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RESEARCH ARTICLE

EFFECT OF SOURCES AND LEVELS OF SILICON ON UPTAKE OF MAJOR NUTRIENTS AND SILICON IN GARLIC

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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 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 up take of NPK and Silicon. 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 up take of NPK and silicon, the source A_2 (CS) and level (B_5) @ 250 kg ha^{-1} recorded significantly highest uptake. The interaction effect of sources and levels of silicon on uptake of nitrogen and potassium l at harvest was significant, however in phosphorus and silicon it was nonsignificant. The uptake of NPK and silicon was significantly increased with treated over control.

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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, silicon is widely used to enhance production as well as improving resistance to lodging and increasing the erectness of leaves. 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. Silicon fertilizers improve the quality of horticultural products. (Matichenkov and Bocharnikova, (2004).

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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.
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 nutrients. 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 crop.

MATERIALS 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 KrishiVidyapeet, 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. Treatment details regarding sources and levels are given below in Table.1. & 2.

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.

Methods used for plant analysis

Uptake of nutrients by the garlic: The uptake of nitrogen, phosphorus, potassium and silicon was worked out by multiplying the percentage of these nutrients in bulb and straw with the corresponding dry matter yields of the respective constituent**.**

Statistical analysis: The data generated after observations of soil, plant and yield and quality characters etc. statistically analyzed by methods suggested by Panse and Sukhatme (1985)

RESULTS AND DISCUSSION

The observations of plant samples were analyzed for nutrient concentration and nutrients uptake of garlic were calculated. The results obtained from the statistical analysis of generated data in present investigation.

Effect of sources and levels of silicon on uptake of nutrients by garlic: The data pertaining to effect of sources and levels of silicon on nutrient uptake of N, P, K and Si by garlic are presented and discussed under following subheads.

Nitrogen uptake by plant (kg ha^{-1}): The nitrogen uptake was significantly influenced due to sources and levels of silicon (Table 4). The source A_2 (CS) recorded significantly highest total nitrogen uptake (40.12 kg ha^{-1}) and the application of Si @ 250 kg ha^{-1} (B_5) recorded significantly highest uptake of nitrogen (52.89 kg ha^{-1}) over all other levels of silicon. The interaction effect of sources and levels of silicon on nitrogen uptake was found significant. The interaction A2B5 (58.95 kg ha^{-1}) recorded the highest uptake than others interactions. The uptake of nitrogen was significantly increased with treated (37.54 kg ha^{-1}) over control (24.59 kg ha^{-1}). This might be due to the proper crop stand, probable root growth, supply of nutrient and conductive physical environment created on account of addition of silicon. Such favourable situation might have facilitated better absorption of nitrogen by crop.
Silicon fertilized plant gained maximum benefits of ample nitrogen availability. This result agrees with reports of Talashikar *et al*. (2000) and Egrinya *et al.* (2008) .

Phosphorus uptake by plant (kg ha^{-1}): The phosphorus uptake was significantly influenced due to sources and levels of silicon are presented in Table 5. The A_2 (CS) recorded the significantly the highest total phosphorus uptake (13.44 kg ha^{-1}) however, it was at with A_1 (13.12 kg ha^{-1}).

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	

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

Table 3. Standard analytical methods used for plant analysis

III.	Plant analysis		
1.	Total N	Micro-kjeldahl method (H_2O_2+H_2SO_4)	Parkinson and Allen (1975)
2.	Total P	Vandomolybdate Yellow color in Nitric Acid System. (Diacid digestion method)	Jackson (1973)
3.	Total K	Flame photometry (Diacid digestion method)	Chapman and Pratt (1961)
4.	Total Si	Triacid digestion method	Nayar *et al.* (1975)

Table 4. Effect of sources and level of silicon on nitrogen uptake by plant (kg ha^{-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	25.21	29.23	33.51	42.86	52.57	36.71
A_2 : CS	31.51	34.26	35.55	40.33	58.95	40.12
A_3 : BA	29.91	29.72	32.30	39.78	47.15	35.77
Mean	28.94	31.07	33.79	40.99	52.89	37.34
Control	24.59					
	S.E. ±			CD at 5%		
A	0.59			1.72		
B	0.77			2.22		
(A × B)	1.33			3.86		
Treat Vs C	1.38			3.98		

Table 5. Phosphorus uptakes by plant (kg ha^{-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	10.78	11.30	12.43	13.99	17.08	13.12
A_2 : CS	11.23	11.91	10.69	14.26	19.11	13.44
A_3 : BA	10.96	10.52	10.43	12.03	16.61	12.11
Mean	10.99	11.24	11.18	13.43	17.60	12.89
Control	8.12					
	S.E. ±			CD at 5%		
A	0.26			0.76		
B	0.34			0.98		
(A × B)	0.59			NS		
Treat Vs C	0.61			1.76		

Table 6. Potassium uptake by plant (kg ha^{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	22.28	26.42	20.97	29.96	38.34	27.59
A_2 : CS	25.00	27.12	27.92	30.27	38.36	29.74
A_3 : BA	21.49	22.17	23.75	29.08	31.73	25.64
Mean	22.92	25.24	24.21	29.77	36.14	27.66
Control	20.10					
	S.E. ±			CD at 5%		
A	0.58			1.55		
B	0.69			2.00		
(A × B)	1.20			3.47		
Treat Vs C	1.24			3.58		

Table 7. Silicon uptake by plants (kg ha^{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	2.77	3.50	3.77	5.09	6.53	4.33
A_2 : CS	3.61	3.88	3.93	5.74	6.96	4.82
A_3 : BA	3.26	3.54	3.60	5.18	5.84	4.28
Mean	3.21	3.64	3.77	5.34	6.45	4.48
Control	2.10					
	S.E. ±			CD at 5%		
A	0.13			0.39		
B	0.17			0.51		
(A × B)	0.30			NS		
Treat Vs C	0.31			0.91		

Application of Si @ 250 kg ha^{-1} (B_5) recorded significantly the highest phosphorus uptake by plant (17.60 kg ha^{-1}). The interaction effect of sources and levels of silicon on phosphorus uptake was found non significant however, the treatment combination of A_2B_5 (19.11kg ha-1) recorded the highest phosphorus uptake at harvest. The uptake of phosphorus was significantly increased with treated (12.89 kg ha^{-1}) over control (8.12 kg ha^{-1}). The increase in total uptake of P due to application of silicon might be attributed to role of silicon in increasing the availability of soil phosphorus which might have increase the biomass and root activity. The similar findings on increases in uptake of nutrients due to application of silicon were reported by Gerroh and Gascho (2005) and Yang *et al.* (2008).

Potassium uptake by plant (kg ha^{-1}): Both, source A_2 (CS) (29.74 kg ha^{-1}) and the level Si @ 250 kg ha^{-1} (B_5) (36.14 kg ha^{-1}) recorded highest potassium uptake over all other sources and levels of silicon (Table 6). The interaction effect of sources and levels of silicon on potassium uptake was found significant and recorded highest uptake by application of Si A_2B_5 (38.36 kg ha^{-1}) over all other interactions. However, it was at par with A_1B_5 (38.34 kg ha^{-1}). The uptake of potassium was significantly increased with treated (27.66 kg ha^{-1}) over control (20.10kg ha^{-1}). The application of chemical fertilizers in combination with silicon levels significantly increased total potassium uptake by upland paddy. The positive response of higher silicon application towards uptake of potassium can be linked to silicification process of cell walls. Increased in the potassium uptake possibly might be due to stimulating effect of silicon on activation of H+-ATPase in the membrane. Similar results were also noticed by Kaya *et al*. (2006) and Egrinya *et al*. (2008)

Silicon uptake by plant (kg ha^{-1}): The source A_2 (CS) recorded significantly the highest total silicon uptake (4.82 kg ha^{-1}) over all other sources and application of Si @ 250 kg ha^{-1} (B_5) recorded significantly the highest silicon uptake (6.45 kg ha^{-1}) over all the levels of silicon (Table 7). The interaction on silicon uptake was found non significant. However, the treatment combination of A_2B_5 (6.96 kg ha^{-1}) recorded highest silicon uptake at harvest. The uptake of silicon was significantly increased with treated (4.48 kg ha^{-1}) over control (2.10 kg ha^{-1}). The higher silicon uptake was associated with increased levels of silicon. This might be due to increase in root growth and available form of silicon in soil. The addition of silicate material to soil have increased in silicon availability might be the reason for higher silicon uptake. The application of silicon leads to improvement in crop stand, enhanced photosynthesis and resistance against biotic stress. This are the certain other factors might have responsible for higher silicon uptake by garlic. These results are in conformity with the findings of Liang *et al*. (2006), Prakash *et al.* (2011).

Conclusion

In case of effect of sources and levels of silicon on up take of NPK and silicon, the source A_2 (CS) and level (B_5) @ 250 kg ha^{-1} recorded significantly highest uptake. The interaction effect of sources and levels of silicon on uptake of nitrogen and potassium 1 at harvest was significant, however in phosphorus and silicon it was non significant. The uptake of NPK and silicon was significantly increased with treated over control.

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