Evaluation of soil fertility status of research farm, College of Agriculture and Research Station, Katghora, Korba, Chhattisgarh, India

ABSTRACT

Total 102 soil surface samples (0-15) were collected from each field of research farm, College of Agriculture, and Research Station Katghora, Korba, (C.G.) to evaluated the soil fertility status, The soil samples were analysed by standard procedures with respect to pH, EC, OC, macronutrients (N, P, K, S) and micronutrients (Fe, Mn, Cu, Zn, and B). The results showed that soil pH varied from 4.31 to 5.42 with mean 4.79 and indicated that the soils were found to be moderately acidic to strongly acidic in soil reaction. The electrical conductivity of soil water suspensions ranged from 0.04 to 0.11with mean 0.07 indicated that soils of study area were suitable for all crops. The OC varied from 2.8 to 6.4, with mean value 4.3 g kg^{-1} and found that about 80 percent soils were under low organic carbon content. Most of the soil samples were found low in available N content, it ranged from 150.53 to 263.16, with mean 224.28 kg ha^{-1}. The available phosphorus varied from 20.51 to 93.32 with mean 49.66 kg ha^{-1}. The available potassium varied from 103.86 to 233.55 with mean 148.81 kg ha^{-1}. The available sulphur varied from 5.99 to 51.55 with mean 22.25 kg ha^{-1}. Micronutrients Fe, Mn, Cu and Zn varied from 6.01 to 44.40 mg kg^{-1} with mean 20.87 mg kg^{-1}, 4.10 to 16.95 with mean 10.82 mg kg^{-1}, 0.38 to 3.58 with mean 1.82 mg kg^{-1} and 0.48 to 1.29 with mean 0.82 mg kg^{-1}, respectively. The available B varied from 0.14 to 0.91with mean 0.48 mg kg^{-1}. All the soil samples were found to be high with respect to Fe, Cu and Mn whereas Zn and B were found deficient as 12.75 and 41.19 percent, respectively. According to NIV, the soils of study area were classified in low fertility class for nitrogen, Potassium, Boron, and sulphur, medium fertility class for phosphorus and zinc, and high fertility class for Fe, Mn, Cu.

Keywords: Physico-chemical properties, available nutrients, Nutrient index Value

INTRODUCTION

Soil fertility refers to the inherent capacity of the soil to provide macro and micronutrients in the soil. The physical, chemical and biological tests provide information about the capacity of soil to supply mineral nutrients (Ganorkar and Chinchmalatpure,2013). Soil productivity is the capacity of the soil to produce crops with a specific system of management and is expressed in terms of yields. Both soil fertility and productivity are the key pillars for food production and soil quality is of equal significance in the background of soil degradation caused by many factors. Balanced fertilizer use refers to application of essential plant nutrients in optimum quantities and in right proportional through appropriate method and right time of application suited for a specific crop and agronomic situation. 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). Nutrient index value method and fertility indicators can be used to evaluate the fertility status of the soil. The soil fertility status under different cropping sequence can also be assessed by using nutrient index approach (Singh *et al.*, 2016).

Material and Methods

The study was conducted on “Evaluation of soil fertility status of research farm, College of Agriculture, And Research Station Katghora, Korba (C.G.)”. The conducted study involved the collection and chemical analysis of 102 soil samples of college farm. The analysis of collected soil samples was carried out in the laboratory of Department of Soil Science and Agricultural Chemistry, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur. The study area was located in 22°35′N longitude 82°75′ E latitude. The soils of the study area, in general red yellow colour with light texture was found to be sandy loam. These soils were found to be acidic in nature soil reaction. Kharif is the main cropping season of study area, the total geographical area paddy is the main crop followed by Maize and pigeon pea pulses crops. Wheat, Maize and linseed crops are also grown in Rabi season. The surface soil samples (0-15 cm) were collected from each field of the study area. The collected soil samples were air dried and soil samples were crushed by wooden hammer and sieved through a 2 mm sieve. Soil pH was determined by glass electrode pH (Piper 1967), EC with Solu-bridge method (Black 1965), OC by wet digestion method (Walkley and Black’s rapid titration method 1934) Available potassium was extracted by shaking with neutral normal ammonium acetate for 5 minutes (Hanway and Heidal 1952), DTPA- extractable micro-nutrients with 0.005 N Di-ethylene Triamine Penta Acetic acid (DTPA), 0.01M calcium chloride dehydrates and 0.1M Tri ethanol amine buffered at adjusted pH 7.3 using an atomic absorption spectrophotometer Lindsay and Norvell (1978)and Available Boron through ammonium acetate and EDTA used as buffer masking solution and azomethine-H (Berger and Trong 1939).

The Nutrient Index values and Fertility Classes

According to Ramamoorthy and Bajaj (1969), the nutrient index values (NIV) for various soil parameters were determined from the amount or proportion of samples with low, medium, or high usable nutrient status and classified into different fertility groups.

$$NIV= \frac{(1 \text{ x} PL) +(2 \text{ x } PM) +(3 \text{ x } PH)}{100}$$

Where,
NIV = nutrient index value
PL= % samples fall under low category.
PM= % sample es fall under medium category.
PM = % sample as fall under high category.

Table 1 Nutrient Index Values for Nutrients

NIV for the Nutrient	Fertility class (based on NIV)		
	Low	**Medium**	**High**
Macronutrients (N, P, K and S) and Micronutrients (Fe, Mn, Cu, Zn and B)	<1.33	1.33-2.33	>2.33

Result and Discussion

Soil pH

A study on the soil reaction (pH) of the study area revealed that the soils were moderately acidic to strongly acidic and the pH varied from 4.31 to 5.42 with a mean value of 4.79±0.25. Out of the total soil samples (102 samples), 82.35% of the soils were found moderately acidic and 17.64 % as strongly acidic in soil reaction. The soil pH shows are acidic which may be due to leaching loss of basic cations from the soil surface because of high rainfall, parent material i.e., igneous rocks are found in the study area they produce acidity in soil after decomposition by weathering and vegetation also leads to acidic conditions. Similar results were reported by Chandrakar *et al*., (2017) while working on the soils pH status of Janjgir-Champa they found that pH of the research area ranged from 4.73 to 5.98 with an average value of 5.83±0.38.

EC (dSm^{-1})

The electrical conductivity of the soil water suspension ranged from 0.04 to 0.11 d Sm^{-1} with a mean value of 0.07±0.01 d Sm^{-1}. All the soil samples fall under the normal range (<1.0 d Sm^{-1}). Table 3 indicated that the soils of study area safe for growing of all types of crops. The very less EC value of area may be ascribed to extensive leaching of all soluble salt to deeper layer and runoff losses from surface soil layer. The results were supported by the research work done previously by Meher *et al*., (2020), in the soils of Pahanda Durg district in Chhattisgarh state. He concluded that the EC ranged between 0.01-0.32 d Sm^{-1} with an average of 0.11 d Sm^{-1}. All samples were under good class i.e., <1.0 d Sm^{-1}

Organic Carbon (g kg^{-1})

The variations in the soil organic carbon content were 2.8 to 6.4 g kg^{-1} with an average of 0.43 ± 0.98 g kg^{-1}. Out of all the soil samples, majority of the soil samples i.e., 79.41% were found to be in low in OC and 20.58% samples in medium organic carbon status. The soil C content was found to be low in the study area which may be due to high temperature that enhanced oxidation of native organic matter and carbon and also low rates of organic matter additions in soils. The obtained results were in line with the results obtained by research work of Meher *et al*. (2020) reported that the OC ranged from 2.7 to 7.1 g kg^{-1} with a mean of 4.8. g kg^{-1} of KVK farm Pahanda in Durg District, Chhattisgarh. Similar results were also supported by Singh *et al*., (2018), Kumar *et al*., (2017), Dadsena *et al*. (2021).

Available Nitrogen (kg ha^{-1})

The available Nitrogen content in the soil samples ranged from 150.53 to 263.16 kg ha^{-1} with a mean value of 224.28±32.70 kg ha^{-1}. All the soil samples were found in low nitrogen status. Asija (1956) is 70-76 % only i.e., it recovers only oxidizable N fraction of dry soil N pool. It can be noted that the whole area seems N deficient which might be due to the fact that these soils were very poor organic C content which is biggest source of N. It can also be due to the extensive leaching and runoff losses of various form of N a tropical environment is its high temperature which leads to rapid loss of soil organic matter due to volatilization. The similar results were supported by Singh *et al*. (2017) investigated the soils of Baloda-Bazar District from 55 different villages and found that soil available nitrogen content ranged from 165.3 to 263.25 kg ha^{-1} in different soil orders, with a mean value of 197.3 kg ha^{-1}, falling it's in the low fertility index group. The similar results were also supported by Tirkey *et al*., (2017).

Available Phosphorus (kg ha^{-1})

The status of the available phosphorus varied from 20.51 to 93.32 kg ha^{-1} with an average value of 49.66±15.80 kg ha^{-1}. Majority of the soil samples i.e., 78.43 % was found to be in medium and 8.82 % in high categories, whereas only 12.74 % in the low categories. The deficient P status can be attributed to low organic carbon content and as maximum phosphorus is fixed kaolinite clay mineral and Al and Fe oxide present in the acidic soil of study area. So, its availability is low to medium. The similar results were reported by Tigga *et al*., (2022), reported that available P content in KVK farm varied from 36.45 to 63.91 kg ha^{-1}, with a mean value of 52.32 kg ha^{-1}. Patil *et al*., (2016) in the soils of the Dindur sub-watershed of Karnataka where it was observed that the status of P was low to medium in range. The results were also supported by Singh *et al*., (2018). Jatav (2010) also conclude that soil P deficiency may also be due to improper fertilization in past, porous texture, soil reaction or other nutrient interaction and fixation.

Available potassium (kg ha^{-1})

The available potassium of the study area varied from 103.86 to 223.55 kg $ha^{-1}$with a mean value of 148.81±32.26 kg ha^{-1}. It was found that 39.21 % and 60.78% of samples were under low and medium category, respectively. It was found that Inceptisol of study area had low to medium the status with respect to available potassium. That may be attributed to presence of kaolinite and micaceous clay minerals that inherently have low to medium K in their crystal lattices. The similar results were supported by Dadsena *et al*., (2021) assessed the soil fertility status of Bamhanidih village, Janjgir–Champa district of Chhattisgarh. They reported that the available K ranges from 202.5-293.7 kg ha^{-1}, with a mean value of 255.3 kg ha^{-1}. The similar result showed that the Palani *et al*. (2021).

Available Sulphur (kg ha^{-1})

The sulphur status varied from 5.99 to 51.55 kg ha^{-1} with a mean value of 22.25±10.58 kg ha^{-1}. It was found that sulphur had 59.80%, 28.43 % and 11.76 % of samples were found in low, medium and high rating, respectively. The study area had S status within low to medium ranged which may be due to the poor organic C reserve in soil along with the leaching and runoff losses of sulphate ions from surface layer of study area. The findings were supported by Mehar *et al*. (2020) who assessed the fertility status of the KVK farm in Pahanda. The similar results were also supported by Dadsena *et al*., (2021). Goswami *et al*. (2014).

Available Manganese (mg kg^{-1})

The status of the available Mn ranged from 4.10 to 16.95 mg kg^{-1} with a mean value of 10.82±2.71 mg ha^{-1}. Almost soil samples were found to be in high levels of Mn were collected soil samples from different villages of Majhwa Block of Mirzapur district. The results showed that the DTPA extractable Mn 4.6 to 16.2 with a mean value 5.13 mg kg^{-1}.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. The similar result showed the Mehar *et al*., (2019), (Mandal and Haldar, 1980). Singh *et al*., (2017)

Available iron (mg kg^{-1})

The status of the available Fe varied from 6.01 to 44 .40 mg kg^{-1} with a mean value of 20.87± 10.10 mg ha^{-1}. Most of the soil sample were found to be in high levels of Fe. During study area in the research farm, high available Fe content in Katghora, Korba, might be due to its topography and cultivation of rice, induced by 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 results were supported by Rajeshwar *et al.* (2009) Krishna *et al.* (2018). Mandal *et al.,* (2018), Dadsena *et al.,* (2021).

Available Copper (mg kg^{-1})

The status of the available Cu in the study area ranged from 0.38 to 3.58 mg kg-^{1} with a mean value of 1.82±0.99 mg ha^{-1}. All the samples were found tobe high in Cu. Evaluated soils of the Baloda Bazar district Chhattisgarh. The soil analysis showed that the available Cu content ranged from 0.20 to 3.00 mg kg^{-1} with an average value of 1.81 mg kg^{-1}.The similar result showed the Singh *et al.* (2018), Dadsena *et al.* (2021) and Palani *et al.* (2021).

Available Zinc (mg kg^{-1})

The status of the available Zn varied from 0.48 to 1.29 mg kg^{-1} with a mean value of 0.82± 0.25 mg ha^{-1}. The results were classified into 3 different rating categories as 12.75, 74.50 and 12.75 % samples were under deficient, sufficient and high categories for available Zn respectively. Zn was related to the important soil characteristics. The Zn deficiency increased with increase in pH and decrease with increase in organic C. Here it can be noted that the dominant portion of the area seems Zn sufficient which might be due to the low soil pH which renders Zn in soil solution and makers it available for crops. The similar result showed the Similar observation was made by Rai *et al.* (1970), Mehar et al., (2019), Barooah *et al.* (2020), Mandal (2018).

Available Boron (mg kg^{-1})

The status of the available B varied from 0.14 to 0.91 mg kg^{-1} with a mean value of 0.48±0.17 mg ha^{-1}(Table 3). The percentage distribution of the soil samples was found to be sufficient (59.80 %) and deficient (40.20%) categories. This may be attributed to continuous cereal-cereal cropping without supporting B fertilizers which resulted in mining of from soil reserve. These results were in line with the finding of Kumar (2014), Mehar *et al.,* (2019).

Table 2: Salient properties of soil in the study area of katghora korba

S. No.	Parameters	Range	Average	SD ±
1	Soil pH	4.31-5.42	4.79	0.25
2	EC (dS/m)	0.04-0.11	0.07	0.01
3	Organic carbon (g kg-^{1})	2.8-6.4	4.3	0.9
4	Nitrogen (kg ha^{-1})	150.53-263.16	224.28	32.8
5	Phosphorus (kg ha^{-1}) Bray method	20.51-93.32	49.66	15.8
6	Potassium (kg ha^{-1})	103.86-233.55	148.81	32.26

7	Sulphur (kg ha^{-1})	5.99-51.55	22.25	10.58
8	Iron (mg kg^{-1})	6.01-44.40	20.87	10.1
9	Manganese (mg kg^{-1})	4.10-16.95	10.82	2.71
10	Copper (mg kg^{-1})	0.38-3.58	1.82	0.99
11	Zinc (mg kg^{-1})	0.48-1.29	0.82	0.25
12	Boron (mg kg^{-1})	0.14-0.91	0.48	0.17

Table 3. The overall fertility status based on the Nutrient Index Value

S. No.	Soil	Range	Mean	%Samples Category			NIV	Fertility Class
				Low	Medium	High		
1	N (kg ha^{-1})	150.5-263.1	224.28	100	0	0	1	Low
2	P(kg ha^{-1})	20.5-93.3	49.66	12.74	78.43	8.82	1.96	Medium
3	K (kg ha^{-1})	103.8-233.5	148.8	39.22	60.78	0	1.60	Low
4	S (kg ha^{-1})	5.99-51.55	22.25	59.80	28.44	11.76	1.51	Low
5	Fe (mg kg^{-1})	6.01-44.40	20.87	0	14.71	85.29	2.85	High
6	Mn (mg kg^{-1})	4.10-16.95	10.82	0	2	100	3	High
7	Cu (mg kg^{-1})	0.38-3.58	1.82	0	0	100	3	High
8	Zn (mg kg^{-1})	0.48-1.29	0.82	13	76	13	2	Medium
9	B (mg kg^{-1}	0.14-0.19	0.48	40.9	59.80	0	1.5	Low

CONCLUSION

The soils of research farm were moderately to strongly acidic with normal electrical conductivity and organic carbon status was found in lower categories. The mean values of macronutrients were found as 224.28, 49.66, 148.80 and 22.25 kg ha^{-1} soil available N, P, K and S, respectively. The average values of micronutrients were observed as 20.87, 10.82, 1.82, 0.82 and 0.48 mg kg^{-1}. As per NIV criteria, the available nitrogen, potassium and sulphur were observed in low fertility whereas available phosphorus classified as medium fertility class. In case of micronutrients, available Fe, Mn and Cu were found in high, Zn in medium and B in low fertility classes.

The soils of study area were classified as moderately to strongly acidic which indicated that lime application is beneficial to crop production. Soil N status was evaluated as low status, 25% extra of General recommended dose (GRD) can be suggested for nitrogenous fertilizer. 60% area was low for sulphur status hence, GRD dose of S in the form of either S powder or bentonite S, should be applied and also recommended use of single super phosphate in place of DAP or complex fertilizers. In case of micronutrients, only boron status was recorded as low category hence borax powder at the rate of 2.5 kg ha^{-1} can be applied. ZnSO4.2H2O should be applied in case of Zn level below critical point @ 25 kg ha^{-1}.

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