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Studies on the Distribution and Availability of Micronutrients in Maharashtra Soils - 2. Zinc

BY

A. R. MOHAPATRA[1] and M. M. KIBE[2]

ABSTRACT

Samples from major soil groups of the Maharashtra State were analysed for neutral normal ammonium acetate and perchloric acid soluble forms of Zn and their relationship with various soil factors and rainfall were examined. Soils containing less than 1 ppm of exchangeable Zn was considered as deficient. On the basis of this standard, most of the soils from zones 3, 4 and 5 A of Central and zone 6 of Eastern Maharashtra are either critical or deficient in Zn. Rainfall, organic carbon, silt plus clay and $CaCO_3$ did not significantly affect the contents of either exchangeable or the $HClO_4$ soluble fractions of Zn. On the other hand, there was a positive correlation between $HClO_4$ - extractable Zn and HCl soluble P_2O_5. The exchangeable Zn forms a small portion of $HClO_4$-soluble Zn in the soils of the State.

INTRODUCTION

In recent years, zinc deficiency has been reported widely in our crops and soils (Kanwar and Randhawa, 1967; Grewal *et al.*, 1969; Krishna Murthy *et al.*, 1969; Mohapatra and Kibe, 1971 b). The first step towards the solution of this problem may be to examine the existing soil groups of the country for their available zinc status and also to ascertain how the different soil and climatic factors control its availability. Since these informations are not completely available for the soils of Maharashtra State, efforts have been made to investigate the above aspects of the problem.

MATERIALS AND METHODS

A total number of 29 soil samples were collected from 0-30 cm layer representing all the 6 major agroclimatic zones of the Maharashtra State. Conventional methods were employed for the estimations of various physical and chemical constituents. Exchangeable zinc was extracted by neutral *N* NH_4 OAc. This extractant was chosen largely on the basis of our previous experience and others (Mohapatra and Kibe, 1971 a; Bandyopadhya and Adhikari, 1968). Data are also not lacking where this extractant was even found to be superior to dithizone (Prasad and Sinha, 1969).

1. Junior Chemist, Central Plantation Crops Research Institute, Regional Station, Vittal 574243, South Kanara, Karnataka. 2. Retired Professor of Agricultural Chemistry, University of Poona, Maharashtra State.

The perchloric-sulphuric acid soluble Zn was extracted according to the procedure of Jackson (1962) and was colorimetrically estimated by dithizone method (A. O. A. C., 1960). All precautions were taken to avoid metallic contaminations during different stages of sampling and analysis. The annual rainfall used in the present study represents the average of last fifty years data.

RESULTS AND DISCUSSION

The results show that (Table 1) the neutral *N* NH_4 OAc and $HClO_4$ soluble forms of Zn varied from 0.38 to 3.36 ppm and 23.00 to 136.00 ppm respectively. When the distribution of exchangeable Zn was considered on zonal basis, it was found in the following order: zone 2(2.32 ppm)> zone 1A (1.74 ppm) > zone 5B (1.52 ppm) > zone 1B (1.38 ppm) > zone 6A (1.23 ppm) > zone 3 (1.13 ppm) > zone 4 (1.05 ppm) > zone 5A (0.95 ppm). The $HClO_4$ extractable Zn in the soils of different zones are arranged as under:

Zone 2 (122.25 ppm) > zone 1A 91.88 ppm) > zone 1B (87.30 ppm) > zone 3 (84.50 ppm) > zone 4 (76.50 ppm) > zone 5A (73.50 ppm) > zone 6B (55.75 ppm) > zone 6A (43.50 ppm) > zone 5B (35.50 ppm). The soils formed from mixed parent materials such as granite, gneiss and schist contained low amount of $HClO_4$ soluble Zn than those of basaltic origin (Vinogradov, 1959). The exchangeable Zn forms a very small portion of $HClO_4$ soluble fraction ranging from 0.36 to 8.26 per cent.

A number of standards are prescribed for grading the available Zn status of soils (Shaw and Dean, 1952; Tucker and Kurtz, 1955; Brown *et al.*, 1962; Jackson, 1962). When the level of sufficiency is considered as one ppm or above for exchangeable Zn, then most of the soils from zones 3, 4, 5A, 6A and 6B, and few from zones 1B and 5B would come under either deficient or critical categories. This confirms the earlier contentions that black cotton soils of the state are deficient in Zn (Bendale *et al.*, 1951; Ranadive *et al.* 1964).

With the intensification of agricultural programme in these areas aimed at higher yields, there is likelihood of a greater demand for Zn by the crops than before. Thus, unless this element is supplemented along with the major nutrients, there are chances of Zn being a limiting factor in production.

Relationships between rainfall, soil properties and forms of Zn

Out of all the factors considered (Table 2), exchangeable Zn was negatively correlated significantly with soil reaction (Nair and Mehta, 1959; Bandyopadhya and Adhikari, 1968; Sharma and Motiramani, 1969). The decreased availability of Zn with an increase in the soil pH may be due to its conversion from available to unavailable forms (Camp, 1945; Bingham *et al.*, 1964).

There was a significant positive correlation between exchangeable and $HClO_4$ extractable Zn fractions (Nair and Mehta, 1959; Bandyopadhya and Adhikari, 1968). The average annual

TABLE 1. Distribution of zinc fractions, pH and HCl soluble phosphorus in the soils of Maharashat State

Location	District	pH	HCl soluble P_2O_5 (%)	NH_4OAc Zn (ppm)	$HClO_4$ Zn (ppm)	NH_4OAc Zn as % of $HClO_4$ Zn
Zone 1 A : High rainfall, Parent material – laterite						
Shirgaon	Ratnagiri	4.6	0.117	1.80	53.04	3.39
Sawantwadi	,,	4.6	0.075	1.45	100.50	1.44
Radhanagari	Kolhapur	4.9	0.090	1.36	101.50	1.33
Ajra	,,	4.7	0.085	2.36	112.50	2·09
Mean			0.091	1.74	91.88	2 06
Zone 1 B : High rainfall, non-laterite, parent material-basalt						
Khopoli	Kolaba	6.9	0.191	0.38	103.00	0.36
Igatpuri	Nasik	6.4	0.145	2.74	109.50	2.20
Palghar	Thana	7.4	0.176	1.22	61.00	2.00
Dahanu	,,	7.2	0.162	0.90	74.50	1.20
Panvel	Kolaba	7.3	0.132	1.66	88.50	1.87
Mean			0.161	1.38	87.30	1.58
Zone 2: Transition belt, parent material – basalt						
Medha	Satara	6.1	0.108	3.36	136.00	2.47
Paud	Poona	7.2	0.186	1.28	108.50	1.17
Mean			0.147	2.32	122.25	1.82
Zone 3 : Arid to semi-arid tract, parent material – basalt						
Fagane	Dhulia	8.0	0.123	0.84	71.50	1.17
Chas	Ahmednagar	7.8	0.245	0.80	101.50	0.78

Table 1 [Continued]

Indapur	Poona	8.1	0.196	1.84	102.00	1.80
Shelgaon	Sholapur	7.7	0.124	1.04	63.00	1.65
Mean			0.172	1.13	84.50	1.35
Zone 4: Zone of moderate rainfall, parent material – basalt						
Mamurabad	Jalgaon	7.6	0 211	0.75	55.50	1.35
Sundarkhed	Buldhana	6.9	0.121	1.24	80.50	1.54
Latur	Osmanabad	7.3	0.145	0.98	87.50	1.12
Dahitane	Sholapur	7.6	0.137	1.25	82.50	1.51
Mean			0.153	1.05	76.50	1.38
Zone 5 A : Zone of moderately high rainfall, parent material – basalt						
Nagpur	Nagpur	7.5	0.198	0.02	62.00	1.64
Selsura	Wardha	7.5	0.116	0.68	67.50	1.09
Nanded	Nanded	7.5	0.125	1.16	91.00	1.27
Mean			0.146	0.95	73.50	1 30
Zone 5 B : Zone of moderately high rainfall, mixed parent material						
Wadgaon	Chanda	5.9	0.048	1.12	32.00	3.50
Bhiwapur	Nagpur	5.6	0.053	2.15	26.00	3.26
Cadumowashi	Chanda	5.8	0.086	1.30	48.50	2.68
Mean			0.062	1.52	35.50	4.81
Zone 6 A : Zone of high rainfall, mixed parent material, acid in reaction						
Deori	Bhandara	4.4	0.046	1.08	23.00	4.69
Amgaon	,,	4.9	0.075	1.38	64.00	2.15
Mean			0.060	1.23	43.50	3.42

Table 1. [Continued

Zone 6 B : Zone of high rainfall, mixed parent material, neutral in reaction						
Karanju	Bhandara	6.5	0.075	0.96	59.00	1.62
Sonapur	Chanda	7.5	0.094	1.10	52.50	2.09
Mean			0.084	1.03	55.75	1.85

TABLE 2. Coefficients of correlation between rainfall, physico-chemical properties and the zinc fractions in the soils of Maharashtra State

Independent variable	Dependent variable	NH_4 OAc extractable Zn	$HClO_4$ extractable Zn
Average annual rainfall		0.293 NS	0.308 NS
Silt + Clay		—0.069 NS	0.272 NS
$CaCo_3$		—0.224 NS	0.092 NS
HCl soluble P_2O_5		—0.261 NS	0.400 *
HCl soluble CaO		—0.363 NS	—0.061 NS
Organic carbon		0.056 NS	0.051 NS
pH		—0.381 *	0.131 NS
Exchangeable Ca		—0.341 NS	—
CEC		—0.289 NS	0.311 NS
$HClO_4$ extractable Zn		0.385 *	—

* Significant at 5 per cent level of probability

NS — Non-significant

rainfall, finer soil separates, organic carbon and $CaCO_3$ had no consistent relations with neutral N NH_4OAc extractable Zn. Similar results were also obtained by Nair and Mehta (1959), Grewal *et al.* (1969), Sharma and Motiramani (1969), Tripathi *et al.* (1969) and Prasad and Sinha (1969).

The relationship between $HClO_4$ soluble Zn and HCl soluble P_2O_5 was positively significant showing that phosphorus combines with Zn to form relatively insoluble $Zn_3(PO_4)_2$ (Jurinak and Inouye, 1962). The $HClO_4$ extractable Zn had no association with silt plus clay and organic carbon which are usually considered as important factors connected with the availability of Zn. The non-significant relationship of Zn with organic carbon appears to be due to the fast oxidation of organic matter under our climatic conditions. Although a positive correlation was noticed between $HClO_4$ extractable Zn and the contents of silt plus clay, the 'r' value did not reach the level of statistical significance.

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