Agric. Res. J Kerala, 1987, 25 (2) 265—268

KINETICS OF AVAILABLE SILICA OF SUBMERGED ACID SOILS

Silicon is a major constituent of the soil and is present in many plant species. Experiments conducted in different parts of the world have proved beyond doubt that silicon is essential for plant growth especially for rice. But plant availability of silicon varies with soil properties. Yoshida (1962) reported that dilute acid soluble silica is better correlated to plant uptake in acid rice soils. The present study was taken up to understand the changes in available silica is some of acid rice soils of India with submergence and relate it to exchangeable Fe, Mn, Al, Ca, K and pH.

Surface (0-15 cm depth) samples of acid soils representing red, laterite and alluvial soils which were collected from *rice growing tracts* of Orissa, West Bengal, Madhya Pradesh and Kerala states have been taken for the study. Details of soil samples collected with their physical and chemical characteristics are given in Table 1.

The red and laterite soils were sandy loam to sandy clay loam and alluvial soils were mostly clay loam in texture. All the soils were acid to moderately acid in reaction, pH being in the range of 4.9 to 6.0. Lime requirement (Woodruff, 1948) was found to be between 1000 to 9000 kg/ha. Cation exchange capacity of these soils was found to be in the range of 9 to 25 me/100 mg soil. Exchangeable Ca and K ranged from 0.2 to 6.7 and 0.1 to 0.6 me/100g soil respectively. Exchangeable Fe and Mn contents were between 8 to 38 and 15 to 44.5 ppm respectively. Active iron content (Asami and Kumuda, 1959) of these soils was in the range of 0.45 to 1.53 per cent. Exchangeable acidity was in the range of 2.6 to 10 mg/100 g soil. Exchangeable Al content varied from 5 to 60 ppm and Mn from 15 to 445 ppm repectively. Most of these soils contained either kaolinite-mica-vermiculite or kaolinite-mica-montmorillonite mixtures with kaolinite being the most dominant clay mineral.

Laboratory incubation experiments were conducted to study the effect of flooding on kinetics of available silica and its relation with exchangeable cations, and pH. Ten gram lots of soil contained in 50ml plastic centrifuge tubes were flooded with distilled water and incubated in the dark at 30 $\pm$ 2°C. Moisture loss due to evaporation was made-up periodically. Samples were drawn at 0, 10, 20, 30-50 and 70 days after flooding and analysed for exchangeable Al in 1*N* KCl exchangeable Fe, Mn, Ca and K in neutral normal ammonium acetate extract and available silica in 0.025 *N* citrid acid. The change in pH was studied separately in beaker containing 50 g of soil flooded with 50 ml distilled water which were also incubated.

Available silica increased abruptly on flooding dry soils, reached a peak in twenty days of flooding after which it decreased in all the soils studied. In some

Table 1

Physical and chemical properties of soils

	Soils	State	Textural class	pH (1:2.5 soil water)	Ex. acidity me/100 g soil	Org. carbon	CEC me/100 g soil	Active acidity me/100 g soil	Exchangeable cations K me/100 g	Ca me/100g	Fe (ppm)	Al (ppm)	Mn (ppm)
1	Bhubaneswar	Orissa	Sandy clay loam	4.7	10.4	0.92	10.7	1.00	0.10	1.8	60	52	24
2	Pattambi	Kerala	,,	5.2	10.0	0.60	19.0	1.50	0.20	1.8	28	23	53
3	Mangalore	Karnataka	,,	4.9	10.4	1.29	10.4	0.71	0.10	1.1	28	10	15
4	Sukenda	Orissa	,,	5.5	6.1	0.80	14.0	0.93	0.11	1.2	34	21	115
5	Alwaye	Kerala	,,	6.0	7.6	1.18	15.0	0.83	0.12	3.5	23	5	16
6	Burdwan I	W. Bengal	Sandy loam	4.8	8.3	0.4	9.0	0 50	0.13	1.8	24	10	46
7	Burdwan II	,,	,,	5.2	7.6	0.43	12.0	0.58	0.15	0.9	23	5	44
8	Burdwan III	,,	,,	5.2	4.5	0.58	10.0	0.20	0.60	1.5	8	15	22
9	Bastar I	M. P.	Sandy clay loam	5.0	10.5	0 91	130	1 41	0.14	3.2	19	11	122
10	Bastar II	M. P.	,,	5.3	6.4	0.59	17.0	0.96	0.10	1.6	25	16	50
11	Cuttack	Orissa	Clay loam	5.0	19.8	0.73	24.0	1.03	0.10	6.7	20	8	56
12	Berhampur	,,	,,	6.1	8.8	0.66	24.0	1·18	0.20	6.6	25	9	57
13	Chiplima	,,	,,	6.3	22.6	0.72	19.0	0.78	0.25	3.8	22	15	57
14	Anjuthengu	Kerala	Sandy	5.8	22.6	0 33	6.3	0.45	Trace	0.2	22	20	13
15	Sakhigopal	Orissa	Clay loam	5.4	15.5	1.26	26.0	1.52	0 20	6.8	26	33	104
16	Kendrapara	,,	,,	5.4	13.5	0.60	25.0	1.53	0.10	5.7	33	31	445

Table 2

Coefficients of correlation of available silica with pH and exchangeable cations

No. of days of incubation	Ca	K	pH	Al	Fe	Mn
0	0.6387*	0.7204"	0.3941	−0.4879	0.3585	0.3236
10	0.6376*	0.6551*	0.2293	−0.3294	0.4991	0.4627
20	0.8232*	0.7256*	0.3367	−0.4074	0.6338*	0.4168
30	0.8428*	0.6861*	0.2420	−0.3308	0,5098	0.5383*
50	0.9131*	0.5402*	0.1899	−0.3582	0,5196*	0.4578
70	0.4052	0.6117*	0.4250	−0.3356	0.7065*	0.1728

* Significant at 5% level

laterite and red soils there was a second peak for available silica after thirty days of flooding.

The release of silica was found to keep pace with dynamics of Fe and Mn. The increase in available silica on flooding might be due to dissolution of Fe and Mn silicates either by soil reduction or by increase in partial pressure of CO_2 on submergence. Imaizumi and Yoshida (1958) reported that available silica in rice soils increased by chelation with silicate Fe, Al and Mn which indirectly reduced the concentration of these elements in the soil solution. According to the above authors, silica may exist mainly in the form of amorphous hydrous aluminosilicates. Sometimes iron oxide is also co-precipitated. Under submerged conditions, reduction of ferric iron oxide also increased the solubility of silicates (Ponnampeuma, 1965).

Nair and Aiyer (1968) reported that 0.025 *N* citric acid gave a closer correlation between SiO_2 content of plants and soluble silicates of soils. According to Imaizumi and Yoshida (1958), amorphous silicates of Fe, Mn and A! which are found in submerged soils on flooding dissolve in dilute acids.

Available silica was found positively related to Fe during 20 to 50 days of flooding which coincide with the peak reduction period of Fe in most of the soils (Ponnamperuma, 1965). It was found to be positively related to exchangeable Mn during 2 to 4 weeks, when reduction and solubility of Mn is maximum (Ponnamperuma, 1 965). Available silica was not found to be related with pH at any stage of submergence. The second rise in soluble silicon was observed near about 50th day of submergence. It might be due to weathering of minerals already present or newly formed ones (Uchiyama and Onikura, 1955).

The senior author wishes to express her gratitude to the ICAR for the senior fellowship awarded to her during this research work.

Central Rice Research Institute
Cuttack, Orissa, India

S. Kabeerathumma
P. Padmaja
S. Patnaik

References

Asami, T. and Kumuda, K. 1959. A new method of estimating free iron in paddy soils. *Soil Pl. Food* 5 (3) 141-145

Imaizumi and Yoshida 1958. Edaphological studies in silicon supplying power of paddy fields. *Bull. Inst. Agr/c. Sci. Japan Ser. B.* 8: 261-304.

Nair, P. K. and Aiyer, R. S. 1968. Available silica in the rice soils of Kerala. *Agr/c. Res. J. Kerala* **6** 20-26

Ponnamperuma, F. N. 1965. Dynamic aspects of flooded soils and the nutrition of the rice plant, *The Mineral Nutrition of the Rice Plant.* Johns Hopkins Press, Baltimore, Maryland, 295-328

Uchiyama, N. and Onikara, Y. 1955. Investigation on clay formation in paddy soils. *J. Sci. Soil Manure, Japan* **30:** 393-396.

Woodruff, C. M. 1948. Testing soils for lime requirement by means of buffer solution and the glass electrode. *Soil Sci.* **66:** 53-63

Yosida, S. 1962. Chemical forms, inhibitor and deposition of silicon in rice plants. *Soil Sci. Nutr.* 8 (3): 107-13.