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Effect of Lime, Organic Matter and Fertilizers on the Availability of Various Forms of Iron in Acid Alluvial Soils

By

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ABSTRACT

A laboratory experiment was carried out to study the behaviour of added lime, organic matter and fertilizers on the availability of various forms of iron in two acid alluvial soils. The exchangeable iron as well as dilute acid extractable iron were higher in Kallidaikurchi soil than in Ambasamudram soil. Both forms of iron increased under water-logging with passage of time. Organic matter addition increased the exchangeable iron whereas lime and lime with other treatments influenced the high content of dilute acid extractable iron. A high degree of association was found to exist between pH values and exchangeable iron (r=0.459**).

INTRODUCTION

The study of trace elements, unlike major nutrients, has not received sufficient emphasis and the information available is fragmentary. Over liming or application of excess organic matter has often created nutritional disorders in field crops which could be traced to deficiency of one or more of micronutrient elements. In recent years more and more high analysis fertilizers which are practically devoid of micronutrient are being used in agricultural production in this State. Hence the deficiency of micronutrients in Tamil Nadu soils is expected to develop progressively. In acid soils the availability of trace elements is more and their toxic effects can be avoided by liming. In view of the above mentioned situation the present study was undertaken to investigate the various forms of iron which is influenced by the addition of lime, organic matter and fertilizers.

MATERIALS AND METHODS

Two different acid alluvial soils having pH 4.4 and 4.8 were collected from Ambasamudram and Kallidaikurchi area. The experiment was conducted with two moisture levels viz. field capacity and water logged condition with dosage of 7500 kg of CaO as lime, 1875kg of Kolingi / ha on dry weight basis as organic matter and N, P_2/O_5 and K_2/O at 188, 88 and 88kg/ha in the form of ammonium sulphate, superphosphate and muriate of potash. Two hundred and fifty grams of soils were taken in glass beakers. Calculated amounts of CaO as lime, organic as Kolingi, matter, ammonium sulphate, superphosphate

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to supply and muriate of potash as N, P, and K were added. The treatment combination and the initial analysis of soils are given in the Table No. 1. The soils were incubated under room temperature with moisture levels maintained at field capacity and waterlogged conditions. Each treatment was duplicated. The soil samples were collected by pushing a glass tube down almost to the bottom of the soil column and the soil was withdrawn with a circular motion and the soil was mixed thoroughly. All analyses of samples were made immediately after collection (Mandal, 1961) Soils were analysed at the end of 7th, 18th, 35th and 65th days from the date of incubation. Moisture determination was made for each soil sample at the time of analyis and the results are expressed on oven dry basis.

TABLE 1. Details about treatments and initial analysis of Ambasamudram (ASD) and Kallidaikurchi (KDK) soils

No.	Treatments	Initial analysis of soil	ASD Soil	KDK Soil
1.	Control			
2.	L			
3.	O	1. Mechanical analysis		
4.	F	Coarse sand	43.30	31.84
5.	LO	Fine sand	35.83	33.48
6.	LF	Silt	4.05	12.28
7.	OF	Clay	16.83	22.85
8.	OLF	2. Water holding capacity	25.90	33.03
	L = Lime	3. Chemical constituents		
	O = Organic matter	Iron oxides (F_2O_3)	3.39	3.09
	F = Fertilizers	Calcium (CaO)	0.10	0.30
		Cation exchange capacity (m.e/100 gm of soil)	18.80	12.10
		Organic carbon	0.96	1.45
		pH	4.4	4.8
		Electrical conductivity	0.9	0.45
		4. Iron and its forms		
		Total iron (in percentage)	3.89	3.09
		Exchangeable iron (in ppm)	18.00	24.80
		Exchangeable ferrous and ferric and dilute acid soluble iron (in ppm)	72.00	98.00

For general analysis A. O. A. C. (1962) methods were adopted. Total iron and various forms of iron such as exchangeable ferrous iron and exchangeable ferrous and ferric and dilute acid soluble iron were extracted by employing the method by Jackson (1958) and the iron content in the extract was estimated colorimetrically using Bausch and Lamb Spectronic '20' type spectrophotometer at 490 mμ light maximum. The readings were converted to corresponding concentration of iron from a standard curve. The influence of lime, organic matter and fertilizers on the various forms of iron was statistically analysed and simple correlations were worked out. Regression equations were set up for significant correlations.

RESULTS AND DISCUSSION

(a) Exchangeable iron : Exchangeable iron extracted by neutral ammonium acetate was high in Kallidaikurchi soil whereas Ambasamudram soil recorded a low value despite its high content of original total iron. The exchangeable iron content of the two soils was high under conditions of incubation than in original soil. The high organic matter and clay content of Kallidaikurchi soil might have influenced the high conversion of total iron into exchangeable iron (Table 2). This

TABLE 2. Progressive changes of exchangeable iron (ppm on moisture free basis)

Treatment No.		Field capacity				Water-logged condition			
		Stages of soil sample collection				Stages of soil sample collection			
		7th day	18th day	35th day	65th day	7th day	18th day	35th day	65th day
ASD	1.	1.0	5.2	1.4	110.6	62.1	43.0	4.4	23.9
	2.	1.2	9.2	10.9	61.2	41.2	83.5	5.3	24.9
	3.	1.0	10.2	4.3	60.9	127.3	75.9	4.1	37.1
	4.	0.5	3.3	1.2	53.0	46.8	76.4	2.4	6.8
	5.	0.5	3.5	7.7	38.0	85.8	63.6	4.2	61.9
	6.	0.8	1.3	1.3	52.3	68.8	78.5	2.5	24.7
	7.	0.6	1.2	1.4	29.6	112.1	72.3	1.0	17.1
	8.	1.0	1.1	1.0	35.6	89.1	56.3	9.7	46.5
KDK	1.	1.2	3.1	1.5	22.7	57.8	113.1	2.0	609.3
	2.	0.6	1.4	1.0	34.9	16.2	85.5	20.2	277.5
	3.	1.0	8.8	8.5	8.5	82.6	165.7	1.2	666.4
	4.	0.5	2.0	2.9	14.3	22.5	114.7	5.8	294.0
	5.	0.8	3.0	2.4	40.1	18.4	112.0	13.7	185.0
	6.	0.8	2.3	2.1	61.9	23.7	147.1	11.3	201.2
	7.	0.5	2.5	1.1	38.9	114.6	122.6	16.2	294.6
	8.	0.9	1.3	1.4	31.9	74.8	140.8	18.2	175.9

1. Soils : Mean	ASD soil 31.02		KDK soil 70.7			S. E. 1.04				C. D. (P=0.05) 2.04
2. Treatments : Mean	T_1 66.7	T_2 42.4	T_3 80.0	T_4 41.0	T_5 40.3	T_6 42.4	T_7 51.5	T_8 42.7	S. E. 2.08	C. D. (P=0.05) 4.08
3. Moisture levels Mean	Field capacity 12.90			Waterlogged condition 88.9					S. E. 1.04	C. D. (P=0.05) 2.4
4. Stages Mean	7th 33.1	18th 50.6		35th 55.6	65th 114.4			S. E. 1.47		C. D. (P=0.05) 2.88

supports the findings of Mandal (1961). An increase in exchangeable iron content was noticed in soils treated with organic matter. An increase in pH reduced the availability of exchangeable iron. This is in accordance with the findings of Solenkey (1971). The treatments with lime combinations were on a par with regard to exchangeable iron content. Under waterlogged condition the soil recorded an increase of exchangeable iron nearly sixfold than under field capacity. This level of increase can be attributed due to reduction of ferric iron into ferrous forms. Similar results were obtained by Mandal (1961). Due to mixed application of lime, organic matter and fertilizers, a steep increase of exchangeable iron content was noticed upto 65th day. Under flooded conditions, the increase was marked even on 18th day of incubation. However a high reduction in exchangeable iron on 35th day revealed the importance of divalent calcium ion in making the iron unextractable (Fig 1b). Exchangeable calcium on 35th day was very high and this caused the reduction in exchangeable iron content. This is in consonance with the results of Solenkey (1971), Between the two soils studied, the exchangeable iron content was always high in Kallidaikurchi soil under different moisture levels, treatments and stages probably due to the presence of high organic matter and clay content.

(b) Exchangeable ferrous and ferric and dilute acid soluble iron (Table 3) Considering the effect of treatments, dilute acid extractable iron was more in limed soils (Table 3).

FIG. I. PROGRESSIVE CHANGES OF FORMS OF IRON WITH TIME.

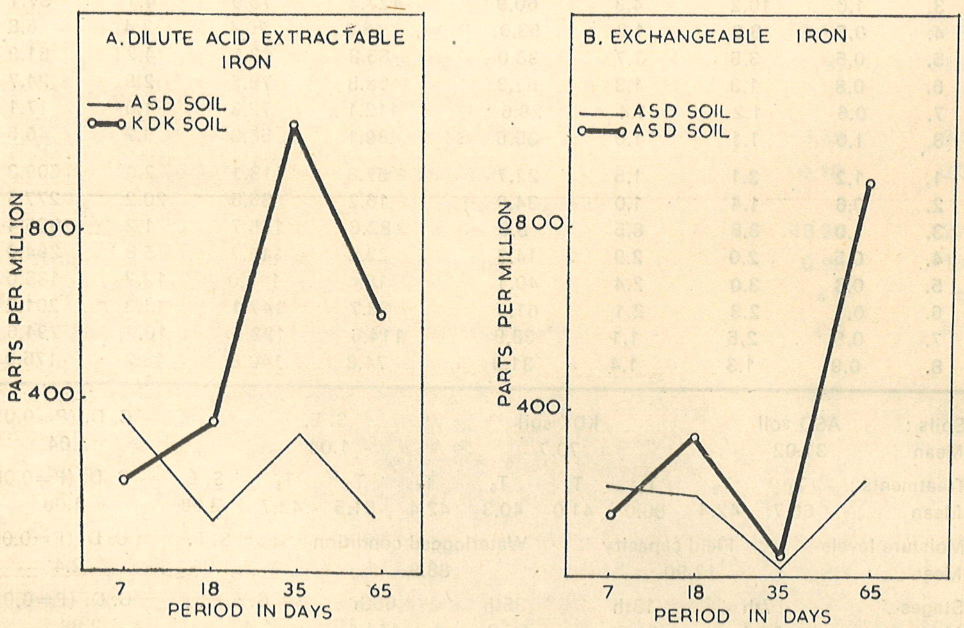

TABLE 3. Exchangeable ferrous and ferric and dilute acid soluble iron (ppm on moisture free basis)

Treatment No.	Field capacity				Waterlogged condition			
	Stages of soil sample collection				Stages of soil sample collection			
	7th day	18th day	35th day	65th day	7th day	18th day	35th day	65th day
ASD soil								
1.	19.6	18.2	178.5	25.0	252.5	146.1	385.0	72.0
2.	15.2	54.1	21.4	7.7	535.5	153.4	662.6	156.2
3.	12.9	38·2	28.3	20.1	807.1	139.2	624.2	100.8
4.	8.5	46.2	100.9	142.7	517.7	172.1	323.1	244.6
5.	16.4	56.4	5.9	14.5	1128.5	315.4	368.8	119.6
6.	2.4	50.6	14.2	33.4	906.6	288.0	1201.1	328.1
7.	10.7	61.6	27.5	78.5	542.3	193.9	373.9	105.5
8.	7.0	102.3	31.2	129.6	1137.3	136.0	667.0	398.7
KDK soil								
1.	16.4	54.3	37.2	24.9	217.0	175.0	1341.9	901.0
2.	22.4	42.6	57.1	14.0	623.6	516.2	2260.0	1136.5
3.	6.1	54.7	34.7	10.1	287.5	446.8	2043.0	1336.3
4.	19.2	60.0	21.0	21.5	609.8	288.8	1346.6	956.8
5.	3.0	34.4	12.3	6.8	511.7	802.1	2493.5	1428.5
6.	7.3	50.6	33.6	32.9	388.4	831.7	2023.7	1207.9
7.	5.0	45.6	50.3	34.4	422.1	449.0	1549.1	1096.1
8.	9.3	78.3	33.1	4.5	213.2	1579.2	3313.3	1231.3

1. Soils	ASD Soil		KDK Soil		S. E.				CD (P=0.05)	
Mean	233.5		546.6		30.98				60.72	
2. Treatments	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	S. E.	C. D. (P=0.05)
	241.8	392.7	374.6	305.5	460.4	462.9	315.3	567.0	62.13	121.77
3. Moisture level	Field capacity		Waterlogged condition		S. E.				C. D. (P=0.05)	
Mean	36.5		743.5		30.98				60.72	
4. Stages	7th	18th	35th	65th	S. E.				C. D. (P=0.05)	
Mean	291.6	234.0	671.1	357.4	43.96				86.16	

This is in accordance with the results of Motomura (1962). A notable feature is that both exchangeable and dilute acid soluble iron behaved similarly under waterlogged condition. There was a maximum increase of dilute acid extractable iron with time and it attained a steady level on 65th day in both soils. This is in accordance with the report Ponnamperuma (1967). This is explained on the assumption that high extraction may be due to the reduction of ferric iron into ferrous iron and poor content of exchangeable iron at 35th day. It showed an equilibrium between the forms of iron the soils.

A peculiar observation made here was a steady rise in dilute acid extractable iron in Kallidaikurchi soil upto 35th day followed by a decrease; but in Ambasamudram soil there was a sudden decline in iron content in 18th day and a rise on 35th day and thereafter a decrease was noted (Fig 1 a). Steady increase in Kallidaikurchi soil was due to the presence of organic matter, clay and high water holding capacity which made the iron more soluble. This is in accordance with the reports of Mandal (1961) and Motomura (1962), whereas due to low clay and organic matter content in Ambasamudram soil, there was a decrease in the iron reduction. A similar result was obtained by Takker (1969)

(c) Relationships: A high degree of association was found to exist between pH values and exchangeable iron (r=0.459**).

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REFERENCES

ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS. Methods of Analysis. 1962.

JACKSON. M. L. 1958. *Soil Chemical analysis*. Constable and Compmany, London.

MANDAL. L. N. 1961. Transformation of iron and manganese in waterlogged rice soils. *Soil Sci.* **91** : 121-26.

MOTOMURA, S. 1962. Effect of organic matter on the formation of ferrous iron in soil *Soil Sci.* and *plant Nutr.* **8** : 20-29.

PONNAMPERUMA, F. N. 1967. Chemical changes in flooded soils and growth of rice I, II and III. International Rice Research Institute, Los Banos, Philippines.

SOLANKEY, B. S. 1971. Effect of Liming on the availability of plant nutrients in acidic soils. *Mysore J. Agri. Sci.* **5** : 145-47.

TAKKER, P. N. 1969. Effect of organic matter on soil manganese and iron. *Soil Sci.* **108** : 108-12.