Short Communication

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Effect of Silicon and Sulphur Fertilization on Growth and Yield of Rice

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Silicon is considered an agronomically essential element for sustainable rice production (Savant *et al.* 1997a) and reported that adequate supply of Si increased the number of panicles, the number of grains per panicle, the percentage ripening and the light-receiving posture of rice plants and also improved the availability and utilization of P by rice plants. Si is absorbed as PAS by rice plants in far larger quantities than the macro nutrients, 108 % greater than nitrogen uptake. A rice crop producing a yield of 5000 kg ha^{-1} removes 230-470 kg Si ha^{-1} and it has the potential to raise the optimum rate of N (Elawad and Green 1979). It develops resistance and/or tolerance to abiotic stresses and could tolerate Fe, Al and Mn toxicities, and the increased mechanical strength of the culm helps reduce crop lodging (Takahashi 1995).

Sulphur is very much beneficial for increasing the production of rice *via* synthesis of chlorophyll, certain amino acids like methionine, cystine, cysteine and some plant hormones such as thiamine and biotin (Rahman *et al*. 2007) and growing of sulphur responsive crops, under high intensive cropping and use of sulphur free fertilizers caused S deficiency in soils of India (Tandon and Tiwari 2007).

In Gujarat, total area under rice cultivation was 7.82 lakh ha^{-1} with total production of 19.3 lakh million tonnes and productivity of 2304 kg ha^{-1} during 2016-17 and continuous cultivation of rice resulted in decreased rice production owing to deficiency of nutrients and lodging *etc* and hence present investigation was carried out to study the response of Si and S on *kharif* rice grown in a loamy sand soil at Anand.

The field experiments were conducted during the *kharif* season (2016-17 and 2017-18) at the Regional Research Station, Anand Agricultural University, Anand, Gujarat. The experimental loamy sand soil had pH 7.8, organic carbon 0.30 %, EC 0.23 dS m^{-1}, available Si (68.73 mg kg^{-1}), P_2O_5 (32.58 kg ha^{-1}), S (9.81 mg kg^{-1}), Fe (7.31 mg kg^{-1}) and Zn (1.23 mg kg^{-1}). There were 12 treatments comprising of four levels of Si (0, 150, 300 and 450 kg ha^{-1} applied through calcium silicate) and three levels of S (0, 20 and 40 kg ha^{-1} applied through bentonite sulphur) as basal dose along with recommended NPK dose of fertilizers (120: 40: 00 kg ha^{-1}). The experiment was laid out in Factorial Randomized Block Design with three replications. All the biometric observations were taken at the time of harvest. The experimental data were analyzed as per the procedure outlined by Steel and Torrie (1982).

The application of 450 kg Si ha^{-1} gave significantly higher total number of tillers per meter row length (87.95, 90.18 and 89.06) of rice in both the years as well as on a pooled basis than control, but it was at par with 300 kg Si ha^{-1} (Table 1) might be due to the role of silicon in cell division, photosynthetic process as well as in the formation of chlorophyll. Liang *et al.* (1996) and Mauad *et al.* (2003) also reported similar findings.

Application 450 kg Si ha^{-1} also resulted in significantly higher plant height than control but it was at par with 150 and 300 kg Si ha^{-1} during first year but in case of second year and pooled basis it was at par with (Si300) and differed significantly from (Si0) and (Si150) treatments (Table 1). Gascho and Korndorfer (1998) observed that both soil and plant parameters were significantly affected by the Si sources and rates

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used while Fallah (2012) reported improved plant height, inter-node length and fresh weight in rice .

Application of 40 kg S ha^{-1} brought significantly higher total number of tillers per meter row length (86.06, 88.41 and 87.24) of rice in both the years as well as on a pooled basis than control (S0), but it was at par with 20 kg S ha^{-1} (S20) in individual years, but differed significantly on pooled basis. The treatment (40 kg S ha^{-1}) had significantly higher plant height than the control, but it was at par with 20 kg S ha^{-1} during first and second year as well as on pooled basis (Table 1).

In pooled data, the highest total numbers of tillers per meter row length (95.21) were observed in treatments having 450 kg Si ha^{-1} and 40 kg S ha^{-1} which was found to be at par with 300 kg ha^{-1} Si and 40 kg ha^{-1} S application, but differed significantly from the rest of the combinations (Table 1). These results are in conformity with the findings of Sudhakar *et al.* (2004). The significantly highest grain yield was recorded due to 450 kg ha^{-1} Si during both the years as well as on a pooled basis (Table 2). The significantly highest straw yield was recorded due to 450 kg ha^{-1} Si during both the years as well as on pooled basis, respectively (Table 2). The increased in yield with Si application could be due to beneficial effects *viz.,* decreasing mutual shading by improving leaf erectness, decreasing susceptibility to lodging, decreasing the incidence of pathogens. The results are in line with the findings of Savant *et al.* (1997). Chen *et al.* (2011) stated that silicon application increased grain yield by increase of spikelet number, filled spikelet percentage and 1000-seed weight.

The significantly highest grain yield was recorded due to sulphur application @ 40 kg ha^{-1} during both the years as well as on a pooled basis but it was at par with 20 kg Si ha^{-1} during both the years as well as on a pooled basis. The highest straw yield was recorded due to sulphur application @ 40 kg ha^{-1} but it was at par with 20 kg Si ha^{-1} (Table 2). The increased rice yields might be due to enhanced leaf-chlorophyll favourably influenced by Sulphur availability in soil resulting in the formation of relatively bold grain leading to increased yield (Rahman *et al.* 2007).

Table 1. Effect of silicon and sulphur on total number of tillers per meter row length and plant height

Treatment	Total number of tillers per meter row length			Plant height (cm)		
	2016-17	**2017-18**	**Pooled**	**2016-17**	**2017-18**	**Pooled**
Silicon levels (kg ha^{-1})						
Si0	77.59	79.19	78.39	98.94	102.13	100.53
Si150	81.69	82.65	82.17	104.40	106.91	105.65
Si300	84.80	86.18	85.49	106.63	111.70	109.16
Si450	87.95	90.18	89.06	109.17	115.97	112.57
S.Em. ±	1.49	1.96	1.03	1.92	2.34	1.86
CD (P=0.05)	4.38	5.76	3.01	5.63	6.87	5.47
Sulphur levels (kg ha^{-1})						
S0	80.37	81.01	80.69	101.30	105.57	103.43
S20	82.59	84.23	83.41	105.22	108.90	107.06
S40	86.06	88.41	87.24	107.69	113.07	110.38
S.Em. ±	1.29	1.70	0.89	1.66	2.03	1.61
CD (P=0.05)	3.80	4.99	2.61	4.88	5.95	4.74
Significant interactions	Si S	Si S	Si S	-	-	-
CV %	5.40	6.96	6.90	5.50	6.43	4.65

Table 2. Effect of silicon and sulphur on grain yield (kg ha^{-1}) and straw yield (kg ha^{-1})

Treatment	Grain yield (kg ha^{-1})			Straw yield (kg ha^{-1})		
	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled
Silicon levels (kg ha^{-1})						
Si0	5680	5736	5708	7184	7348	7248
Si150	5791	5816	5804	7379	7553	7466
Si300	5902	5953	5928	7610	7705	7658
Si450	6211	6294	6252	8025	8159	8092
S.Em. ±	128	144	128	196	174	175
CD (P=0.05)	378	422	377	576	511	513
Sulphur levels (kg ha^{-1})						
S0	5667	5704	5686	7205	7356	7281
S20	5938	5954	5946	7576	7733	7655
S40	6084	6191	6137	7893	7984	7912
S.Em. ±	111	124	111	170	151	151
CD (P=0.05)	327	366	327	499	443	444
Significant interactions	-	-	-	-	-	-
CV %	6.56	7.27	3.43	7.82	6.81	3.60

Conclusion

It is concluded that application of 300 kg Si ha^{-1} and 20 kg S ha^{-1} with recommended dose of fertilizer (120-40-00 kg ha^{-1}) may result in optimum yield of grain and straw in rice.

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