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DISTRIBUTION OF DTPA-EXTRACTABLE MICRONUTRINENTS IN *INCEPTISOL* OF BALODA BLOCK IN JANJGIR DISTRICT OF CHHATTISGARH

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ABSTRACT

Evaluation of the soil fertility status of *Inceptisol* group of Baloda block of Janjgir-Champa district of Chhattisgarh was carried out during 2009-10. Grid based surface (0-15 cm) soil samples were collected by systematic survey from 87 villages in Baloda block in such that each 10 ha area represented one sampling point and total 1948 soil samples covering all soil types out of this, 1003 samples were identified from *Inceptisol.* These samples were analyzed for pH, EC, organic C and DTPA-extractable Zn, Cu, Fe, Mn. The pH varied from 4.70 to 7.50 with the mean value 5.89, EC ranged from 0.05 to 0.37 with the mean value 0.13 dS/m. The variation in organic C content in soil samples was ranged from 0.23 to 0.83 with the mean value 0.44 %. DTPA-extractable Fe, Mn, Cu and Zn status were recorded as 4.54 to 68.70 (30.18 mg Fe/kg), 3.72 to 59.58 (26.08 mg Mn/kg), 0.2 to 8.78 (2.79 mg Cu/kg) and 0.06 to 3.34 (0.68 mg Zn/kg), respectively. Soil pH showed significant and negative correlations with DTPA-extractable Fe, Mn, Cu and Zn. EC indicated significant and negative correlated with DTPA-extractable Mn, Cu and Zn. Soil organic C showed negative relationship with DTPA-extractable Fe, Mn, Cu and Zn.

Keywords:
DTPA-Extractable Micronutrient, Fertility status, *Inceptisol*

INTRODUCTION

In view of the finite nature of natural resources, their management in a sustained fashion has become an issue of primary concern. Sustainability of the agricultural a production system is the most crucial issue in this part of the green revolution. A system is sustainable when it improves or at least maintains the quality of soil, water and atmosphere. Application of chemical fertilizers has been rated as one of the most important production factor affecting the sustainability. As the world population continues to increase at an alarming rate, the demands placed upon agriculture to supply future food will be one of the greatest challenges facing the human population. Its injudicious uses of chemical fertilizers are the serious threat to sustainable agricultural production system.

Micronutrients are important for maintaining soil health and also increasing productivity of crops (Yadav and Meena, 2009). These are needed in very small amounts. The soil must supply micronutrients for desired growth of plants and synthesis of human food. Increased removal of micronutrients as a consequence of adoption of HYVs and intensive cropping together with shift towards high analysis NPK fertilizers has caused decline in the level of micronutrients in the soil to below normal at which productivity of crops can't be sustained. The deficiencies of micronutrients have become major constraints to productivity, stability and sustainability of soils. Availability of micronutrients is influenced by their distribution in soil and other physico-chemical properties of soil (Sharma and Chaudhary, 2007). However, knowledge about the status of micronutrients and their interrelationship with soil characteristics is helpful in understanding the inherent capacity of soil to supply these nutrients to plants. Besides soil characteristics, land use pattern also plays a vital role in governing the nutrient dynamics and fertility of soils (Venkatesh *et al*., 2003). Due adoption of intensive exhausting cropping system under a particular land use system may influenced physico-chemical properties which may modify DTPA-extractable micronutrients content and their availability to crops. So, analysis of these properties along with micronutrient status of different land use systems may have significant importance.

Soil test-based fertility management is an effective tool for increasing productivity of agricultural soils that have high degree of spatial variability resulting from the combined effects of physical, chemical or biological processes (Goovaerts, 1998). However, major constraints impede wide scale adoption of soil testing in most developing countries. In India, these include the prevalence of small holding systems of farming as

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well as lack of infrastructural facilities for extensive soil testing (Sen *et al.*, 2008). Soil testing provides information regarding nutrient availability in soils which forms the basis for the fertilizer recommendations for maximizing crop yields. Soil testing program is beneficial to formulated specific fertilizer recommendations. Keeping in view of above facets, the present investigation was undertaken to assess the status of soil properties and micronutrient in *Inceptisol* group of Baloda block of Janjgir-Champa district.

MATERIALS AND METHODS

Baloda is a town and a Nager Panchayat in Janjgir-Champa district in state of Chhattisgarh, India. It is located 22.15° North latitude, 82.48° East longitude with an altitude of 280 m above the mean sea level. Different group of the soils covered *viz*. *Inceptisol*, *Alfisol* and *Vertisol* under the Baloda bloack. The *Inceptisol* group of the soil has been taken for fertility evaluation under various aspects. One thousand three (0-15 cm depth) soil samples were collected from Baloda block using GPS marked. The scale of 1:4000 has been used as the cadastral map for conducting the field survey works. Soil samples (15 cm) were collected from each grid point using soil auger and local spade with proper labels. Soil samples collected from the study area were dried and crushed with the help of wooden rod and passed through 2 mm sieve and stored in properly labeled plastic bags for analysis by adopting standard laboratory methods.

Soil pH was determined by glass electrode pH (Piper, 1967), Electrical Conductivity with Solu-bridge method (Black, 1965), Soil organic C (Walkley and Black, 1934). Micronutrients Zn, Cu, Fe and Mn were extracted by using 0.005 M diethylene triamine penta acetic acid (DTPA), 0.01M calcium chloride dehydrate and 0.1M triethanol amine buffered at pH 7.3 (Lindsay and Norvell, 1978) and concentrations were analyzed by atomic absorption spectrophotometer The data on available Fe, Cu, Mn and Zn of soils were characterized for deficient and adequate status using the threshold values 4.5 mg/kg for Fe, 0.2 mg/kg for Cu, (Katyal and Randhawa, 1983), 3.5 mg/kg for Mn (Shukla and Gupta,1975) and 0.6 mg/kg for Zn (Katyal,1985). The samples were categorized as per the rating limit given in Table 2.

RESULTS AND DISCUSSION

Physico-chemical properties of soils

The results of soil analysis pertaining to some salient properties under study are presented in Table 1. The mean values of different parameters indicated that *Inceptisol* of the area under study was slightly acidic in nature, normal in salinity, low in organic C, available N, P and medium in available K. The mean values on micronutrient status (Zn, Fe, Mn and Cu) of the soil had sufficient level.

Available Fe

DTPA-extractable Fe content in *Inceptisol* varied from 4.54 to 68.70 mg/kg with an average amount of available Fe was 30.18 mg/kg (Table 1). Considering 4.5 mg/kg (Table 2) DTPA-extractable Fe as critical limit (Lindsay and Norvell, 1978), the data reveals that 7.28% soil samples were found to be sufficient in available Fe content and 92.72% found under higher level (Table 3).

Table 1: Salient soil properties of study area

Soil characteristics	Range	Mean
pH (1:2.5, Soil water)	4.7 - 7.50	5.89
E.C. (dS/m)	0.05 - 0.37	0.13
O.C. (%)	0.23 - 0.83	0.44
Available N (kg/ha)	112.9 - 338.69	185.16
Available P (kg/ha)	4.13 - 23.35	8.86
Available K (kg/ha)	104.27 - 481.15	212.62
Available Fe (mg/kg)	4.54 - 68.70	30.18
Available Mn (mg/kg)	3.72 - 59.58	26.08
Available Cu (mg/kg)	0.2 - 8.78	2.79
Available Zn (mg/kg)	0.06 - 3.34	0.68

Table 2: Limits for the soil test values used for rating the soil

Classification for pH values			
Strongly acid	**Moderately acid**	**Slightly acid**	**Neutral**
<5.5	5.5-6.0	6.0-6.5	6.5-7.5
Classification for total soluble salt content (EC as dS/m)			
No deleterious effect on crop	**Critical for germination**	**Critical for salt sensitive crop**	**Injurious to most crops**
<1.0	1.0-2.0	2.0-3.0	>3.0
Parameters	**Low**	**Medium**	**High**
O.C. (%)	0.25-0.50	0.50-0.75	>0.75
Micronutrients			
	Deficient	**Sufficient**	**High level**
Av. Fe (mg/kg)	<4.50	>4.50	>9.00
Av. Mn (mg/kg)	<3.50	>3.50	>7.00
Av. Cu (mg/kg)	<0.20	>0.20	>0.40
Av. Zn (mg/kg)	<0.60	>0.60	>1.20

Higher amount of available Fe content in *Inceptisol* of Baloda block might be due to its topography and cultivation of rice which induced prolonged submergence coupled with reducing conditions. This order of the soils in study area is not deficient in Fe as the amount of Fe required by crops is being released by Fe bearing minerals in these soils. The soil pH had reverse effect on the availability of Fe content in soil. Rajeswar *et al.* (2009) in soils of Garikapadu of Krishna District of Andhra Pradesh have also reported the similar trends in available Fe content. DTPA-Fe reveled a negative and significant correlation (r = -0.199*) with pH (Table 4) which confirms the basic chemistry of Fe availability in various pH level of the soil. Talukdar *et al.* (2009) and Somasundaram *et al.* (2009) also reported significant negative correlation of available Fe with pH of the soil. The correlation of Fe level with EC showed a negative and non significant result (r = -0.711), Similar observations were also reported by Somasundaram *et al.* (2009). The DTPA-Fe indicated negative and significant correlation (r = -0.072*) with soil organic C (Table 4.), Similar observation was found by Mogia and Bandyopadhyay (1993) in South Andaman.

Available Mn

Data generated from the present field study clearly indicated that DTPA-extractable Mn in soils (*Inceptisol*) was varied from 3.72 to 59.58 mg/kg with an average content of available Mn was 26.08 mg/kg (Table 1). Considering 3.5 mg/kg (Table 2) DTPA-extractable Mn as critical limit (Lindsay and Norvell, 1978), the data revealed that 1.99% soil samples were found to be sufficient in available Mn and 98.01% found to be higher level (Table 3). The Mn bearing minerals in the parent material might be the reason for higher Mn content in the soils and due to better supply of Mn to rice in flooded soil as Mn is soluble in relatively acidic and reduced soil condition (Mandal and Haldar, 1980).

Like Fe availability, Mn status also resulted a negative and significant correlation with pH (r = -0.311*), EE (r = -0.126*) and Soil organic C (r = -0.073**) Table 4, it may be due to the formation of insoluble higher valent oxides of Mn at high pH (Sahoo *et al.*, 1995). Bansal and Takkar (1985) reported that the DTPA-extractable Mn decreased significantly with increase in soil pH. Rai *et al*. (1970) claimed a negative correlation between available Mn and organic C level in deep black soils of Madhya Pradesh.

Available Cu

DTPA-extractable Cu content in soils under study area varied from 0.2 to 8.78 mg/kg with an average content of available Cu was 2.79 mg/kg (Table 1). DTPA-extractable Cu as critical limit, only 1.10% soil samples were found to be sufficient in available content of Cu and 98.90% soil sample found to be in higher level (Table 3).

A significant negative correlation (r= -0.598*) was observed between soil pH and available Cu (Table 4). Similar relation was also observed by Kumar *et al.* (2009) in Santhal Paraganas Region of Jharkhand. A negative and significant relationship (r = -0.269*) was found between available Cu and electrical conductivity. A significant negative correlation (r = -0.145*) was observed between organic C and available Cu (Table 4). Significant and negative correlation between available Cu and organic C was observed by Kumar *et al.* (2009) in Santhal Paraganas Region of Jharkhand, Agrawal and Motiramani (1966) in soils of Madhya Pradesh.

Available Zn

The DTPA-extractable Zn content of soils under study varied from 0.06 to 3.24 mg/kg with an average content of available Zn was 0.68 mg/kg (Table 1). The critical limit (Table 2) of Zn in soil has been marked as 0.6 mg/kg (Lindsay and Norvell, 1978). It was observed from the analytical results that 54.54 percent soil samples were found to be deficient 36.39 % soil samples were found to be sufficient and only 9.07 % soil sample found to be in higher level in available Zn content (Table 3). In view of widespread deficiency of Zn in *Inceptisol* of Baloda block, required Zn application for optimum production and to get full benefit from NPK fertilization. The Zn deficiency increased with increase in pH. Similar observation was made by Rai *et al*. (1970) in deep black soils of Madhya Pradesh.

A significant and negative relationship (r = -0.314*) was observed with pH (Table 4), thereby indicating that availability of Zn decreases with increase in soil pH. This positive relationship might be attributed to the increased availability of Mn, Zn and Cu under low pH condition which increased solubility of oxides and hydroxides of these micronutrients. Similar relation was also observed by Bali *et al.* (2010) and Talukdar *et al*. (2009). A significant and negative relationship (r = -0.144*) was observed with EC, no significant correlation found between available Zn and Organic C (r = 0.035) in *Inceptisol* for Baloda block. Similar result observed by Kumar *et al.* (2009) in Dumka series of Santhal Paraganas Region of Jharkhand.

Table 3: Limits for the soil test values used for rating the soil

Classification for pH values			
Strongly acid	**Moderately acid**	**Slightly acid**	**Neutral**
15.25	38.98	37.59	8.18
Classification for total soluble salt content (EC as dS/m)			
No deleterious effect on crop	**Critical for germination**	**Critical for salt sensitive crop**	**Injurious to most crops**
100	-	-	-
Parameters	**Low**	**Medium**	**High**
O.C. (%)	78.36	19.54	2.09
Micronutrients			
	Deficient	**Sufficient**	**High level**
Av. Fe (mg/kg)	0	7.28	92.72
Av. Mn (mg/kg)	0	1.99	98.01
Av. Cu (mg/kg)	0	1.10	98.90
Av. Zn (mg/kg)	54.54	36.39	9.07

Table 4 Correlation coefficient (r) between physico-chemial properties and DTPA-extractable Fe, Mn, Cu, and Zn of *Inceptisol* of baloda block.

Soil properties	**Available micronutrient content (mg/kg)**			
	Fe	**Mn**	**Cu**	**Zn**
p H	-0.199*	-0.311*	-0.598*	-0.314*
EC	-0.042	-0.126*	-0.269*	-0.144*
OC	-0.072**	-0.073**	-0.145*	-0.035

*Significant at 1% level **Significant at 5% level

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