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KINETICS OF SILICON IN RELATION TO DIFFERENT LEVELS OF MAJOR NUTRIENTS IN THE LATERITIC FLOODED RICE SOILS

Silicon is the most abundant element in the earth's crust which contains 59% SiO_2 (Jackson, 1964). Silicon has been reported to benefit rice by improving the solar energy utilization, increasing the water use efficiency, increasing the strength of straw and increasing resistance against pests and diseases (Elawad and Green, 1979). Silicon is present in soil entirely as a simple molecule, monosilicic acid - ortho silicic acid, $Si(OH)_4$, which is in equilibrium with quartz. The concentration of silicon in the solutions of flooded soils increases slightly after flooding and then decreases gradually. After several months of submergence the silicon concentration may be lower than at start (Ponnamperuma, 1972).

A field experiment was conducted in a well drained lateritic sandy loam soil (pH 4.70, CEC 3.40 me/100 g, EC 0.23 dS/m, organic carbon 0.82%, available N 0.020%, available P 10.55 ppm, available K 18.25 ppm, availalble silicon 88.98 ppm). Different levels of N, P_2O_5 and K_2O were applied to the soil (Table 1). Piezometers were installed at 20 cm depth in every plot for the collection of soil solution. The test variety used was IR 42. Soil solution, wet soil and plant samples were collected from 13th day of transplanting to 50% flowering. The available silicon in wet soil samples was estimated by using normal sodium acetate (pH 4.0) and plant- content of silicon was estimated by triple acid digestion method suggested by Imaizumi and Yoshida (1958).

Table 1 shows the chemical kinetics of silicon in the soil and soil solution during the different periods of rice growth as influenced by different levels of N, P and K. The average Si content of the various treatments in the soil varied between periods, with a initial increase followed by a decrease and then a progressive increase, the maximum value (143.7 ppm) being recorded at 75 days after transplanting whereas the average soil solution content of Si of the various treatments showed decreasing and increasing tendencies and finally at 75 days after transplanting it was found much less than that at 13 days after transplanting. The contents of silicon in soil and soil solution were not significantly influenced by the treatments except for soil samples collected at 65 days after transplanting where T_1 recorded the highest concentration of silicon (150.5 ppm). Waterlogging a soil is likely to increase its water soluble silicic acid presumably due to its release from hydrated ferric oxide surface (Elawad and Green, 1979). Decomposing rice straw with its high content of silicon may also contribute to the increased silicon content of the soil solution in flooded soils (Patrick and Reddy, 1978). The subsequent decrease may be the result of combination with alumino-silicates following the decrease in $^{p}CO_2$ (Ponnamperuma 1972). Further increase is probably due to release of absorbed and occluded silica from hydroxides of iron and aluminium (Mc-Keague and Cline, 1963). The concentration of silicon in the soil solution

Table 1. Silicon content of the soil and soil solution of wet soil samples (over dry basis) during the different stages of rice growth, ppm

Treatments $N:P_2O_5:K_2O$ (kg/ha)	13 DAT		23 DAT		33 DAT		44 DAT		54 DAT		65 DAT		75 DAT	
	Soil	Soil solution	Soil	Soil solution	Soil	Soil solution	Soil	Soil solution	Soil	Soil solution	Soil	Soil solution	Soil	Soil solution
T_1 0:0:0	150.9	2.5	122.9	0.9	115.5	1.0	110.5	1.5	133.9	1.5	150.5	1.0	143.7	0.9
T_2 40:0:0	138.4	3.4	147.6	1.5	113.3	1.1	105.8	1.1	137.4	1.4	122.8	1.0	153.9	1.1
T_3 80:0:0	131.1	4.3	129.6	1.2	116.2	0.9	107.1	1.0	129.1	1.6	130.1	1.1	134.0	1.0
T_4 40:20:20	124.8	4.3	127.4	1.4	120.0	1.1	109.3	2.2	127.9	1.7	138.9	1.0	149.7	1.0
T_5 80:40:40	115.2	2.7	135.7	1.1	110.7	0.8	103.7	1.3	130.3	1.3	144.8	0.9	137.3	0.7
CD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	18.19	NS	NS	NS
Mean	132.1	3.4	132.2	1.2	115.1	1.0	107.3	1.4	131.7	1.5	137.4	1.0	143.7	0.9

NS - Not significant DAT - Days after transplanting

Table 2. Content and uptake of silicon during different stages of growth and yield of rice as influenced by different levels of N, P and K

Treatments	13 DAT		23 DAT		33 DAT		44 DAT		54 DAT		65 DAT		75 DAT		Grain		Yield (kg/ha)	
	Content %	Uptake kg/ha	Content %	Uptake kg/ha	Content %	Uptake kg/ha	Content %	Uptake kg/ha	Content %	Uptake kg/ha	Content %	Uptake kg/ha	Content %	Uptake kg/ha	Content %	Uptake kg/ha	Grain	Straw
T_1	3.9	5.3	2.8	13.0	2.9	27.4	4.8	78.8	7.0	181.4	7.5	339.6	7.4	481.3	2.9	120.5	5208	3831
T_2	4.1	7.0	3.1	12.1	3.6	37.7	6.6	141.5	7.7	244.9	6.8	278.7	8.6	502.9	2.0	98.1	5465	4519
T_3	3.2	5.8	3.7	13.8	3.9	37.5	6.3	128.1	7.5	246.5	6.5	312.3	8.3	462.3	2.3	111.3	5559	4595
T_4	3.3	4.6	3.1	13.5	3.5	30.6	5.2	142.8	8.0	237.6	6.8	321.3	8.5	534.0	2.9	140.2	5682	4380
T_5	3.7	6.1	4.3	24.6	4.0	45.5	6.6	174.1	8.1	300.9	7.1	390.3	9.3	616.2	2.2	111.1	5691	5123
CD (0.05)	NS	NS	NS	7.93	0.60	NS	NS	NS	NS	NS	NS	NS	0.93	NS	NS	NS	NS	NS

NS - Not significant DAT - Days after transplanting increases with soil reduction, apparently because of the reduction of Fe (III) oxide hydrate that sorbs silicon (Ponnamperuma, 1956; 1978).

The content of silicon and its uptake showed different patterns for the various treatments tried. However, for all the treatments the uptake of silicon followed a progressive increase from 13 days after transplanting to 75 days after transplanting. The silicon content of plant samples was found to be significantly different between treatments, at 33 days after transplanting and at 75 days after transplanting and also Si uptake at 23 days after transplanting (Table 2). The highest rate of uptake and the highest content (3.7 ppm to 9.3 ppm) of silicon was shown by T_5 receiving the maximum doze of NPK. All other treatments were on par. The highest rate of uptake and content of silicon in T_5 might have been due to the influence of applied K (Elawad and Green, 1979). The content and uptake of Si by the grain did not produce any significant variation between treatments and the grain and straw yields of the treatments were also on par. The early growth stages of rice recorded lower values of silicon content up to 33 days after transplanting. A sharp increase of silicon content of soil noticed from 44 days after transplanting may be the reason for the high content of silicon in the plant tissues. Almost a similar trend was observed for uptake pattern also.

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Regional Agricultural Research Station
Pattambi 679 306
Kerala, India

K. Anilakumar
I. Johnkutty
M.A. Hassan
P.K.G. Menon

REFERENCES

Elawad, S.H. and Green, V.E. Jr. 1979. Silicon and rice plant environment: A review of recent research. *IL RISO. 28 (3): 235- 253*

Imaizumi, K. and Yoshida, *S.* 1958. Edaphological sutudies on silicon supplying power of paddy fields. *Bull. nat. Inst. agric. Sci. Ser. B.* 8: 261-304

Jackson, M.L. 1964. Chemical composition of the soil. *Chemistry of the Soil*, Bear, F.E. (Ed.) 2nd ed. Von Nostrand Reimhold Co., p. 71-141

McKeague, J.A. and Cline, M.G. 1963. Silica in soils, *Adv. Agron.* 15: 339-396 ,

Patrick, W.H. Jr. and Reddy, C.N. 1978. Chemical changes in rice soils. *Soils and Rice.* International Rice Research Institute, Los Banos, Philippines, p. 361-379

Ponnamperuma, F.N. 1965. Dynamic aspects of flooded soils. *The Mineral Nutrition of the Rice Plant.* The John Hopkins Press, Baltmore, USA, p. 295-328

Ponnamperuma, F.N. 1972. The chemistry of submerged soils *Adv. Agoron.* 24: 29-96

Ponnamperuma, F.N. 1978. Electro-chemical changes in submerged soils and the growth of rice. *Soils and Rice,* International Rice Research Institute, Los Banos, Philippines, p. 421-448