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Silicon Fertilization in Paddy Field

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***Abstract*---**Present study has been done to document the effect of silicon fertilization on various yield parameters of rice (*Oryza sativa* L.) in land farm under natural environmental conditions. In the current study, the comparison of application of 125 kg/hectare silicon fertilizer + basal fertilizer has been done with control (basal fertilizer without silicon). The significant rise of 88.89% in no. of tillers, 20% in effective tiller, 88.89% in no. of tillers per hill, 92.69% in effective tillers per hill ,4.08% no. of spikes per panicle, 99.16% in total spike in plant, 182.22% in total spikelets per hill, 42.98% in weight of grains/1000, 34.88% number of grain per panicle, 160.65% number of grain per hill, 38.96% grain yield, 30.93% husk yield, 3.41% harvest yield has been observed in crop grown in silicon fertilized soil than control. The results indicates that silicon fertilizer can be used in farm land of rice to increase the yield of paddy..

***Keywords*---**Paddy, Silicon fertilizer, Spike, Spikelets, Weight of grain, Harvest index percentage.

Introduction

Soil, the loose surface material that covers most land, other than providing the structural support to plants also act as a source of water and nutrients. Organic content of soil makes less than 10% of the soil and is responsible for holding the water and thus determines the potential for producing food and support all other biodiversity [1].

Silicon, second only to oxygen in occurrence, is present in the earth's crust and is found in minerals and rocks. It is not considered as an essential nutrient by plant scientists because most of the plants can complete their life cycles in its absence. But by virtue of significance in plant's life, Silicon has' been termed as 'quasi essential element' [2]. It has been found effective in various biotic and abiotic

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stresses[3]. A lack of Si in soil is not common, but the concentration of soluble silicic acid can be too low to meet plant needs[4] .A significant relationship between silicate weathering and CO_2 consumption [5] has been found and it might be possible to increase carbon sequestration in soils by growing plants which sequester more carbon in their phytoliths, and that breeding for this trait might also be possible [6].

Paddy is farmed all over the world and is one of the most significant cereal crops. According to Agricultural Market Intelligence Centre, PJTSAU), the USDA predicted global rice availability for the 2019-20 selling period at 67.10 million tonnes and the figure was raised by 6 lakh tonnes - 67.16 million tonnes within few months. The demand for Basmati rice export can also be evident in the overseas market of Nepal, Burma, Vietnam, and other nations for Indian coarse rice. In 2020-21, basmati rice exports totalled 4.6 million tonnes worth $4.01 billion (31,026 crores), up from 4.45 million tonnes worth $4.33 billion the previous year (Rs. 29,849 crores) [7]. Usually husk and straw of rice, accumulator of rice, are removed from the field and are used as animal fodder, fuel etc. Due to this silicon recycling got hampered resulted in no replenishment of silicon in soil. Worldwide [8] repeated reports indicates the importance of silicon fertilization on rice crop production [9]. Keeping in view the current study has been designed with the objective to study the effect of silicon fertilizer on growth parameters and yield attributes of variety Karan Bhog-521 of rice in the soil of Haryana, India.

Materials and Methodology

Study site

The experiment was conducted at land farm of village Timarpur, District Rohtak, Haryana, India during July –October 2021. This village is situated at 28°47'38"N latitude and 76°29'49"E longitude. Climate of this region is arid to semi-arid and soil is loamy to clayey loamy in nature. The average temperature in these month ranges from 29.2 and 25.9 ^{0}C, rainfall of 183-16 mm and relative humidity of 74% and 50% respectively with average photoperiod of 10 hours respectively[10].

Seeds of rice

The certified seeds of variety Karan bhog -521 of rice (*Oryza sativa* L.) were used and for raising seedlings wet-bed method was used. Seedlings of about thirty days old were transplanted to the experimental plots. At the time of transplantation, standing water level was maintained at the level of 3- 5 cm and after this 1.5 -2 cm level was maintained until two weeks before harvesting. The plots were kept free of weeds by mechanical removal.

Experiment design and fertilizers used

The experiment was conducted in randomized complete block design with two treatments and four replications of treatment. For the study, each experiment area was divided into four equal plots. The two treatments consist of basal fertilizer (Urea 250 kg/hectare, DAP 110 kg/hectare, Potash 25 kg/hectare, Zinc 12 kg/hectare and 125 kg/hectare granulated silicon fertilizer). The silicon fertilizer used for this purpose was agrisilica granular with granule size of 2-5mm with pH of 8.1, containing 26% available silicon purchased and dose recommendation from Agripower Australia Limited and dose specification as recommended by agripower Australia limited. Urea was applied in three split doses, DAP in single dose along with first irrigation about 4 days after transplantation, Potash, in single dose, was added after panicle initiation, Zinc in single dose and silicon fertilizer was applied in single dose 10 days after transplantation.

Measurement of Growth and Yield Parameters: To measure the growth parameters, 20 paddy plants from each block were collected at the panicle initiation and harvesting stage at the age of 60 and 125 days after transplantation. For measuring plant height, panicle leaf length, leaves length, scale was used. For measuring leaf area Petiole Pro mobile app was used. For counting no. of tillers, effective tillers, spikelets per spike etc., the whole plant was separated into stem, leaf, panicle leaf, straw, husk and grain. Grain weight, harvest index was measured after harvest at full maturity. For measuring grain weight, grains were removed from each panicle and weight was determined [10].

Statistics used and significant value: Results were analysed by ANNOVA (Analysis of Variance) by using excel window version 2011. Data were statistically analysed using analysis of variance (ANOVA) in Excel. The treatment means were compared by Turkey HSD Test at p value<0.01 and<0.05.

Results and Discussion

The effect of application of silicon fertilizer on morphological parameter and yield has been represented in the form of graphs and tables.

Table 1. Effect of silicon fertilization on plant height, plant thickness, no. of tillers and effective tillers per hill of Karan bhog 521 variety of rice (*Oryza sativa* L.) at 60 days after transplantation

Group	Plant height (cm)	Plant thickness (cm)	No. of tillers per hill	Effective tillers per hill
Control	$151.3671^{a}\pm0.4936$	$18.58167^{b}\pm0.1436$	$23.1^{b}\pm0.6563$	$22.172^{b}\pm0.4755$
Si treatment	$152.7895^{a}\pm0.5532$ (0.94%)	$24.1018^{a}\pm0.3166$ (29.71%) ^{xx}	$43.633^{a}\pm0.9571$ (88.89%) ^{xx}	$42.724^{a}\pm0.9379$ (92.69%) ^{xx}

*depicts percentage stimulation over the control. The data depicted in table are mean of four replications and ± SEM. The values shown in different letters in each group represent significant differences at P<0.01** and P < 0.05*

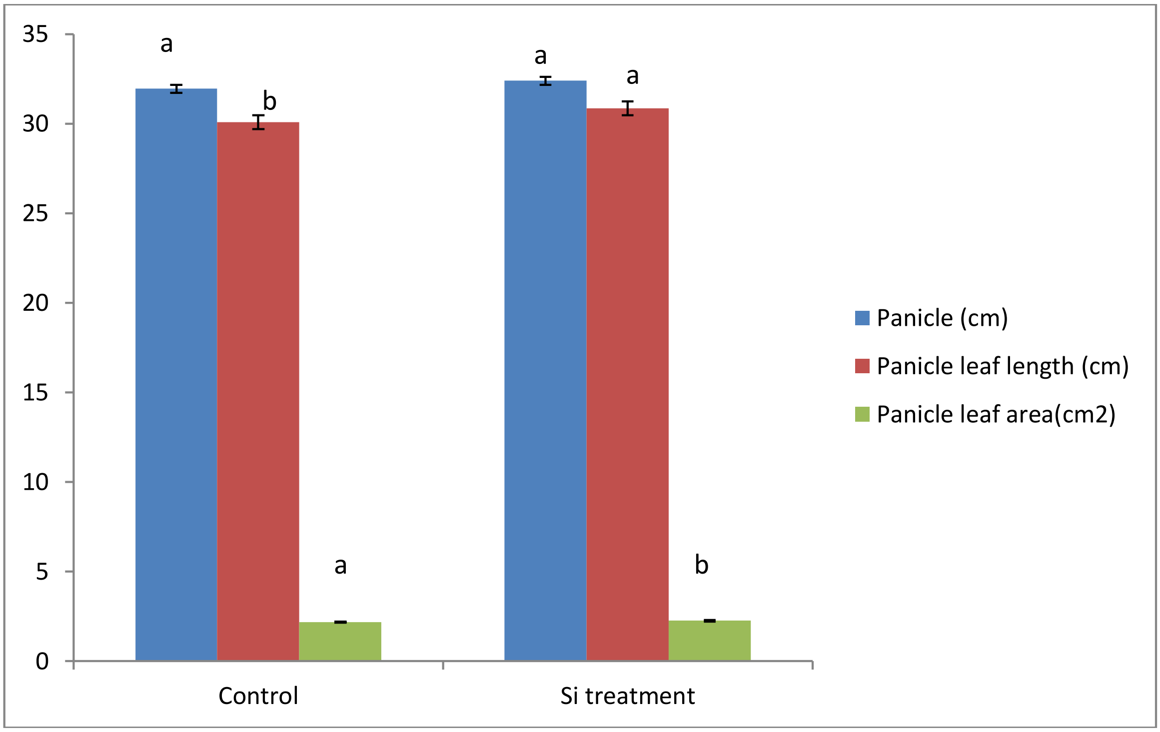

Figure 1. Effect of silicate fertilization on panicle length, panicle leaf length and panicle leaf area of Karan bhog 521 variety of rice (*Oryza sativa* L.) after 60 days of transplantation.

The data depicted in figure are mean of four replications and ± SEM. The values shown in different letters in each group represent significant differences at P<0.01.

Table 2. Effect of silicate fertilization on number of spikes per hill, total spikes, no. of spikelets and total spikelets per plant of Karan bhog -521 variety of rice (*Oryza sativa* L.) at 125 days after transplantation.

Group	No. of spikes per hill	Total spikes in plant	No. of spikelets per hill	Total spikelets per plant
Control	10.6^{b}±0.1028	235.133^{b}±5.7866	83.1^{b}±1.6535	19518.77^{b}±597.6552
Si treated	11.033^{a}±0.1312 (4.08%) ^{x}	468.3^{a}±11.6903 (99.16%) ^{xx}	117.2^{a}±1.6893 (41.03%) ^{xx}	55086.5^{a}±1757.6143 (182.22%) ^{xx}

*depicts percentage stimulation over the control. The data depicted in table are mean of four replications and ±SEM. The values shown in different letters in each group represent significant differences at P<0.01** and P < 0.05*

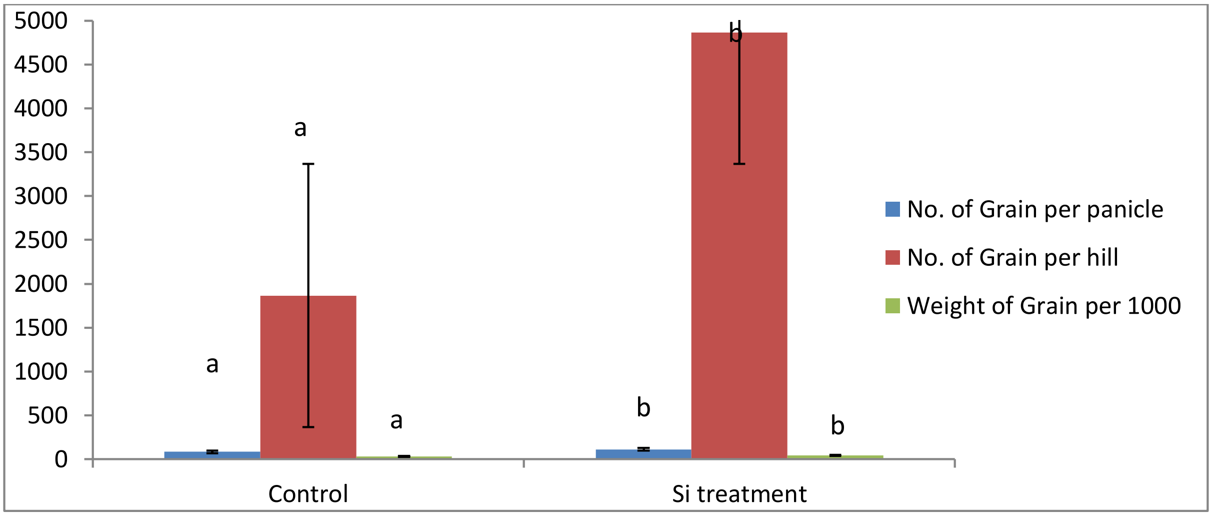

Figure 2. Effect of silicate fertilization on number of grains per panicle, number of grains per hill and weight of grain /1000 of Karan bhog 521 variety of rice (*Oryza sativa* L.) after 125 days of transplantation.

The data depicted are mean of four replications and ±SEM. The values shown in different letters in each group represent significant differences at P<0.01.

Table 3. Effect of silicate fertilization on grain yield, husk yield and harvest index Karan bhog 521 variety of rice (*Oryza sativa* L.)

Group	Grain yield (kg)	Husk yield (kg)	Harvest index
Control	1540^{b}±35.2767	1940^{b}±83.2666	0.44^{a}±0.0058
Si treatment	2140^{a}±58.1187 (38.96%)^{xx}	2540^{a}±58.1187 (30.93%)^{xx}	0.455^{a}±0.0033 (3.41%)

*depicts percentage stimulation over the control. The data depicted in table are mean of four replications and ± SEM. The values shown in different letters in each group represent significant differences at P<0.01** and P < 0.05*

In the present study exogenous application of fertilizer, though, has increased the height of rice plant (0.94%) (Table 1), but the increase was statistically insignificant. Reduction in the plant height has been reported in rapeseed [11] which might have helped in providing the resistance in winter conditions. Number of tillers, fertile tillers, Panicle leaf length and Spikelet formation is considered as a determining factor towards the yield output. In present study significant rise of 29.71% in plant thickness, 88.89% in no. of tillers, 20% in effective tillers, 88.89% in no. of tillers per hill, 92.69% in effective tillers per hill (Table 1), 2.57% in flag leaf length, 3.49% in flag leaf area(figure 1), 4.08% no. of spikes per panicle, 99.16% in total spike in plant, 41.03% in no. of spikelets per panicle, 182.22% in total spikelets per hill (Table 2), 42.98% in weight of grains/1000, 34.88% number of grain per panicle, 160.65% number of grain per hill(Figure 2), 38.96% grain yield, 30.93% husk yield, 3.41% harvest yield has been recorded variety (Table 3) in plant of Si treated than control in Karan bhog-521 variety of rice. Similar findings has been documented on wheat at tillering, at the stage of anthesis, grain yield, number of spikes and number of grains per spike of wheat and rice [12,13,14] . It has also been reported that applying Si fertilizer could improve rice grain yield through increasing spikelet formation, fertilization, and grain filling, which is in parallel with *Lsi6* gene expression [15], which lead to increase in grain filling and ultimately enhance rice production. The study shows that deficiency of silicon can become a yield decreasing element for rice production and application of silicon fertilizer may become contributory for the economic paddy production [16].

Conclusion

Limited information on the status of plant-available Si, accumulation and interaction of Si with plant nutrient in Indian context. The study done by Department of Soil Science and Agricultural Chemistry, University of Agricultural Sciences, Bengaluru revealed the deficiency of plant available silicon in South Indian soils and good response of crops to exogenous silicon fertilization[17]. In North India no broad spectrum study to document the effect of application of silicon fertilizer has not been conducted yet. An effort has been made to document the effect of exogenous silicon application on rice crop in natural field conditions. The present study documents the significant beneficial effects of silicon fertilization on rice grain yield, harvest index and as well as soil parameters. The current study also document the beneficial effects of Silicon fertilizer on blast disease of rice and uniform maturity of grain leading to better quality and quantity of crop. So silicon fertilizer application can be recommended as a beneficial element for the growth and yield productivity of rice as fertilizer in the soil of District Rohtak, Haryana, India. The need is to identify the crop effective, economical cheaper, soil friendly, locally available sources of silicon for agronomy and famers.

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