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Effect of different levels of Silicon on Yield and Yield Attributes of Rice

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ABSTRACT

A pot experiment was laid out at Bangladesh Institute of Nuclear Agriculture, Mymensingh, Bangladesh during January to May, 2012 to investigate the effect of different levels of silicon application on rice growth, yield contributing characters and grain yield of BINA Dhan-8. Silicon was applied through $CaSiO_3$ viz. 0, 5, 7.5, 10, 12.5 and 15 g per pot. This study was carried out in Completely Randomized Design (CRD) with three replications. It was found that silicon (Si) supply levels significantly increased the number of panicles, number of filled grains/panicle, 1000-grain weight and grain yields per pot. The maximum grain yield 46.50 g/pot obtained from 10 g per pot Si application level. In fine it was observed that judicious supply of silicon significantly influence growth, chlorophyll content and yield potentials of rice.

Key words: growth, BINA Dhan-8, judicious, yield potentials

INTRODUCTION

Silicon (Si) is the second most abundant (28%) constituent of the total soil weight in the earth's crust, which is next to oxygen (47%) [3]. It has been shown to be crucial for maximum growth and yield of a number of plant species, including *Oryza sativa* under the family Gramineae. Rice, a major cereal crop, contains high amount of silica in the stem and leaves, ranging from 10 to 20% [15]. It is known to be the most Si-accumulating species. Its absorption brings several benefits, especially for rice, such as the increase of cell wall thickness below the cuticle, imparting mechanical resistance to the penetration of fungi, decrease in transpiration and improvement of leaf angle, making leaves more erect, thus reducing self-shading, especially under high nitrogen rates. Although silicon is not considered as essential plant nutrients but in Japan, Korea and USA it is proved that silicon is a fundamental element for rice farming [4, 8, 17]. Increased level of silicon in the rice plant are associated with decreased levels of grain discoloration at harvest and silicon has been reported to reduce shattering of the grains in rice and to increase the number and weight of filled grains. Silicon deposition varies greatly among different organs of the rice plant like hull, leaf, leaf sheath, culm and root.

Balanced dose of major nutrient fertilizers along with judicious supply of micro-nutrients and agronomically essential elements such as silicon (Si) can increase rice yield significantly [9]. In Taiwan, silicate slag has also been found to be effective on a wide range of paddy soils, although its use has not been yet become a standard practice owing to its high price compared with low price received for the crop [13].

In Bangladesh no specific research work was carried out with silicon application levels on growth and yield performances of HYV rice. Therefore, the present study was undertaken to optimize the suitable silicon level for optimum growth and yield of BINA Dhan-8.

MATERIALS AND METHODS

A pot experiment was conducted at Bangladesh Institute of Nuclear Agriculture, Mymensingh, Bangladesh during January, 2012 to June, 2012. Plastic pots of about 15 liters capacity were used for the experiment. The soil was collected from the research field of Environmental Science Department, Bangladesh Agricultural University, Mymensingh at a depth of 0-15 cm. The rice cultivar used in the experiment was BINA Dhan-8, a high yielding rice variety (HYV) in Bangladesh.

Six different levels of silicon fertilizer treatments were maintained in Completely Randomized Design (CRD) with three replications. Silicon was supplied from calcium silicate ($CaSiO_3$). The experiment consisted of six treatments which were control (T_1), 5 (T_2), 7.5(T_3), 10(T_4), 12.5(T_5) and 15g (T_6) per pot. The amounts of calcium silicate were applied after 3 days of transplanting for each pot.

In each pot a small hole were made at the lower portion and 10 kg of well ground, dried soils were placed in each plastic pot. Each experimental pots

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were fertilized with Urea, Triple Super Phosphate (TSP) and Muriate of Potash (MoP) at the rate of 12 g (N), 6 g (P_2O_5) and 6 g (K_2O) per pot, respectively. The full amounts of TSP, MoP were applied as a basal dose and urea was applied in three split.

Sprouted BINA Dhan-8 seeds were sown in a plastic tray. The seedlings were uprooted after 20 days of sowing very carefully from seed bed and immediately two healthy seedlings were transplanted per pot. Considerable spacing was maintained in between pots and rows for convenience of cultural operations, observation and data collection. Irrigation, plant protection measures and other intercultural operations were done uniformly as per requirement. The experiment was terminated at plant maturity, when the plants were ripen and started to die.

The data on SPAD readings, plant height, no. of filled grain/panicle, panicle length, 1000 grain weight, grain yield, straw yield were measured from each plot. A chlorophyll meter (SPAD-502, Minolta Camera Co. Ltd, Osaka, Japan) was used to record the chlorophyll content (SPAD value) from rice plant. A fully matured leaf from the top of the plant was selected for recording the SPAD values and the mean of five readings per plant was taken. Significant treatment mean differences were determined using Duncan's multiple range test (DMRT) [2] and LSD test at 0.05 level of probability.

RESULTS AND DISCUSSION

The SPAD reading of BINA Dhan-8 was significantly influenced by the different treatments of Silicon. The highest SPAD reading (47.07) was observed in the treatment T_4 which was treated with silicon @ 10g/pot (Table 1) where the lowest SPAD reading (41.03) was observed in the treatment T_1. Maximum SPAD reading value 43.1 was recorded with silicate application which ultimately contributed to higher grain yield of rice which is in consistent with another author [1].

Plant height

Study of the data revealed that there was a significant impact of silicon treatment on the average plant height of rice (Table 1). The highest plant height (91.67cm) was attained in treatment T_4 and second highest plant height (90.33cm) was obtained in treatment T_6. The lowest plant height (85.67cm) was found in treatment T_1 (control) which was significantly lower from all other treatments. Similar results were also observed from authors where they found increasing supply of Si increased the length of culms which ultimately results in increased plant height [10, 11].

No. of effective tillers hill^{-1}

There was a significant impact of different silicon treatment on the number of effective tillers hill^{-1} of rice (Table). The highest number of effective panicles hill^{-1} (17.00) was found from the treatment T_4 where lowest number of effective panicles hill^{-1} (11.67) was recorded in treatment T_1 (control). These results are in agreement with those of scientists who reported that Si markedly increase the number of effective tillers of rice [12].

Panicle length

Panicle length of rice differed significantly with different doses of silicon (Table 1). Application of Silicon @ 10g resulted the largest panicle length (23.17 cm) where smallest panicle length was observed in the control (no silicon) treatment receiving pot. The results are in line with other experiment where reported that silicon significantly increased the length of panicles of rice [11].

No. of filled grains panicle^{-1}

Analysis of the data revealed that the number of filled grains panicle^{-1} was significantly influenced from silicon application. Maximum number of filled grains panicle^{-1} (119) was produced by treatment T_4 which was statistically at par with treatment T_3 (117) whereas minimum number of filled grains panicle^{-1} (87.67) was produced by T_1 (control) treatment. It might be because of the availability of silicon to the crop at later growth stages which might have resulted in more number of filled grains panicle^{-1}. Significant

Table 4.1 Growth and yield contributing characters of BINA Dhan-8 as influenced by different levels of Si application

Treatments	SPAD reading	Plant height (cm)	Total no. of tillers hill^{-1}	No. of panicles hill^{-1}	Panicle length (cm)	No. of filled grains panicle^{-1}	1000 grain weight (g)	Grain yield (g pot^{-1})
T_1	41.03 c	85.67 c	14.33 b	11.67 d	21.17 b	87.67 d	23.37 c	26.21 e
T_2	42.67 bc	87.33 bc	15.33 b	12.67 cd	22.67 a	93.67 c	24.49 bc	35.67 d
T_3	43.20 bc	87.67bc	15.67 b	14.33 b	22.83 a	117.0 a	25.29 ab	39.47 c
T_4	47.07 a	91.67 a	18.33 a	17.00 a	23.17 a	119.0 a	26.07 a	46.50 a
T_5	42.00 bc	88.33bc	14.67 b	12.33 cd	22.33 ab	107.0 b	24.09 bc	42.95 b
T_6	43.90 b	90.33 ab	14.33 b	13.33 bc	21.33 b	93.67 c	24.33 bc	35.69 d
LSD	2.54	3.18	1.69	1.21	1.19	4.20	1.16	1.92
SE(±)	0.853	0.885	0.618	0.782	0.336	5.41	0.387	2.87
Level of sign.	**	**	**	**	**	**	**	**
CV%	3.30	2.02	6.16	5.02	3.01	2.29	3.19	2.87

increase in filled grains panicle^{-1} with increasing Si rates up to certain limit was also reported from another investigation [14].

1000-grain weight

Study of the data revealed that application of silicon resulted in a significant increase in 1000-grain weight of BINA Dhan-8 (Table 1). The highest thousand-grain weight (26.07g) was found from the treatment T_4 which was statistically identical with the treatment T_3 (25.29g). The lowest thousand-grain weight (23.37g) was noticed from the treatment T_1 (control) treatment. Application of Si might enhanced accumulation of assimilates in the grains after photosynthesis. Similar pattern of response was also observed in rice by other scientists [5, 7, 10].

Grain yield

Grain yield of BINA Dhan-8 responded significantly to different silicon application levels, which have been presented in Table 1. All the treatments produced significantly higher grain yield over control. The highest grain yield (46.43g pot^{-1}) was produced by treatment T_4. On the contrary, the lowest grain yield (26.21g pot^{-1}) was found in T_1 (control) treatment. The findings are in agreement with those of authors who stated that silicon have little effect on vegetative growth of rice but improved growth during the reproductive stage and increased grain yield of rice [6,16].

CONCLUSION

The results obtained from present experiment indicate that the effects of silicon application were significant on SPAD value (chlorophyll content), yield contributing attributes and yield of BINA Dhan-8. The results of the study also indicated that, 46.5 g pot^{-1} increased grain yield by using 10g Si as compared to control treatment. Balanced Si management practices need to be established and followed to improve Si use efficiency leading to desirable grain yield. More study may be carried out to find out the better utilization of Silicon in rice.

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