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Micronutrient status in soil of Palari block under Baloda bazar district of Chhattisgarh

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Abstract
A Study was undertaken to evaluate the fertility status of Palari block, Baloda Bazar district, Chhattisgarh covering 18 villages during 2016-2017. The systematic collection of samples was carried out in geo–referenced surface (0-0.15m) soils samples from 970 sites representing *Inceptisols*, *Alfisols* and *Vertisols* using Global Positioning System and mapped on 1:4000 Scale. The soil samples were analysed for Fe, Cu, Mn, B and Zn for delineation of the fertility status in relation to salient physico-chemical characteristics. The available micronutrient Fe, Cu, Mn, B and Zn contents were ranged from 6.14 to 45.52, 0.2-5.06, 2.54-41.72, 0.70-3.40 and 0.20-2.94 mg kg^{-1} respectively in soils of the Palari block. The 45.56% soil samples were deficient in available Zn whereas only 0.10% samples were deficient for available Mn. Fe, Cu and B deficiency was not observed in the soils.

Keywords: *Inceptisols, Alfisols, Vertisols* and physico-chemical

Introduction
The importance of soil fertility and plant nutrition to the health and survival of all life cannot be understated. As human population continue to increase, human disturbance of earth's ecosystem to produce food and fiber will place greater demand on soils to supply essential nutrients. Therefore, it is critical that we increase our understanding regarding the chemical, biological, and physical properties relationships in the soil-plant-atmosphere continuum that control nutrient availability.

The evidence is clear that the soil's native ability to supply sufficient nutrients has decreased with the higher plant productivity levels associated with increased human demand for food. One of the greatest challenges of our generation will be to develop and implement soil, crop and nutrient management technologies that enhance the quality of the soil, water and air. If we do not improve or sustain the productive capacity of our fragile soils, we can-not continue to support the food and fiber demand of our growing population.

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 production systems 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. The increasing population has forced farmers to make use of high doses of chemical fertilizers. Its unscientific use (nutrient imbalances, incorrect amounts) is a serious threat to sustainable agricultural production system.

Material Method
Location and climate
Palari block is situated in Baloda Bazar district of Chhattisgarh state lying between 21.53° N latitude, 82.16° E longitude with an altitude of 270 m above the mean sea level. The location of study area is shown in the map of the Chhattisgarh state (Fig.). There are about 18 villages which includes for evaluation of soil fertility status in Palari block.

The region generally experiences hot, sub humid climate, having average rainfall of 1157.1 mm, with erratic pattern of distribution. Due to high rainfall and proximity to Eastern coast, the climate remains humid for about five months. On the basis of rainfall and temperature, the year may be divided into three distinct season's namely rainy season from June to September, winter season from 2nd fortnight September to January and summer season from February to June.

The monsoon enters around 15th June and usually withdraws by 15th July. The climate of the area is characterized by hot summers and cool winters.

Soil characteristics

The survey area comes under the soil orders of *Alfisols*, *Inceptisols* and *Vertisols*. These soils are locally known as Dorsa, Matasi and Kanhar respectively. The *Alfisols* occur on midland situation, are deep and hence have good water holding capacity, roughly twice as that of *Inceptisols.* Most Alfisols fields are bunded and leveled. Impact of drought is relatively less in this situation. The *Inceptisols* is light-textured (gravelly and sandy), upland-unbunded, low water holding capacity, low fertility, excessive soil erosion type of soil. While *Vertisols* is clayey in texture, dark brown to black in colour, neutral to alkaline in reaction due to presence of lime concretion and is deep (1-1.5 m). The structure varied from coarse angular blocky to massive and cloddy. Soil is represented as typical fine *Smetices*, *Hyperthermic* and *Typic Haplustert.*

Determination of available micronutrients in soil

The micronutrients Fe, Mn, Cu and Zn were extracted by using 0.005 M diethylene triamine penta acetic acid (DTPA), 0.01 M Calcium chloride dehydrate and 0.1 M triethanol amine (TEA) buffered at pH 7.3 (Lindsay and Norvell, 1978) [5] and concentrations were analysed by atomic absorption spectrophotometer (AAS).

Hot water soluble boron was extracted by boiling soil-water suspension 1:2 for five minutes and determined by Azomethine -H colorimetric method (Wolf, 1974).

Results and Discussion

Soil physico-chemical properties of the study area

Soil Physico- chemical Properties are shown on the table. 1. The pH ranged from 5.5 to 8.1, 6.0 to 7.9 and 5.7 to 8.1 in *Inceptisols*, *Alfisols* and *Vertisols*, respectively. The electrical conductivity (EC) varied from 0.08 to 0.63 dS m^{-1} with a mean value of 0.2 dS m^{-1} at 25^0C of the Palari block. Organic carbon status of soils of Palari block is revealed that most of the soils are having low to medium status of organic carbon. It ranged from 0.22% to 0.80% with a mean value of 0.48% in *Inceptisols*, *Alfisols* and *Vertisols* of Palari block.

Available Fe status

The DTPA-extractable Fe content of soils under study area ranged from 6.14 to 45.52 mg kg^{-1} with mean 25.67 mg kg^{-1}. These findings corroborate with results as reported by Rajeshwar *et al*. (2009) [9] in soils of Krishna district of Andhra Pradesh and also confirm the findings of Singh *et al*. (2009) [11] in the DTPA-extractable Fe in the soils of district Gajipur, Uttar Pradesh.

Considering 4.5 mg kg^{-1} DTPA-extractable Fe as critical limit (Lindsay and Norvell 1978) [5], the data shown on table-2 reveals that only 0.52% soil samples were found to be sufficient in available Fe content and 99.48% soil samples were found to be higher level.

High available Fe content in soils of Palari block might be due to its topography and cultivation of rice, which induced prolonged submergence coupled with reducing conditions. Majority of the soils were not deficient in Fe as the amount of iron required by crops is being released by iron bearing minerals in these soils.

The soil pH had reverse effect on the availability of Fe content in soil. It was concluded from the table 2 that 99.33%, 100% and 99.54% samples recorded higher level of Fe and none of samples observed deficient level of Fe, whereas 0.67%, 0% and 0.46% samples recorded sufficient Fe in *Inceptisols*, *Alfisols* and *Vertisols* respectively.

The highest and lowest mean values of DTPA-extractable Fe was recorded 33.3 and 20.6 mg kg^{-1} Fe in Sonar devri and Gitkera villages, respectively of Palari block.

Available Mn status

The available manganese status of soils of the study area is classified under deficient (<3.5 mg/kg), sufficient (3.5-7.0 mg/kg) and high level (>7.0 mg/kg), respectively. The DTPA-extractable Mn content of soils under study area varied from 2.54 to 41.72 mg kg-1 with mean value of 24.39 mg kg^{-1}. 99.23% of the sampled soils under study were in high level of Mn status in *Vertisols*.

The results showed on table-3 that the only 0.33% soil samples were noted under deficient Mn in *Inceptisols*, whereas none of soil sample was found under deficient categories in *Alfisols* and *Vertisols*. The DTPA-extractable Mn content estimation from total 970 soil samples of Palari block covering about 18 villages was done and it was observed that nearly 99.28% samples under high level (>7.0), 0.62% in sufficient level (3.5-7.0) and 0.10% in deficient (< 3.50) level of available Mn. Out of total samples collected the soil type wise 99.08% samples under high, 0.92% under sufficient in *Vertisols* and 99.67% under high and only 0.33% samples were found under sufficient level in *Inceptisols* and 100% samples were high level in *Alfisols* whereas none of soil samples were found under deficient categories in all soil group.

Similar results were also reported by Jatav (2010) [2] in the soils of *Inceptisols* group of Baloda block of Janjgir-Champa district of Chhattisgarh and Verma (2012) [15] in the *Inceptisols*, *Alfisols* and *Vertisols* orders of Malkharauda block in Janjgir-Champa district (C.G.). Higher organic carbon may further increase the DTPA-extractable Mn content in soil. Mn deficiency was not observed in major parts of the block because the soils are dominantly medium to fine in texture and Mn is mobilized under reduced conditions during rice cultivation which resulted in higher availability of Mn to rice (Mandal and Haldar, 1980) [6].

The highest and lowest mean values of available Mn content in study area were 36.3 and 12.4 mg kg^{-1} in Odan and Sonar devri villages of Palari block, respectively.

Available Cu status

The DTPA-extractable Cu content of soils under study area varied from 0.20 to 5.06 mg kg^{-1} in *Inceptisols*, *Alfisols* and *Vertisols* with an average value 1.51 mg kg^{-1}.

The available Cu ranged from 0.4 to 4.2, 0.4 to 2.4 and 0.2 to 5.06 mg kg^{-1} with an average value of 1.6, 1.3 and 1.5 mg kg^{-1} in *Inceptisols*, *Alfisols* and *Vertisols*, respectively of study area.

Considering deficient (<0.2), sufficient (0.2-0.4) and high (>0.4 mg kg^{-1}) level DTPA-extractable Cu as critical limit (Follett and Lindsay, 1970), 99.28% soil samples were found to be in higher level, and only 0.72% in sufficient available content of Cu in soils of Palari block (table 4).

A major group of soils fell under higher level of available copper (>0.4 mg kg^{-1}) having 99.67%, 100% and 99.08% in *Inceptisols*, *Alfisols* and *Vertisols*, respectively of Palari block.

Most of the soil samples were found under high level in available Cu content with a model class of >0.4 mg kg^{-1}

DTPA-extractable Cu. Kumar *et al*., (2009) [4], Rajeshwar *et al*., (2009) [9], Jatav (2010) [2], Verma (2012) [15] and several other workers reported available copper in similar range.

The highest and lowest mean values of available Cu for *Inceptisols*, *Alfisols* and *Vertisols* were 2.8 and 1.0 mg kg^{-1} in Vatgan and Palari, Thelki villages, respectively of Palari block.

Available Zn status

The study of the DTPA-extractable Zn varied from 0.02 to 6.18 mg kg^{-1} with an average value of 0.82 mg kg^{-1} in the study area.

Considering the soil test rating for DTPA-extractable Zn (<0.6 mg kg^{-1} as deficient, 0.6-1.2 mg kg^{-1} as sufficient and >1.2 mg kg^{-1} high level) as critical limit for Zn deficiency (Lindsay and Norvell, 1978) [5].

The overall samples were found to be 45.56% in deficient, 33.82% in sufficient and only 20.62% samples were found to be high level in available Zn content in soil (table 5).

Distribution of samples with respect to available Zn in *Alfisols* were 76.47% samples under deficient, 17.65% under sufficient and 5.88% under high level and in *Inceptisols* 43.23% samples under deficient, 34.00% under sufficient and only 22.77% samples under high level whereas in *Vertisols* 45.85% samples under deficient, 34.15% under sufficient and only 20.00% samples under high category of available Zn content.

The results are in conformity with the finding of Shukla (2011) [12] in soils of Pamgarh block in Janjgir-Champa district (C.G.). Similar findings were also reported by Vaisnow (2010) in *Vertisols* of Dhamtari block under Dhamtari district of Chhattisgarh.

The highest mean values of available Zn were 1.0 mg kg^{-1} in Odan, Rasota and Sasaha villages whereas lowest mean value found 0.42 mg kg^{-1} in Sonar devri village, respectively for study soil groups of Palari block.

Available B status

The results show that the available boron content ranges from 0.70 to 3.40 mg kg^{-1} with an average value of 1.75 mg kg^{-1} in *Inceptisols*, *Alfisols* and *Vertisols* of Palari block, respectively (Table 6).

Considering the soils having <0.50 mg kg^{-1} as low, 0.50-1.00 mg kg^{-1} as medium and >1.00 mg kg^{-1} as high in available boron contents, the data presented in table 6 revealed that 4.54% samples had medium and 95.46% samples had high in available boron content whereas none of soil sample was found under deficient categories in study area.

Distribution of the samples with respect to available boron indicated that in *Alfisols* about 100% samples had high level of available boron content. In *Inceptisols*, about 4.63% samples were found in sufficient level and 95.37% samples in high boron content where as in *Vertisols* 95.38% samples recorded in high and 4.62% samples in sufficient boron content.

The highest and lowest mean value of available boron content were recorded to be 2.1 and 1.0 mg kg^{-1} in Dhaura bhatha and Sonar devri villages, respectively of Palari block.

Table 1: Soil physico-chemical properties of the study area

Soil Characteristics	Range	Mean	S.D
pH(Soil:water,1:2.5)	5.5 - 8.1	7.3	± 0.58
E.C.(dSm^{-1})	0.08 -0.63	0.20	± 0.09
O.C. (%)	0.22 – 0.80	0.48	± 0.17
Available N (kg ha^{-1})	77 – 282	153	± 58.05
Available P (kg ha^{-1})	1.34 – 26.61	13.8	± 5.25
Available K (kg ha^{-1})	113 – 567	238	± 90.57
Available S (kg ha^{-1})	3.64 – 33.88	14.0	± 6.50
Available B (mg kg^{-1})	0.70 – 3.40	1.75	± 0.54
Available Fe (mg kg^{-1})	6.14 – 45.52	25.67	± 6.86
Available Mn (mg kg^{-1})	2.54 – 41.72	24.39	± 8.12
Available Cu (mg kg^{-1})	0.20 – 5.06	1.51	± 0.86
Available Zn (mg kg^{-1})	0.20 – 2.94	0.78	± 0.49

Table 2: Distribution of available iron status in the soils of Palari block

Available Fe (mg kg^{-1})	*Inceptisols*		*Alfisols*		*Vertisols*		Total (%)
	No. of samples	% Samples	No. of samples	% Samples	No. of samples	% Samples	
Deficient (<4.50)	-	-	-	-	-	-	-
Sufficient (4.50-9.00)	2	0.67	-	-	3	0.46	0.52
High level (>9.00)	301	99.33	17	100	647	99.54	99.48
Total	303		17		650		100%

Table 3: Distribution of available manganese status in the soils of Palari block

Available Mn (mg kg^{-1})	*Inceptisols*		*Alfisols*		*Vertisols*		Total (%)
	No. of samples	% Samples	No. of samples	% Samples	No. of samples	% Samples	
Deficient (<3.50)	1	0.33	-	-	-	-	0.10
Sufficient (3.50-7.00)	1	0.33	-	-	5	0.77	0.62
High level (>7.00)	301	99.34	301	99.34	645	99.23	99.28
Total	303		17		650		100%

Table 4: Distribution of available copper status in the soils of Palari block

Available Cu(mg kg^{-1})	*Inceptisols*		*Alfisols*		*Vertisols*		Total (%)
	No. of samples	% Samples	No. of samples	% Samples	No. of samples	% Samples	
Deficient (<0.20)	-	-	-	-	-	-	-
Sufficient (0.20-0.40)	1	0.33	-	-	6	0.92	0.72
High level (>0.40)	302	99.67	17	100	644	99.08	99.28
Total	303		17		650		100%

Table 5: Distribution of available zinc status in the soils of Palari block

Available Zn (mg kg^{-1})	*Inceptisols*		*Alfisols*		*Vertisols*		Total (%)
	No. of samples	% Samples	No. of samples	% Samples	No. of samples	% Samples	
Deficient (<0.60)	131	43.23	13	76.47	298	45.85	45.56
Sufficient (0.60-1.20)	103	34.00	3	17.65	222	34.15	33.82
High level (>1.20)	69	22.77	1	5.88	130	20.00	20.62
Total	303		17		650		100

Table 6: Distribution of available boron status in the soils of Palari block

Available B (mg kg^{-1})	*Inceptisols*		*Alfisols*		*Vertisols*		Total (%)
	No. of samples	% Samples	No. of samples	% Samples	No. of samples	% Samples	
Deficient (<0.50)	-	-	-	-	-	-	-
Sufficient (0.50-1.00)	14	4.63	-	-	30	4.62	4.54
High level (>1.00)	289	95.37	17	100	620	95.38	95.46
Total	303		17		650		100

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