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EFFECT OF SILICON RATES ON THE YIELD OF RICE (VAR. BR_3) IN DIFFERENT SOILS

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A pot experiment in 1987 was conducted to assess the influence of 5 silicon levels (0,50,100, 200 and 400 ppm) on the yield performance of BR_3 rice in two different soils. Results showed that silicon application progressively increased the grain yield of rice upto 200 ppm and straw yield upto 400 ppm of the nutrient. The increase in grain yield largely resulted from a significant improvement in both number of filled grains per panicle and individual grain weight. A significantly higher grain yield was also obtained in Modhupur red brown terrace soils than Brahmaputra grey flood plain soils. Silicon rate comparatively showed a greater influence on the tissue nitogen content of the straw than in the grain. The maximum grain uptake of nitrogen was obtained with application of 100 ppm of silicon while that for straw was achieved at the 400 ppm level. Total nitrogen uptake of the biological parts above the ground level was maximum at the 200 ppm silicon level which was 46% higher than in the control.

Key words: Silicon rate, Soil types, Grain yield.

Introduction

The average rice yield in Bangladesh is only 2.2 t/ha as against over 6.0 t/ha in Japan, Korea and also in some countries of Europe [4]. The use of heavy fertilizer inputs especially nitrogen often results in yield reduction due to increased lodging and mutual shading accompanied by the crop's susceptibility to insect pests and diseases.

Silicon has been known as a beneficial element for rice in Japan from the early part of the 9th century and is now considered to be essential element for rice cultivation [1,17]. The materials containing sodium silicate has been widely tested in many rice growing countries and today the application of silicate fertilizers is common in Japan and Korea [1]. Silicon deficiency and responses to this element in rice have also been reported in other parts of South East Asia, such as in Thailand and Srilanka [15,18].

Yield improvement from silicon application is believed to be associated with higher tissue silicon concentration which enables the plant to better withstand many unfavourable situations, especially counter-acting the lodging effects of nitrogen supply. In Bangladesh, little information is available concerning this element particularly with respect to leaf morphology, dry matter production and other nutrient uptakes. Therefore, the present study has been planned to evaluate the effect of various levels of silicon on yield and nitrogen uptake of a modern rice variety in two different soils of Bangladesh.

Materials and Methods

A pot experiment was carried out at the campus of Bangladesh Institute of Nuclear Agriculture, Mymensingh, during the period from Jan-June 1987. The pot sets containing the experimental establishments were exposed to open air to receive natural air, rain and sunshine. The variables were silicon levels and soils. There were five silicon levels viz. 0,50,100,200 and 400 ppm (0,1.8, 3.8, 7.6 and 15.2 g/pot of technical grade sodium metasilicate respectively). The soils representing Madhupur red brown terrace (S_I) and Brahmaputra grey flood-plain (S_{II}) were collected from the selected sites at depths of 0-15 cm, air-dried, cleaned and placed in pots of 7 kilograms capacity. Pre-planting soil analysis indicated that the two soils differed in texture as well as in other physio-chemical properties (Table 1). Soils of Madhupur red brown terrace were more acidic and contained more clay and organic carbon. Total nitrogen (%) and exchangeable K (me/100g) were similar in the two soils (0.060, 0.062 and

TABLE 1. MECHANICAL AND CHEMCIAL CHARACTERISTICS OF SOILS.

Characteristics	Madhupur red brown terrace soil (S_I)	Brahamputra grey floodplain soil (S_{II})
a. Mechanical Composition: (oven dry basis)		
Sand (%)	49.64	54.24
Silt (%)	22.00	29.40
Clay (%)	28.36	16.36
Textural class	Sandy clay loam	Sandy loam
b. Chemcial Composition : (oven dry basis)		
Soil pH	4.2	6.7
Organic carbon(%)	0.74	0.59
Organic matter (%)	1.27	1.01
Total nitrogen (%)	0.060	0.062
Available phosphorous (ppm)	11.00	16.00
Exchangeable K (me/100 gm)	0.04	0.05

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0.04 respectively), but available phosphorous was higher in S_{II}.

There were ten treatment combinations, replicated four times within a randomized complete block design. Five kg. of processed soils were taken in polythene bags and individual bags then placed in earthen pots. Each pot was fertilized with 160,120, and 80 kg/ha of N, p_2O_5 and K_2O supplied through urea, triple super phosphate and muriate of potash respectively. The soils in each pot received silicon treatment in single application applied once prior to transplanting. Seedlings of BR_3 rice variety were raised in special sand beds over the plastic trays and the 20 day old seedlings were transplanted on 29th Jan. Two seedlings per pot were used and considerable spacings maintained between the pots and the rows for convenience of cultural operations and data collection. The surface soil was loosened at times by hand and appropriate water management practices were followed as per recommendation of BRRI [3] for the variety under consideration.

Tiller counts were taken on the 45th day after transplantings. At maturity on 2nd June, the crop was harvested flush with the soil level and the data on plant height, panicle length, number of filled grains/panicle, individual grain weight, grain and straw yield were recorded. Post-harvest plant samples were oven-dried at 80° for 24 hr, milled and preserved for nitrogen estimation by the Kjeldhal Method[2]. The collected data were analysed statistically and the mean differences were adjudged by using SEd and CD [13].

Results and Discussion

Analysis of variance showed that the interaction between the silicon rates and the soils was not statistically significant for either the yield or yield parameters studied, therefore, main treatment effects only are considered here.

Silicon rate. A general observation was that during the later stage of tillering the lower leaves of the plants receiving high silicon rates appeared rusty which , however, gradually disappeared with the progress of vegetative growth. Also, the silicon treated plants initiated panicles 4-6 days earlier than in the control treatment.

Application of silicon favourably influenced the grain yield of rice (Table 2). The yield increased progressively with the increase of silicon upto 200 ppm and decreased thereafter. The maximum grain yield of 11.11 g/pot was obtained from the application of 200 ppm of silicon which remained statistically identical to that obtained from 100 ppm of the silicon treatment. These results are in agreement with Takahashi [19] who reported increased grain yield of low land rice by application of 100 ppm of silicon. The crop receiving 100 and 200 ppm silicon in the present experiment outyielded the control by 11 and 17% respectively reported by Lee *et al.* [8], and Zhao *et al.* [21]. However, the straw yield increased linearly with the silicon rate upto 400 ppm. At 400 and 200 ppm levels, the increase were 31 and 20 % respectively, compared to the control. This results is in agreement with that reported by Kurup *et. al.* [7], and Okamoto [11].

It is further observed from Table 2 that the yield increase from silicon application is largely attributable to the advantage gained in grain filling and grain weight since the other characters were not influenced by the treatment. Both these parameters were higher at the 100 and 200 ppm levels compared to either the lower concentrations of silicon or the control. In an earlier study Nishihara *et al.* [9] found that silicon deficient plants produced a reduced number of spikelets per plant than the silicon opulent plants. Larger grain size with silicon application was also observed by Okamoto[12] and Kido *et al.* [6].

A further increase in straw yield at 400 ppm silicon level compared to 200 ppm level can not directly be explained by the trend of yield parameters studied within the scope of present study. However, pawar *et. al.* [14] indicated that a progressive increase in straw yield over the application range of 100-400 ppm silicon might have been due to increased plant height and greater dry matter content resulting from stronger and more plants compared to the control.

Soil types. Only the grain yield obtained from Madhupur red brown terrace soil was significantly higher (p/0.05) than

TABLE 2. EFFECT OF SILICON RATE ON THE GRAIN YIELD AND YIELD COMPONENTS OF RICE.

Silicon rate (ppm)	Grain yield (g/pot)	Straw yield (g/pot)	Effective tillers/ pot (No.)	Filled grains panicle (No.)	Individual grains weight (mg)	Plant height (cm)	Panicle length (cm)
0	9.52	13.23	8.9	52.7	20.3	60.4	17.8
50	9.80	14.08	9.1	56.4	21.0	62.4	18.3
100	10.57	15.02	9.4	65.2	21.8	62.7	18.6
200	11.11	15.91	9.4	67.9	22.3	63.1	18.3
400	10.26	17.36	8.1	60.8	20.8	62.6	17.3
SEd (±)	0.34	0.83	NS	3.90	0.04	NS	NS
CD at 5%	0.69	1.69	NS	7.96	0.08	NS	NS

TABLE 3. EFFECT OF SOIL TYPE ON THE GRAIN YIELD AND YIELD CONTENTS OF RICE.

	Grain yield (g/pot)	Straw yield (g/pot)	Effective tillers/ pot (No.)	Filled grains/ panicle (No.)	Individual grains weight (mg)	Plant height (cm)	Panicle length (cm)
S_I	10.48	15.16	9.20	62.0	21.3	62.5	18.2
S_{II}	10.03	15.00	8.75	59.0	21.1	62.0	17.9
CE at 5%	0.43	NS	NS	NS	NS	NS	NS

TABLE 4. EFFECT OF SILICON AND SOIL ON THE PLANT NITROGEN CONTENT AND NITROGEN UPTAKE.

Treatment	Tissue nitrogen content		Nitrogen uptake (g/pot)		
	Grain	Straw	Grain	Straw	Total
A. Silicon rate (ppm)					
0	0.71	0.32	0.067	0.043	0.11
50	0.82	0.35	0.080	0.048	0.14
100	0.85	0.40	0.089	0.060	0.15
200	0.80	0.41	0.090	0.065	0.16
400	0.73	0.38	0.075	0.066	0.14
SEd (±)	NS	0.02	0.008	0.008	0.012
CD at 5%	NS	0.04	0.016	0.016	0.024
B. Soil types					
S_I	0.82	0.40	0.080	0.060	0.15
S_{II}	0.75	0.34	0.075	0.052	0.13
SEd (±)	NS	0.01	0.008	0.005	0.008
CD at 5%	NS	0.02	0.016	0.010	0.016

that of Brahmaputra grey flood plain soil (Table 3). Again the yield parameters studied could not explain this yield as none of the characters was significantly influenced by the treatment. However, a trend of improvement in effective tillers and filled grains was noted for Madhupur red brown terrace soils than in Brahmaputra grey flood plain soils. It would appear that in addition to these yield parameters, the uptake of silicon and possibly phosphorus may be worthy of consideration but these parameters were not studied in this experiment. In this context, Zang *et. al.* [20] mentioned that silicon response in terms of rice grain yields was between 10 and 20% higher in whitish and sandy soils where available silicon was either close to or less than a critical value of 9.5 mg SiO_2/100 g of soil.

Further, the crop was fertilized with 160 kgN/ha (0.37g N/pot) but analysis showed that nitrogen concentration in plant tissue and in terms of nitrogen uptake varied considerably by both the treatments of silicon and soil (Table 4). A trend of increasing tissue nitrogen in the grain was marked up to 100 ppm of silicon application and decreased there after the differences were, however, not significant. Nitrogen concentration in the straw showed a trend similar to that of grains but the differences were significant with the peak attained at the 200 ppm levels. As a result, the higher nitrogen yield for the grain was obtained from 100 ppm of silicon application, while the peak value for the straw was recorded from the 400 ppm treatment. Again, the total nitrogen uptake by above ground parts was significantly higher at both 100 and 200 ppm levels of silicon compared to any other treatment. Nitrogen uptake by the whole plant improved from 27- 46 % over control when the silicon rate was increased from 50-200 ppm. Similar results of improving plant nitrogen content and hence, nitrogen uptake have been reported by Okamoto [10], and Sadanadan *et. al.* [16]. Decreasing values of both the tissue nitrogen content and the nitrogen uptake were, however, reported by Islam *et al.* [5].

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