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

By

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ABSTRACT

An incubation study was carried out to study the influence of added lime, organic matter and fertilizers on the availability of various forms of manganese in two acid alluvial soils. Various forms of manganese like water soluble, exchangeable and easily reducible manganese were higher in Kallidaikurchi soil than in Ambasamudram soil. Addition of fertilizers with passage of time under water logged condition increased the water soluble manganese whereas addition of organic matter increased the higher content of exchangeable manganese in the above conditions. Fertilizers together with lime and organic matter increased the easily reducible manganese. Field capacity increased the easily reducible manganese with lime than under water logged condition. A high degree of relationship was observed between water soluble manganese with exchangeable as well as reducible manganese under field capacity (r=0.489**, 0.451**)

INTRODUCTION

A knowledge of the function of different forms of manganese in soil and the changes that occur under different moisture levels will help for better understanding of the need for this element. In Tamil Nadu the information regarding the distribution of manganese and its forms under the influence of normal application of lime, organic matter and fertilizers is meagre. The present investigation attempts to fill up this lacuna .

MATERIALS AND METHODS

Two acid alluvial soils from Ambasamudram and Kallidaikurchi were collected for an incubation study involving two moisture levels *viz.* field capacity and water logged condition coupled with a dosage of 7500 kg of CaO as lime, 1875 kg Kolingi/ha on dry weight basis, N, P_2O_5 and K_2O at 188, 88 and 88 kg/ha in the form of ammonium sulphate, super-phosphate and muriate of potash were added to study the progressive variation of water soluble, exchangeable and easily reducible manganese for a period of sixty five days. The soil samples were collected by pushing a glass tube down almost to the bottom of the soil column. All analyses of samples were made immediately after collection (Mandal, 1961) and 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 analysis and the results are expressed on oven dry basis.

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For general analysis A. O. A. C. (1962) methods were adopted. Various forms of manganese *viz.*, total, water soluble, exchangeable and easily reducible manganese were extracted by employing the method of Jackson (1958) by suitably modifying the estimation procedure for the water logged soil samples. Manganese content in the extracts were estimated colorimetrically using 'Spectronic-20' type spectrophotometer at 540 mμ light maximum. The readings were converted to corresponding concentration of manganese from a standard curve. Treatment combination and initial analysis of soils are given in the Table 1. The data were statistically analysed.

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

No.	Treatments	Initial analysis of soils	ASD soil	KDK soil
T_1	Control	1. Mechanical analysis (Percentage on moisture free basis)		
T_2	L	Coarse sand	43.30	31.84
T_3	O	Fine sand	35.83	33.48
T_4	F	Silt	4.05	12.28
T_5	LO	Clay	16.83	22.85
T_6	LF	2. Water holding capacity	25.90	33.03
T_7	OF	3. Chemical constituents (Percentage on moisture free basis)		
T_8	OLF	Iron oxides (F_2O_3)	3.39	3.09
L — Lime		Ca'cium (CaO)	0.10	0.30
O — Organic matter		(tion exchange capacity e/100 gram of soil	18.80	12.10
F — Fertilizers		Organic carbon	0.96	1.45
		pH	4.4	4.8
		Electrical conductivity	0.9	0.45
		4. Manganese and its form (ppm, on moisture free basis)		
		Total manganese	680.00	810.00
		Water soluble manganese	2.50	3.50
		Exchangeable manganese	15.50	20.80
		Easily reducible manganese	25.50	42.00

RESULTS AND DISCUSSION

(a) Water soluble manganese: Table 2 shows there was no appreciable difference between the two soils as regards to water soluble manganese. Addition of fertilizer increased it to a high level. The low pH may be the reason for high amount of water

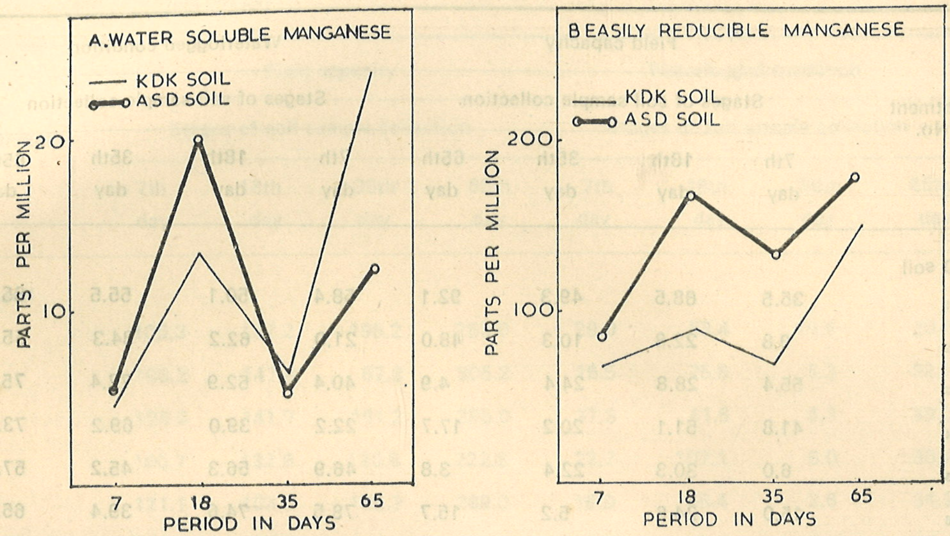
TABLE 2. Progressive changes of water soluble manganese (ppm on moisture free basis)

Treatment number		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	T_1	5.1	37.6	13.9	17.6	7.5	3.6	5.4	20.1
	T_2	2.3	28.1	2.9	7.7	5.2	4.0	6.5	6.4
	T_3	6.1	33.4	4.0	13.3	7.5	8.0	3.1	9.0
	T_4	5.9	33.2	6.5	13.7	7.8	4.2	5.0	12.8
	T_5	2.6	31.1	2.7	6.3	3.0	3.9	2.7	20.9
	T_6	3.0	30.5	2.6	8.7	12.3	3.3	2.6	7.7
	T_7	2.8	35.9	6.0	11.8	8.1	8.7	13.8	19.5
	T_8	2.3	46.6	4.9	9.8	2.5	3.3	4.6	10.0
KDK	T_1	5.3	6.4	4.7	6.1	10.5	3.0	3.0	26.3
	T_2	2.2	17.4	6.8	5.4	4.7	8.0	3.5	23.5
	T_3	2.0	31.4	5.7	7.1	5.7	3.4	6.3	34.5
	T_4	0.7	36.1	11.1	9.5	7.1	4.5	12.7	76.2
	T_5	1.1	20.8	12.9	14.5	7.4	7.2	6.7	55.0
	T_6	3.1	17.4	5.8	6.3	12.3	3.2	3.6	47.6
	T_7	2.3	17.7	5.9	8.4	6.4	3.9	4.3	29.3
	T_8	2.2	25.4	3.4	7.5	3.3	5.7	2.5	20.3

1. Soils	ASD soil		KDK soil				S. E.	C. D. (P=0.05)	
Mean	10.7		12.0				0.71	1.39	
2. Treatments	T1	T2	T3	T4	T5	T6	T7	T8	S. E.	C. D. (P=0.05)
Mean	11.0	8.4	11.3	15.4	12.4	10.6	11.5	10.0	1.45	2.84
3. Stages	7th day	18th day	35th day	65th day	S. E.	C. D. (P=0.5)				
Mean	5.0	16.5	5.9	18.1	1.01	1.97				

soluble manganese in that treatment. This is in accordance with the reports of Cheng and Ovello Hae (1970) and Bhardwaj and Shukla (1970). The increase in water soluble manganese content after 35th day (Fig 1 a) might be due to the decomposition of organic matter and period of waterlogging. Waterlogged condition increased the water soluble manganese two fold when compared to field capacity. This is in accordance with the findings of Anjanayalu (1964) and Sherma and Shinde (1968). High content of water soluble manganese in Kallidaikurchi soil was due to high content of total manganese, organic matter and waterlogged condition of the soil.

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



(b) Exchangeable Manganese: Organic matter addition increased the exchangeable manganese slightly (Table 3). A probable explanation may be that manganese is easily reduced under submerged conditions; consequently additional organic matter was not necessary for manganese reduction to proceed immediately after submergence. The above assumption is based on the findings of Redmann and Patrick (1963). The waterlogged condition favourably influenced the content of exchangeable manganese. This is in accordance with the results of Aomine (1962). The increase in exchangeable manganese was continuous with the passage of time and is in accordance with the findings of Ponnamperuma (1967).

(c) Easily Reducible Manganese: The easily reducible manganese was low in limed soils which may be due to high pH (Table 4). This is in close accordance with the results of Baser and Sexena (1970). Field capacity increased the easily reducible manganese nearly three times over water logged condition. This is due to low percentage of moisture coupled with aerobic condition. This is in close agreement with reports of Kosegarten (1957). Easily reducible manganese declined considerably under waterlogged condition due to anerobic condition. The content of easily reducible manganese was high on 65th day (Fig 1b). This can be attributed to lower oxidising power of various oxides with increase in pH as stated by Mulder and Gerretsen (1952).

Relationships: Simple correlations were worked out among various forms of manganese. Relationships were also worked out separately for field capacity and waterlogged condition.

TABLE 3. Progressive changes of exchangeable manganese (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								
T_1	35.5	68.5	49.3	92.1	58.4	50.1	55.5	85.1
T_2	9.8	22.8	10.3	48.0	21.0	62.2	84.3	55.6
T_3	55.4	28.8	24.4	4.9	40.4	52.9	72.4	75.6
T_4	41.8	51.1	20.2	17.7	22.2	39.0	69.2	73.4
T_5	6.0	30.3	22.4	3.8	46.9	56.3	45.2	57.7
T_6	15.0	24.6	5.2	15.7	78.5	74.6	39.4	65.2
T_7	34.1	53.5	24.6	41.0	56.6	42.7	63.8	62.0
T_8	10.6	34.0	17.6	10.0	66.0	34.2	50.5	66.7
KDK soil								
T_1	110.5	61.9	23.1	121.9	270.8	337.3	267.8	168.2
T_2	12.4	30.1	15.7	33.0	166.6	328.1	236.1	225.8
T_3	61.8	50.3	31.5	32.3	219.6	565.0	326.2	309.6
T_4	43.8	55.1	22.7	35.0	279.2	357.3	287.5	218.3
T_5	5.2	35.4	4.8	23.3	178.6	419.2	282.8	202.0
T_6	7.8	32.0	12.5	16.0	200.0	433.1	321.1	219.4
T_7	44.2	37.9	47.7	24.4	182.5	428.0	318.9	212.5
T_8	21.2	64.3	7.2	38.8	169.3	528.5	292.6	249.2

1. Soils	ASD soil	KDK soil	S. E.	C. D. (P=0.05)
Mean	43.4	162.0	3.48	6.81

2. Treatments	T1	T2	T3	T4	T5	T6	T7	T8	S. E.	C. D. (P=0.05)
Mean	116.4	85.8	122.4	102.4	88.8	97.5	104.8	103.7	6.95	13.92

3. Moisture level	Field capacity	Waterlogged condition	S. E.	C. D. (P=0.05)
Mean	33.0	172.4	3.48	6.81

4. Stages	7th day	18th day	35th day	65th day	S.E.	C. D. (P=0.05)
Mean	80.5	140.7	98.7	90.9	4.92	9.64

TABLE 4. Progressive changes of easily reducible manganese (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								
T_1	105.3	157.2	196.2	258.0	29.9	53.4	10.6	20.6
T_2	105.2	147.4	67.9	305.2	16.5	75.8	5.3	32.7
T_3	126.8	141.7	161.2	285.0	37.3	41.6	6.3	39.2
T_4	100.7	132.9	120.8	222.8	22.7	107.1	5.0	88.4
T_5	121.1	103.0	155.3	289.0	16.9	68.4	2.6	34.2
T_6	123.8	105.6	134.6	276.1	15.9	31.0	6.4	65.4
T_7	122.6	117.1	104.5	145.0	20.8	28.8	2.3	26.8
T_8	135.1	129.7	140.5	298.0	36.1	85.7	15.7	48.7
KDK soil								
T_1	143.5	238.0	202.4	313.7	82.5	103.8	53.1	156.6
T_2	35.9	135.0	121.7	180.2	35.4	44.5	76.6	85.8
T_3	86.9	228.0	230.4	270.7	59.9	233.0	85.2	108.5
T_4	66.2	189.6	155.1	184.7	87.1	237.7	62.3	128.2
T_5	134.8	220.9	217.0	221.8	54.4	98.0	85.3	150.3
T_6	143.5	188.1	204.2	206.6	83.9	78.2	38.5	80.3
T_7	108.0	200.5	161.5	189.7	28.4	127.7	93.8	117.2
T_8	129.1	200.3	235.6	389.5	53.8	115.3	86.9	96.0

1. Soils	ASD soil		KDK soil			S. E.			C. D. (P=0.05)	
Mean	74.7		139.7			3.45			6.77	
2. Treatments	T1	T2	T3	T4	T5	T6	T7	T8	S. E.	C. D. (P=0.05)
Mean	132.9	92.4	133.8	119.4	120.8	112.2	100.0	137.2	6.91	13.54
3. Stages	7th day	18th day	35th day	65th day	S. E.	C. D. (P=0.05)				
Mean	77.50	130.5	101.9	164.8	4.89	9.58				
4. Moisture level	Field capacity	Waterlogged condition	S. E.	C. D. (P=0.05)						
Mean	173.0	64.2	3.45	6.77						

A high degree of relationship between the values was recorded for water soluble manganese with exchangeable manganese as well as easily reducible manganese under field capacity (r = 0.486**, r = 0.451 **). Under water logged condition, exchangeable manganese showed a high degree of correlation with easily reducible manganese (r=0.702**).

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