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Correcting zinc deficiency and manganese toxicity in rice soils by water management Techniques.

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Five acid rice soil types of Kerala marginally deficient in zinc (all the five) and high in manganese (only 3 types) were subjected to a study on the effect of dewatering and drying the soils to simulate field conditions and operations. Drying enhanced the available zinc status in all the soils, the level being much greater than the original status The change was only marginal and non-significant in respect of available manganese. The results indicate that simple water management techniques like dewatering and aerating the soil at tillering phase corresponding to 20-30 days after planting, take care of the zinc nutrition of the rice crop for a soil marginally deficient in zinc thus obviating the need of application of costly zinc sulphate.

With the advent of modern cultivation practices, continuous use of inorganic fertilizers with inadequate levels of organic manures have aggravated the problem of micronutrient deficiency particularly of zinc (Katyal 1972, I.R.R.I. 1973, Katyal and Ponnamperuma, 1974.)

Several workers have demonstrated the occurrence of high and toxic concentration of Mn (II) compounds in certain submerged soils. (Ponnamperuma *et al.*, 1969, and Ponnamperuma, 1977). Further drying a soil previously under submergence has resulted in alleviation of zinc deficiency (I R R I 1970). The possibilities of integrating submergence and drying operations with different stages of crop growth in different acid soil types in offering a cheap agronomic method requires detailed investigation. This has been attempted.

MATERIAL AND METHODS

Five rice soils were selected for the study namely *Kari** (Entisol), *Karapadom** (Entisol) *Kayal** (Entisol), Lateritic alluvium (Oxisol) and sandy alluvium (Entisol). The soils varied widely in physical and chemical characteristics and also in the available zinc and manganese status (Table 1).

Hundred grams of soil samples were placed in 500 ml plastic wide mouthed bottles and flooded with about 250 ml double distilled water to obtain a soil water ratio of 1 : 2.5 (to provide a standing watercolumn of 5 cm over the surface of the soil). Five replications were provided for each soil for averaging out the errors. Redox potential and pH were monitored at 10 days interval starting from the date of commencement of the experiment using a pH-cum-Redox meter fitted with a compound platinum and calomel electrode.

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Samples were drawn from the incubated system at 10 days interval by using a clean glass tube after recording the Eh and pH and was extracted for zinc and manganese using 0.1 N HCl.

On the 30th day of incubation the soils were placed in the sun and dried till the soil was just moist and there was no more standing water (sun drying was adopted in order that zinc and manganese in the soil-water system may not be lost from the total system). The soils were immediately resubmerged and Eh and pH was observed before taking samples for analysis. The observations and sampling were continued thrice at 10 days interval after resubmergence. The 30th day of incubation corresponds to the active tillering phase of the paddy crop when the demand for zinc becomes maximum. The observational data on pH, Eh and change in manganese and zinc concentrations are summarised in Table 2.

RESULTS AND DISCUSSION

The results on dewatering coupled with drying on the release pattern of available zinc and manganese in the five different soils under study in relation to Eh, pH changes, original status of available manganese and zinc are presented in table 2.

The results obtained showed that as a result of continuous submergence there is a marked decrease in the 'Eh' values of the soils. The decrease being more marked in the lateritic alluvium in the midland region and in the Karapadom of Kuttanad. The 30th day from transplantation usually corresponds to the active tillering phase of medium duration transplanted rice crop. Draining the field and moderately drying the soil at this stage is known to induce better tillering and synchronizes with the frist top dressing of nitrogen. At this stage the effect of dewatering and drying markedly increase the 'Eh' slightly decreases the pH and was found to increase significantly the available zinc status in all the soils studied to a much greater extent than the original status. Taking the soil from an anaerobic situation to a semiaerobic situation thus results in an increase of 200-300 per cent of the available zinc status. Uptake studies on zinc by the rice crop carried out at I.R.R.I. indicate that the peak period of zinc utilization more or less corresponds to the active tillering phase of the crop (I R R I 1970).

The results of the present study thus suggests that simple water management techniques and strict adherence to conventional practice of dewatering and aerating the soil at tillering phase takes care of the zinc nutrition of the rice crop for a soil marginally deficient in available zinc but well supplied with total zinc (Table 1).

With regard to manganese however, though drying produces a slight decrease in the available managense status, the decrease is not as marked as the observed increase with respect to zinc. Though reports are also available (Zende 1954) to show that drying brings about an increase in available manganese by auto-reduction (non-biological) such mechanisms are not probably operating in the highly acid soil situations of the State.

*Karapadom - Riverine alluvium of the Kuttanad.

*Kari - Peaty soils found in Kuttanad but not histosolic.

*Kayal Reclaimed late-bed soils of Kuttanad region.

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Table .1. Physico-chemical properties of the soils used for the study

	Karapadom	Kari	Kayal	Lateritic alluvium	Sandy alluvium
Clay %	38.1	62.7	23.0	29.6	5.8
pH	4.2	4.3	4.8	4.5	5.4
E. C. (millimlos/cm.)	0.640	3.490	1.007	1.140	0 053
Organic matter %	5.605	15.910	3.860	1.920	0.727
C. E. C. (me./100 g)	26.47	36.90	21.60	8.730	4.200
*Available Mn (ppm)	35	12	51	6	1
*Available Zn (ppm)	4	6	4	3	2
Total Mn (ppm)	160	140	319	115	790
Total Zn (ppm)	120	140	135	540	90

*0.1 N H C l extractable.

Table 2. Effect of drying in relation to Mn and Zn availability

Days	Karapadam	Lateritic alluvium	Sandy alluvium	Kayal	Kari
		1. Eh (millivelts)			
0 B. D.	601.5	590.0	541.5	531.5	561.5
10th day B. D.	293.5	239.0	251.5	149.5	246.5
20th day B. D.	216.5	99.0	120.0	151.0	220.0
30th day B. D.	96.0	86.0	116.0	143.0	221.5
35th day A. D.	513.0	498.0	501.0	510.0	540.0
45th day A. D.	401.0	196.0	210.0	310.0	369.5
		2. pH.			
0 B. D.	4.9	4.5	5.0	4.9	3.9
10th day B. D.	5.5	5.6	5.9	5.4	4.3
20th day B. D.	5.8	5.9	6.2	5.5	4.6
30th day B. D.	5.9	5.4	6.2	5.7	4.9
35th day A. D.	4.5	4.9	5.6	5.1	3.3
45th day A. D.	4.9	5.1	5.9	5.4	4.3
		3. Available Zn (ppm)*			
0 B. D.	4	3	2	4	6
10th day B. D.	12	4	2	6	4
20th day B. D.	4	2	2	3	5
30th day B. D.	3	2	1	2	4
35th day A. D.	14	8	6	9	11
45th day A. D.	12	10	5	9	9
		4. Available Mn (ppm)*			
0 B. D.	35	6	1	51	12
10th day A. D.	96	29	1	96	19
20th day A. D.	110	34	1	108	48
30th day B. D.	115	39	1	96	64
35th day A. D.	94	29	1	91	29
45th day A. D.	110	40	1	98	30

B. D. Before drying A. D. After drying

*0.1 N HCl extractable.