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Effect of sources and levels of silicon on availability of micro nutrients in the soil of garlic field

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Abstract

The present investigation was under taken on garlic (Allium *sativum* L.) cv. Phule Nilima to study the effect of silicon, at “All India Coordinated Research Project on Vegetable Crops”, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar in *rabi* season of 2017-18, by using different sources and levels of silicon on chemical properties of soil and nutrient availability in the soil related to growth, yield and quality characters in garlic. Also to study the effect of sources and levels of silicon on total availability of micro nutrients in the experimental field of garlic.

Fifteen treatment combinations formed by three sources of fertilizer silicon (viz., diatomaceous earth, calcium silicate and bagasse ash) with five levels of silicon (viz., 0,100,150, 200 and 250 kg ha^{-1}) and one absolute control, were tried and each replicated three times. The basal dose of fertilizer 100 N, 50 P_2O_5 and 50 K_2O kg ha^{-1}was applied before planting.

The available micro nutrients viz., Fe, Mn, Zn, Cu was significantly influenced due to application of sources. The source A2 (CS) recorded significantly highest Fe and Mn. and source A1 (DE) recorded significantly highest Zn and Cu.

In case of levels of silicon the available micronutrients Fe, Mn, Zn, and Cu was showed significant influence due to application of silicon @ 250 kg ha $^{-1}$.

The interaction effect of sources and levels of silicon on an available Fe, Mn, Zn, and Cu in soil at harvest was non-significant.

The available Fe, Mn, Zn, and Cu in soil at harvest were significantly increased with treated over control.

Keywords: diatomaceous earth, calcium silicate, bagasse ash, silicon and micronutrients

Introduction

The word Silicon is derived from the latin word ‘Silex’, meaning flint. Silica refers to a compound in which each molecule of silicon is chemically bound to two oxygen molecules (SiO_2; Silicon dioxide). Silicon (Si) is the second most abundant element (27.72 %) after oxygen (46.60 %) in the earth crust. Silicon dioxide comprises 50 – 70 % of the soil mass, the earth crust contains large proportion of silicon and this silicon is mostly in the form of silicates.

Under field condition, Si fertilization is widely used to enhance production as well as improving resistance to lodging and increasing the erectness of leaves; these effects allow better light transmittance through plant canopies and thus indirectly improve whole plant photosynthesis. Silicon fertilizers can improve calcium content, nitrogen, and ratio of sugar to nicotine in tobacco and makes the quality higher. Si fertilizer can improve the sugar content in grape, watermelon, can increase the vitamin C content in eggplant, cabbage, onion, garlic and ginger. It also increases the protein content in soybean and peanut. Si fertilizers can improve quality of tea. Silicon fertilizers improve the quality of horticultural products. (Matichenkov and Bocharnikova, 2004) [4].

However until now silicon has not been put in list of essential elements for higher plants due to lack of evidence that plant is unable to complete its life cycle in absence of silicon. However, the fact that a large effect is that element must be directly involved in plant metabolism.

Garlic contains approximately 33 sulfur compound. Garlic (*Allium sativum* L.) member of Alliaceae or Lilliaceae family is the important bulb crop next to onion. Garlic originated in central Asia where it was extended to the Mediterranean region in the prehistoric dates (Thompson and Kelly, 1957) [8]. The cloves of garlic bulb used in flavoring of various vegetarian and non-vegetarian dishes.

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Garlic has higher nutritive value as compared to other bulbous crops. In Ayurveda garlic is considered as “Nectar of life.” It is rich source of carbohydrates (29.0%), proteins (6.3%), minerals (0.3%), essential oils (0.1– 0.4%) and also contain appreciable quantities of fats and vitamin C. It has antibacterial, antifungal, antiviral and anti-protozoal properties.

Garlic is important crop in rabi season. By using different sources and levels of silicon through soil, improves the quality and yield of garlic. Garlic bulbs supplied with N, P, K with silicon improves bulb quality and nutrient. Nitrogen showed a direct positive effect on pungency and total soluble solids (TSS) content. However due to lack of experimental evidence regarding significant effect of silicon on quality and yield, the present investigation was therefore undertaken to assess the efficiency of different sources and levels of silicon on availability of NPK as well as silicon in soil at harvest of garlic crop.

Material and Methods

The present investigation entitled “Response of garlic to silicon”. (Cv. Phule Nilima) was carried out at, All India Coordinated Research Project on Vegetable Crop, Department of Horticulture, Mahatma Phule Krishi Vidyapeet, Rahuri in *Rabi 2017 – 18.*

Table 1: Treatment details

A. Factor “A”	Sources of Silicon (three sources of silicon)
1. A_1	Diatomaceous earth (36%)
2. A2	Calcium Silicate (36%)
3. A3	Bagasse ash (27.9 %)
B. Factor “B”	Level of Si kgha^{-1} (five levels of silicon)
1. B_1	000 (control)
2. B_2	100
3. B_3	150
4. B_4	200
5. B_5	250
C. Absolute control	

The experiment was laid out in Factorial Randomized Block Design (FRBD) with control three replications having 16 treatments including one absolute control. Treatment details regarding sources and levels are given below in Table.1. & 2.

Table 2: Treatment combinations

Sr. No.	Treatments	Combinations	Sr. No.	Treatments	Combinations
1	T_1	A_1B_1	9	T_9	A_2B_4
2	T_2	A_1B_2	10	T_{10}	A_2B_5
3	T_3	A_1B_3	11	T_{11}	A_3B_1
4	T_4	A_1B_4	12	T_{12}	A_3B_2
5	T_5	A_1B_5	13	T_{13}	A_3B_3
6	T_6	A_2B_1	14	T_{14}	A_3B_4
7	T_7	A_2B_2	15	T_{15}	A_3B_5
8	T_8	A_2B_3	16	T_{16}	Absolute control

I. Application of silicon sources and fertilizers

Different silicon sources as diatomaceous earth, calcium silicate, and bagasse ash, were applied as basal dose 15 days before planting. A basal dose of 50:50:50; N: P_2O_5: K_2O kg ha^{-1} was applied at the time of planting through urea, single super phosphate and muriate of potash for all treatments. The second split dose of nitrogen i.e.50 kg N ha^{-1} was applied in equal two split doses at 30and 45 days after planting.

II. Soil analysis

Before sowing and after harvest of Garlic crop the representative soil samples were collected from each experimental plot. The collected soil samples were air dried under shade, pounded in wooden pestle and mortar, sieved through 2 mm sieve and utilized for analysis chemical properties of soils.

III. Available micronutrients

Micronutrients in soil were determined by atomic absorption spectrophotometer using DTPA extractant as described by Lindsay and Norvell (1978) [3].

IV. Statistical analysis

The data generated after observations of soil, plant and pest and disease incidence from present experiment was statistically analyzed by methods suggested by Panse and Sukhatme (1985) [6].

Results and Discussion

The data on effect of sources, levels of silicon and their interactions on available micro nutrient at harvest of garlic under field experiment are presented below.

1. DTPA Fe content of soil at harvest

The data in respect of effect of different sources and levels of silicon on available Fe at harvest presented in Table 3.

The soil available Fe in soil found significantly influenced due to sources, levels and their interaction.

The source A_2 (CS) significantly recorded the highest available Fe (4.50 mg kg $^{-1}$) over all other sources of silicon.

The levels of silicon was significantly influenced on soil available Fe. Application of Si @ 250 kg ha^{-1} (B_5) recorded significantly the highest available Fe in soil (4.48 mg kg^{-1}) over rest of the levels of silicon. However, it was at with B_4 (4.35 mg kg-^{1}) and B_3 (4.46 mg kg^{-1})

The interaction effect of sources and levels of silicon on an available Fe in soil at harvest was non-significant. However the treatment combination of A_2B_5 (4.70 mg kg $^{-1}$) recorded the highest Fe at harvest.

The available Fe at harvest was significantly increased with treated (4.30mg kg^{-1}) over control (3.70 mg kg^{-1}).

Similar results were also noticed by Okuda and Takahashi (1962) [5] Singh *et al.* (2005) [7] and Das *et al.* (2013) [1].

Table 3: Effect of sources and level of silicon on available Fe in soil at harvest (mg kg $^{-1}$)

Silicon sources (A)	Levels of silicon (B) kg ha^{-1}					
	B_1 0	B_2 100	B_3 150	B_4 200	B_5 250	Mean
A_1 : DE	4.18	4.00	4.31	4.26	4.51	4.25
A_2 : CS	4.15	4.58	4.58	4.49	4.70	4.50
A_3 : BA	3.92	3.84	4.48	4.13	4.23	4.16
Mean	4.08	4.14	4.46	4.35	4.48	4.30
Control	3.70					
	S.E. ±			CD at 5%		
A	0.07			0.22		
B	0.10			0.29		
(A × B)	0.17			NS		
Treat Vs C	0.18			0.52		
Initial	3.94					

2. DTPA *Mn* content of soil at harvest

The data in respect of effect of different sources and levels of silicon on available Mn at harvest presented in Table 4.

The soil available Mn in soil found significantly influenced due to sources, levels and their interaction.

The source A_2 (CS) significantly recorded the highest available Mn (8.47mg kg $^{-1}$) over all other sources of silicon. However, it was at bar with A_1 (8.20 mg kg^{-1}).

The levels of silicon were significantly influenced on soil available Mn. Application of Si @ 250 kg ha^{-1} (B_5) recorded significantly the highest available Mn in soil (8.78 mg kg^{-1}) over rest of the levels of silicon. However, it was at with B_4 (8.67 mg kg^{-1}) and B_1 (8.11 mg kg-^{1}).

The interaction effect of sources and levels of silicon on an available Mn in soil at harvest was non-significant. However, the treatment combination A_2B_5 (9.67 mg kg^{-1}) recorded highest Mn at harvest.

The available Mn at harvest was significantly increased with treated (8.09 mg kg^{-1}) over control (6.67 mg kg^{-1}).

Similar results were also noticed by Okuda and Takahashi (1962) [5], Singh *et al.* (2005) [7] Durgude *et al.* (2014) [2] and Das *et al.* (2013) [1].

Table 4: Effect of sources and level of silicon on available Mn in soil at harvest (mg kg $^{-1}$)

Silicon sources (A)	**Levels of silicon (B) kg ha^{-1}**					
	B_1 0	**B_2 100**	**B_3 150**	**B_4 200**	**B_5 250**	**Mean**
A_1 : DE	9.00	8.00	7.00	8.67	8.33	8.20
A_2 : CS	7.67	7.67	8.00	9.33	9.67	8.47
A_3 : BA	7.67	7.33	6.67	8.00	8.33	7.60
Mean	8.11	7.67	7.22	8.67	8.78	8.09
Control	6.67					
	S.E. ±			CD at 5%		
A	0.21			0.62		
B	0.27			0.80		
(A × B)	0.48			NS		
Treat Vs C	0.49			1.43		
Initial	8.90					

3. DTPA Zn content of soil at harvest

The data in respect of effect of different sources and levels of silicon on available Zn at harvest presented in Table 5.

The soil available Zn in soil found significantly influenced due to sources, levels and their interaction.

The source A_1 (DE) significantly recorded the highest available Zn (0.67mg kg $^{-1}$) over all other sources of silicon. However, it was at bar with A_2 (0.65 mg kg^{-1})

The levels of silicon were significantly influenced on soil available Zn Application of Si @ 250 kg ha^{-1} (B_5) recorded significantly the highest available Zn in soil (0.69 mg kg^{-1}) over rest of the levels of silicon. However, it was at with B_3 (0.63 mg kg-^{1}) and B_4 (0.67mg kg^{-1})

The interaction effect of sources and levels of silicon on an available Zn in soil at harvest was non-significant. However, the treatment combination of A_1B_5 (0.73 mg kg^{-1}) recorded highest Zn at harvest.

The available Zn at harvest was significantly increased with treated (0.64 mg kg^{-1}) over control (0.57 mg kg^{-1}).

The application of silicon significantly increased DTPA Zn content in soil at harvest. These findings recorded by Okuda and Takahashi (1962) [5], Durgude *et al* (2014) [2], Das *et al.* (2013) [1] and Singh *et al.* (2005) [7].

Table 5: Effect of sources and level of silicon on available Zn in soil at harvest (mg kg $^{-1}$)

Silicon sources (A)	**Levels of silicon (B) kg ha^{-1}**					
	B_1 0	**B_2 100**	**B_3 150**	**B_4 200**	**B_5 250**	**Mean**
A_1 : DE	0.65	0.66	0.61	0.69	**0.73**	**0.67**
A_2 : CS	0.59	0.60	0.66	0.68	0.69	0.65
A_3 : BA	0.54	0.58	0.61	0.63	0.64	0.60
Mean	0.60	0.61	0.63	0.67	0.69	0.64
Control	0.57					
	S.E. ±			CD at 5%		
A	0.016			0.04		
B	0.020			0.060		
(A × B)	0.03			NS		
Treat Vs C	0.03			0.10		
Initial	0.69					

4. DTPA *Cu* content of soil at harvest

The data in respect of effect of different sources and levels of silicon on available Cu at harvest presented in Table 6.

The soil available Zn in soil found significantly influenced due to sources, levels and their interaction.

The source A_1 (DE) significantly recorded the highest available Cu (1.40 mg kg^{-1}) over all other sources of silicon. However, it was at par with A_2 (1.38 mg kg^{-1}) and A_3 (1.32mg kg^{-1}).

The levels of silicon were significantly influenced on soil available Cu Application of Si @ 250 kg ha^{-1} (B_5) recorded significantly the highest available Cu in soil (1.46 mg kg^{-1}) over rest of the levels of silicon. However, it was at with B_4 (1.40 mg kg^{-1}).

The interaction effect of sources and levels of silicon on an available Cu in soil at harvest was non-significant. However, the treatment combination of A_1B_5 (1.48 mg kg^{-1}) and A_2B_5 (1.48 mg kg-1) recorded highest Cu at harvest.

The available Cu at harvest was significantly increased with treated (1.37 mg kg^{-1}) over control (1.26mg kg^{-1}).

These findings recorded by Okuda and Takahashi (1962) [5], Durgude *et al* (2014) [2] and Das *et al.* (2013) [1].

Table 6: Effect of sources and level of silicon on available Cu in soil at harvest (mg kg^{-1})

Silicon sources (A)	**Levels of silicon (B) kg ha^{-1}**					
	B_1 0	**B_2 100**	**B_3 150**	**B_4 200**	**B_5 250**	**Mean**
A_1 : DE	1.34	1.36	1.38	1.43	1.48	1.40
A_2 : CS	1.29	1.33	1.40	1.41	1.48	1.38
A_3 : BA	1.24	1.25	1.34	1.36	1.41	1.32
Mean	1.29	1.31	1.37	1.40	1.46	1.37
Control	1.26					
	S.E. ±			CD at 5%		
A	0.014			0.04		
B	0.019			0.054		
(A × B)	0.03			NS		
Treat Vs C	0.03			0.09		
Initial	1.40					

Conclusion

The available micro nutrients viz., Fe, Mn, Zn, Cu was significantly influenced due to application of sources. The source A_2 (CS) recorded significantly highest Fe and Mn. and source A1 (DE) recorded significantly highest Zn and Cu.

In case of levels of silicon the available micronutrients Fe, Mn, Zn, and Cu was showed significant influence due to application of silicon @ 250 kg ha^{-1}.

The interaction effect of sources and levels of silicon on an available Fe, Mn, Zn, and Cu in soil at harvest was non-significant.

The available Fe, Mn, Zn, and Cu in soil at harvest were significantly increased with treated over control.

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