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Effect of soil and foliar application of silicon on yield and economics of banana (*Musa paradisiaca* L.) cv. Rajapuri

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Abstract
The experiment was under taken in ICAR-AICRP on Fruits, Kittur Rani Channamma College of Horticulture, Arabhavi, Belagavi district, Karnataka during the year 2020-2021. The experiment was laid out in randomized complete block design with eight treatments and three replications. The study reported that the soil application of calcium silicate @ 100 g per plant at 4, 5, 6 months after planting + foliar spray of potassium silicate at 4 ml per litre from 4th to 8th months after planting at monthly interval + bunch spray of potassium silicate at 6 ml per litre after denavelling and one month after 1st spray significantly improved the finger weight (115.24 g), finger length (13.47 cm), finger girth (12.15 cm), number of hands per bunch (8.45), bunch length (52.78 cm), bunch width (40.47 cm), bunch weight (15.70 kg), yield per hectare (48.45 t/ha) and B:C ratio (2.29:1) over control (T_8) in banana cv. Rajapuri.

Keywords: Silicon, uptake, banana, yield, Rajapuri

Introduction
Banana (*Musa paradisiaca* L.) is a monocarpic herb belonging to the family musaceae originated in South East Asia. It is an economically important fruit crop grown mainly in tropical and subtropical regions of the world. In terms of importance as a food crop, banana ranks next only to rice, wheat and maize, serving as a source of nutrients and calories for millions of people (Patil and Jagadeesh, 2016) [13]. Among the different varieties of banana grown in Karnataka, the cultivar Rajapuri of *Musa* AAB group, is a popular variety grown majorly in districts of North Karnataka like Belagavi, Dharwad and Bagalkote. It is also known as Jawari bale meaning local type. The plant is small, grows up to 6-8 feet and is hardy which is resistant to cold and strong winds. It has broader leaves measures up to 3 feet. It is the most preferred variety among consumers due to its attractive medium sized fruits and unique blend of sour and sweet taste of the fruits.

Almost 28 per cent of earth's crust consists of silicon (Si), the second most abundant element on earth following oxygen. The name silicon is derived from the latin word 'Silex' or 'Silicis' meaning flint. It is most commonly available in soil in the form of solution as silicic acid (H_4SiO_4) (Ma *et al.*, 2001) [8]. Silicon has a key role in plant environment relationship because it can improve plant abilities to withstand edaphic climatic and/ or biological adversities by acting as a "Natural antistress" mechanism that enables higher yields and better quality end product (Vijayan *et al.*, 2021) [16]. Si improves mechanical strength and increases resistance to strong winds and rain. It is also known to increase drought tolerance in plants by maintaining plant water balance (Melo *et al.*, 2003) [10]. Si enhances growth and yield of all crops, promotes upright growth and favourable exposure of leaves to light. It also prevents lodging and decreases some aboitic stresses such as temperature and salinity (Matoh *et al.*, 1991) [9].

With this background information and based on the possible benefits of silicon, the present study was carried out to know the effect of soil and foliar application of silicon on yield and economics of banana (*Musa paradisiaca* L.) cv. Rajapuri.

Material and Methods
The experiment was carried at ICAR- AICRP on Fruits, Kittur Rani Channamma College of Horticulture, Arabhavi, University of Horticultural Sciences, Bagalkot, Karnataka, India. The experiment was laid out in randomized complete block design (RCBD) with eight treatments. The five plants were selected randomly for recording observations from each treatment.

The treatment details are given below

T_1: Foliar spray of potassium silicate @ 4 ml/litre from 4th to 8th months after planting at monthly interval

T_2: Foliar spray of potassium silicate @ 4 ml/litre from 4th to 8th months after planting at monthly interval + bunch spray of potassium silicate @ 4 ml/litre after denavelling and one month after 1st spray

T_3: Foliar spray of potassium silicate @ 4 ml/litre from 4th to 8th months after planting at monthly interval + bunch spray of potassium silicate @ 6 ml/litre after denavelling and one month after 1st spray

T_4: Soil application of calcium silicate @ 100 g/plant at 4, 5, 6 months after planting

T_5: Soil application of calcium silicate @ 100 g/plant at 4, 5, 6 months after planting + foliar spray of potassium silicate @ 4 ml/litre from 4th to 8th months after planting at monthly interval

T_6: Soil application of calcium silicate @ 100 g/plant at 4, 5, 6 months after planting + foliar spray of potassium silicate @ 4 ml/litre from 4th to 8th months after planting at monthly interval + bunch spray of potassium silicate @ 4 ml/litre after denavelling and one month after 1st spray

T_7: Soil application of calcium silicate @ 100 g/plant at 4, 5, 6 months after planting + foliar spray of potassium silicate @ 4 ml/litre from 4th to 8th months after planting at monthly interval + bunch spray of potassium silicate @ 6 ml/litre after denavelling and one month after 1st spray

T_8: Control

The data on different yield parameters were recorded and was subjected to statistical analysis for meaningful conclusions.

Results and Discussion

Finger weight (g)

Finger weight of banana had significantly influenced by soil and foliar application of silicon (Table 1). Increased finger weight (115.24 g) was recorded in treatment T_7 (Soil application of calcium silicate @ 100 g/plant at 4, 5, 6 months after planting + foliar spray of potassium silicate @ 4 ml/litre from 4th to 8th months after planting at monthly interval + bunch spray of potassium silicate @ 6 ml/litre after denavelling and one month after 1st spray) whereas, the lowest finger weight (85.38 g) was recorded in T_8 (Control). The increase in finger weight might be due to application of silicon promoted higher photosynthetic activity and biomass synthesis in the plant which may have resulted in more metabolites in the plant, resulting in an increase in finger weight. As the growth and development of the fingers progressed, the significant amount of water and other metabolites flowed into the fingers. Patil and Jagadeesh (2016) [13] reported higher finger weight (150.42 g) in banana cv. Grand Naine with bunch spray of potassium silicate at 6 ml/litre. The results of present study are close conformity with Patil (2016) [13] and Rakesh (2018) [14] in banana. cv. Grand Naine.

Finger length (cm)

Among all the treatments, the maximum finger length (13.47 cm) was recorded in treatment T_7 (Soil application of calcium silicate @ 100 g/plant at 4, 5, 6 months after planting + foliar spray of potassium silicate @ 4 ml/litre from 4th to 8th months after planting at monthly interval + bunch spray of potassium silicate @ 6 ml/litre after denavelling and one month after 1st spray) whereas, the minimum finger length (10.54 cm) was reported in T_8 (control) (Table 1). Bhavya (2010) [2] stated that, this might be due to beneficial effect of silicon which led to cell expansion. Ashok (2013) [1] noticed maximum finger length (20.03 cm) in banana cv. Grand Naine with RDF + 750 kg/ha of diatomaceous earth. Similar records were found by Das *et al.* (2017) [4] in guava and Rakesh (2018) [14] in banana cv. Grand Naine.

Finger girth (cm)

The finger girth was significantly influenced by soil and foliar application of silicon (Table 1). Among all the treatments, the maximum finger girth (12.15 cm) was recorded in treatment T_7 (Soil application of calcium silicate @ 100 g/plant at 4, 5, 6 months after planting + foliar spray of potassium silicate @ 4 ml/litre from 4th to 8th months after planting at monthly interval + bunch spray of potassium silicate @ 6 ml/litre after denavelling and one month after 1st spray) whereas, the minimum finger girth (8.20 cm) was reported in T_8 (control). Bhavya (2010) [2] stated that, this might be due to beneficial effect of silicon which led to cell expansion. Ashok (2013) [1] noticed maximum finger girth (3.85 cm) in banana cv. Grand Naine with RDF + 750 kg/ha of diatomaceous earth. Similar records were found by Costa *et al.* (2015) [3] in Palmer mango, Patil and Jagadeesh (2016) [13] and Rakesh (2018) [14] in banana cv. Grand Naine.

Number of hands per bunch

The results showed that, the highest number of hands per bunch (8.45) was observed in treatment T_7 (soil application of calcium silicate at 100 g per plant at 4, 5, 6 months after planting + foliar spray of potassium silicate at 4 ml per litre from 4th to 8th months after planting at monthly interval + bunch spray of potassium silicate at 6 ml per litre after denavelling and one month after 1st spray) as against lowest (6.34) was recorded in T_8 (control) is presented in Table1. Silicon stimulated nutrient uptake and photosynthesis, these factors resulted in the production of more number of hands and fingers. Rakesh (2018) [14] reported more number of hands per bunch (10.17) in banana cv. Grand Naine. Similar outcomes were mentioned by Bhavya (2010) [2] in Bangalore Blue grapes, Thippeshappa *et al.* (2014) in sapota, Costa *et al.* (2015) [3] in Palmer mango, Patil and Jagadeesh (2016) [13] in banana, and Das *et al.* (2017) [4] in guava.

Bunch length and width (cm)

The treatment T_7 (Soil application of calcium silicate at 100 g per plant at 4, 5, 6 months after planting + foliar spray of potassium silicate at 4 ml per litre from 4th to 8th months after planting at monthly interval + bunch spray of potassium silicate at 6 ml per litre after denavelling and one month after 1st spray) reported the maximum bunch length and bunch width (52.78 and 40.47 cm) as against minimum bunch length and width (42.49 and 33.59 cm) was reported in T_8 (control) (Table. 2). Silicon increased the cell division and expansion, as well as their effect on RNA and DNA synthesis, which could be the primary reason for the increased bunch length and width. Ashok (2013) [1] noted maximum bunch length (94.05 cm) and bunch width (46.25 cm) in banana cv. Grand Naine with RDF + 750 kg/ha of diatomaceous earth. The identical outcomes were recorded by Bhavya (2010) [2] in

Bangalore Blue grapes, Ashok (2013) [1] and Hanumanthaiah *et al.* (2015) [6] in banana.

Bunch weight (kg)

The results depicted that, the weight of bunch was significantly influenced by soil and foliar application of silicon (Table. 2). Among all the treatments, the treatment T_7 (Soil application of calcium silicate at 100 g/plant at 4, 5, 6 months after planting + foliar spray of potassium silicate at 4 ml/litre from 4th to 8th months after planting at monthly interval + bunch spray of potassium silicate at 6 ml/litre after denavelling and one month after 1st spray) was recorded the highest bunch weight (15.70 kg) whereas, the lowest bunch weight (9.07 kg) was reported in T_8 (control). The rise in bunch weight might be due to the fact that silicon increased the bunch size and finger size. The increased finger size could be a substantial contributor to the weight of the bunch. Patil and Jagadeesh (2016) [13] reported increased bunch weight (32.05 kg) in banana cv. Grand Naine as bunch spray of potassium silicate at 6ml/litre. The similar records were observed by Costa *et al.* (2015) [3] in Palmer mango, Das *et al.* (2017) [4] in guava and Rakesh (2018) [14] in banana.

Yield per hectare (t/ha)

The results on yield per plot and yield hectare were significantly influenced by soil and foliar application of silicon (Table. 2). Among all the treatments, the treatment T_7 (Soil application of calcium silicate at 100 g/plant at 4, 5, 6 months after planting + foliar spray of potassium silicate at 4 ml/litre from 4th to 8th months after planting at monthly interval + bunch spray of potassium silicate at 6 ml/litre after denavelling and one month after 1st spray) was recorded the maximum yield per plot and yield per hectare (4.43 q/plot and 48.45 t/ha) as against minimum yield per plot and hectare (2.44 q/plot and 27.97 t/ha) was recorded in T_8 (control). Increased yield could be attributed to more number of functional leaves and leaf area resulting in increased photosynthetic activity, carbohydrate formation and nutrient uptake. Ashok (2013) [1] reported highest yield (69.39 t/ha) in banana cv. Grand Naine with RDF+750 kg/ha of diatomaceous earth. The similar findings were also noticed by Hajiboland *et al.* (2017) [5] in strawberry, Noorullah *et al.* (2017) [11] in mango and Rakesh (2018) [14] in banana.

Benefit: Cost ratio

The benefit: cost ratio was significantly influenced by foliar and bunch nutrition (Table 3). The highest benefit cost ratio (2.29:1) was reported in T_7 (Soil application of calcium silicate at 100 g/plant at 4, 5, 6 months after planting + foliar spray of potassium silicate at 4 ml/litre from 4th to 8th months after planting at monthly interval + bunch spray of potassium silicate at 6 ml/litre after denavelling and one month after 1st spray) whereas, the lowest (1.37:1) was recorded in T_8 (control). The similar results were noticed by Hanumanthaiah (2012) [7] in banana cv. Elakki Bale, Ashok (2013) [1] and Patil (2016) [13] in cv. Grand Naine.

Table 1: Effect of soil and foliar application of silicon on finger parameters of banana cv. Rajapuri

Treatments	Finger parameters			
	Finger weight (g)	Finger length(cm)	Finger girth (cm)	Hands per bunch
T_1	96.64	12.08	9.86	6.94
T_2	98.78	12.51	10.00	7.12
T_3	109.01	13.19	11.11	7.98
T_4	91.02	11.52	9.83	6.53
T_5	107.31	12.20	10.22	7.49
T_6	112.53	13.35	11.50	8.24
T_7	115.24	13.47	12.15	8.45
T_8	85.38	10.54	8.20	6.34
S.Em ±	4.12	0.48	0.57	0.24
CD @ 5%	12.49	1.45	1.72	0.74

Table 2: Effect of soil and foliar application of silicon on yield attributes of banana cv. Rajapuri

Treatments	Bunch parameters			
	Bunch length (cm)	Bunch width (cm)	Bunch weight (kg)	Yield (t/ha)
T_1	47.66	36.51	10.07	31.06
T_2	48.87	37.52	11.17	34.45
T_3	51.09	37.71	13.20	40.73
T_4	47.05	36.38	9.33	28.80
T_5	50.29	38.91	12.27	37.85
T_6	52.19	39.87	14.43	44.54
T_7	52.78	40.47	15.70	48.45
T_8	42.49	33.59	9.07	27.97
S.Em ±	1.58	0.97	0.51	1.17
CD @ 5%	4.79	2.96	1.55	3.54

Table 3: Effect of soil and foliar application of silicon on Benefit Cost ratio of banana cv. Rajapuri

Treatments	Benefit Cost ratio			
	Total cost of cultivation (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	Benefit: Cost ratio
T_1	3,65,181	5,58,000	1,92,819	1.53
T_2	3,68,333	6,12,000	2,43,667	1.66
T_3	3,62,282	7,20,000	3,57,718	1.99
T_4	3,60,573	5,04,000	1,43,427	1.40

T_5	3,72,090	6,66,000	2,93,910	1.79
T_6	3,75,242	7,92,000	4,16,758	2.11
T_7	3,76,818	8,64,000	4,87,182	2.29
T_8	3,54,783	4,86,000	1,31,217	1.37

Conclusion

Based on the findings of this research, it is possible to conclude that, soil application of calcium silicate at 100 g/plant at 4, 5, 6 months after planting + foliar spray of potassium silicate at 4 ml/litre from 4th to 8th months after planting at monthly interval + bunch spray of potassium silicate at 6 ml/litre after denavelling and one month after 1st spray (T_7) significantly enhances the yield and economics of banana cv. Rajapuri which attracts the consumers and ensures highest profit.

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