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Evaluations of soil fertility status of available major nutrients (N, P & K) and micro nutrients (Fe, Mn, Cu & Zn) in *Vertisol* of Balodabazar block in Balodabazar district of Chhattisgarh

Chandrabhooshan Singh, RK Bajpai, Alok Tiwari, Mithilesh Chandra and Bal Krishna

Abstract
Evaluation of the soil fertility status of *Vertisol* group of Balodabazar block of Balodabazar district of Chhattisgarh was carried out during 2016-17. Grid-based surface (0-15 cm) soil samples were collected by systematic survey from 55 villages in Balodabazar block in such that each 10 ha area represented one sampling point and total 2170 soil samples covering all soil types out of this, 1346 samples were identified from *Vertisol.* The available N content ranges from 105 to 263 kg ha^{-1} with mean values 197 kg ha^{-1}, The average available P content ranged from 1.5 to 34.9 kg ha^{-1} with an average value of 18.0 kg ha^{-1} and the available potassium content ranges from 115-643 kg ha^{-1} with an average value of 417 kg ha^{-1}. The available Fe content ranges from 2.40 to 44.12 mg kg^{-1} with mean values 16.46 kg ha^{-1}, The average available Zn content ranged from 0.20 to 3.00 mg kg^{-1} with an average value of 0.95 mg kg^{-1}, available Cu content ranges from 0.20 to 3.00 kg ha^{-1} with an average value of 1.81 kg ha^{-1} and available Mn content ranges from 2.20 to 45.76 kg ha^{-1} with an average value of 23.85 kg ha^{-1}.

Keywords: soil Fertility, Major Nutrients, Micro Nutrients

Introduction
Chhattisgarh state lies between $17^0$46' – 24^0 '8' N latitude and $80^0$15' – $84^0$24' E longitude. The total geographical area of the State is 136034.28 km^2 north to south and 336 km. from East to West with a total area of 1,35,194 sq. km. The use of plant nutrients in a balanced manner is the prime factor for efficient fertilizer program. Balanced nutrient use ensures high production level and helps to maintain the soil health. Chhattisgarh State has four major soils type i.e. Entisols, Inceptisols, Alfisols and Vertisols and broadly comes under red and yellow soils group. Almost all soils are deficient in nitrogen and phosphorus and medium to high in potassium. Soil fertility is determined by the presence or absence of nutrients i.e. macro and micronutrients. Soil fertility is the inherent ability of soils to supply nutrient elements to plants. Soil fertility is related to the number of available nutrients. Some measure it by the yield capacity, and others took it to be a function of organic matter or even soil texture. In brief, soil fertility refers to the availability status of essential macro and micronutrients in the soil (Tisdale et.al., 1993) [11].

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 agriculture production systems is the most crucial issue as our natural resources are continuingly being degraded. A system is sustainable when it improves or 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. The increasing population and food demand have forced farmers to make use of high doses of chemical fertilizers. The unscientific use of fertilizers (nutrient imbalances, incorrect amount) is a serious threat to sustainable agriculture production system. Soil-test based fertility management is an effective tool for increasing productivity of agricultural soils that have a high degree of spatial variability resulting from the combined effects of physical, chemical or biological processes (Goovaerts, 1998) [2]. However, major constraints impede wide-scale adoption of soil testing in most developing countries. In India,

these include the prevalence of smallholding system of farming as well as lack of infrastructural facilities for extensive soil testing (Sen *et al* 2008) [9]. However, major constraints impede wide-scale adoption of soil testing in most developing countries. In India, these include the prevalence of smallholding systems of farming as well as lack of infrastructural facilities for extensive soil testing. Under this context, Geographic Information System (GIS)-based soil fertility mapping has appeared as a promising alternative. 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 recommendation.

Materials and Methods

Balodabazar block is located in Balodabazar district of Chhattisgarh. The nearest major railhead is Bhatapara railway station is 24.8 km away from its district main city. It is located 85.7 km away from capital city Raipur of the Chhattisgarh. A different group of soils covered *viz Inceptisol, Alfisol Entisol,* and *Vertisol* under Balodabazar block. The *Alfisol* group of the soil has been taken for fertility evaluation under various aspects. Soil samples (0-15 cm depth) were collected from Balodabazar 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) [8], Electrical Conductivity with Solu-bridge method (Black, 1965) [1], Soil organic C (Walkley and Black, 1934) [13]. Available N was determined by alkaline $KMnO_4$ method (Subbiah and Asija, 1956), available P determined with 0.5 M $NaHCO_3$ described by Olsen, 1954 and Available K was determined by neutral ammonium acetate (Hanway and Heidal, 1952) [3]. Available micronutrients Fe, Mn, Cu, & Zn, estimated by DTPA extractable method (Lindsay & Norvell, 1978) [6]. The samples were categorized as per the rating is given in Table 1.

Table 1: Limits for the soil test values used for rating the soil.

Classification for pH values			
Strongly acidic	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-1)			
<1.0	1.0-2.0	2.0-3.0	>3.0
Parameter	Low	Medium	High
O.C (%)	0.25-0.50	0.50-0.75	>0.75
Available N (kg ha^{-1})	<280	280-560	>560
Available P (kg ha^{-1})	<12.5	12.5-25	>25
Available K (kg ha^{-1})	<135	1.35-335	>335
Available Fe (mg kg^{-1})	<4.5	4.5-9	>9
Available Zn (mg kg^{-1})	<0.6	0.6-1.2	>1.2
Available Cu (mg kg^{-1})	<0.2	0.2-0.4	>0.4
Available Mn (mg kg^{-1})	<3.50	3.50-7.00	>7.00

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 of micronutrient status (Zn, Fe, Mn, and Cu) of the soil had sufficient level.

Table 2: Salient soil properties of study area

Soil characteristics	**Range**	**Mean**
pH (1:2:5, Soil water)	4.7-8	6.8
E.C.(dS m^{-1})	0.10-0.70	0.30
O.C. (%)	0.30-0.75	0.30
Available N (kg ha^{-1})	105-263	197
Available P (kg ha^{-1})	1.5-34.9	18.0
Available K (kg ha^{-1})	115-643	417
Available Fe (mg ha^{-1})	2.40-44.12	16.46
Available Zn (mg ha^{-1})	0.20-3.00	0.95
Available Cu (mg ha^{-1})	0.44-3.00	1.81
Available Mn (mg ha^{-1})	2.20-45.76	23.85

Result and Discussion

Physico-chemical characteristics of soils

Soil reaction (pH)

The Vertisol samples of the study area were determined for pH (Table 2) and observed in the range of 4.7-8 with the mean value of 6.8.

A total 1346 number of soil samples were categorized for pH estimation and it was observed that nearly 46.29% %samples under neutral and 31.65%samples were categorized under the acidic soil (Table 3). Jibhakate *et al*., (2009) [5] Similar result was also found in soils of kotal tahsil in Nagpur district of Maharashtra, in which pH ranges from 7.1 to 8.1 as reported by).

Salt concentration (EC)

The total soluble salt contents expressed as electrical conductivity (EC) varied from 0.10-0.70 dS m^{-1} with the mean value of 0.30 dS m^{-1} at 25°C (Table 2). The result has shown the EC values under normal range (<1.0dSm-1). The normal EC may be ascribed to leaching of salt to lower horizons due to its light textured nature. A similar result was also found in soils of Pamgarh block of Janjgir district of Chhattisgarh as described by Shukla (2011) [10].

Organic Carbon

The organic carbon (OC) analyzed in all sampled Vertisols exhibited in the range of 0.30-0.75 with a mean value of 0.30 (Table 2). Thus, the Vertisols of balodabazar is medium in OC content. Distribution of soil samples with respect to OC content indicates (Table 3) that about 23.55% samples had low (<0.50%) organic C, 69.54% in medium (0.50-0.75%) and only 6.91% samples had higher organic C (>0.75%). A similar result was also found in black soil group (Alfisols and Vertisols) reported by Vaisnow (2010) [12]. Use of almost nil

to the very low amount of organic manures like farmyard manure and chemical fertilizers is imbalanced application is the main reason for poor organic C resulted in a low productivity of the region. Moreover, high temperature during summer prevailing in the area may also be responsible for the rapid burning of organic matter, thus resulting in low organic C content of these soils. Since organic matter content is an indicator of available N status of soils, thus the soils of the area are also dominantly low in the respect their available N.

Available macronutrient status of soils

The data presented in Table 2 the available N content ranges from 105 to 263 kg ha^{-1} with mean values 197 kg ha^{-1} Considering the soil test rating for available N (<280 as low, 280-560 as medium and >560 as high in the status of N), the soil samples i.e. 100% were found as low available N content in Alfisol. In this way, almost all the soil samples tested for available N were found to be deficient in N. Similar results reported by Jatav (2010) [4].

The average available P content ranged from 1.5 to 34.9 kg ha^{-1} with an average value of 18.0 kg ha^{-1} Considering the soil test rating for available phosphorus (<12.5 kg ha^{-1} as low, 12.5-25 kg ha^{-1} as medium and > 25 kg ha^{-1} as high) majority of the soils fell under medium status about 61.59%. These reactions affect the availability of P and as a result of these reactions, a very small amount of total P is present in soil solution at any time reflected by soil testing. However, a low to medium range of soil available P under study area may be most affected by past fertilization, pH, organic matter content, texture various soil management and agronomic practices. Similar results finding by Shukla (2011) [10].

The results showed that the available potassium content ranges from 115-643 kg ha^{-1} with an average value of 417 kg ha^{-1}. Considering the soils having <135 kg ha^{-1} as low, 135-335 kg ha^{-1} as medium and >335 kg ha^{-1} as high in available potassium content. 72.44% samples were found high available K content. Similar results finding by Vaisnow (2010) [12].

Available micronutrient status of soils

The available Fe content ranges from 2.40 to 44.12 mg kg-1 with mean values 16.46 kg ha^{-1} Considering 4.50 mg kg-1 DTPA-extractable Fe as a critical limit (Table 1) (Lindsay and Norvell, 1978) [6], 1.78% soil samples were found deficient, and 21.84% found sufficient however 76.37% samples recorded higher level of available Fe content (Table 3).

The average available Zn content ranged from 0.20 to 3.00 mg kg^{-1} with an average value of 0.95 mg kg^{-1}. Considering the soil test rating for DTPA-extractable Zn (<0.60 mg kg-1 as deficient, 0.60-1.20 mg kg-1 as sufficient and >1.20 mg kg-1 as high level) as critical limit for Zn deficiency (Lindsay and Norvell, 1978) [6] (Table 1), 34.55% samples were found to be deficient, 39.00% samples sufficient and 26.45% samples were found to be under higher level in available Zn content (Table 3).

The results showed that the available Cu content ranges from 0.20 to 3.00 kg ha^{-1} with an average value of 1.81 kg ha^{-1}. Considering deficient (<0.2 mg kg-1), sufficient (0.2-0.4 mg kg1) and high (>0.4 mg kg-1) level DTPA-extractable Cu as critical limit (Follett and Lindsay, 1970) in Table 1, 98.89% soil samples were found to be in higher level, and only 1.11% sufficient available content of Cu, in soils of Balodabazar block (Table 3).

The results showed that the available Mn content ranges from 2.20 to 45.76 kg ha^{-1} with an average value of 23.85 kg ha^{-1}. Considering deficient (<3.50 mg kg-1), sufficient (3.50-7.00 mg kg1) and high (>7.00 mg kg-1) level DTPA-extractable Mn as critical limit (Follett and Lindsay, 1970) in Table 3, 92.79% soil samples were found to be in higher level, and only 1.19% insufficient available content of Mn, in soils of Balodabazar block (Table 3).

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

Classification for pH values			
Acidic	Neutral	Saline	Alkaline
31.65%	46.29%	22.06%	-
Classification for total soluble salt content (EC as dS m-1)			
<1.0	1.0-2.0	2.0-3.0	>3.0
100%			
Parameter	**Low**	**Medium**	**High**
O.C (%)	23.55%	69.54%	6.91%
Available N (kg ha^{-1})	100%	-	-
Available P (kg ha^{-1})	24.07%	61.59%	14.34%
Available K (kg ha^{-1})	0.22%	27.34%	72.44%
Available Fe (mg kg^{-1})	1.78%	21.84%	76.37%
Available Zn (mg kg^{-1})	34.55%	39.00%	26.45%
Available Cu (mg kg^{-1})	-	1.11%	98.89%
Available Mn (mg kg^{-1})	1.19%	6.02%	92.79%

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