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Original Research Article

Evaluation of Soil Fertility Status and its Variation in Arang Block of Raipur District in Chhattisgarh

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A B S T R A C T

Modern day agriculture is mostly about nutrient management that ultimately blessed us with crop yield. For this to happen we have to know the spatial variability of soil fertility status and its uptake by crop plant. In this study, all soil physico-chemical properties (pH, EC, OC), Available macronutrients (N, P, K, S) and Available micronutrients (B, Fe, Mn, Cu, Zn) status with their spatial variability in Arang block of Raipur district in Chhattisgarh was conducted. Soil reaction of the study area varied from acidic to saline range with EC mostly below <1.0 dS/m for collected samples. Soil OC and available Nitrogen content was low to medium, P varied from low to high in different villages, Soil K and S status varied from low to high fertility category. Also Fe, Cu and Mn status found in high range but Zn status found to be varied from deficient to sufficient range. Hot water extractable B was also determined. These observed spatial variability used in further fertilizer recommendation and input management based on requirement of crop plants.

Introduction

Soil fertility is the property by virtue of which soil provide all essential nutrients to crop plant in optimum quantity. So, details study regarding soil fertility is essential for better crop production and management. A detailed investigation of chemical, physical and biological properties of soil will provide us a greater insight into these soil dynamics. It will throw a better understanding of soil fertility and problem lies in it for successful crop production.

Currently the intensive crop production using HYV and hybrid varieties completely exhaust the soil nutrient pool. Again to meet the plant nutrient requirement farmer add only urea, DAP and potash in the most area of our country neglecting micronutrient fertilization making this an imbalance input management system. So, for better, precise and balance fertilizer management in farm spatial fertility evaluation is very important in it.

Indian agriculture in recent years progressed dramatically owing to modernization, mechanization and use of advance

technologies. Using these advance technology like GIS, GPS and remote sensing we can evaluate the spatial variability of soil fertility for precise nutrient management in a large area easily and effectively in very less time. Using these techniques input management and their optimization get easier and convenient for us. So, for better assessment of soil nutrient status and their uptake by plant we had conducted a study in Arang block of Chhattisgarh to evaluate the fertility status of this area. In this current study the results obtained, problem detected and their preventive measures were discussed here briefly.

Materials and Methods

Study area

The study was carried out at Arang block of Raipur district. It is situated in mid-eastern part of Chhattisgarh state and comes under Chhattisgarh plains agro climatic zone. Raipur district is situated between 22° 33' N to 21°14'N Latitude and 82° 60' to 81° 38'E Longitude and 311 meter above sea level. The general climatic condition of study area is sub-humid to semi-arid as it located near the tropics of cancer. The soils found in the study area are *Entisol, Inceptisol, Alfisol* and *Vertisol* dominant in nature.

Sample collection and analysis

Total 500 soil samples from surface layer (0-15cm) were collected from 20 villages of Arang block, the study area. Samples were collected in Grid basis i.e. one per 2.5 ha irrigated and 10 ha of rainfed area. GPS coordinate of all sampling sites recorded using a hand held GPS device.

The collected soil samples were air dried after grinding with wooden pestle and mortar, than sieved through 2-mm sieve, labeled and stored. The samples were analyzed for 12 chemical parameters viz. pH by pH meter, electrical conductivity (EC) by solu-bridge method (Jackson 1973), organic carbon (OC) by method of Walkley and Black (1934), available nitrogen (N) using method described by Subbiah and Asija (1956), phosphorus (P) using method of Olsen *et al.*, (1954), available potassium (K) by method of Hanway and Heidal, (1952), available sulphur (S) by method of Williams and Steinbergs (1959), available zinc (Zn), iron (Fe), copper (Cu) and manganese (Mn) using DTPA extractant method proposed by Lindsay and Norvell (1978) and available boron (B) using hot water extractant method described by Berger and Troug (1944).

The analytical results of each soil sample was categorized as low, medium and high categories for OC and macronutrients and as deficient, moderate and sufficient for micronutrient based on standard rating values (Table 1 and 2).

Nutrient index values and fertility rating

Nutrient index value (NIV) was calculated from the number or proportion of samples under low, medium and high available nutrient status (Ramamoorthy and Bajaj 1969). *i.e.*,

$$NIV = \frac{1 \times PL + 2 \times PM + 3 \times PH}{100}$$

Where, NIV = nutrient index value;
PL, PM, and PH are the percentage of soil samples falling in the category of low, medium and high nutrient status and given weightage of one, two and three respectively.

The index values are rated into various fertility categories viz., low (<1.67), medium (1.67-2.33) and high (>2.33) for available N, P and K.

For available S and micronutrients, the ratings are very low (<1.33), low (1.33-1.66), marginal (1.66-2.00), adequate (2.00-2.33), high (2.33-2.66) and very high (>2.66).

Results and Discussion

Soil reaction

The soil reaction of the study varied from 6.00 to 8.21 in a very narrow range with mean value of 7.04 and out of all 500 samples 10.80% were found in acidic, 73.00% were found within neutral and rest 16.20% fall under saline reaction category (Table 1). It might be due to *vertisols* dominant soil and semi-arid climate of the region (Balakrishna *et al.,* 2017).

Electrical conductivity

The electrical conductivity of the soil water suspension ranges from 0.20 to 1.00 dS/m in soil of study area with a mean value of 0.32 dS/m. Most of the collected soil samples (99.40%) fall under normal E.C. (<1.0 dS/m) category (Table 2). It indicated that there is no soil limitation for crop production from soluble salt concentration in soil.

Organic carbon

Organic Carbon content in study area ranges from 0.18 to 0.65% with a mean value of 0.36%. From all collected soil samples 92.40% samples fall under low and rest 7.60% under medium fertility category (Table 3). It may be ascribed due to the fact that soils have very low carbon pool and high C decomposition due to warm climate (Jatav *et al.,* 2012).

Available nitrogen

Available N content in soil of study area ranges from 92.95 to 281.36 kg/ha with mean value of 142.23 kg/ha. It has been revealed that 99.80 % of the study area was deficient in available N and only 1 sample found in medium range (Table 4). It may be ascribed to the poor organic carbon pool of soil (Jatav *et al.,* 2012)

Available phosphorus

Available P content in the study area found to be varied from 5.37 to 39.42 kg/ha with average content of 19.79 kg/ha. It was revealed that 19.60% samples fall under deficient category, 56.40% samples in medium range and rest 24% samples found in higher range of available P content (Table 5). It might be due to poor C pool and fixation by montmorillonitic clay of the soil in the region (Singh *et al.,* 2017).

Available potassium

Soil available K status ranges from 101.25–590.69 kg/ha with mean value of 319.67 kg/ha. Among all the collected soil samples 0.40 % samples found under low, 56.80 % samples found under medium and 42.80 % samples were in high fertility categories (Table 6) indicating there is no K deficient area within study area.

Available sulphur

Available S status was found to be ranging between 5.60 to 60.58 kg/ha with a mean content of 15.14 kg/ha. Also it was found that among all collected samples 84.00% in low, 9.40% in medium and 6.60% samples in high fertility category (Table 7).

Available boron

Hot water extractable B content in the study area found to be ranges from 0.10 to 0.99 mg/kg with a mean value of 0.34 mg/kg soil. Also among the total samples collected 91.60% samples found in deficient and rest 8.40% in sufficient fertility status (Table 8).

Table.1 Distribution of soil samples under different pH rating

Soil pH Classes	Range	No of Samples	% of Samples
Acidic	< 6.5	54	10.80
Neutral	6.5 - 7.5	365	73.00
Saline	7.5 - 8.5	81	16.20
Alkaline	> 8.5	0	0.00

Table.2 Distribution of soil samples under different EC rating

Soil EC Classes	Range dS/m	No of Samples	% of Samples
Low	< 1	497	99.40
Medium	1.0 - 2.0	3	0.60
High	2.0 - 3.0	0	0.00
Very High	> 3.0	0	0.00

Table.3 Distribution of soil samples under different Organic Carbon rating

Soil OC Classes	Range (%)	No of Samples	% of Samples
Low	<0.5	462	92.40
Medium	0.5-0.75	38	7.60
High	>0.75	0	0.00

Table.4 Distribution of soil samples under different Nitrogen rating

Soil N Classes	Range (Kg/ha)	No of Samples	% of Samples
Low	<280	499	99.80
Medium	280-560	1	0.20
High	>560	0	0.00

Table.5 Distribution of soil samples under different Phosphorus rating

Soil P Classes	Range (Kg/ha)	No of Samples	% of Samples
Low	<12.50	98	19.60
Medium	12.50-25.00	282	56.40
High	>25.00	120	24.00

Table.6 Distribution of soil samples under different Potassium rating

Soil K Classes	Range (Kg/ha)	No of Samples	% of Samples
Low	<135	2	0.40
Medium	135-335	284	56.80
High	>335	214	42.80

Table.7 Distribution of soil samples under different Sulfur rating

Soil S Classes	Range (Kg/ha)	No of Samples	% of Samples
Low	<22.5	420	84.00
Medium	22.5-35.0	47	9.40
High	>35.0	33	6.60

Table.8 Distribution of soil samples under different Boron rating

Soil B Classes	Range (mg/kg)	No. of Samples	% of Samples
Deficient	<0.50	458	91.60
Sufficient	0.50-1.00	42	8.40
High	>1.00	0	0.00

Table.9 Distribution of soil samples under different Iron rating

Soil Fe Classes	Range (mg/kg)	No. of Samples	% of Samples
Deficient	<4.5	0	0.00
Sufficient	4.5-9.0	0	0.00
High	>9.0	500	100.00

Table.10 Distribution of soil samples under different Manganese rating

Soil Mn Classes	Range (mg/kg)	No. of Samples	% of Samples
Deficient	<3.5	0	0.00
Sufficient	3.5-7.0	0	0.00
High	>7.0	500	100.00

Table.11 Distribution of soil samples under different Copper rating

Soil Cu Classes	Range (mg/kg)	No. of Samples	% of Samples
Deficient	<0.20	0	0.00
Sufficient	0.20-0.40	0	0.00
High	>0.40	500	100.00

Table.12 Distribution of soil samples under different Zinc rating

Soil Zn Classes	Range (mg/kg)	No. of Samples	% of Samples
Deficient	<0.60	494	98.80
Sufficient	0.60-1.20	6	1.20
High	>1.20	0	0.00

Limits for classification of soil test values

Soil Physico-Chemical Properties			
Soil pH values			
Acidic	**Neutral**	**Saline**	**Alkaline**
< 6.5	6.6-7.5	7.6-8.5	>8.5
Electrical conductivity (dS m^{-1})			
Good	**Fair**	**Poor**	**Toxic**
<1.0	1.0-2.0	2.0-3.0	>3.0
Organic C content (%)			
Soil Parameters	**Low**	**Medium**	**High**
Organic C (%)	<0.5	0.5-0.75	>0.75
Classification for Available Macronutrient Status			
Soil Parameters	**Low**	**Medium**	**High**
Available N(kg/ha)	<280	280-560	>560
Available P (kg/ha)	<12.5	12.5-25	>25
Available K (kg/ha)	<135	135-335	>335
Available S (kg/ha)	<22.5	22.5-35	>35
Classification for Available Micronutrient Status			
Soil Parameters	**Low**	**Medium**	**High**
Available Fe (mg/kg)	<4.5	4.5-9.0	>9.0
Available Mn (mg/kg)	<3.5	3.5-7.0	>7.0
Available Cu (mg/kg)	<0.2	0.2-0.4	>0.4
Available Zn (mg/kg)	<0.6	0.6-1.2	> 1.2
Available B (mg/kg)	<0.5	0.5-1.0	>1.0

Salient properties of soil in the study area:-

S. No.	Soil Characteristics	Range	Average	Standard Deviation	% Samples Category			NIV	Fertility Rating
					Low	Medium	High		
1	pH	6.00-8.10	7.04	0.44	-	-	-	-	-
2	EC (dS/m)	0.20-1.00	0.32	0.09	-	-	-	-	-
3	OC (%)	0.18-0.65	0.36	0.09	-	-	-	-	-
4	N (kg/ha)	92.95-281.36	142.23	35.08	99.80	0.20	0.00	1.002	Low
5	P (kg/ha)	5.37-39.42	19.79	7.85	19.60	56.40	24.00	2.044	Medium
6	K (kg/ha)	101.25-590.69	319.67	107.18	0.40	56.80	42.80	2.424	High
7	S (kg/ha)	5.60-60.58	15.14	9.92	84.00	9.40	6.60	1.226	Very Low
8	Fe (mg/kg)	10.12-39.38	24.80	6.17	0.00	0.00	100.00	3.000	Very High
9	Mn (mg/kg)	7.16-35.56	19.37	5.33	0.00	0.00	100.00	3.000	Very High
10	Cu (mg/kg)	0.91-9.72	3.62	1.56	0.00	0.00	100.00	3.000	Very High
11	Zn (mg/kg)	0.12-1.13	0.33	0.10	98.80	1.20	0.00	1.012	Very Low
12	B (mg/kg)	0.10-0.99	0.34	0.15	91.60	8.40	0.00	1.084	Very Low

DTPA extractable micronutrients

Available Fe content in the study area found to be ranging from 10.12 to 39.38 mg/kg with mean value of 24.80 mg/kg. of all collected samples were found in high fertility category (Table 9).

Available Mn content in all soil samples were in high category with its content found to be within 7.16 to 35.56 mg/kg with a mean value of 19.37 mg/kg of soil (Table 10) in the study area.

Available Cu content in study area found to be ranges from 0.91 to 9.72 mg/kg with a mean value of 3.62 mg/kg. Also it was found that all samples were in high fertility category (Table 11).

Available Zn content in study area found to be ranges from 0.12 to1.13 mg/kg with a mean value of 0.33 mg/kg. Also it was found that 98.80% samples were in deficient and 1.20% samples in sufficient fertility category (Table 12).

Nutrient management and fertilizer recommendation

As the study area is a block which is an extensive area where there are a lot of cropping practices by different farmers a lot of crop plants are cultivated based on their nutrient requirement proper input should be provided. For crop plants, in the deficient, sufficient and high fertility area of a particular nutrient 25% more than recommended, exact recommended and 25% less than recommended dose of fertilizer respectively should be provided. But for fruit and plantation crop nutrient uptake should be correlated with soil nutrient and accordingly nutrient should be applied to soil of the area.

From the above intensive study of the Arang block in Raipur district of Chhattisgarh it can be concluded that the soil of area dominantly found to be in neutral reaction range with conductivity less than 1 dS/m implied that soil suitable for cultivation of the most of crop plants without major problem.

Soil of the most of area found to be low to medium in organic C status and found deficient in available N. P status was found to be medium, whereas soil K status was observed high. Micronutrient Fe, Mn and Cu status of study area were found to be very high but S, Zn and B were found under deficient.

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