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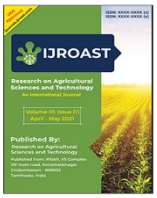

Effect of silicon on growth and yield attributes of transplanted paddy under wetland ecosystem

Karthikeyan. A*, Meena. S, Babu. S and Ravikumar. C

Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar-608002, Tamil Nadu, India

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ABSTRACT

A field experiment was carried out at farmer's field, Keezhamankudi village, Bhuvanagiri taluk of Cuddalore district to study the effect of silicon on growth and yield attributes of transplanted paddy under wetland ecosystem from February to June, 2020. The experiment was laid out in Randomized Block Design (RBD) replicated thrice with thirteen treatments. Among the different treatments studied, application of 125 % RDF + Soil application of Silica GR (soil conditioner) @ 25 kg ha^{-1} + Soil application of Micronutrient mixture (TN grade XI) @ 12.5 kg ha^{-1} (T_{13}) excelled over all other treatments and recorded higher values for the growth attributes *viz.*, plant height (109.75 cm), number of tillers $hill^{-1}$ (16.54), leaf area index (6.47), root length (27.91 cm), root volume (34.76 cm^3), and dry matter production (13826 kg ha^{-1}) and yield attributes *viz.,* number of panicles m^{-2} (642), number of grains $panicles^{-1}$ (138.98), grain (6854 kg ha^{-1}) and straw yield (9842 kg ha^{-1}). Hence, application of 125 % RDF + Soil application of Silica GR (soil conditioner) @ 25 kg ha^{-1} + Soil application of Micronutrient mixture (TN grade XI) @ 12.5 kg ha^{-1} (T_{13}) was noticed as a viable practice for achieving higher productivity and profitability in transplanted paddy.

INTRODUCTION

Rice is the staple food for more than half of the world's population. Rice contributes 42 per cent of total food grain production and 45 per cent of cereal production. The slogan 'Rice is life' is the most appropriate for India as this crop plays a vital role in our national food security and means of livelihood for millions of people. As per USDA Global Market Analysis; 2019-20, Rice is cultivated worldwide in an area of 160.70 million ha with the production of 497.71 million tonnes having a productivity of 4.62 t ha^{-1}. In India, rice is grown in an area of 43.66 million hectares having an annual production of 118.87 million tonnes with a productivity of 4.08 t ha^{-1} [1]. In Tamil Nadu, rice is cultivated in an area of 18.50 lakh hectares with a production of 72.00 lakh metric tonnes productivity of 3.89 t ha^{-1} [2]. The population of the country is burgeoning, which may stabilize around 1.4 and 1.6 billion by 2025 and 2050 requiring annually 380 and 450 MT of food grains respectively [3]. Hence, crop productivity has to be increased to meet out the demand of growing population. Various crop productivity enhancing strategies such as sowing high yielding varieties, proper weeding, providing timely irrigation, good nutrient management are being followed. Among them, adequate nutrient management is one of the best ways to enhance the productivity of rice [4].

Silicon (Si) is the second most abundant element after oxygen in the Earth's crust with nearly 29 per cent mean content [5]. Plants can only absorb Si in the form of soluble mono silicic acid (H_2SiO_4) [6]. Silicon plays a significant role in imparting biotic, abiotic stress resistance and enhancing crop productivity [7]. Rice is known as a silicon accumulator and a high silicon demanding crop [8] which contains Si at levels up to 10 per cent in dry matter weight. It also plays a crucial role in preventing or minimizing the lodging of cereal crops, a matter of great importance in the productivity of agricultural crops. Its absorption makes leaves more erect, thus reducing self-shading which in turn boosting light interception, enhancing the root system, increasing cell wall thickness below the cuticle and improving plant defense mechanism [9]. Hence, the present experiment was conducted to study the effect of silicon on growth and yield attributes of transplanted paddy under wetland ecosystem.

*Corresponding author: Department of Agronomy, Faculty of Agriculture, Annamalai University, Tamil Nadu, 608002, India
E-mail: arikarthi75@gmail.com

Materials and Methods

A field experiment was carried out at farmer's field, Keezhamankudi village, Bhuvanagiri taluk of Cuddalore district to study the effect of silicon on growth and yield attributes of transplanted paddy under wetland ecosystem from February to June, 2020. The experimental field was located at 11° 43′ N latitude and 79° 49′ E longitude at an altitude of +5.79 m above mean sea level. The rainfall received during cropping period is 70.8 mm. The mean maximum and minimum temperature during cropping period are 34.3°C and 25.02°C respectively. The relative humidity ranges from 75 to 91 percent. The soil of the experiment site is clay loam (Soil pH 8.4; EC 0.89 dSm^{-1}). The available soil nitrogen, phosphorus, potassium and silicon were 248, 17.18, 310 and 268 kg ha^{-1} respectively. The experiment was laid out in Randomized Block Design (RBD) replicated thrice with thirteen treatments *viz.,* T_1 - Without any fertilizer application (control), T_2 - RDF alone (120:40:40 kg of NPK ha^{-1}), T_3 - Soil application of Silica GR (soil conditioner) @ 25 kg ha^{-1}, T_4 - RDF + Soil application of Silica GR (soil conditioner) @ 25 kg ha^{-1}, T_5 - RDF + Soil application of Micronutrient mixture (TN grade XI) @ 12.5 kg ha^{-1}, T_6 - RDF + Soil application of Silica GR (soil conditioner) @ 25 kg ha^{-1} + Soil application of Micronutrient mixture (TN grade XI) @ 12.5 kg ha^{-1}, T_7 - 75 % RDF + Soil application of Silica GR (soil conditioner) @ 25 kg ha^{-1}, T_8 - 75 % RDF + Soil application of Micronutrient mixture (TN grade XI) @ 12.5 kg ha^{-1}, T_9 - 75 % RDF + Soil application of Silica GR (soil conditioner) @ 25 kg ha^{-1} + Soil application of Micronutrient mixture (TN grade XI) @ 12.5 kg ha^{-1}, T_{10} - 125 % RDF alone, T_{11} - 125 % RDF + Soil application of Silica GR (soil conditioner) @ 25 kg ha^{-1}, T_{12} - 125 % RDF + Soil application of Micronutrient mixture (TN grade XI) @ 12.5 kg ha^{-1}, T_{13} - 125 % RDF + Soil application of Silica GR (soil conditioner) @ 25 kg ha^{-1} + Soil application of Micronutrient mixture (TN grade XI) @ 12.5 kg ha^{-1}. Entire dose of P_2O_5 was applied as basal. N and K_2O were applied in four equal splits at basal, tillering, panicle initiation and heading stages. The rice variety chosen for study was ADT 43. The biometric observations were taken at critical stages of the crop. All the recorded data were statistically analyzed as suggested by [10].

Results and discussion

Growth attributes

Application of silicon significantly influenced the growth attributes of rice (Table 1). Application of 125 % RDF + Soil application of Silica GR (soil conditioner) @ 25 kg ha^{-1} + Soil application of Micronutrient mixture (TN grade XI) @ 12.5 kg ha^{-1} (T_{13}) recorded higher growth attributes *viz.*, plant height (109.75 cm), no. of tillers $hill^{-1}$ (16.54), leaf area index (6.47), root length (27.91 cm), root volume (34.76 cm^3) and dry matter production (13826 kg ha^{-1}). This was followed by application of 125 % RDF + Soil application of Silica GR (soil conditioner) @ 25 kg ha^{-1} (T_{11}) recorded the plant height (105.41 cm), no. of tillers $hill^{-1}$ (15.85), leaf area index (6.19), root length (26.83 cm), root volume (33.48 cm^3) and dry matter production (13259 kg ha^{-1}) which was on par with 125 % RDF + Soil application of Micronutrient mixture (TN grade XI) @ 12.5 kg ha^{-1} (T_{12}). The least values for growth attributes were recorded under the control (T_1). This increase in growth attributes might be due to application of silicon that enhances the uptake of essential nutrients involved in metabolism of paddy [11]. Silicon application significantly increased the plant height might be due to deposition of silicon in leaf tissues and maintained leaf in erected position [12]. Silicon nutrition improves interception of light by keeping leaves erect thereby stimulating canopy photosynthesis in rice that increased leaf area. The results were in line with other studies [13, 14].

Tillering is the production of expanding auxiliary buds which is clearly depends upon the nutritional condition of mother culm which was improved by silicon that produces a greater number of tillers $hill^{-1}$. Similar findings in line with the others [15, 16]. The maximum root length and root volume of rice could be due to the silicon fertilization increased the development of secondary and tertiary cells of endodermis, thus allowing better root penetration in soils and a faster growth of roots [16]. The beneficial effect of silicon on dry matter production (DMP) was mainly due to the leaf erectness, better penetration of solar energy leading to higher photosynthetic activity that produces more dry matter. The present results were in agreement with the findings of [17,18].

Table 1. Effect of silicon on growth attributes of transplanted rice

Treatment	Plant height at harvest	LAI at flow.	No. of tillers $hill^{-1}$	Root length (cm)	Root volume (cm^3)	DMP at harvest (kg ha^{-1})
T_1	60.35	3.62	6.19	14.12	18.42	6573
T_2	76.73	4.54	12.11	19.89	24.96	9015
T_3	68.51	4.11	9.54	17.56	21.84	8050
T_4	94.81	5.50	14.27	24.10	29.05	11534
T_5	93.69	5.42	14.09	23.89	29.08	11364
T_6	100.18	5.79	15.02	25.47	31.20	12371
T_7	84.29	4.84	12.93	21.88	26..43	9924
T_8	79.43	4.57	12.22	20.50	24.91	9201
T_9	89.38	5.14	13.52	22.90	27.78	10556
T_{10}	96.80	5.51	14.37	24.42	30.01	11753
T_{11}	105.41	6.19	15.85	26.83	33.48	13259
T_{12}	104.06	6.12	15.75	26.50	32.79	13042
T_{13}	109.75	6.47	16.54	27.91	34.76	13826
SEm±	1.09	0.08	0.19	0.33	0.38	162.50
CD P=0.05)	3.21	0.26	0.56	0.98	1.13	476.14

Yield attributes and yield

Yield attributes and yield of rice was significantly increased with silicon fertilization [Table 2]. Among different treatments, application of 125 % RDF + Soil application of Silica GR (soil conditioner) @ 25 kg ha^{-1} + Soil application of Micronutrient mixture (TN grade XI) @ 12.5 kg ha^{-1} (T_{13}) recorded higher no. of panicles m^{-2} (642), no. of grains $panicles^{-1}$ (138.98), grain yield (6854 kg ha^{-1}) and straw yield (9842 kg ha^{-1}) of rice. Application of 125 % RDF + Soil application of Silica GR (soil conditioner) @ 25 kg ha^{-1} (T_{11}) was next in order which recorded no. of panicles m^{-2} of 603, no. of grains $panicles^{-1}$ of 135.12, grain yield of 6349 kg ha^{-1} and straw yield of 9438 kg ha^{-1}. This was on par with 125 % RDF + Soil application of Micronutrient mixture (TN grade XI) @ 12.5 kg ha^{-1} (T_{12}). The least values for growth attributes were recorded under the control (T_1).

Table 2. Effect of silicon on yield attributes and yield of transplanted rice

Treatment	Yield attributes			Yield	
	No. of panicles m^{-2}	No. of grains $panicle^{-1}$	Test weight	Grain yield	Straw yield
T_1	215	63.19	15.46	1902	4510
T_2	320	100.86	15.61	4380	7208
T_3	261	95.40	15.53	3426	6194
T_4	480	123.60	15.79	5562	8515
T_5	474	122.52	15.78	5459	8380
T_6	549	129.42	15.85	5943	8953
T_7	370	108.51	15.67	4782	7715
T_8	328	102.25	15.62	4465	7346
T_9	416	115.75	15.72	5072	8039
T_{10}	493	125.10	15.81	5627	8611
T_{11}	603	135.12	15.90	6349	9438
T_{12}	591	134.96	15.89	6231	9272
T_{13}	642	138.98	15.94	6854	9842
SEm±	4.72	1.16	NS	57.43	99.86
CD (P=0.05)	13.83	3.42	NS	168.26	292.59

Panicle formation is directly related to number of productive tillers plant^{-1}, application silicon enhanced the number of productive tillers which resulted in more panicle number per unit area [19]. Availability of silicon might have more assimilation of carbohydrates in panicles which resulted in increased number of grains in rice. These results were in harmony with the findings of [20, 21]. Silicon application enhances the uptake of essential nutrients in balanced manner which leads to more translocation of essential nutrients in plants helps to increase the grain and straw yield. These results are in conformity with the findings of [22, 23].

Conclusion

From the present study, it can be concluded that application of 125 % RDF + Soil application of Silica GR (soil conditioner) @ 25 kg ha^{-1} + Soil application of Micronutrient mixture (TN grade XI) @ 12.5 kg ha^{-1} (T_{13}) remarkably increased the growth and yield of transplanted rice.

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