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RESPONSE OF SILICON AND MICRO NUTRIENTS ON FRUIT CHARACTER AND NUTRIENT CONTENT IN LEAF OF SAPOTA

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ABSTRACT

Experiment was conducted to know the response of nutrients on fruit character and its influence on enhancing yield and quality and also on accumulation of nutrients in leaf. Potassium silicate, calcium silicate was taken as silicon source and solubor as boron and kiecite-G were used as micronutrient source. Fruit characters like fruit weight (99.96 g), fruit length (5.55 g), fruit diameter (5.85 g), volume of fruit (102.38 g) and maximum shelf life (10.90 days) was recorded with treatment supplemented with foliar application of potassium silicate at 8 ml per litre. Highest yield per tree (124.81 kg) and hectare (12.48 t) were recorded in treatment supplemented with foliar application of potassium silicate at 8 ml per litre where as highest B:C ratio (2.36) was recorded in treatment which is supplied calcium silicate as soil application. The highest nutrients like nitrogen (1.583 %), phosphorous (0.175 %), potassium (1.20 %) and silicon content (1.20 %) in leaf were recorded with potassium silicate spray (8 ml per litre).
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Key words : Silicon, Micro nutrients, Nutrient content, Sapota.   .

INTRODUCTION

Sapota is one of the important fruit crops of India botanically called as *Manilkara achras* (Mill) Forsberg which belongs to family Sapotaceae. Sapota is mainly valued for its sweet and delicious fruit. The mature fruits are also used for making mixed jams and they provide a valuable source of raw material for the manufacture of industrial glucose, pectin and natural fruit jellies.

In sapota less research work has been carried out especially on nutrition, so there is ample scope for studies on nutrition aspects. Silicon is one of the beneficial element can helps in improving growth of plant by correcting their deficiencies especially in highly weathered soil especially in tropical regions. 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 take up directly as silicic acid (Ma *et al.*, 2001).

Micronutrients play a major role in crop production due to their essentiality in plant metabolism and adverse effects that manifest due to their deficiency. Besides affecting plant growth, micronutrients also play a major role in disease resistance in cultivated crop species. Micronutrients can tremendously boost horticultural crop yield and improve quality and post-harvest life of horticultural produce (Raja, 2009).

MATERIALS AND METHOD

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.

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 application) 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.

Potassium silicate (diluted to 1:5 ratio) at the concentration of 6 ml per litre and 8 ml per litre were mixed in 8 litres of water per tree and sprayed at monthly intervals. Similarly, soil application of calcium silicate powder was applied once at the beginning of the experiment at the rate of 1, 1.5, 2, 2.5 kg per tree respectively around the tree basin and thoroughly mixed with soil. Boron at the rate of 2 g per litre and 3 g per litre and multi micronutrients at the rate of 3 ml per litre and 4 ml per litre were sprayed at monthly intervals.

Twenty two year old healthy trees were selected with spacing of 10 x 10 meter. Three trees were selected per treatment and replication and totally ninety nine trees were selected for the experiment. The recommended dose of fertilizers was applied as per the package of practice of UAS, Bengaluru. Fertilizer dose of 400 g of Nitrogen, 160 g of Phosphorous and 450 g of Potassium was applied in the form of Urea, Rock phosphate and Muriate of potash in addition to 50 kg of farm yard manure. The fertilizers were applied in two split doses and observations were recorded. As it is grown in rainfed condition additional irrigation was given at the critical stages of growth period. No severe pest and diseases were recorded during research period.

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 DISSCUSSION

Maximum number of fruits per square meter and tree differed significantly in the treatment with foliar application of silicon at 8 ml per litre (Table 1). Silicon might helped in cell division, more nutrient and water uptake and resulted in production of more number of fruits. Similar observations were made by Gorecki and Danielski busch (2009) in green house cucumber, Nesreen *et al.* (2011) in beans and Stamatakis *et al.* (2003) in tomato.

There was significant increase in weight, length, diameter and volume of fruit with soil and foliar application of silicon and micronutrients over control and significant results were obtained with foliar application of potassium silicate at 8 ml per litre (Table-11). Due to higher photosynthetic activity, these results in more translocation of metabolites and there by size of fruit have been increased. The results are in accordance with Nam Sangyoung *et al.* (1996) and Nesreen *et al.* (2011).

Foliar application of potassium silicate with 8 ml per litre extended its shelf life up to 10.90 days compared to control (Table 1). Silicon might help in improving fruit quality due to suppression of respiration and reduction in ethylene evolution and thus minimized physiological loss in weight of the fruit. The results are in conformity with Babak and Majid (2011). Potassium silicate also helped in synthesis of more sugar content in fruit and thus resulted in increasing maximum total soluble solids (Table 1). The results are in accordance with Stamatakis *et al.* (2003).

The highest nitrogen, phosphorous and potassium content in the leaf was observed in the treatment with foliar application of potassium silicate at 8 ml per litre (Figure 1). Silicon application avoided leaching loss of N and helped thus helped in more accumulation of nitrogen in leaf. Similar results were observed by. Silicon rendered more P available to the plants reversing its fixation as silicon itself competed for P fixation and thus slowly released P helped in more accumulation of P content in leaf.

Treatments with Potassium silicate recorded more per cent of potassium compared to treatments with calcium silicate as it contained potassium along with silicon. The above results are in conformity with the findings of Nesreen *et al.* (2011), Kamenidou *et al.* (2009) and Kamenidou *et al.* (2008).

Calcium content and magnesium content in the leaf differed significantly among different treatments and the highest calcium content in the leaf was recorded in the treatment with soil application of calcium silicate at 2.5 kg per tree (Figure 1). Calcium silicate as it contain calcium resulted in more uptake of calcium and silicon also helped in uptake of calcium and thus resulted in more accumulation of calcium in leaf. Similar observations were made by Stamatakis *et al.* (2003) and Prado and Natale (2005). As calcium silicate contained magnesium along with calcium and resulted in more uptake of magnesium by leaf. Silicon also helped in uptake of magnesium.

Table-1. Effect of soil and foliar application of silicon and micronutrients on fruit characters and quality of sapota.

Treatments	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Volume of fruit (ml)	Shelf life (days)	T.S.S. (%)
T_1- Control	83.33	5.03	5.29	92.13	8.16	21.04
T_2- Foliar application of Potassium silicate @ 6 ml/l	98.66	5.53	5.74	100.77	9.25	24.81
T_3- Foliar application of Potassium silicate @ 8 ml/l	99.66	5.55	5.85	102.38	10.90	25.16
T_4- Soil application of Calcium silicate @ 1.0 Kg/tree	92.33	5.39	5.54	96.50	9.16	22.36
T_5- Soil application of Calcium silicate @ 1.5 Kg/tree	94.00	5.46	5.66	96.86	9.08	22.54
T_6- Soil application of Calcium silicate @ 2.0 Kg/tree	96.00	5.50	5.71	97.83	10.25	22.74
T_7- Soil application of Calcium silicate @ 2.5 Kg/tree	98.33	5.52	5.72	98.93	10.66	23.20
T_8- Foliar application of Boron @ 2 g/l	90.00	5.38	5.49	94.11	10.16	21.90
T_9- Foliar application of Boron @ 3 g/l	89.66	5.17	5.38	93.33	9.25	21.43
T_{10}- Foliar application of Micronutrients @ 3 ml/l	90.00	5.29	5.49	94.16	8.83	21.66
T_{11}- Foliar application of Micronutrients @ 4 ml/l	91.33	5.32	5.53	95.33	9.16	22.10
F-test	*	*	*	*	*	*
S. Em ±	2.62	0.116	0.06	1.45	0.53	0.83
CD at 5%	7.75	0.342	0.19	4.30	1.58	2.46

* = Significant, NS = Non-significant

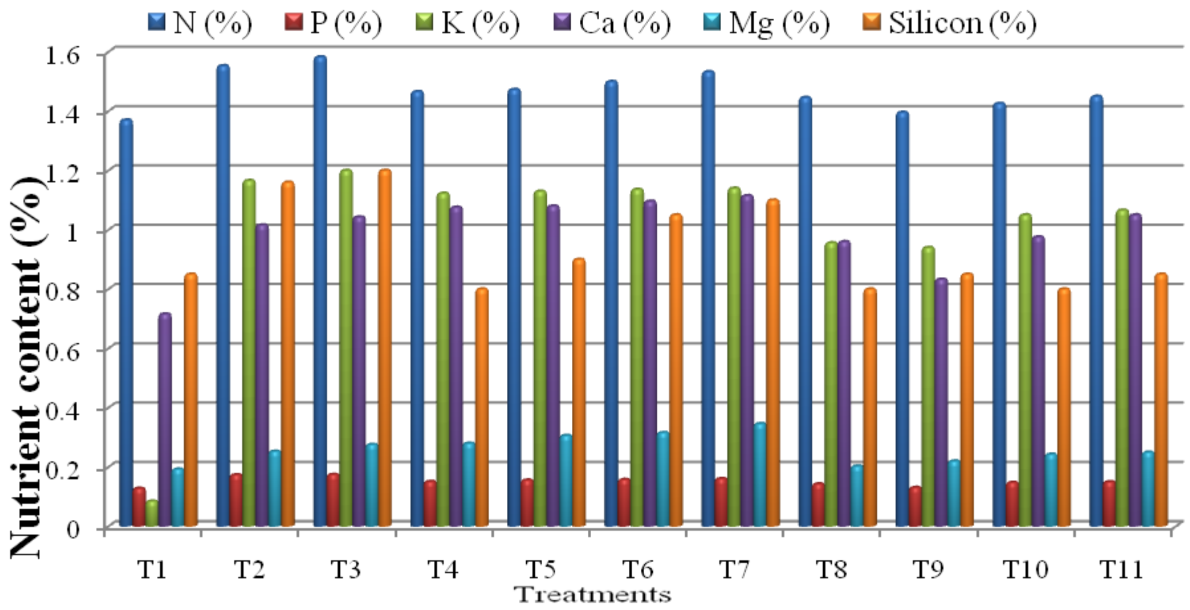
Table-2. Effect of soil and foliar application of silicon and micronutrients on yield and economics of sapota

Treatments	Fruit Yield/ tree (Kg)	Yield (t)	Gross income (₹)	Total cost of cultivation (₹)	Net returns (₹)	Benefit cost (B:C) ratio
T_1- Control	95.26	9.52	1,42,800	68,016	74,784	2.09
T_2- Potassium silicate (foliar application) @ 6 ml/l	118.49	11.84	1,77,600	93,387	84,213	1.90
T_3- Potassium silicate (foliar application) @ 8 ml/l	124.81	12.48	1,87,200	97,678	89,522	1.91
T_4- Calcium silicate (soil application) @ 1.0 Kg/tree	109.87	10.98	1,64,700	71,476	93,224	2.30
T_5- Calcium silicate (soil application) @ 1.5Kg/tree	111.47	11.14	1,67,100	72,079	94,841	2.31
T_6- Calcium silicate (soil application) @ 2.0 Kg/tree	113.99	11.39	1,70,850	72,562	98,288	2.35
T_7- Calcium silicate (soil application) @ 2.5 Kg/tree	116.96	11.68	1,72,200	72,959	99,141	2.36
T_8- Boron (foliar application) @ 2 g/l	105.83	10.58	1,58,700	78,248	80,452	2.02
T_9- Boron (foliar application) @ 3 g/l	104.86	10.48	1,57,200	79,859	77,341	1.96
T_{10}- Micronutrients (foliar application) @ 3 ml/l	106.66	10.66	1,59,900	79,169	80,731	2.01
T_{11}- Micronutrients (foliar application) @ 4 ml/l	108.86	10.88	1,63,200	80,634	82,566	2.02
F-test	*	*				
S. Em ±	2.43	0.24				
CD at 5%	7.18	0.71				

The content of silicon in leaf was found to be high due to foliar spray of potassium silicate at 8 ml per litre (Figure-1) compared to other treatments. The results are in conformity with findings of Vladimir *et al*. (2001) in citrus, Ma and Yamaji (2006) in rice, Figen *et al.* (2008) in spinach and Milne *et al.* (2012) in lettuce.

The highest yield per tree (124.81 kg) and highest yield per hectare (12.48 t) was recorded in the treatment with foliar spray of potassium silicate at 8 ml per litre which was on par with treatment supplemented with potassium silicate at 6 ml per litre (Table-2). Potassium silicate had positive effect on growth and yield. Increased yield might have attributed due to increased photosynthetic activity of plant, water metabolism, chlorophyll content, more formation of carbohydrates, membrane lipid peroxidation, protective enzymes under drought condition and

Figure-1: Effect of soil and foliar application of silicon and micro nutrients on nutrient content in sapota leaf at the stage of fruit harvest



more uptake of essential nutrients (Yasuto and Eiichi, 1983). Similar results were noticed by Nesreen *et al.* (2011) in beans and Ma *et al.* (2004) in cucumber.

As shown in the Table 2, the cost of cultivation per hectare area revealed that, the treatment foliar spray of potassium silicate 8 ml/L (T_3) gave the maximum gross income (₹1, 87,200) followed by treatment foliar spray of potassium silicate 6 ml/L T_2 (₹1, 77,600). The maximum net returns was obtained in treatment soil application of calcium silicate at 2.5 kg (T_7) per tree (₹99, 141) followed by soil application of calcium silicate at 2.0 kg (T_6) per tree (₹98, 288) and the same treatments were recorded highest benefit to cost (B:C) ratio, T_7 (2.36) followed by T_6 (2.35).

The result of this study highlights the role of potassium silicate in improving growth and yield of sapota. By using potassium silicate at 8 ml per litre helped in increasing yield of sapota and where as with application of calcium silicate at 2.5 kg per tree resulted in obtaining highest benefit to cost (B:C) ratio.

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