F. 2015. Effect of potassium, zinc and boron on growth, yield and fruit quality of Keitt mango trees. Res. J. Pharma. Bio. Chem. Sci., **6(4):** 800-812.

Black, C. A., 1965. Method of soil analysis part II, chemical and microbial properties no.9 in the series agronomy. American Soc. Agron. Inc. Madison, Wisconstin, USA.

Dhinesh, B. K., Dubey, A. K. and Yadav, D. S. 2007. Effect of micronurtients on enhancing the productivity and quality of Kinnow mandarin. Indian J. Hort. **64(3):** 353-356.

Ebbs, S. D. and Kochian, L. V., 1997. Toxicity of zinc and copper to Brassica species: implications for phytoremediation. J. Environ. Qual., **26**: 776–781.

Fang, C. and Jianwei, L., 2006. Effect of iron chelate application on citrus in the three gorges area (Southeast China). Better Crops, **90** (1): 33-35.

Guvvali, T., 2016. Effect of micronutrients on growth, yield and quality of sapota cv. Kalipatti under HDP system. Thesis submitted, at UHS, Bagalkot. Pp-2

Jackson, M. L., 1967. Soil chemical analysis, Printice hall of India., Pvt. Ltd. New Delhi.

Jeyakumar, P. and Balamohan, T. N. 2013. Micronutrients for horticultural crops. (http://agritech.tnau.ac.in)

Khan, A. S., Nasir, M., Malik, A. U., Basra, S. M. A. and Jaskani,V. 2015. Combined application of boron and zinc influence the leaf mineral status, growth, productivity and fruit quality of 'Kinnow Mandarin' *(Citrus nobilis* Lour × *Citrus deliciosa* Tenora*).* J. Pl. Nutri.**, 38(6):** 821-838.

Kumar, S. and Verma, D. K. 2004. Effect of micro-nutrients and NAA on yield and quality of litchi cv. Dehradun. Proceedings of International Sem. on Recent Trend in Hi-tech Horticulture and Post Harvest Tech., pp.193.

Lee, C. W., Choi, J. M. and Pak, C. H., 1996. Micronutrient toxicity in seed geranium (*Pelargonium hortorum* Baley). J. Ameican Soc. Hort. Sci*.,* **121**: 77–82.

Mikkelsen, R., 2011. Cation Exchange: A Review., Regional Newsletter Inter. Pl. Nutri. Institute., pps, 1-4

Mishra, D. 2014. Nutrient removal studies in guava under high density orcharding system. J. Agri. Crop Sci., **1:** 36-38

Paparnakis, A., Chatzissavvidis1, C. and Antoniadis, V., 2013. How apple responds to boron excess in acidic and limed soil. J. Soil Sci. Pl. Nutri., **4**: 787-796.

Sayed, R. M., Mohammad, G. and Maryam, R. 2012. The interaction of zinc with other elements in plants:a review. Int. J. Agri. Crop Sci., **4 (24):** 1881-1884.

Subbaiah, V. B. and Asija, G. L., 1956. A rapid procedure for the estimation of available nitrogen in soil. Curr. Sci., **25**: 258-260.