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Evaluation of soil fertility status of Matiya village of Kasdol block under Balodabazar district of Chhattisgarh

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Abstract
A study was undertaken to evaluate the available nutrient status in the soils of Matiya village of Kasdol block under Balodabazar district of Chhattisgarh. The GPS based 94 soil samples were collected by stratified multi stage random sampling method. The soil analysis showed that the pH, electrical conductivity and organic carbon status ranged between 4.9-7.4, 0.08-0.9 dS m^{-1} and 0.28-0.81% with mean value of 6.27, 0.27 dS m^{-1}, 0.44% respectively. The available nitrogen, phosphorus, potassium and sulphur status ranges between 99.47-281.84 kg ha^{-1}, 4.75-18.55 kg ha^{-1}, 145.04-585.87 kg ha^{-1} and 5.04-26.88 kg ha^{-1} respectively with mean value of 152.80 kg ha^{-1}, 10.40 kg ha^{-1}, 280.49 kg ha^{-1} and 10.99 kg ha^{-1} respectively. The available micronutrient as Zinc, Boron, Iron, manganese and Copper status was found 0.56-2.10 mg kg^{-1}, 0.60-2.40 mg kg^{-1}, 2.14-33.62 mg kg^{-1}, 15.02-38.50 mg kg^{-1} and 0.28-3.12 mg kg^{-1} respectively with mean value of 0.83 mg kg^{-1}, 1.45 mg kg^{-1}, 21.64 mg kg^{-1}, 32.54 mg kg^{-1} and 2.22 mg kg^{-1} respectively. The pH and the electrical conductivity were found under slightly acidic and normal range (< 1 dSm^{-1}) respectively.

Keywords: physico-chemical properties, available nutrients, soil fertility index

Introduction
Agriculture, the backbone of Indian economy, contributes to the overall economic growth of the country and determines the standard of life for more than 50% of the Indian population. The population of the country is increasing day by day and the land holding is decreasing. The increasing population does not want to face the problem of food-grains; therefore, it is necessary to enhance the agricultural production and productivity by sustainable system. 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 that affecting the sustainability. The increasing population has forced on farmers to make use of high doses of chemical fertilizers. Its unscientific use (imbalance dose) is a serious threat to sustainable agricultural production system.

Soil fertility and plant nutrition are two closely related subjects that emphasize the forms and availability of nutrients in soils, their movement to and their uptake by roots, and the utilization of nutrients within plants reported by Foth and Ellis, (1997) [2] that without maintaining soil fertility, one cannot talk about increment of agricultural production in feeding the alarmingly increasing population. Therefore, to get optimum, sustained-long lasting and self-sufficient crop production, soil fertility has to be maintained. Continued removals of nutrients, with little or no replacement have aggravated the potential for future nutrient related plant stress and yield loss. Therefore, evaluating the fertility status of a soil is important to know the productivity of a soil as soil fertility is one of the parameters of soil productivity. (Gebeyaw and Tilahun, 2007) [3].

Table 1: A Salient soil properties of the Matiya village

Soil characteristics	Range	Mean	S.D.
pH (1:2.5, Soil: water)	4.9-7.4	6.27	± 0.57
E.C. (dS m^{-1})	0.08-0.9	0.27	± 0.22
O.C. (%)	0.28-0.81	0.44	± 0.11
Available N (kg ha^{-1})	99.47-281.84	152.80	± 39.13
Available P (kg ha^{-1})	4.75-18.55	10.40	± 3.25
Available K (kg ha^{-1})	145.04-585.87	280.49	± 126.43

Available S (kg ha^{-1})	5.04-26.88	10.99	± 5.35
Available Zn (mg kg^{-1})	0.56-2.10	0.83	± 0.24
Available B (mg kg^{-1})	0.60-2.40	1.45	± 0.49
Available Fe (mg kg^{-1})	2.14-33.62	21.64	± 5.09
Available Mn (mg kg^{-1})	15.02-38.50	32.54	± 6.73
Available Cu (mg kg^{-1})	0.28-3.12	2.22	± 0.65

Materials and methods

Matiya is a village under Kasdol block of Balodabazar district of Chhattisgarh that comes under Chhattisgarh plain zone and this zone has an increase in soil depth, water holding capacity, cation exchange capacity and preponderance of calcium and magnesium ions. The soils have been classified in to four soil orders that widely differ in their production potential and physical characteristics. They are locally called, bhata (*Entisols*), matasi (*Inceptisols*), dorsa (*Alfisols*) and kanhar (*Vertisols*).The soil samples were collected from the field on GPS based. The soil samples have been taken in a zig-zag pattern from the depth of 15-20 cm. systematically across a grid from each of 10 hectare arid area for rainfed and 2.5 hectare for irrigated land. Within each of such sample point, five samples were randomly taken for further analysis, to represent the 10 hectares for rainfed and 2.5 ha for irrigated area. The collected soil sample should be thoroughly mixed and air dried at 20-25 °C and 20 % to 60 % relative humidity. After air drying, soil samples were crushed gently in pestle and mortar and sieved through a 2 mm Sieve. The material larger than 2 mm is discarded.

The selected samples were analysed for soil pH (1:2.5) soil:water suspension after stirring for 30 minutes by glass electrode pH meter as suggested by Piper (1967) [14], Organic Carbon determined by Walkley and Black's rapid titration method (1934). Available nitrogen content was analysed by alkaline potassium permanganate solution and determining the ammonia liberated (Subbiah and Asija, 1956) [16]. For determining soil available Phosphorous, the Olsen's methods (Olsen *et al.*, 1954) [13] are used for neutral-alkaline soils. The potassium is estimated by using a flame-photometer. Extractant are used as neutral normal ammonium acetate. (Jackson, 1967). Available Sulphur in soil was determined by the $CaCl_2.H_2O$ (0.15% Solution) by turbid metric method (Williams and Steinbergs, 1969) [19]. The available Zn, Cu, Mn, and Fe were determined by DTPA (Diethylene Triamine Penta Acetic Acid) method developed by Lindsay and Novell (1978) using atomic absorption spectrophotometer. The available boron content in soil was determined by Hot water method given by Burger and Troug (1939) [1].

The categorization of the soils of the Matiya village whole into the three fertility classes was done according to the nutrient index values calculated from the soil test summarized giving their percentage distribution into low, medium and high categories. The nutrient index (Muhr *et al.* (1965) [12] was given by-

$$\text{Nutrient index} = \frac{[\%\text{ samples in high category} \times 3 + \%\text{ in medium Category} \times 2 + \%\text{ in low category} \times 1] / 100}{}$$

In this percent assessment, a nutrient index less than 1.67 denotes low category and that falling between 1.67 and 2.33 represents the medium fertility class. Value of 2.34 and above (maxi 3.00) signifies a high fertility class in respect of the particular nutrient (Ghosh and Hasan, 1976) [4].

Result and Discussion

The GPS based 94 surface soil samples were collected from Matiya village of Kasdol block based on stratified multi stage random sampling method. The soil pH varied from 4.9-7.4 with mean value of 6.27 that is neutral in nature. Similar results were also found in soils of Katol tahsil in Nagpur district of Maharashtra, in which pH ranges from 7.1 to 8.1 and the alkaline reaction of soils is probably due to the presence of sufficient free lime content as reported by Jibhakate *et al.* (2009) [7]. Vaisnow (2010) [17] claimed acidic to slightly alkaline with pH ranged 4.7 to 8.2 in the *Vertisols* of Dhamtari block of Dhamtari district of Chhattisgarh. The electrical conductivity ranged between 0.08-0.9 dS m^{-1} with mean value of 0.27 dS m^{-1}. Electrical conductivity was found normal. Similar result were found by Jatav (2010) [6], Shukla (2011) [15] and Vaisnow (2010) [17] observed that the Electrical conductivity of soil water suspension are less than 1dSm^{-1} of *Inceptisol* of Baloda block, *Inceptisol*, *Alfisol* and *Vertisol* of Pamgarh block in Janjgir-Champa district (C.G.) and *Vertisols of* Dhamtari (C.G.). The organic carbon content ranged 0.28-0.81% with mean value of 0.44 %.

The status of available nitrogen in the soil is varied from 99.47-281.84 kg ha^{-1} with mean value of 152.80 kg ha^{-1}, the soil test rating for available nitrogen is (<280 as low, 280-560 as medium and >560 kg^{-1} as high level. Approximately 98.94% samples fall under low rating. Similarly Kumar *et al.* (2015) [9] observed that available nitrogen status in the surface soil of different tehsil/ blocks of Raipur district of Chhattisgarh ranged from 113 to 386 kg ha^{-1} with mean value of 245 kg ha^{-1} and 72% low and 48% medium. The available phosphorus status is varied from 4.75-18.55 kg ha^{-1} with mean value of 10.40 kg ha^{-1} and the soil test rating for available phosphorus is (<12 as low, 12.5-25 as medium and >25 kg^{-1} as high level and approximately 72.34% samples found under low rating. Similar result was found by Kumar *et al.* (2017) [10] studied to assess the nutrients status of rice-chickpea grown areas of Chhattisgarh plain region of Chhattisgarh revealed that the available Olsen – P ranged from 2.1 – 44.5 kg ha^{-1} with mean value of 8.8 kg ha^{-1}. The overall per cent sample category under low, medium and high was 85, 15 and 0.0, respectively. The available potassium status in the soil ranged between 145.04-585.87 kg ha^{-1} with mean value of 280.49 kg ha^{-1}. The soil test rating for available potassium is (<135 as low, 135-335 as medium and >335 kg^{-1} as high level and approximately 73.40% samples falls under medium rating. Kumar *et al.* (2015) [9] observed that available potassium status in surface soil of different tehsil/ blocks of Raipur district of Chhattisgarh ranged from 200 – 614 kg ha^{-1}. The percent sample category under low, medium and high 0, 17 and 83 respectively. The available sulphur status ranged between 5.04-26.88 kg ha^{-1} with mean value of 10.99 kg ha^{-1} and the soil test rating for available sulphur is (<22.4 as low, 22.4-35 as medium and >35 kg^{-1} as high level. and approximately 94.68% samples falls under low rating. The available nitrogen, phosphorus and sulphur status is low and the available potassium status is medium in the soils of Matiya village. Similarly Goswami *et al.* (2016) [8] reported that available sulphur (S) varied from 13.72 to 92.96 (mean 38.31 kg ha-1) found 14.28 % samples under (L), 38.09 % in (M) and 47.61 % in (H) status of Sulphur of soil of selected blocks of Bastar district, Chhattisgarh. The available

micronutrient as Zinc, Boron, Iron, manganese and Copper status was found 0.56-2.10 mg kg^{-1}, 0.60-2.40 mg kg^{-1}, 2.14-33.62 mg kg^{-1}, 15.02-38.50 mg kg^{-1} and 0.28-3.12 mg kg^{-1} respectively with mean value of 0.83 mg kg^{-1}, 1.45 mg kg^{-1}, 21.64 mg kg^{-1}, 32.54 mg kg^{-1} and 2.22 mg kg^{-1} respectively. Approximately 92.55% and 72.34% samples of zinc and boron fall under medium and high fertility class respectively. 98.94%, 100% and 98.94 soil samples of iron, manganese and copper falls under high fertility class respectively. The soil test rating for available macro and micronutrients are given in table 2.

Table 2: Soil test rating for available macro and micronutrients.

Macronutrients (Ramamurthy and Bajaj, 1969)			
Soil Parameters	**Low**	**Medium**	**High**
Av. N (kg ha^{-1})	<280	280-560	>560
Av. P (kg ha^{-1})	<12.5	12.5-25	>25
Av. K (kg ha^{-1})	<135	135-335	>335
Av. S (kg ha^{-1})	<22.4	22.4-35	>35
Micronutrients (Katyal and Randhawa, 1983)			
Soil Parameters	Deficient	Sufficient	High level
Av. Fe (mg kg^{-1})	<4.50	4.5-9.0	>9.00
Av. Mn (mg kg^{-1})	<3.50	3.5-7.0	>7.00
Av. Cu (mg kg^{-1})	<0.20	0.2-0.4	>0.40
Av. Zn (mg kg^{-1})	<0.60	0.6-1.2	>1.20
Av. B (mg kg^{-1})	<0.5	0.5-1	>1

The soil fertility index for nitrogen, phosphorus, and sulphur was found 1.01, 1.28 and 1.05 respectively and fertility class were recorded as low. The soil fertility index for potassium is recorded as 2.27 under medium fertility class. The soil fertility index for zinc and boron was 2.05 and 2.72 respectively which comes under low and medium fertility class respectively and the soil fertility class for iron, manganese and copper were found as 2.98, 3 and 2.99 respectively and categorised as high fertility class which is given in table 3.

Table 3: Samples distribution, Nutrient index and fertility class for macro and micronutrients.

Available Nutrients	No. of samples				Percent of samples			Nutrient Index Value	Fertility Class (LMH)
	Total	L	M	H	L	M	H		
N	94	93	1	0	98.94	1.06	0.00	1.01	L
P		68	26	0	72.34	27.66	0.00	1.28	L
K		0	69	25	0.00	73.40	26.60	2.27	M
S		89	5	0	94.68	5.32	0.00	1.05	L
Zn		1	87	6	1.06	92.55	6.38	2.05	M
B		0	26	68	0.00	27.66	72.34	2.72	H
Fe		1	0	93	1.06	0.00	98.94	2.98	H
Mn		0	0	94	0.00	0.00	100.00	3.00	H
Cu		0	1	93	0.00	1.06	98.94	2.99	H

(L=Low, M=Medium and H=High)

Conclusion

It can be concluded from the above results that the soils of Matiya village of Kasdol block under Baloda Bazar district of Chhattisgarh has showed the status of available nitrogen, phosphorus, potassium and sulphur content was low (98.94%), low (72.34%), medium (73.40%) and low (94.68%) level respectively and characterized under strongly acidic to neutral in soil reaction (pH). The soluble salt content (EC) found less than 1 dS m^{-1} that comes under safe limit for soils. The 73.40 per cent soil samples of Matiya were found under low and 25.53 per cent soil samples under medium and 1.06 per cent soil sample under high organic carbon status. Hence, the soils of the study area need proper attention for balanced fertilization so that optimum level of crop production can be achieved. The soils of the study area need regular monitoring to avoid any possible deficiency of the plant nutrients. The soil test results obtained under study must be correlated with crop response.

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