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CHANGE IN PROPERTIES OF SOIL DUE TO APPLICATION OF DIFFERENT SOURCES OF SILICON IN 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, MPKV, Rahuri, Dist. Ahmednagar in *rabi* season of 2017-18, by using different sources and levels of silicon on chemical properties of soil and silicon availability in the soil related to growth, yield and quality characters in 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. In case of effect of sources and levels of silicon on chemical properties of soil, source A_1 (DE) recorded significantly highest OC, while source A_2 (CS) recorded significantly highest pH and EC (dsm^{-1}) while in case of levels (B_5) application of Si @ 250 kg ha^{-1} recorded significantly highest pH, EC, and OC. The interaction effect of sources and levels of silicon was not significant for all three soil properties under study. The pH, EC and Organic Carbon were significantly increased with treated over control.

KEYWORDS: Diatomaceous earth, calcium silicate, bagasse ash, silicon, soil pH, electrical conductivity and organic carbon.

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, water melon, can increase the vitamin C content in eggplant, cabbage, green Chinese 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 product. (Matichenkov and Bocharnikova, (2004).

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). The cloves of garlic bulb used in flavoring of various vegetarian and non-vegetarian dishes.

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 antiprotozoal properties.

As per different literatures, by using different sources and levels of silicon through soil improves the quality and yield of different crops. 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 quality and yield of garlic related to soil chemical and physical properties.

3. MATERIAL AND METHODS

The present investigation was carried out at, All India Coordinated Research Project on Vegetable Crop, Department of Horticulture, MPKV, Rahuri in *Rabi 2017 – 18.*The experiment was laid out in Factorial Randomized Block Design (FRBD) with control three replications having 16 treatments including one absolute control.

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

1. 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.

2. Characterization of silicon sources

Total silicon was determined by HCL (12.1*N*) + HF (48 %) method by Korndorfer *et al.* (2004). In this method of 0.1 g sample, 1 ml of HCL and 4 ml of hydrogen fluoride taken in a 250 ml silicon free plastic conical flask. After 12 hrs, 50 ml of boric acid (70 g l-^{1}) and 40 ml of distilled water were added. Silicon in the extract was determined colorimetrically by using spectrophotometer at 630 ηm wavelength.

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

3. 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. These soil samples were analyzed by adopting standard methods.

II. Soil chemical properties

1. pH

The soil pH was measured with the help of pH meter having glass electrode and calomel electrode using 1:2.5, soil: water ratio as described by Jackson (1973).

2. Electrical conductivity

It was determined with the help of conductivity meter using soil water ratio of 1: 2.5 as described by Jackson (1973).

3. Organic carbon

Organic carbon in soil (0.5 mm sieved) was determined as per wet oxidation method by Nelson and Sommer (1982).

Statistical analysis

The data generated after observations of soil, was statistically analyzed by methods suggested by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

The data on effect of sources and levels of silicon and their interactions on chemical properties and soil available nutrient at harvest of garlic under field experiment are presented in the following Tables

1. Effect of sources and levels of silicon on Soil pH at harvest

The data in respect of effect of sources and levels of silicon on soil pH at harvest presented in Table 3.

The soil pH was significantly influenced due to sources of silicon. The mean source A_2 (CS) recorded significantly highest pH (8.16) over all the sources. However, it was at par with silicon sources A_1 (8.04).

The levels of silicon significantly influenced the pH. Application of Si level @ 250 kg ha^{-1} (B_5) recorded significantly highest value (8.33).

The interaction effect of sources and levels of silicon was non significant. However, treatment combination of A_2B_5 (8.45) recorded highest pH at harvest.

The pH was significantly increased with treated (8.05) over control (7.67).

Table 3: Effect of sources and levels of silicon on soil pH at harvest.

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	7.92	7.98	7.84	8.08	8.38	8.04
A_2 : CS	8.08	8.05	8.07	8.15	8.45	**8.16**
A_3 : BA	7.92	7.62	7.92	7.91	8.17	7.91
Mean	7.97	7.88	7.94	8.17	**8.33**	8.04
Control	**7.67**					
	S.E. ±			CD at 5%		
A	0.04			0.19		
B	0.08			0.25		
(A × B)	0.15			NS		
Treat Vs C	0.15			0.44		
Initial	7.84					

There was slight increase in soil pH with increase in levels of silicon. This might be due to electrochemical change that take place under moist condition of garlic crop. Also might be due to profuse root growth which leads to production of significant amount of CO_2 and release of mild organic acids tended to increase pH of soil at harvest. This was in agreement with the findings of Pichel and Hayer (2013) and Durgude *et al.* (2014)

2. Effect of sources and levels of silicon on electrical conductivity of soil at harvest:

The electrical conductivity of soil was significantly influenced by sources of silicon (Table 4.). The mean source of A_2 (CS) recorded significantly the highest EC (0.45 dSm^{-1}). However, it was at par with A_1 and A_3 (0.42 dSm^{-1}).

The levels of silicon significantly influenced on soil EC at harvest. The application of Si @ 250 kg ha^{-1} (B_5) recorded significantly the highest electrical conductivity (0.47 dSm^{-1}) over all the levels of silicon.

The interaction effect of sources and levels of silicon was non significant. However, the treatment combination of A_2B_5 (0.48dSm^{-1}) recorded highest EC.

The EC was significantly increased with treated (0.43 dSm^{-1}) over control (0.35 dSm^{-1}).

Table 4: Effect of sources and levels of silicon on electrical conductivity of soil at harvest.

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	0.37	0.44	0.40	0.40	0.47	0.42
A_2 : CS	0.44	0.45	0.43	0.43	0.48	**0.45**

A_3 : BA	0.40	0.41	0.42	0.43	0.46	0.42
Mean	0.40	0.43	0.42	0.42	**0.47**	**0.43**
Control	**0.35**					
	S.E. ±			CD at 5%		
A	0.008			0.023		
B	0.010			0.030		
(A × B)	0.017			NS		
Treat Vs C	0.018			0.053		
Initial	0.40					

The electrical conductivity of soil was slightly increased with levels of silicon. The variability in dissolution of soluble salts from soil and silicon sources under moist soil. There by increased the ionic concentration of the soil solution. Similar findings were reported by Pichel and Hayer (2013) and Durgude *et al.* (2014).

3. Effect of sources and level of silicon on soil organic carbon at harvest

The data in respect to effect of sources and levels of silicon on soil organic carbon at harvest presented in Table 5.The organic carbon content in soil was significantly influenced by different sources of silicon. The mean source of A_1 (DE) recorded significantly the highest organic carbon content in soil at harvest (0.52 %) over all the sources. However, it was at par with A_2 (0.50 %)

The levels of silicon significantly influenced on soil organic carbon. Application of Si @ 250 kg ha^{-1} (B_5) recorded significantly the highest organic carbon content in soil at harvest (0.53 %). However, it was at par with B_4 (0.51 %).

The interaction effect of sources and levels of silicon on organic carbon content in soil at harvest was not significant. However, the treatment combination of A_1B_5 (0.55%)recorded highest OC at harvest.

The organic carbon was significantly increased with treated (0.50%) over control (0.46%).

Table 5: Effect of sources and levels of silicon on soil organic carbon at harvest.

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	0.49	0.50	0.51	0.53	0.55	**0.52**
A_2 : CS	0.48	0.49	0.49	0.49	0.52	0.50
A_3 : BA	0.49	0.48	0.49	0.50	0.51	0.49
Mean	0.49	0.49	0.50	0.51	**0.53**	0.50
Control	**0.46**					
	S.E. ±			CD at 5%		
A	0.006			0.017		
B	0.007			0.02		
(A × B)	0.013			NS		
Treat Vs C	0.014			0.041		
Initial	0.48					

The results obtained are in agreement with the results of Pichel and Hayer (2013) who reported non-significant correlation between silicon content and organic carbon in soil.

CONCLUSION

The application of silicon through Calcium silicate @ 250 kg ha^{-1} alongwith recommended dose of fertilizer (100:50:50 kg ha^{-1} and FYM) was found beneficial for increase in quality as well as yield of garlic.

In case of effect of sources and levels of silicon on chemical properties of soil, source A_1 (DE) recorded significantly highest OC, while source A_2 (CS) recorded significantly highest pH and EC (dsm^{-1}) while in case of levels (B_5) application of Si @ 250 kg ha^{-1} recorded significantly highest pH, EC, and OC.

The interaction effect of sources and levels of silicon was not significant for all three soil properties under study.

The pH, EC and organic carbon were significantly increased with treated over control.

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