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INFLUENCE OF DIATOMACEOUS EARTH AS SOURCE OF SILICON ON LEAF NUTRIENT STATUS AND YIELD ATTRIBUTING CHARACTERS OF BANANA CV. GRAND NAINE

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ABSTRACT
Field experiment was conducted to know the response of Diatomaceous earth as a source of silicon on leaf nutrient status and yield attributing characters of banana in farmer field under Kittur Rani Channamma College of Horticulture, Arabhavi, Belgaum District, Karnataka state during 2013-14. The experiment was laid out in a randomized block design with nine treatment replicated three times. The treatment comprised of application of 750, 500 and 250 kg/ha of Diatomaceous Earth in combination with half and full dose of RDF (200:100:300 g NPK/plant/year). Leaf sample under different treatment were collected and utilized for analysis of nutrient status. The highest macronutrient *viz*., Nitrogen (3.48 %), Phosphorous (0.37 %) and Potassium (4.23 %) and Micronutrients viz, Calcium (0.75 %), Magnesium (0.35%), Zinc (27.03 ppm), Copper (12.37 ppm) and Silicon (0.79 %) were recorded in plants applied with RDF + 750 kg/ha of DE. Yield attributing characters like finger length (20.03 cm), diameter of the fingers (3.85 cm), number of hands per bunch (11.13), number of fingers per bunch (195.38) and bunch weight (26.67 kg) was also found in the plants applied with RDF + 750 kg/ha of DE which resulted in more yield and quality of banana fruits.

INTRODUCTION

Banana contributes 37 per cent of the total fruit production in India. Southern parts of the countries are leading in banana production and productivity due to presence of favorable climatic conditions. The area under banana cultivation was 8.03 lakh ha with production of 297.25 lakh mt and the productivity of 37mt per hectare. However, Karnataka state alone has 1.02 lakh ha of area, producing 26.75 lakh mt with the productivity of 26.1 mt per hectare (Anon, 2014).

Banana is a heavy feeder of nutrients and thus need balanced nutrition for optimum growth and fruit production, and in turn potential yields. A deficiency or excess of nutrients can cause substantial damage to the plant. Studies have clearly demonstrated that for high productivity of banana, application of recommended dose of essential nutrients at appropriate growth stage is necessary (Pandey *et al*., 2005 and Thangaselvabai *et al*., 2009.). Further the crop well responds to micronutrient and some of the beneficial element like silicon.

Silicon is considered as an important beneficial element as it helps in growth and development of plant. Most of the plants absorb silicon in the form of monosilicic acid ($Si(OH)_4$). Cereals and grasses contain 0.2 - 2.0 per cent Si, where as dicotyledons accumulate $1/10^{th}$ of its concentration. Si is deposited in the walls of epidermal cells after absorption by the plants which contributes considerably to stem strength. Silicic acid is not much mobile element in plants. Therefore a continuous supply of this element would be required particularly for healthy and productive development of plant during all growth stages.

Silicon is not considered as an essential element, but it has positive growth effect including increased dry mass and yield, enhanced pollination and most commonly increased disease resistance (Gillman *et al.,* 2003). The role of silicon in plant biology is known to tolerate multiple stresses including biotic and abiotic stresses. It is also known to increase drought tolerance in plants by maintaining plant water balance, photosynthetic activity, and erectness of leaves and structure of xylem vessels regulating transpiration rates (Melo *et al*., 2003).

Silicon is known to effectively mitigate various abiotic stresses such as manganese, aluminium and heavy metal toxicities, salinity, drought, chilling and freezing stresses (Liang *et al*., 2007). Improved water economy and dry matter yield with Si application and further it enhanced leaf water potential under water stress conditions, reduced incidence of micronutrient and metal toxicity. Three contrasted genotypes of *Musa* sp. like *M. acuminate* cv. Grande Naine, *M. acuminate* sp. Banksii and *M. balbisiana* sp. Tani were grown for 6 weeks under optimal conditions in hydroponics and were subjected to a wide range of Si supply (0-1.66 mM Si) to quantify the Si uptake and distribution in banana, as well as the effect of Si on banana growth. The rate of Si uptake and the Si concentration in plant tissues increased markedly with the Si supply (Henriet *et al*., 2006). Therefore, based on the possible benefits of silicon, the present study was planned to know the response of silicon

on leaf nutrient status and yield of bananacv Grand Naine.

MATERIALS AND METHODS

The experiment was conducted during 2013-14 at farmer's field under Kittur Rani Channamma College of Horticulture, Arabhavi, Belgaum. The area falls under the zone of Karnataka with annual average rain fall of 580 mm. The average maximum temperature of the location is 33.17°C and the average minimum temperature is 18.92°C and the relative humidity ranges from 60 to 90 per cent.

Experimental details

The experiment was laid out in Randomized Block Design (RBD) with nine treatments replicated thrice with 48 plants under each treatment. The treatment details are T_1 - Absolute control; T_2 - Recommended dose of fertilizer (200:100:300 g NPK/plant); T_3 - Half of Recommended dose of fertilizer; T_4 - Half of RDF + 250 kg/ha of DE; T_5 - Half of RDF + 500 kg/ha of DE; T_6 - Half of RDF + 750 kg/ha of DE; T_7 - RDF + 250 kg/ha of DE; T_8 - RDF + 500 kg/ha of DE; and T_9 - RDF + 750 kg/ha of DE. Diatomaceous earth (DE) was used as a source of silicon and was applied as basal dose to the respective treatment in this experiment. The inorganic nutrient *i.e.* nitrogen was applied in the form of urea (46% N), phosphorous applied in the form of Diamonium phosphate (18% N: 46% P: 0% K) and potassium applied in the form of muriate of potash (60% K). These nutrients were applied to the respective treatment according to the package of practice of UHS, Bagalkot (Anon, 2013).

Leaf analysis

Leaf sampling and processing

Leaf samples from apex were collected from the designated plants in the treatment in each replication at six months stage after planting. Leaf strips from both sides of the middle portion of the lamina were taken (Hewitt, 1955). After cleaning with distilled water, leaf samples were oven- dried at 50^{0}C till they attain constant weight. The samples were analysed for total nitrogen, phosphorous, potassium, calcium, magnesium, micronutrients like zinc, copper and silicon content.

Estimation of total nitrogen, phosphorous and potassium were analyzed as per the procedure given by Jackson, 1967. Calcium and magnesium were analyzed as per the procedure given by titration with EDTA (disodiumdihydrogen-ethylenediamine tetraacetate) which was reported by Tucker and Kurtz (1960). Zinc and Copper content was estimated by Diethylene triamine pentaacetic acid (DTPA) method (Lindasay and Norwell, 1978). Silicon content was estimated by ANSA (1-amino-2-napthol-4-sulfonic acid) method (Kadalli*et al*., 2013).

The fruit characters were measured by using meter scale and expressed in centimetres. Number of hands per bunch, Number of fingers per bunch was physically counted and mean was worked out.Yield per hectare was calculated by multiplying respective plot yield in each treatment and expressed in tones per hectare.

RESULTS AND DISCUSSION

Composition of nutrient in the leaf after six months of planting indirectly reflects on the growth, development and yield.

Table 1: Effect of Diatomaceous Earth on Macronutrient status of banana leaf at six months after planting

Treatment	N (%)	P (%)	K (%)
T_1- Absolute control	2.74	0.28	2.94
T_2- Recommended dose of fertilizer (RDF)	3.33	0.33	3.78
T_3- Half of Recommended dose of fertilizer	3.13	0.3	3.17
T_4- Half of RDF + 250 kg/ha of DE	3.15	0.31	3.37
T_5- Half of RDF + 500 kg/ha of DE	3.16	0.32	3.54
T_6- Half of RDF + 750 kg/ha of DE	3.18	0.32	3.63
T_7- RDF + 250 kg/ha of DE	3.38	0.33	3.93
T_8- RDF + 500 kg/ha of DE	3.43	0.34	4.15
T_9- RDF + 750 kg/ha of DE	3.48	0.37	4.23
S.Em $\pm$	0.1	0.01	0.16
CD (P=0.05)	0.29	0.04	0.47

DE: Diatomaceous Earth

Table 2: Effect of Diatomaceous Earth on Micronutrient status of banana leafat six months after planting.

Treatment	Calcium (%)	Magnesium (%)	Zinc (ppm)	Copper (ppm)	Silicon(%)
T_1- Absolute control	0.46	0.23	17	5.8	0.59
T_2- Recommended dose of fertilizer(RDF)	0.65	0.31	21.8	7.6	0.49
T_3- Half of Recommended dose of fertilizer	0.47	0.26	18.7	6.43	0.62
T_4- Half of RDF + 250 kg/ha of DE	0.49	0.28	19.1	7.43	0.74
T_5- Half of RDF + 500 kg/ha of DE	0.53	0.28	19.6	7.77	0.82
T_6- Half of RDF + 750 kg/ha of DE	0.57	0.29	20.2	7.87	0.94
T_7- RDF + 250 kg/ha of DE	0.69	0.32	22.2	8.97	0.81
T_8- RDF + 500 kg/ha of DE	0.7	0.34	25.4	11.2	0.81
T_9- RDF + 750 kg/ha of DE	0.75	0.35	27	12.37	0.79
S.Em $\pm$	0.02	0.01	0.94	0.64	0.12
CD (P=0.05)	0.07	0.03	2.81	1.91	0.35

DE: Diatomaceous Earth

Table 3: Effect of Diatomaceous Earth on yield parameters of banana cv. Grand Naine

Treatments	Finger length (cm)	Finger diameter (cm)	No. of hands per bunch	No. of fingers /bunch	Bunch weight (kg)	Yield(t/ ha)
T_1- Absolute control	12.57	3.52	5.37	90.85	7.75	21.25
T_2- Recommended dose of fertilizer(RDF)	16.64	3.51	10.1	172.85	22.1	57.89
T_3- Half of Recommended dose of fertilizer	14.96	3.21	7.73	136.67	16.66	39.88
T_4- Half of RDF + 250 kg/ha of DE	15.27	3.27	8.22	148.33	17.48	44.17
T_5- Half of RDF + 500 kg/ha of DE	15.44	3.36	8.45	154.67	19.52	47.76
T_6- Half of RDF + 750 kg/ha of DE	15.54	3.48	9.25	166.67	20.37	52.35
T_7- RDF + 250 kg/ha of DE	17.89	3.54	10.1	175.17	23.77	61.37
T_8- RDF + 500 kg/ha of DE	19.17	3.7	10.7	186.83	24.76	66.2
T_9- RDF + 750 kg/ha of DE	20.03	3.85	11.1	195.38	26.67	69.39
S.Em $\pm$	0.74	0.1	0.29	6.13	0.91	1.85
CD (P = 0.05)	2.22	0.3	0.87	18.37	2.74	5.53

DE: Diatomaceous Earth

The highest nitrogen content in the leaf (3.47%) was observed in the treatment T_9 (RDF + 750 kg/ha of DE) whereas, lowest nitrogen content in the leaf was recorded in the treatment T_1 (Table 1). Silicon application might have avoided leaching of nitrogen from the soil and thus helped in more uptake. Similar results were observed by Lalithya *et al*. (2014) in sapota, Bhavya (2010) in Bangalore Blue grapes, Stamatakis *et al*. (2003) in tomato and Kamenidou *et al*. (2008) in ornamental sunflower.

The highest phosphorous content in the leaf (0.37%) was observed in the pants applied with RDF + 750 kg/ha of DE, while lowest phosphorous content in the leaf of plants in the control plants (Table 1). Silicon in solution rendered more P available to plants reversing its fixation as silicon itself competed for P fixation sites and thus, slowly released P and helped in more uptake. The above results are in conformity with the findings of Lalithya *et al*. (2014) in sapota, Bhavya (2010) in Bangalore Blue grapes, Pulz *et al*. (2008) in potato, Nesreen *et al*. (2011) in beans and Kamenidou *et al*. (2008) in ornamental sunflower.

The maximum potassium content in the leaf (4.23%) was recorded in the treatment T_9 whereas, lowest potassium content in the leaf of control plants (Table1). This might be attributed to the reason thatsilicon helped in more uptake of potassium due to its synergistic effect. Nesreen *et al*. (2011) recorded that, the application of potassium silicate increased per cent K in leaf. Similar results were observed by Lalithya *et al*. (2014) in sapota, Bhavya (2010) in Bangalore Blue grapes, Kamenidou and Toddy (2008) in Ornamental sunflower and Gorecki and Danielski (2009) in cucumber.

According to Regan and Peter (2011), the improved soilretention and plant uptake of key nutrients indicated the potential use of Agri Power Silica to displace a significant portion of NPK fertilizers. Silicon can help in reducing ureaand phosphate inputs thereby reducing costs and significantly reducing the environmental impact of these fertilizers.

The highest calcium, magnesium and copper content (0.75%, 0.35% and 12.36 ppm respectively) was noticed in the treatment T_9 whereas, lowest calcium, magnesium and copper content (0.46%, 0.23% and 5.80 ppm respectively) was observed in the treatment T_1 (Table 2). This is due to its helps in more absorption of calcium, magnesium and copper in to the plant tissue. Similar results were noticed by Lalithya *et al*. (2014) in sapota, Bhavya (2010) in Bangalore Blue grapes, Stamatakis *et al*. (2003) in tomato and Prado and Natale (2005) in passion fruit, Mary (2005) in rose, Kamenidou and Toddy (2008) in ornamental sunflower, Kamenidou *et al*. (2009) in zinnia and Kamenidou *et al*. (2010) in gerbera.

The highest silicon content (0.94 %) was noticed in the treatment T_6 (Half of RDF + 750 kg/ha of DE) whereas, lowest silicon content was observed in the treatment T_2 (Table 2). Application of higher dose of Diatomaceous Earth leads to more absorption on silicon by leaves of banana plants. The results are in conformity with findings of Lalithya *et al*. (2014) in sapota, Bhavya (2010) in Bangalore Blue grapes, Savvas *et al*. (2009) in tomato, Milne *et al*. (2012) in lettuce, Kamenidou *et al*. (2009) in gerbera and Mary (2005) in rose.

The average yield and yield contributing characters like finger length (20.03 cm), diameter of the fingers (3.85 cm), Number of hands per bunch (11.13), Number of fingers per bunch (195.38) and bunch weight (26.67 kg) was maximum in the treatment T_9, and maximum yield was noticed in the treatment T_9 (RDF + 750 kg/ha DE), while the lowest yield was observed in the treatment T_1 (Absolute control). Increased yield might have attributed to leaf erectness which facilitated better penetration of sunlight leading to higher photosynthetic activity of plant, more formation of carbohydrates and more uptakes of nutrients. Similar results were also noticed by Reaple and Laane (2008) in papaya, Bhavya (2010) in Bangalore Blue grapes Lalithya *et al*. (2014) in sapota.

In conclusion the result of this study highlights the role of silicon in improving nutrient content in banana. By using Full dose of RDF + 750 kg of DE helped in more utilization of nutrients and thus resulted in obtaining more yield and quality of banana.

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