Agri. Res J. Kerala, 1975 *13 (1) 15—19*

AVAILBALE ZINC, COPPER, IRON AND MANGANESE STATUS OF THE ACID RICE SOILS OF KUTTANAD, KERALA STATE

R. S. AIYER, C. K. RAJAGOPAL and N. S. MONEY

College of Agriculture, Vellayani, Kerala

Since the introduction of the high yielding varieties of rice, instances of micronutrient deficiencies especially with respect to zinc and copper and response to their application has been observed in the extensive rice growing tract of the State, namely Kuttanad. This investigation was conducted to assess the available micronutrient status of the three major soil types of the region viz , Kari (Peat), Kayal (reclaimed lake-bed) and Karapadom (river borne alluvium) soils in order to take up detailed response studies and demarcate areas of deficiency.

Materials and methods

Surface soil samples 0-20 cm. were collected from 14 locations in the Kayal areas, 8 locations in Kari areas and 7 locations in Karapadom areas, after harvesting of the rice crop in the months of March and April and before letting in of saline water from the adjoining Vembanad lake. The soil samples were air dried, passed through a 2 mm sieve (plastic) and the micronutrient cations zinc, copper, iron and manganese determined in the Atomic Absorption Spectrophotometer (Varian Techtron AA 120). Available zinc was determined by extracting the soil with neutral N ammonium acetate mixed with 0.01 % dithizone in CCl_4 with soil : solution ratio of 1:10 and shaking period of 1 hr. The extracted zinc was then converted into the hydrochloric acid phase and the extent of absorption measured using the resonance line 2139 A.

Available copper was extracted with neutral N ammonium acetate for one hour maintaining a soil : solution ratio of 1:2 and the copper in the extract deter. mined using the resonance line 3247 A, Available iron was extracted with N ammonium acetate, pH 4.8, for 30 minutes maintaining a soil :solution ratio of 1:4 and iron in the extract determined using the resonance line 2483 A. Exchangeable manganese was extracted with neutral N ammonium acetate for 10 hours maintaining a soil:solution ratio of 1:25 and manganese in the extract determined using the resonance line 2483 A. The following critical limits were fixed for the micronutrient cations viz., zn- 0.5 ppm; Cu -0 5 ppm; Fe -2 ppm; exchangeable Mn-- 3.0 ppm.

Results and discussion

The micronutrient status of the three different types of acid rice soils of Kuttanad viz., Kari, Kayal and Karapadom are presented in Table 1.

Table 1

Available Zn, Cu, Fe and Exchangeable Mn status of Kuttanad Soils

No.	Description and location	Zn	Cu	Fe	Mn
			(in parts per million)		
	Kayal soils				
I.	A Block uttanad	2.6	0.04	20.0	12.0
	Marthandom Block	1.0	0.04	2.0	33.0
	R Block	3.0	0.04	1.8	20.0
4.	Block	1.8	0.04	3.2	25.0
	Marthandom Block	5.5	0.04	2.0	25.0
6.	Martha Block	1.8	0.04	15.0	15.0
	Chithira Kayal	0.2	0.12	4.0	19.0
8.	Chithi Kayal	0.2	0.12	[illegible]	5.0
9,	14000 Kayal ld)	Nil	0.62	52.0	[illegible]
JO.	24000 Kayal New)	0.2	0.16	160.0	12.0
11.	Rani Kayal,		0.16	[illegible]	7.0
12.	Rani G Block	Nil	0,20	12.0	[illegible] 5
	R Block, V Sub Block	1.0	0.26	6.0	10.0
	Chithira Kayal Sub Block I	0.3	[illegible]	6.0	10.0
	Kari soils				
15.	Naduthuruthi Padashekaram, Kaduthuruthi	2.4	0.20	650.0	10.0
16.	Alamkari, Kaduthuruthi	4.0	0.30	[illegible]	16.0
	Kolathara Padasekharam, Vaikom	2.0	0.52	196.0	11.0
18.	Thevalakkadu, Vaikom	0.2	0.56	64.4	7.0
19.	Marappally, Vaikom	1 0	0.26	206.0	20.0
20.	Mundar, V Block, Vaikom	1.0	0.26	420.0	110.0
21.	Mundar, II Block, Kallara	1.5	0.16	260.0	75.0
22.	Mundar X Block, Kallara	2.0	0.26	880.0	80.0
	Karapadom soils				
23.	Monkomo Kuttanad	10.5	0.22	110.0	14.0
	Veliyanad, Kuttanad	1.0	0.30	74.0	10.0
25.	elamperoor, West Kuttanad	[illegible]	0.26	74.0	10.0
	elamperoor East Kuttanad	2.2	0.22	36.0	2.0
	Vettikari Padom, Pun	10.5	[illegible]	156.0	18.0
	Math: Padom, Neumdu	2.0	0.20	82.0	6.0
29.	Mathu Vadakke Padom, Nedumudi	2.5	0.26	212.0	25.0

It may be seen from the results that 7 out of 14 Kayal soils have available zinc status well below the critical limit. These represent an extensive area of about 8000 hectares in Kuttanad, where the soils are submerged for the greater part of the year with salt water except during the cropping period between November - December to February - March when the soil is again submerged but with salt water. Out of 8 locations in Kari soils and 7 locations in Karapadom only in one location each, the available zinc status was below critical level. These results thus show that the Kayal soils with a pH range between 5.1 and 6.6 and heavily infested with molluscan lime shells and having a Mg status higher than the other two soil types are, in general, low in available zinc status. It is known that continuous water-logging decreases the concentration of zinc in the soil solution, and this decrease is greater in neutral and calcareous soils. Presence of high amounts of magnesium is also known to be associated with zinc deficiency though significant correlations could not be obtained, in the present study, with the exchangeable Ca + Mg stuatus of the soils. Further. high amounts of phosphatic fertiliser applications are also known to cause dificiency of zinc to rice crop grown in soils with marginal values for availabld zinc. (Prabha, 1971) and in Kuttanad area high rates of application of phosphatic fertilisers are not uncommon. High amounts of soluble phosphatic fertilisers render zinc unavailable These results suggest that the rice croo in the Kayal soils of Kuttanad are likely to respond to applications of zinc by foliar or seedling dipping method or to the soil.

Out of the 29 samples of soils studied only 3 samples (8,17 and 18) have available copper status above the critical limit of 0 5 ppm. Even these three soils have an available copper status only marginally above the critical limit. Thus in general, all the three major soil types in Kuttanad are deficient in available copper. Further work is necessary on the response of high yielding varieties to application of copper in these soils.

On a comparative basis the Kayal soils have a significantly lower amount of available iron compared to the Kari and Karapadom soils, while no pattern is discernible in the exchangeable manganese status. Out of 29 samples studied only one sample had an exchangeable manganese status below the critical limit.

Table 2 presents the ranges in some of the important soil properties studied for the three types of soils Table 3 presents the correlation between available zinc, copper, iron and exchangeable manganese with the soil properties studied.

Available zinc is not found to be significantly correlated with any of the properties studied. However. copper is significantly correlated to organic carbon and CEC. The positive relation with organic carbon suggests that the organic matter in these soils do not fix copper as has been observed in the Nilgiri soils by Rajagopalan *et al* (1974). Similar positive correlations have been reported by

Table 2

Important soil chemical characteristics

Soil type	pH	organic carbon	CEC me./100g	Exch. Ca + Mg me./100g	Clay
Kayal soils (14 samples)	5.1-6.6	1.14-3.04	10.37-27.06	4.90-13.65	8.0-55.5
Kari soils (8 samples)	4.3-4.5	9.86-10.88	39.88-44.66	3.92- 4.31	54.0-58.0
Karapadom soils) (7 samples)	2.9-5.0	1.33-4.09	16.20-27.62	4.90- 8.84	1).0-39.0

Table 3

Correlations between available Zn, Cu, Fe and exchangeable Mn and soil properties.

	Organic carbon	CEC	Exch.Ca + Mg	PH	Clay
Zinc	0.013	- 0.215	0.099	- 0.014	0.001
Copper	I 0.482*	0.400*	0.203	~ 0.265	0.040
Iron	+ 0.689*	0.566*	0.408*	0.425*	0.270
Manganese	0.205	0.523*	~ 0.338	0.30!	0.349*

Rai and Mishra (1967) and Badhe *et al* (1971). The available iron status is significantly and positively correlated with organic carbon and CEC and negatively correlated with pH and exchangeable Ca+Mg. Problems of iron toxicity are often encountered in Kuttanad, as has been reported by Subramoney and Balakrishna Kurup (1961) and the present results suggest that it is likely to be more serious in the Kari and Karapadom soils than in the Kayal soils. Exchangeable manganese was found to be significantly and positively correlated with CEC and clay content.

Summary

Determination of available zinc, copper, iron and exchangeable manganese in the Kari, Karapadom and Kayal soils of Kuttanad region, Kerala State, revealed that all the three soil types are highly deficient in available copper (90%). Available zinc was deficient in 50% of the Kayal soils studied. High amounts of available iron in the Kari soils suggest the possibility of iron toxicity to rice in these soils. Significant and positive correlations existed between available copper on the one hand and organic carbon (r= + 0.400) and CEC (r= + 0.566! on the other. Available iron was significantly and positively correlated with organic carbon (r= + 0 689) and CEC (r= + 0.566) and significantly and negatively correlated with pi! (r= - 0.425) and exchangeable Ca + Mg (r= - 0.408). The results warrant application of copper in all the three types of Kuttanad soils and of zinc in the Kayal soils.

ttX)o(C£)rxOo

പ്രധാന സൂക്ഷ്മ മൂലകങ്ങളായ സിങ്ക്, കോപ്പർ, അയേൺ, മാംഗനീസ് എന്നിവയുടെ ലഭ്യത കേരളത്തിലെ കുട്ടനാടൻ പ്രദേശങ്ങളിലുള്ള കരി, കരപ്പാടം, കായൽ നിലങ്ങളിലെ മണ്ണിൽ നടത്തിയ വിശകലപഠനത്തിൽ നിന്നും കോപ്പർ 90 % നിലങ്ങളിലും സിങ്ക് 50 % കായൽ നിലങ്ങളിലും സസ്യാവശ്യങ്ങൾക്ക മതിയായ തോതിലല്ല അടങ്ങിയിരിക്കുന്നതെന്ന് വ്യക്തമാകുകയുണ്ടായി. ഇതിനുപുറമേ കരിനിലങ്ങളിൽ കാണപ്പെട്ട അധികരിച്ചതോതിലുള്ള അയേൺ ഈ നിലങ്ങളിൽ ഇത് മൂലമുണ്ടാകുന്ന നെൽച്ചെടികളിലെ "ഇരുമ്പുദോഷ"ത്തിന്റെ (iron toxicity) സാദ്ധ്യതയെ വെളിപ്പെടുത്തുന്നു.

REFERENCES

Prabha, R. 1971. Studies on the effect of zinc on rice (var. 1R-8) as influenced by levels of phosphorus in Vellayani Kayal soils. M. Sc. (Ag) thesis submitted to the Kerala University.

Rajagopala, C K., Moosa Sheriff. M.. Selvakumari. G., Madappan, K and Devarajan, R. 1974. Relation between organic carbon and available micro-nutrients in the soils of Nilgiris. *J. Indian Soc Soil Sci.* 22, 347-351

Rai, **M. M. and** Mishra. M. K. 1967. Available copper in Madya Pradesh soils., J. *Indian Soc. Soil Sci.*, IS, 49-51

Badhe, N, N., Naphade, K. T. and Ballai, D. K, 1971. Slalus of available copper and manganese of soils from Bhandra District in Maharashtra. *J. Indian Soc. Soil Sci.*, 19, 175-178

Subramoney, N. and Balakrishna Kurup, T. K. 1961' Investigations on the phenomenon of scum formation in paddy fields in Kerala State. *J. Indian Soc. Soil Sci.,* 9, 253-255

(M. S. *received 18-8-1975*)