

SOIL FERTILITY STATUS OF MAJOR NUTRIENT IN *VERTISOL* OF DHAMTARI BLOCK

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Abstract: The present investigation entitled “Evaluation of soil fertility status in *Vertisol* of Dhamtari block, under Dhamtari district in Chhattisgarh.” was carried out for soil fertility evaluation during 2009-10 and analyzed for nitrogen, phosphorus and potassium content for delineation the fertility status in *Vertisols* in relation to salient physicochemical characteristics. There was Grid based surface (0-15 cm) soil samples by systematic survey were collected from 69 villages in Dhamtari block where 516 samples were identified from *Vertisol*. The available phosphorus and potassium was negative but non-significant correlation showed with soil pH and the positive but no significant correlation with nitrogen, the pH was positively and significant correlated with electrical conductivity. The positive and significant correlation observed between organic carbon and nitrogen. The organic carbon showed the negative and non-significant correlation with phosphorus and potassium. The nitrogen, phosphorus and potassium showed no significant correlation among them. After evaluation found as the status of available nitrogen in *Vertisols* were found to be low nitrogen status, available phosphorus found low to high and available potassium content generally found medium to high and only 1.75 percent soil samples tested low in available potassium. The nutrient index with respect to available nitrogen, phosphorus and potassium were also calculated on village basis. Four categories of soil fertility viz. Low- Low- Low (LLL), Low-Low-Medium (LLM), Low-Medium-Medium (LMM) and Low-Medium-High (LMH) were observed in *Vertisol* of Dhamtari Block.

Keywords: fertility status, major nutrients, *Vertisol*

INTRODUCTION

Macronutrients (N, P and K) are important soil elements that control its fertility. Soil fertility is one of the important factors controlling yield of the crops. Soil characterization in relation to evaluation of fertility status of the soils of an area or region is an important aspect in context of sustainable agriculture production. Because of imbalanced and adequate fertilizer use coupled with low efficiency of other inputs, the response (production) efficiency of chemical fertilizer nutrients has declined tremendously under intensive agriculture in recent years. The results of numerous field experiments in different parts of India have, therefore indicated “fertilizer-induced un-sustainability of crop productivity”. Variation in nutrient supply is a natural phenomena and some of them may be sufficient where others deficient. The stagnation in crop productivity can not be boosted without judicious use of macro and micronutrient fertilizers to overcome existing deficiencies/imbalance.

Soil fertility is an important factor which determines the growth of plant. Soil fertility is the inherent ability of soils to supply nutrient elements to the plants. Soil Fertility is related to the amount of available nutrients, which measure it by the yield capacity, and still others look it to be a function of organic matter or even soil texture. 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.

Study Area

Dhamtari is a block comes under Dhamtari district in the state of Chhattisgarh. This district is situated between 20°40' North, 81°33' East longitude. The total area of district is 2029 Sq. Km. and 305 meter above the mean sea level. The *Vertisols* group of the soil covered under the different village of the Dhamtari block in Dhamtari district of Chhattisgarh has been taken for fertility evaluation of various aspects and sixty-nine villages comes under *Vertisols*.

MATERIAL AND METHOD

Collection of soil samples

The soil sample was collected from representative area. A field can be treated as a single sampling unit only if it is appreciably uniform in all respect variation in slope, texture, color, crops grown and management levels followed should be taken into amount. Separate sets of composite samples need to be collected from each such area. Recently fertilized plot, bunds, channels, marshy tracts and spots near trees, wells, compost piles or other non-representative locations must be avoided during sampling. The soil samples should be taken in a zigzag pattern. The collected soil sample thoroughly mixed on a clean piece of cloth, polythene sheet or thick paper and kept it in with suitable description and identification marks.

Analysis of Samples

Soil samples collected from the study area, after air drying soil samples are crushed gently in pestle and mortar and sieved through a 2 mm sieve. The

material larger than 2 mm is discarded and then used for the determination of soil pH, organic matter, macronutrients and micronutrients content by adopting standard laboratory methods.

The pH was determined by glass electrode pH meter in soil water suspension (1:2.5) (Piper, 1950). Electrical Conductivity with Solu-bridge method which is reciprocal of resistance, thus, increases with increases in salt concentration described by Black (1965), Organic Carbon by wet digestion method (Walkley and Black's rapid titration method, 1934),

Available nitrogen was estimated by alkaline KMnO_4 method (Subbiah and Asija, 1956), Available phosphorus was extracted by 0.5M NaHCO_3 solution buffer at pH 8.5 (Olsen *et al.*, 1954) is used for neutral- alkaline soils while the Bray and Kurtz P1 methods (Bray and Kurtz 1945) is used for acid soils. Available potassium is estimated through neutral normal ammonium acetate by using a flame-photometer described by Jackson (1967). The samples were categorized as per the rating limit given in Table 1.

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

Classification for pH values			
Strongly acid	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})			
No deleterious effect on crop	Critical for germination	Critical for salt sensitive crop	Injurious to most crops
<1.0	1.0-2.0	2.0-3.0	>3.0
Parameters	Low	Medium	High
O.C. (%)	0.25-0.50	0.50-0.75	>0.75
Macronutrients			
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

RESULT AND DISCUSSION

Soil reaction (pH)

The *Vertisols* samples of the study area were determined for pH (Table 2) and observed in the range of 4.7 – 8.2 with the mean value of 7.01.

pH estimation from total 516 soil samples of Dhamtari block and it was observed that nearly 5.24% samples under moderately acidic (5.5-6.0), 8.13 % under slightly acidic (6.0-6.5), 0.39 % under strongly acidic (<5.5) and only 77.32 % samples

were categorized under neutral in reaction (Table 3). The tables revealed that the surface soils studied were strongly acidic (4.7) to slightly alkaline (8.2) in reaction and appeared to be influenced by rainfall and topography (Thangaswami *et al* 2005, Rajeshwar *et al.*, 2009). This wide variation in soil pH of *Vertisols* may be attributed to be injudicious use of irrigation water imbalance and continued use of nitrogenous fertilizers and continuous rice-rice cropping system prevailing in the area under study.

Table 2. Salient soil properties of study area

Soil characteristics	Range	Mean	S.D
pH (1:2.5, Soil water)	4.7-8.2	7.01	± 0.5
E.C. (dS m^{-1})	0.01-0.89	0.22	± 0.11
O.C. (%)	0.15-0.91	0.54	± 0.14
Available N (kg ha^{-1})	100.35-451.58	219.48	± 63.52
Available P (kg ha^{-1})	0.35-51.96	8.13	± 6.79
Available K (kg ha^{-1})	23.52-566.04	262.11	± 73.42
Available Fe (mg kg^{-1})	0.22-6.52	2.46	± 1.02

Available Mn (mg kg ⁻¹)	3.66-95.0	21.99	±8.17
Available Cu (mg kg ⁻¹)	6.36-97.02	38.61	±14.39
Available Zn (mg kg ⁻¹)	0.04-3.66	0.82	±0.57

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

Classification for pH values			
Strongly acid	Moderately acid	Slightly acid	Neutral
0.39	5.24	8.13	77.32
Classification for total soluble salt content (EC as dS m ⁻¹)			
No deleterious effect on crop	Critical for germination	Critical for salt sensitive crop	Injurious to most crops
5.23	44.28	31.10	19.19
Parameters	Low	Medium	High
O.C. (%)	32.95	56.59	8.33
Macronutrients			
Av. N (kg ha ⁻¹)	75	25	0
Av. P (kg ha ⁻¹)	81.40	15.50	3.10
Av. K (kg ha ⁻¹)	1.75	81.38	16.87

Salt concentration (EC)

The total soluble salt content expressed as electrical conductivity (EC), varied from 0.01 to 0.89 dS m⁻¹ with a mean value of 0.22 dS m⁻¹ at 25°C (Table 2) and 44.28% samples have found that critical for germination (Table 3). The total soluble salts observed under studied samples were safe for germination and growth of plants.

Organic Carbon

The organic carbon analyzed in all sampled *Vertisol* exhibited in the range of 0.15 to 0.91 with a mean value of 0.54 % (Table 2). Thus, the *Vertisol* of Dhamtari block is medium in Organic Carbon content. Distribution of soil samples with respect to organic Carbon content indicates (Table 3) that about 32.95 % samples had low (<0.50 %) organic C, 56.59 % in medium (0.50-0.75%) and only 8.33 % samples had higher organic Carbon (>0.75%). Most of the soils found under medium organic carbon status,

Available N

The available N content (Table 2) of *Vertisol* ranged from 100.35 to 441.58 kg ha⁻¹ with an average value of 219.48 kg ha⁻¹. The majority of the sampled area (75 %) covering in *Vertisol* of Dhamtari block fall under low status (<280 kg ha⁻¹) in available N content (Table 3). Only 25% soil samples were categorized under medium (280-560 kg ha⁻¹) status. In this way, almost all the soil samples tested were found to be deficient in N. It is fact that the available N analyzed by alkaline KMnO₄ method as suggested by Subbiah and Asija (1956) do not exhibit the exact availability of N in dry soil. It is the measure of the oxidisable N in dry soil. It is quite obvious that efficiency of

applied nitrogen is very low due to the fact that nitrogen is lost through various mechanisms like ammonia volatilization, nitrification, succeeding denitrification, chemical and microbial fixation, leaching and runoff (De Datta and Buresh, 1989) which resulted in low amount of nitrogen in soil. These results are in conformity with the findings of Sharma *et al.* (2008), Kumar *et al.* (2009) and Rajeshwar *et al.* (2009).

Available P

The available P varied from 0.35 to 51.96 kg ha⁻¹ with a mean value 8.13 kg ha⁻¹ in *Vertisol* (Table 2). The study indicates that about 2/3rd of the sampled area exhibited low and 1/3rd under medium range of phosphorus content (Table 3). or the available phosphorus content in larger area is generally low, Phosphorus is present in soil as solid phase with varying degree of solubility. When water soluble P is added to the soil, it is converted very quickly to insoluble solid phase by reacting with soil constituents and the farmers are producing higher yields with intensive cropping associated with imbalance use of fertilizers leading to higher Phosphorus P-uptake. Moreover, the farmer's are applying higher doses of nitrogenous fertilizers leading to soil reaction towards acidic range as also evident from soil pH from this study. Phosphorus fixation may occur due to acidity and high amount of clay in *Vertisol* attributing low level of phosphorus in these soils. Similar results were also reported by Sood *et al.* (2003), Kumar *et al.* (2009) and Kumar *et al.* (1995).

Available K

The available Potassium content in *Vertisol* ranged from 23.52 to 566.04 kg ha⁻¹ with an average value 262.11 kg ha⁻¹ (Table 2). The data reveals that 81.38 % soil samples tested were in medium level of available Potassium and only 1.75 % samples were tested under low range and 16.87 % samples were tested were in high level of available Potassium (Table 3). Adequate level of available Potassium in *Vertisol* of the study area may be attributed to the prevalence of K-rich clay minerals like *illite* and *kaolinite*.

Relationship between soil properties and available macronutrients

The correlation studies presented in table 4, indicated that pH showed positive and non significant correlation with available nitrogen ($r = 0.016$), organic carbon ($r = 0.028$). These findings are in conformity with the results of Sharma *et al* (2008).

The soil reaction (pH) showed significant and positive correlation ($r = 0.119^{**}$) with electrical conductivity. The soil pH showed non significant and negative correlation ($r = -0.015$) with phosphorus. These results are in agreement with Kumar *et al.* (2009), because at higher pH, phosphorus is precipitated as Ca-phosphate and reduced phosphorus availability. However, potassium showed a negative and non significant correlation ($r = -0.009$) with soil reaction.

The electrical conductivity of *Vertisols* showed positive and non significant correlation ($r = 0.065$) with nitrogen, $r = 0.085$ with phosphorus, (Table 4). Sharma *et al.* (2008) also observed positive

relationship between electrical conductivity and available nitrogen and phosphorus in the soils of Amritsar, Punjab. However, available potassium showed negative and non significant relationship ($r = -0.062$) and organic carbon showed positive and non significant relationship ($r = 0.048$). Almost similar results were also reported by Sharma *et al.* (2008).

The correlation studies presented in table 4 revealed that there was a significant and positive relationship ($r = 0.123^{**}$) between available nitrogen and organic carbon. These findings are in conformity with the results reported by Sharma *et al.* (2008). This relationship was found because most of the soil nitrogen is in organic forms. There is a definite relation of organic carbon with available nitrogen because organic matter can release the mineral soluble nitrogen in the soil. Hence, organic carbon status of the soil can predict the available nitrogen which shows positive relationship. Whereas, available phosphorus and potassium showed negative and non significant relation ($r = -0.061$) and ($r = -0.001$) with organic carbon, It may be attributed due to the presence of calcium ions in *Vertisols* of Dhamtari Block, which may lead to phosphate fixation and thus showing the inverse relationship while forming the complex with organic matter.

The correlation studies presented in table 4 and revealed that available potassium had non-significant and negative relation ($r = -0.067$) with available nitrogen and ($r = -0.008$) with available phosphorus, respectively. Similarly, available nitrogen showed non-significant and negative relation ($r = -0.076$) with available phosphorus.

Table 4. Correlation coefficients (r) between physico-chemical properties and available N, P and K in *Vertisol* of Dhamtari block.

	PH	EC	OC	N	P	K
pH						
EC.	0.119**					
OC.	0.028	0.048				
N	0.016	0.065	0.123**			
P	-0.015	0.085	-0.061	-0.076		
K	-0.009	-0.062	-0.001	-0.067	-0.008	

*Significant at 5% level **Significant at 1% level

Thus, it can be concluded from the present study that the *Vertisols* of Dhamtari Block were indicated slightly acidic to neutral in reaction. However, all soil samples were in safe limit of electrical conductivity and majority of the soil samples represented low to medium in organic carbon. These soils are low in available nitrogen and available phosphorus content. However, available potassium is

low to medium in these soils, hence, the *Vertisols* needs regular attention regarding nutrient management practices and regular monitoring of soil health for better crop production.

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