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RESPONSE OF SOIL AND FOLIAR APPLICATION OF SILICON AND MICRO NUTRIENTS ON SOIL NUTRIENT AVAILABILITY OF SAPOTA

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ABSTRACT

The silicon sources like potassium silicate and calcium silicate and Solubor as boron source and kiecite –G as micronutrient source were used for the field experiment to know the response of soil and foliar application of silicon and micronutrients which influences on nutrient availability. With application of potassium silicate at 8 mL per litre resulted in lowest organic content (1.34 %) and treatment control showed the highest organic carbon content (1.68 %) in the soil at fruit harvest stage. 145.33 kg/ha, 9.68 kg/ha and 105.63 kg/ha of available nitrogen, phosphorous and potassium content were observed respectively in the treatment with application of potassium silicate at 8 mL per litre as foliar spray where as more nutrient contents were observed in the soils of control plots at the time of fruit harvest. This indicates that at the time of fruit harvest minimum nutrients were available in the soil and maximum uptake of nutrients were observed in the silicon treated plot resulted in maximum production and quality of fruits.

INTRODUCTION

Sapota (*Manilkara achras* (Mill) Forsberg) is a native of Mexico belongs to the family Sapotaceae. It is a delicious fruit mainly introduced for its fruits. Among sapota varieties kalipatti is gaining more importance around Bengaluru and Northern Districts of Karnataka. This variety is known for its prolific yield and high sugar content. Sapota is gaining more importance now a days but this crop suffers from a malady like mummification or lacks quality fruits due to improper nutrient supply or due to pest and disease incidence. In order to improve the yield and quality of the crop several nutrient studies were conducted. In the present study foliar and soil application of silicon and micronutrients were applied at different concentration to know the nutrient availability and nutrient uptake from the soil.

Silicon is one of the abundant elements in the lithosphere and it is the most abundant element in soil next to oxygen and comprises 28 per cent of its weight and 3-17 per cent in soil solution (Epstein, 1999). It is most commonly found in soils in the form of solution as silicic acid (H_4SiO_4) and plants takeup directly as silicic acid (Ma *et al.,* 2001). Being a dominant component of soil minerals, it has many important functions in environment, although Si is not considered as an essential plant nutrient because of its ubiquitous presence in the biosphere, most plants can be grown from seed to seed without its presence. Many plants can accumulate Si concentrations higher than essential macro nutrients (Epstein, 1999).

Vladimir *et al.* (2001) observed a relationship between soil silicon status and leaf silicon content. Supply of silica resulted in conducive physical environment leads to better aeration, root activity and nutrient adsorption. The nutrients presented in fly ash enriched the soil and there by enhanced the uptake of nutrients (Mongia *et al.*, 2003). The silicon supply is mainly depended on silicon supplying ability of the soil. Supplemental application of silicon increased the shoot silicon concentration and leads to dry matter production (Prakash *et al.,* 2011).

Foliar spray of micronutrients helps in efficient utilization of nutrients to plants directly through leaves within few days we can realise the effect of micronutrient spray.

Therefore, based on the possible benefits of silicon and micro nutrients, the present study was undertaken to know the response of soil and foliar application of silicon and micro nutrients on soil nutrient availability of sapota.

MATERIALS AND METHODS

Experimental site was located in the hilly region of Karnataka at 13°7′ North latitude, 75°57′ East longitude and is at an altitude of 982 meter above the mean sea level. The average annual rainfall of an area is 2400 mm. The average maximum temperature of the location is 33°C and the average minimum temperature is 10°C and the relative humidity ranges from 60 to 90 per cent.

Initial soil characteristics

The initial physical and chemical properties of soil are given in the Table 1. The soil of an experimental plot contained 34.92 per cent coarse sand, 38.82 per cent of fine sand, 16.25 per cent of silt and 10.50 per cent of clay. The initial organic carbon content in the soil was 1.39 per cent and the available nitrogen, phosphorous and potassium content in the soil were 220.81, 21.40 and 170.80 kg per hectare, respectively.

Sources and composition of nutrient sources

Different nutrient sources were used for conducting the experiment, the sources of nutrients and their compositions are given below.

Sources	Composition
Potassium silicate	Si-0.8%, B-0.2%, K-1.3%
Calcium silicate	Ca-30%, Mg-7%, Si-12%
Boron(sodium octa borate tetra hydrate boron)	B-20% minimum
Micronutrients (multi micromix)	Fe-2.0%, Mn-1.0%, Zn-3.0%, B-0.5%.

EXPERIMENTAL DETAILS

Field experiments were conducted at College of Horticulture, Mudigere during 2010-2012. Experiments were laid out in Randomized Complete Block Design with eleven treatments *viz.,* T_1: control (no silicon application), T_2: Potassium silicate (foliar applicaton) at 6 mL per litre, T_3: Potassium silicate (foliar application) at 8 mL per litre, T_4: Calcium silicate (soil application) with 1 kg per tree, T_5: Calcium silicate (soil application) with 1.5 kg per tree, T_6: Calcium silicate (soil application) with 2.0 kg per tree, T_7: Calcium silicate (soil application) with 2.5 kg per tree, T_8: boron (foliar application) at 2 g per litre, T_9: boron (foliar application) at 3 g per litre, T_{10}: micronutrients (foliar application) at 3 mL per litre and T_{11}: micronutrients (foliar application) at 4 mL per litre.

Soil sampling and processing

The soil samples were collected before imposition of the treatment and after harvest of sapota fruits. Soils from each treatment were collected at 0-30 cm depth separately and dried under shade for 2 days. Then they are sieved by using 2 mm mesh and then packed in polythene cover with proper labelling and stored in dried condition for analysis.

The soil samples were analysed for p^H, electrical conductivity, organic carbon, available nitrogen, phosphorous, potassium, exchangeable calcium and magnesium and available silicon by following standard methods of analysis.

Available nitrogen in soil was determined by alkaline potassium permanganate method as described by Subbaiah and Asija (1956). The available phosphorous 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. The available potassium was extracted from soil by using neutral normal ammonium acetate solution and the aliquot was fed to calibrated flame photometer for K estimation (Black, 1965).

For estimation of both Ca and Mg buffer complex solution, EBT indicator was added to a known aliquot and was titrated against standard EDTA solution till the pink colour turned to sky blue colour. For estimation of calcium alone 10 per cent of NaOH solution and murexide powder was added to a known aliquot and the constant was titrated against standard EDTA solution till lavender blue colour obtained (Jackson, 1967). The Mg content was recorded by deducting Ca values from Ca + Mg.

Available silicon (kg/ha)

Silicon was estimated by acetic acid method. 5 g of soil was weighed and transferred to the centrifuge tube and 12.5 mL of 0.5 N acetic acid was added and then mechanically shook for an hour. Centrifuged the content for 3 min with 3000 rpm to get a clear solution. Then filtrate the content to get clear, colourless solution. Then 0.5 mL of aliquot was taken and to this 10.5 mL of distilled water was added. Again to this 0.25 mL of HCl (Hydrochloric acid), 0.5 mL of 10 per cent ammonium molybdate, 0.5 mL of 20 per cent tartaric acid and 0.5 mL of reducing agent ANSA (Amino Napthol Sulphonic Acid) was added. The absorbance was measured at 630 nm with an ultraviolet visible spectrophotometer. Standard solutions with concentration of 0.2, 0.4, 0.8, 1.2 and 1.6 ppm were prepared by the following procedure.

Si (kg/ha) = Absorbance value × slope × Dilution factor × 2.24

Statistical analysis of experimental data

The experimental data collected relating to different parameters were statistically analysed as described by Sundar Raj *et al.* (1972) and the results were tested at 5 per cent level of significance by Fischer method of analysis of variance.

RESULTS AND DISCUSSION

With application of silicon and micro nutrients there was there was no significant variation among the treatments with respect to soil pH and EC but significant difference had been noticed with respect to organic carbon. The highest organic carbon (1.68 %) was recorded in control whereas lowest organic carbon (1.34 %) was observed in the treatment with foliar application of silicon at 8 mL per lire (Table 2).

The data regarding to response of soil and foliar application of silicon and micronutrients on nutrient availability was significant. The maximum available nitrogen was recorded in control (175.83 kg/ha) due to lesser crop uptake. Significantly minimum available nitrogen (145.33 kg/ha) in soil after harvest was recorded in treatment supplemented with potassium silicate at 8 mL per litre (Table 3). It seems that, nutrients were retained in soil without leaching due to the effect of silicon which in turn subjected for maximum uptake by the crop. Similar results were noticed by Regan and Peter (2011). Joseph

Table 1: Initial physical and chemical properties of soil from experimental site

S. No.	Parameters	Content
Physical properties		
a.	Coarse sand (%)	34.92
b.	Fine sand (%)	38.82
c.	Silt (%)	16.25
d.	Clay (%)	10.50
Soil texture: Red sandy clay loam		
Chemical properties		
a.	pH	05.50
b.	EC (dSm^{-1})	00.06
c.	Organic carbon (%)	01.39
d.	Available nitrogen (kg/ha)	220.81
e.	Available Phosphorus (kg/ha)	21.40
f.	Available Potassium (kg/ha)	170.80

Table 2: Effect of soil and foliar application of silicon and micronutrients on physico-chemical properties of soil at fruit harvest

Treatment	SoilpH	EC (dS/m)	Organic carbon(%)
T_1- Control	5.88	0.065	1.68
T_2- Potassium silicate (foliar application) @ 6 mL/L	5.42	0.055	1.35
T_3- Potassium silicate (foliar application) @ 8 mL/L	5.37	0.060	1.34
T_4- Calcium silicate (soil application) @ 1.0 kg/tree	5.57	0.068	1.50
T_5- Calcium silicate (soil application) @ 1.5kg/tree	5.12	0.056	1.46
T_6- Calcium silicate (soil application) @ 2.0 kg/tree	5.30	0.065	1.41
T_7- Calcium silicate (soil application) @ 2.5 kg/tree	5.24	0.056	1.39
T_8- Boron (foliar application) @ 2 g/l	5.09	0.053	1.65
T_9- Boron (foliar application) @ 3 g/l	5.84	0.053	1.67
T_{10}- Micronutrients (foliar application) @ 3 mL/L	5.17	0.055	1.61
T_{11}- Micronutrients (foliar application) @ 4 mL/L	5.08	0.065	1.52
F-test	NS	NS	*
SEm ±	0.29	0.004	0.04
CD at 5%	-	0.013	0.12

* = Significant, NS = Non-significant, EC= Electrical conductivity

Table 3: Effect of soil and foliar application of silicon and micronutrients on available nutrient status of soil at fruit harvest

Treatment	Available N (kg/ha)	Available P_2O_5(kg/ha)	Available K_2O(kg/ha)	Exch. Ca (ppm)	Exch. Mg (ppm)	Available Si(kg/ha)
T_1- Control	175.83	11.32	158.53	165.45	36.59	57.63
T_2- Potassium silicate (foliar application) @ 6 mL/L	146.66	9.83	108.35	148.52	29.47	75.58
T_3- Potassium silicate (foliar application) @ 8 mL/L	145.33	9.68	105.63	146.10	25.96	77.98
T_4- Calcium silicate (soil application) @ 1.0 kg/tree	156.33	10.21	133.56	175.82	39.92	87.01
T_5- Calcium silicate (soil application) @ 1.5 kg/tree	154.33	10.05	125.60	229.29	33.96	96.56
T_6- Calcium silicate (soil application) @ 2.0 kg/tree	153.66	10.02	119.96	225.26	33.42	106.37
T_7- Calcium silicate (soil application) @ 2.5 kg/tree	149.00	9.91	113.56	215.73	33.26	136.30
T_8- Boron (foliar application) @ 2 g/l	165.83	10.50	151.49	159.49	31.18	88.53
T_9- Boron (foliar application) @ 3 g/l	171.33	11.19	154.86	160.71	32.61	90.84
T_{10}- Micronutrients (foliar application) @ 3 mL/L	163.66	10.23	148.16	158.74	31.08	74.54
T_{11}- Micronutrients (foliar application) @ 4 mL/L	157.66	10.21	146.76	156.78	30.01	68.80
F-test	*	*	*	*	*	*
SEm ±	2.14	0.20	0.84	2.29	0.65	4.12
CD at 5%	6.33	0.61	2.50	6.76	1.92	12.15

* = Significant, NS = Non-significant

(2011) observed that with application silicon cost of production can be minimized as it avoids leaching loss of nitrogen from the soil.

The maximum availability of phosphorous (11.32 kg/ha) was recorded in the treatment T_1 (control). However, the minimum availability of phosphorous (9.68 kg/ha) was recorded in treatment with foliar application of potassium silicate at 8 mL per litre. Similarly, the maximum potassium (158.53 kg/ha) was recorded in the treatment T_1 (control) and the minimum potassium (105.63 kg/ha) was recorded in treatment with foliar application of potassium silicate at 8 mL per litre (Table 3). Leaching loss of both phosphorous and potassium might be avoided with application of silicon and thus increased more nutrient availability and crop uptake. Similar observations were made by Mongia *et al.* (2003). Silicon amendments help in reducing the leaching of phosphate, nitrate and potassium from the soil (Matichenkov and Bocharnikova, 2010).

The maximum calcium was recorded in the treatment with soil application of calcium silicate at 1.5 kg per tree and the maximum magnesium was recorded in treatment with soil application of calcium silicate at 1.0 kg per tree. Minimum content of calcium and magnesium in soil was recorded in the treatment with foliar application of potassium silicate at 8 mL per litre (Table 3). Exchangeable calcium and magnesium in soil was more in treatments supplemented with calcium silicate as calcium silicate contained both Ca and Mg. Application of calcium; magnesium and silicon helped in more uptakes of nutrients from soil and resulted in more accumulation of nutrients in leaf. Similar results were observed by Barbosa *et al.* (2001). Putra *et al.* (2010) stated that application of silicon resulted in more uptake of nutrients like nitrogen, phosphorous, potassium, calcium and magnesium from the soil resulted in more concentration of nutrients in leaf tissue.

The maximum silicon content in soil was recorded in the treatment with soil application of calcium silicate at 2.5 kg per tree (Table 3). Silicon application to the soil resulted in more availability of silicon in soil with application of calcium silicate as soil application compared to foliar application. The results are in accordance with the findings of Vladimir *et al.* (2001), Matichenkov and Calvert (2002) and Barbosa *et al.* (2001).

In conclusion the result of this study highlights the role of silicon and micronutrients in improving nutrient availability of sapota. By using potassium silicate at 8 mL per litre helped in more utilization of macro nutrients and thus resulted in obtaining more yield and quality of fruits.

REFERENCES

Barbosa Filho, M. P., Snyder, G. H., Fageria, N. K., Dantoff, L. E.

and Silva, O. F. 2001. Calcium silicate as source of silicon for upland rice. *Revista Brasilerira de ciencia do solo*. **25(2):** 325-330.

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

Epstein, E. 1999. Silicon. annu. rev. plant physiol, *Pl. Mol. Biol.* **50:** 641-644.

Jackson, M. L. 1967. Soil Chemical Analysis, Printice Hall of India. Pvt. Ltd. New Delhi.

Joseph, R. Heckman. 2011. Pumpkin production using silicon, crop rotation, and Mulch. *Vegetable Crops Edition*. **17(10):** 1-2.

Ma, J. F., Goto, S., Tamaki, K. and Ichii, M. 2001. Role of root hairs and lateral roots in silicon uptake by rice. *Plant Phy.* **127:** 1773-1780.

Matichenkov, V. V. and Bocharnikova, E. A. 2010. Technology for natural water protection against pollution from cultivated areas, 2020. 15th Annual Australian Agron. Conf.

Matichenkov, V. V. and Calvert, D. V. 2002. Silicon as a beneficial element for sugarcane. *J. American Soc. Sugarcane Technologists.* **22:** 21-30.

Mongia, A. D., Chhabra, R. and Khajanchi Lal. 2003. Possibility of using fly ash as a source of silica for increasing rice productivity on a reclaimed alkali soil. *J. Indian Soc. soil Sci.* **51(1):** 89-91.

Prakash, N. B., Chandrashekar, N., Mahendra, C., Patil, S. U., Thippeshappa, G. N. and Laane, H. M. 2011. Effect of foliar spray of soluble silicic acid on growth and yield parameters of wetland rice in hilly and coastal zone soils of Karnataka, South India. *J. Plant Nutr.* **34(12):** 1883-1893.

Putra, E. T. S., Zakaria, W., Abdullah, N. A. H. and Saleh, G. 2010. Weak neck of *Musa* sp. cv. Rasthali: A review on its genetic, crop nutrition and post harvest. *J. Agron.* **9(2):** 45-51.

Regan Crooks and Peter Prentice 2011. the benefits of silicon fertiliser for sustainably increasing crop productivity. The 5th Intl. Conf. on Silicon in Agric., Beijing, pp. 1-18.

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

Sundar Raj, N., Nagaraj, S., Venkataramu, M. N. and Jagannath, M. K. 1972. Design and analysis of field experiments. *Univ. Agric. Sci.* pp. 106-110.

Vladimir Matchinkov, Elena Bocharnikova and David Calvert. 2001. Response of citrus to silicon soil amendments. *Proc. Fla. State Hort. Soc.* **114**: 94-97.