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"Response of low land rice to application of silicon in Vertisols of Scarce Rainfall Zone of Andhra Pradesh (Oryza sativa L.)"

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Abstract:

Background: *Rice (Oryza Sativa L.) is the important staple food crop in the world. It is second highest produced grain in the world after corn (maize) and it is the most important crop with regard to human nutrition and calory intake, providing more than one fifth of the calories consumed by the world population. Rice is a high silicon accumulating plant and the plant is benefited from Si nutrition. The present experiment is proposed to find out the "Response of low land rice to application of silicon in Vertisols of Scarce Rainfall Zone of Andhra Pradesh"*

Methods: *A field experiment was carried out at College Farm, Agricultural College, Mahanandi, Acharya N.G. Ranga Agricultural University during rabi, 2022-2023. The experiment was laid out in randomized block design with nine treatments and three replications.*

Result: *The results suggested that soil application of 300 kg ha-1 calcium silicate enhanced the soil available nutrients and yield of transplanted rice. So, taking into consideration of three aspects like improving soil properties, yield and B:C ratio, the soil application of 300 kg ha-1 calcium silicate was the best option for the farmers.*

Keywords: *Silicon, Calcium silicate, Rice, yield.*

1. INTRODUCTION

Rice is cultivated in more than 114 countries under diversified Agro -climatic conditions. In India it is cultivated in most of the states with an area of 46.38 m ha, with a production of 130.29 Mt and productivity of 2809 kg ha^{-1}. Andhra Pradesh has an area of 2.25 m ha and production of 7.79 Mt and productivity is 3470 kg ha^{-1}. (Directorate of Economics and Statistics, Department of Agriculture, GoI, 2022).

Nutrients are the most important inputs in crop production as it constitutes a portion in cost of cultivation and the deficiency of any nutrient causes more reduction in yield. Efficient management practices of nutrients help to get more yields with minimum cost. The nutrients can be supplied through organic or inorganic sources or both. Paddy responds better to higher doses of nutrients, any deficiency at critical stages lead to maximum reduction in yield. Application of nutrients coinciding with peak nutrient requirement of the crop helps to get maximum yield particularly, at panicle initiation and heading stage. Not only major nutrients but also micro and beneficial nutrients play a significant role in uptake, translocation and assimilation of nutrients through their influence on growth parameters and yield attributes in plant system.

Rice is a high silicon accumulating plant and the plant is benefited from Si nutrition. Rice crop can uptake Si in the range of 230-470 kg ha^{-1}. Silicon is the second most abundant element in the earth's crust. It is not considered as an essential element but Si is a beneficial element for plant growth and is agronomically essential for improving and sustaining rice productivity. Besides rice yield increase, Si has many advantages of increasing nutrient availability (N, P, K, Ca, Mg, S, Zn), decreases nutrient toxicity (Fe, P, Al) and minimizing biotic and abiotic stress in plants (Savant *et al.*, 1997). Hence, the application of Si to soil or plant is practically useful in laterite derived paddy soils, not only to increase yield but also to alleviate the Fe toxicity problems. Si increases the mechanical strength of the culm, thus reducing crop lodging (Savant *et al*., 1997). In soil, Si is not a much mobile element to plants. Therefore, a continued supply of this element would be required particularly for the healthy and productive development of plant during all growth stages. Silicon concentration of plant shoots varies differently among plant species, ranging from 0.1 to 10 % Si on a dry weight basis.

Silicon is present as monosilicic acid and polysilicic acid and complexes with both organic and inorganic compounds such as aluminum oxides and hydroxides in the soil solution. Plant available silicon (PAS) is taken up by the plants and has a direct effect on crop growth. The solubility of Si in soil is affected by a number of different dynamic processes occurring in the soil including the particle size of the silicon fertilizer, pH, aluminum, iron, phosphate ions, organic complexes, dissolution reactions and soil moisture.

Keeping this in a view, the present field experiment was conducted to study the response of low land rice to application of silicon in Vertisols of Scarce Rainfall Zone of Andhra Pradesh (*Oryza sativa* L.).

2. Materials and Methods

The experiment was conducted at the College Farm, Agricultural College, Mahanandi (Nandyal district) of Acharya N.G. Ranga Agricultural University, which is geographically situated at 15.51^0 N latitude, 78.61^0 E longitude with an altitude of 233.48 meters above the mean sea level in Scarce Rainfall Zone of Andhra Pradesh and according to Troll's classification, it falls under Semi-Arid Tropics (SAT). The treatments comprised of T_1: Application of silicon @ 50 kg ha^{-1}, T_2: Application of silicon @ 100 kg ha^{-1}, T_3: Application of silicon @ 150 kg ha^{-1}, T_4: Application of silicon @ 200 kg ha^{-1}, T_5: Application of silicon @ 250 kg ha^{-1}, T_6: Application of silicon @ 300 kg ha^{-1}, T_7: Application of silicon @ 350 kg ha^{-1}, T_8: Application of silicon @ 400 kg ha^{-1}, T_9: Control (No silicon).

The soil of the experimental field was sandy loam in texture with neutral in reaction (p^H 7.34), low in organic carbon (0.47 %), available nitrogen (256 kg ha^{-1}) and medium in available phosphorus (46 kg ha^{-1}) and high in available potassium (582 kg ha^{-1}). BPT-5204 variety of rice was released from Rice Research Unit, Bapatla, Acharya N.G. Ranga Agricultural University, Andhra Pradesh. It is a long duration variety with a crop period of 150 - 155 days, medium slender and white translucent grains, dwarf to medium tall, erect, nonlodging open type canopy with dark green erect short leaves and suitable for low land conditions. It has fine grain variety with excellent cooking quality.

The observations were recorded on growth parameters (plant height, leaf area index, dry matter production, number of tillers m^{-2}, days to 50% flowering and days to maturity), yield attributes (number of panicles m^{-2}, length of the panicle, grain weight of panicle, thousand grain weight, straw yield, grain yield and harvest index), The data were collected on five randomly selected plant and the data were subjected to statistical analysis.

3. Results And Discussion

Effect on yield attributes

At 30 DAT, 60 DAT and at harvest stage of crop growth taller plant height was observed in the treatment (T_6) with application of silicon @ 300 kg ha^{-1} over other doses of fertilizer application. But at 90 DAT taller plant height was observed in the treatment (T_8) with application of silicon @ 400 kg ha^{-1} over other doses of fertilizer application. Increase in supply of silicon to the soil by inorganic fertilizers could have enhanced the cell elongation and multiplication resulting in taller plant height of paddy. Silicon application that lead to increase of plant height might be due to the accumulation of silicon in plant tissues that caused the erectness of leaves and stems.

The highest (2.34, 4.48 and 3.41 at 30, 60 and 90 DAT respectively) LAI values were observed with application of silicon @ 300 kg ha^{-1} (T_6) and it was on par with application of silicon @ 350 kg ha^{-1} (T_7). The lowest LAI values (1.90, 3.82 and 2.88 at 30, 60 and 90 DAT respectively) were observed in control treatment (T_9).

The highest dry matter production during all the stages (30, 60 DAS and at harvest) of crop growth was with the application of silicon @ 300 kg ha^{-1} (T_6) might be due to availability of nutrients in soil by the application of adequate doses of fertilizers which triggered the plant growth vigorously.

Number of tillers m $^{-2}$ was highest with the application of silicon @ 300 kg ha^{-1} (T_6) (327 m^{-2}) over other treatments but it was on par with T_7 (324 m^{-2}) and T_8 (319 m^{-2}). The lowest number of tillers m^{-2} was noticed with control, T_9 (273 m^{-2}) and was on par with T_2 (284 m^{-2}).

Number of days for 50 % flowering was significantly earlier with the application of silicon @ 300 kg ha^{-1} (T_6) (107 days$^{)}$ over other treatments but it was on par with T_7, T_4 and T_3 (108 days). Significantly maximum days for 50% flowering was noticed with control, T_9 (110 days) and was on par with T_2 (109 days).

Days to maturity was significantly earlier with the application of silicon @ 300 kg ha^{-1} (T_6) (156 days) over other treatments. Significantly maximum days for maturity was noticed with control, T_9 (159 days) and was on par with $T_{1,}$ $T_{4,}$ $T_{5,}$ $T_{7,}$ T_8 (158 days) and $T_{2,}$ $T_{3,}$ (158 days).

Effect on yield parameters

Higher number of panicles m^{-2} (309) in paddy was recorded with application of silicon @ 300 kg ha^{-1} (T_6) over other treatments and was on par with T_7 (306). The lowest number of panicles m^{-2} was noticed with control, T_9 (254) and was non-significant with other treatments T_2 (261), T_3 (262), T_1 (265), T_4 (267), T_5 (276), T_8 (293).

Significantly maximum length of panicle (22 cm) in paddy was recorded with application of silicon @ 300 kg ha^{-1} (T_6) over other treatments. The minimum length of panicle was noticed with control, T_9 (20.17 cm) and was on par with T_1 (20.33 cm), T_8 (20.75 cm), T_4 (20.50 cm), T_2 (20.83). The other treatments length of panicles was recorded as T_3 (21.07 cm) and T_5 (21.17 cm).

Significantly maximum number of grains panicle^{-1} (120.67) in paddy was recorded with application of silicon @ 300 kg ha^{-1} (T_6) was over other treatments and on par with T_7 (120 cm). The minimum number of grains panicle^{-1} was noticed with control, T_9 (107.33 cm) and was on par with T_1 and T_4 (109.33). The number of grains panicle^{-1} recorded in other treatments were T_8 (118), T_2 (111.33) and T_3 (109.67).

Maximum grain weight of panicle (1.68 g) in paddy was recorded with application of silicon @ 300 kg ha^{-1} (T_6) was on par with T_7 (1.65 g). The minimum grain weight of panicle was noticed with control, T_9 (1.40 g).

Test weight (1000 grains) weighed across treatments indicate significant differences among treatments with highest being registered with application of silicon @ 300 kg ha^{-1}, T_6 (14.10 g). Minimum thousand grain weight was recorded with control (T_9).

Higher seed yield (6393 kg ha^{-1}) of paddy was recorded with application of silicon @ 300 kg ha^{-1} (T_6) and was at par with T_7 (6172 kg ha^{-1}) and T_8 (6123 kg ha^{-1}). Lower seed yield (4528 kg ha^{-1}) was recorded with control (T_9) followed by T_1 (5048 kg ha^{-1}).

Significantly higher straw yield (6138 kg ha^{-1}) of paddy was recorded with application of silicon @ 300 kg ha^{-1} (T_6) and was at par with T_8 (6107 kg ha^{-1}), T_7 (6064 kg ha^{-1}) and T_5 (6018 kg ha^{-1}). Lower straw yield (5022 kg ha^{-1}) was recorded with (T_9) control (5022 kg ha^{-1}). Highest harvest index (51.02 %) of paddy was recorded in the treatment (T_6) with the application of silicon @ 300 kg ha^{-1} and was on par with treatments T_7 (50.44%). The lower harvest index (47.41 %) was recorded in control (T_9).

Table1. *Influence of different levels of silicon on yield attributes in rice*

Treatments	No. of panicles m^{-2}	Length of panicles (cm)	No. of grains panicle^{-1}	Grain weight of panicle (g)	1000 grain weight (g)
T1: Application of Silicon @ 50 kg ha^{-1}	265.0	20.33	109.3	1.46	13.37
T2: Application of Silicon @ 100 kg ha^{-1}	261.0	20.83	111.3	1.49	13.40
T3: Application of Silicon @ 150 kg ha^{-1}	262.3	21.07	109.6	1.54	13.93

T4: Application of Silicon @ 200 kg ha^{-1}	266.6	20.50	109.3	1.45	13.30
T5: Application of Silicon @ 250 kg ha^{-1}	276.3	21.17	112.6	1.52	13.53
T6: Application of Silicon @ 300 kg ha^{-1}	309.0	22.00	120.6	1.68	14.10
T7: Application of Silicon @ 350 kg ha^{-1}	306.0	21.00	120.0	1.65	13.77
T8: Application of Silicon @ 400 kg ha^{-1}	293.6	20.75	118.0	1.6	13.60
T9: Control (No silicon)	254.3	20.17	107.3	1.4	13.10
S.Em ±	1.41	0.264	0.68	0.01	0.250
CD (0.05)	4.23	0.790	2.04	0.04	0.770

Table 2. *Influence of different levels of silicon on yield attributes in rice*

Treatments	**Grain yield (kg ha^{-1})**	**Straw yield (kg ha^{-1})**	**HI**
T1: Application of Silicon @ 50 kg ha^{-1}	5048	5333	48.63
T2: Application of Silicon @ 100 kg ha^{-1}	5136	5372	48.88
T3: Application of Silicon @ 150 kg ha^{-1}	5206	5681	47.82
T4: Application of Silicon @ 200 kg ha^{-1}	5857	6008	49.36
T5: Application of Silicon @ 250 kg ha^{-1}	6012	6018	49.98
T6: Application of Silicon @ 300 kg ha^{-1}	6393	6138	51.02
T7: Application of Silicon @ 350 kg ha^{-1}	6172	6064	50.44
T8: Application of Silicon @ 400 kg ha^{-1}	6124	6107	50.07
T9: Control (No silicon)	4528	5022	47.41
S.Em ±	60.66	67.12	0.540
CD (0.05)	181.9	201.2	1.620

4. Conclusion

Based on the above investigation, it is concluded that soil application of 300 kg ha^{-1} calcium silicate enhanced the soil available nutrients and yield of transplanted rice in Scarce Rainfall Zone of Andhra Pradesh.

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