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Assessment of Macro and Micro Nutrients of Soil in a Small Agricultural Watershed

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Abstract: This study deals with the determination of various topographic parameters and characteristics of micro & macro nutrient of soil sample existing in the *Sandhari nala* watershed. The specific locations of various soils sampling area situated at different villages of watershed were identified using Global Positioning System (GPS). Soil samples collected from different locations of the watershed were analyzed for their macro (N, P, K) and micro (zinc, iron, copper, manganese) nutrients. The availability of nitrogen and phosphorus was found to be low in almost all soil samples, whereas the availability of potassium was found medium rang. The availability of micro nutrient (zinc, copper, iron) was found to be in critical level in almost all soil samples. The data reveals that in soils are deficient in N, P, & K which requires addition of extra fertilizer and manures to make it suitable plantation and increase their healthy growth.
Keywords: Watershed, Topography Survey, Soil Analysis.

Introduction

Watershed development is an important component of rural development and natural resource management strategies in many countries. A watershed is generally considered as geo-hydrological unit from which runoff resulting from precipitation, flows past a single point known as the outlet into either a stream or a lake or an ocean.

Macronutrients (N, P and K) and Micronutrients (Fe, Mn, Zn, and Cu) are important soil elements that control its fertility. Top soil confine humus, an important food resource for plants, which increase biological activity, soil fertility and control the air and water content of soil[16]. The importance of soil fertility and plant nutrition to the health and survival of all life is well 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 on the chemical, biological, and physical properties and their relationships in the soil-plant-atmosphere continuum that control nutrient availability. Nutrient balance is the key component to increase crop yields. 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. In Chhattisgarh state, about 156 tons of nitrogen , 68 tons of phosphorus and 137 tons of potassium removed by crops per year[15]. Because of imbalanced and inadequate fertilizer use coupled with low efficiency of other inputs, nutrients have declined tremendously under intensive agriculture in recent years. Plant growth depends upon soil fertility and the inherent ability of soils to supply essential nutrient elements to plants. Soil fertility is related to the amount of available nutrients which is measured by crop yield capacity and still others look it to be a major function of organic matter or even soil texture. pH affects all chemical, physical and biological soil properties[2].

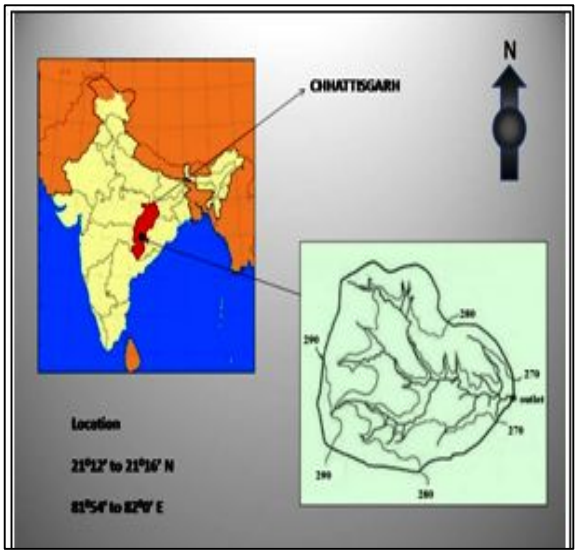
Soil test-based fertility management is an effective tool for increasing productivity of agricultural soils that have high degree of spatial variability resulting from the combined effects of physical, chemical or biological processes[5]. Soil sampling and testing provides an estimate of the capacity of the soil to supply adequate nutrients to meet the needs of growing crops. The test results are compared to standard response data to estimate the need to supply additional nutrients for optimum crop production. Traditionally, the goal of soil sampling was to develop a representative estimate of the average nutrient needs for a field so that the best single rate of application could be determined.

The main objective of the study is assessed of macronutrients (N, P and K) and micronutrients (Fe, Mn, Zn, and Cu) in agricultural watershed. The study helps in understanding the future scope of growth of vegetation in the region.

Materials and Methods

Study Area: Sanghari nala watershed has been considered for this study, which is in Arang block of Raipur district (fig.1). The watershed comprises of several villages namely Rasni, Khamtarai, Kalai, Jaraud, Chhatauna, Ghumrabhata and Bodra. The watershed is located within $81^0$54' to $82^0$0' E longitude and $21^0$12' to $21^0$16'' N latitude at an altitude ranged from 270 to 300 m above mean sea level (MSL) covering a watershed area of 54.50 km^2. The average slope of the watershed is 1.5%.

Fig. 1: Location map of the study area



The watershed receives an average annual rainfall of 1420 mm out of which the monsoon season contributes more than 80% rainfall. About 80-90% of total Rainfall occurs between June to September, most of which goes as runoff resulting continuous depletion and poor recharge of ground water due to high infiltration rate, poor moisture retention capacity and low irrigation potential, majority cultivated area is rainfed.

The daily mean temperature ranges from a maximum of 41^0C to a minimum of 10^0C. The daily mea relative humidity varies from a minimum of 10% in the month of April to a maximum of 41% in the month of July. Major soil texture, clay, sandy clay loam and sandy loam soils were found in the watershed area.

Topography: The GPS surveying techniques was used to identify the specific locations of various soil samples situated at different villages of watershed (fig.2) since the Global Positioning System (GPS) is an integral part of topograhic surveys. The topographic datasets were originally stored as point measurement. Each point had northing, easting, and elevation values.

Analytical details of soil samples: Total 7 soil samples were collected from different depth at various locations (Table 1). These samples were dried at room temperature and grind in powder form and analyzed in the laboratory for the analysis of different chemical properties.

Fig. 2: Location of soil sampling point in watershed

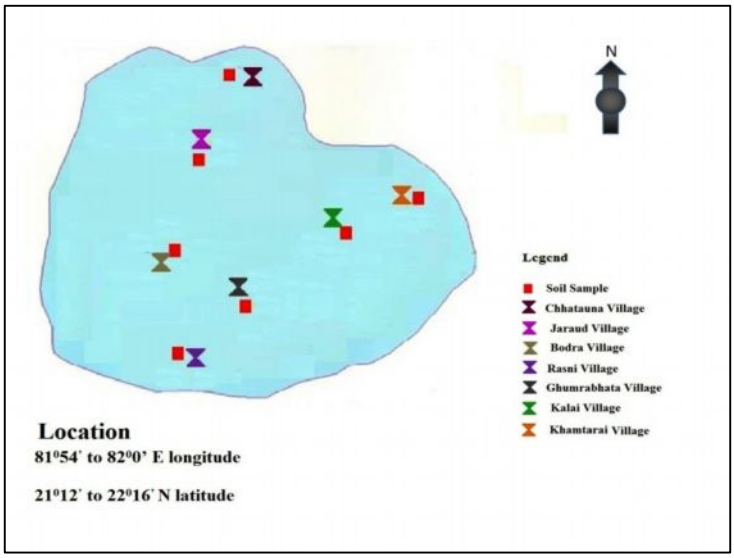


Table 1: Details of soil samples at different locations point

S.N.	Village Name	Sample Code	Depth (cm)	Location		
				N	E	Elevation (m)
1	Amethi	AM-1	22	21°13.469'	81°59.504'	270
2	Bodra	BD-1	18	21°12.893'	81°55.836'	284
3	Ghumrabhata	GH-S1	16	21°12.609'	81°56.864'	287
4	Khamtarai	KH-1	17	21°13.907'	81°57.746'	273
5	Jaroud	J-2	17	21°14.262'	81°56.031'	284
6	Kalai	KL-1	20	21°13.947'	81°56.953'	280
7	Chhatauna	CHHT-S1	15	21°15.680'	81°56.497'	285

A V-shaped hole was duged with the required depth and slice of approximately 2.5-3.0 cm thick was cut out. Both sides of the slice were trimmed leaving a 3.0 cm strip, which is then put in a clean container. After that, the soil was mixed thoroughly in the container and all soil clods had broken up. From the bulked sample, about 500 gm sample was taken as air-dried at room temperature within 12 hours of extraction. The micro and macrao properties of soil analyzed by standard procedure as presented in (Table 2).

Table 2: Laboratory methods used for chemical analysis of soil

S.N.	Particulars	Method used
1	Available N (kg ha^{-1})	Alkaline permanganate method (Subbaiah and Asija, 1956)
2	Available P (kg ha^{-1})	Olsen's method (Olsen *et al.,* 1954)
3	Available K (kg ha^{-1})	Flame photometric method (Jackson, 1967)
4	pH	pH meter
5	Electrical Conductivity (mili mhos)	Solubridge conductivity meter method (Black, 1965)
6	Micro component (Zinc, Iron, copper, Manganese) ppm	Atomic absorption Spectrophotometeric method

pH: It was measured by glass electrode pH meter in 1:2.5 soil water suspension after stirring for 30 minutes as described by piper[11].

Electrical conductivity: The soluble salts in soils are determined by values of electrical conductivity. Solution offers some resistance to passage of electric current through them, depending upon the salt content.

Higher the salt content, lower is the resistance to flow of salt concentration. EC which is reciprocal of resistance, thus, increases with increase in salt concentration. It was determined by the procedure as described by Black[1]. According to ohm's law - Conductivity is inversely proportional to resistance. The EC of soil water extract is generally measured in smaller units such as milliohms/cm (mmhos/cm or microhms/cm at 25^0C). The international unit (SI) of expression Siemens/m(S/m) and smaller SI unit is deci Siemen/m (dS/m). One dS/m = one mmhos/cm.

Available nitrogen: Available nitrogen in soil was determined by alkaline potassium permanganate method as described by Subbiah and Asija[14]. The procedures involve distilling the soil with alkaline potassium permanganate solution and absorb the ammonia liberated in boric acid which is then titrated with Standard sulphamic acid.

Available phosphorus: Available phosphorus was estimated by the ascorbic acid method as described by Olsen[10].

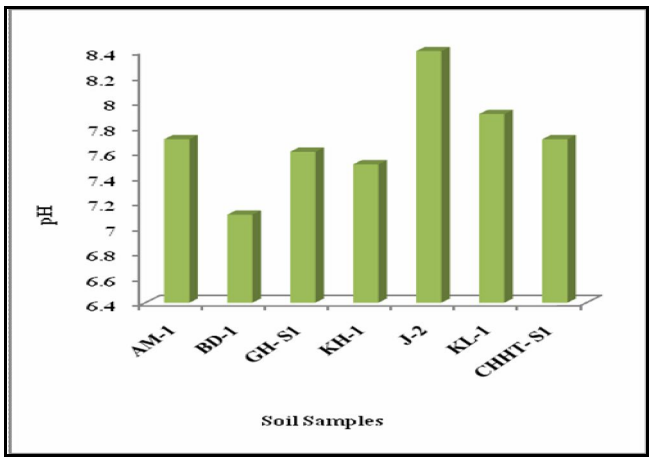
Available potassium: Available potassium was extracted from the 5 gm soil with the help of suitable extractant neutral normal ammonium acetate by shaking, followed by filtration or centrifugation and K is determined in the extract using flame photometer. The availability iof potassium was estimated by the method described by Jackson[6]. The photometer analysis is based on the measurement of the intensity of characteristic line emission given by the element to be determined.

Micro nutrient: The available Zn, Cu, Mn and Fe in soils was estimated by the method developed by Lindsay and Novell[8] using DTPA (Diethyl Triamine Penta Acetic Acid) which was found useful for separating soils into deficient and non deficient categories for Zn, Cu, Mn, and Fe by using atomic absorption spectrophotometer.

Results And Discussion

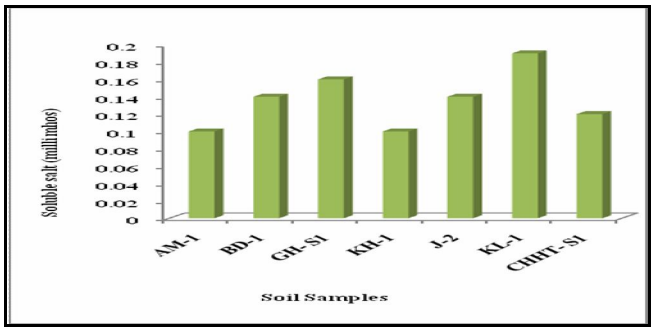
pH and EC of Soil Nutrient: The pH value measures the ratio of H^+ ions to OH^- base ions in the soil. If the soil solution has more H^+, the soil is acidic. If the OH^- dominates, the soil is alkaline. The equal balance between them is neutral and its value 7.0. Brady found that a pH range of 6.5 to 7.5 is optimal for plant nutrient availability[2]. As evident from the fig. 3, pH value is ranges from 7.1 to 8.4 (Average: 7.7) in the different soil sample. The pH of the soil samples was found to be 57.1 % of sample showed slightly alkaline nature, 28.6 % of soil samples was shown moderately alkaline nature and rest was 14.3 % shown neutral according to Foot & Ellis[3]. The minimum value of pH was found to be7.1 in sample BD-1 and maximum was 8.4 in sample J-2. The neutral to alkaline pH may be attributed to the reaction of applied fertilizer material with soil colloids, which resulted in the reaction of basic cations on the exchangeable complex of the soil.

Fig. 3: pH value of various soil samples



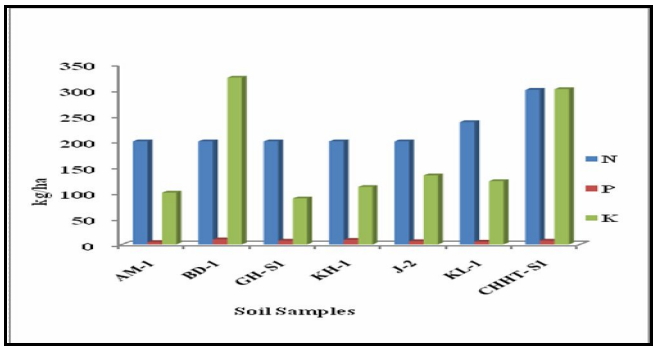
The value of Electrical Conductivity (EC) ranges (0.10 to 0.19, Average: 0.1 milli mhos) in different soil samples (Fig. 4). The highest value of EC was found to be 0.19 milli mhos in Sample KL-1 whereas the lowest amount of EC was 0.1 milli mhos found tobe in sample AM-1.

Fig. 4: Soluble salt value of various soil samples



Macro nutrient of soil samples: As evident from the fig.5 the availability of Nitrogen in different soil samples were ranged (200.70 to 301.06, Average: 220.4 kg/ha) (Fig. 5). On the basis of the rating of nitrogen suggested by Subbiah and Asija, 85.6 % of the soil samples was found to be low < (250 kg ha^{-1}) and rest was (14.3%) in the medium category (250-500 kg ha^{-1}) [14]. Most of the sample was shown the lower availability of nitrogen. The availability of nitrogen is not only an essential part of carbohydrates, fats and oils but also an essential ingredient of proteins. The available nitrogen is an important factor to increase the soil fertility. Generally, normal soil contains 272 – 544 kg ha^{-1} of available nitrogen[4]. The deficiency of nitrogen shows uniform yellowing of older leaves including veins, leaves that will eventually turn brown and die. The excess of nitrogen shows plants will be dark green in color and new growth will be succulent.

Fig. 5: Macro nutrient value of soil samples



The value of Phosphorus in different soil samples were ranged (4.8 to 9.85, Average: 7.0 kg/ha) (Fig. 5). On the basis of limits suggested by Muhr all the soil samples showed the lower availability of Phosphorus < (20 kg ha^{-1}) [9]. It is a constituent of the cell nucleus, essential for cell division and the development of meristematic tissues at the growing points. It makes 0.1 to 0.5% of dry weight of the plant. The normal value of phosphorus in soil should be (22.5 – 56 kg ha^{-1})[4]. The deficiency of phosphorus shows plant growth will be slow and stunted whereas the excess of phosphorus will not have direct effect on the plant but may show visual deficiencies of Zn, Fe, and Mn.

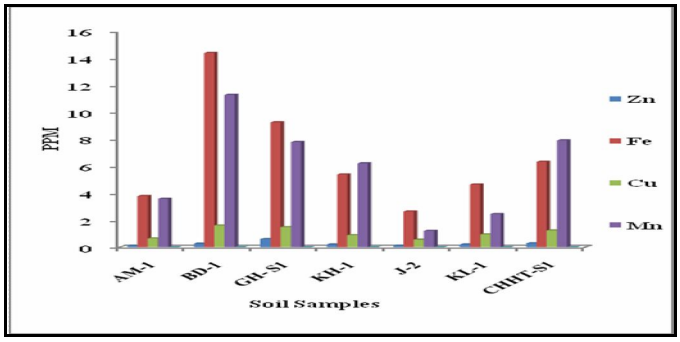
Table 3: Macro nutrient properties of soil samples

S. No.	Village Name	Sample Code	Chemical Properties				
			pH	Soluble salt (milli mhos)	Nitrogen available (kg/ha)	Phosphorus available (kg/ha)	Potash available (kg/ha)
1	Amethi	AM-1	7.7	0.10	200.70	4.48	100.8
2	Bodra	BD-1	7.1	0.14	200.70	9.85	324.8
3	Ghumrabhata	GH- S1	7.6	0.16	200.70	7.16	89.6
4	Khamtarai	KH-1	7.5	0.10	200.70	8.96	112.0
5	Jaroud	J-2	8.4	0.14	200.70	6.27	134.4
6	Kalai	KL-1	7.9	0.19	238.34	5.37	125.2
7	Chhatauna	CHHT- S1	7.7	0.12	301.06	7.16	302.4
Average			7.7	0.1	220.4	7.0	169.6

The value of Potassium was ranged (89.6 to 324.8, Average: 169.6 kg ha^{-1}) (Fig. 5). On the basis of limits suggested by Muhr most of the soil samples (71.4 %) were found to be medium range (125-300 kg ha^{-1}) and rest (28.6 %) was found to be low ranges[9]. The deficiency of potassium shows yellowing stars from tip/margin of lower leaves and extends to center of leaf base. The excess of potassium shows plants will exhibit typical Mg, and possibly Ca deficiency symptom due to a cation imbalance.

Micro nutrient analysis of soil samples: The value of zinc content ranges from 0.11 to 0.60 ppm within the average of 0.3 ppm in different soil samples (Fig. 6). In the deficiency of zinc upper leaves will show chlorosis on midrib. The excess of zinc shows the Fe deficiency will develop.

Fig. 6: Micro nutrient of various soil samples



The value of Iron content was found to be ranged from (2.65 to 14.4, Average: 6.6 ppm) in different soil samples (Fig. 6). The deficiency of iron shows veins remain conspicuously green and other leaf portion turn yellow and tending towards whiteness, whereas the excess iron shows a bronzing of leaves with tiny brown spots on the leaves.

The value of copper nutrient was found to be ranged from (0.56 to 1.61, Average: 1.1 ppm) in different soil samples (Fig. 6). The deficiency of copper shows leaves including veins become yellow and tending towards whiteness occurrence of marginal leaf burning, whereas excess copper shows Fe deficiency may be induced with very slow growth. Roots may be stunted.

The value of manganese content was found to be ranged from (1.21 to 11.3, Average: 5.8 ppm) in different soil samples (Fig. 6). The deficiency of manganese shows interveinal yellowing of young leaves but not tending towards whiteness whereas the excess manganese older leaves will show brown spots surrounded by a chlorotic zone and circle.

Table 4: Micro nutrient properties of soil samples

S. No.	Village Name	Sample Code	Chemical Properties			
			Zinc (ppm)	Iron (ppm)	Copper (ppm)	Manganese (ppm)
1	Amethi	AM-1	0.11	3.79	0.65	3.59
2	Bodra	BD-1	0.26	14.4	1.61	11.3
3	Ghumrabhata	GH- S1	0.60	9.26	1.49	7.80
4	Khamtarai	KH-1	0.20	5.39	0.89	6.22
5	Jaroud	J-2	0.11	2.65	0.56	1.21
6	Kalai	KL-1	0.20	4.65	0.95	2.46
7	Chhatauna	CHHT-S1	0.29	6.33	1.24	7.92
Average			0.3	6.6	1.1	5.8

Conclusions

Most of the soil sample shows the slightly alkaline nature and low value of EC, N and P. The potassium was medium range in almost soil. Excess of phosphorus will not have direct effect on the plant but may show visual deficiencies Zn, Fe and Mn, whereas, due to the excess of potassium plants will exhibit typical Mg and possibly Ca deficiency symptom due to a cation imbalance. The excess amount of micro nutrient shows a bronzing of leaves with tiny brawn spots on the leaves. The data reveals that in location point where the soil

are deficient in N, P, & K which requires addition of extra fertilizer and manures to make it suitable plantation and for increasing plant growth.

References

1. Black,C.A.and Evans,D.D. Method of soil analysis. American Society of Agronomy, Madison, Wisconsin, USA. 1965, 131-137.
2. Brady, N.C. and Weil, R.R., The Nature and Properties of Soils, 13th Ed. Prentice- Hall Inc., New Jersey, USA., 2002, 960.
3. Foth, H.D. and Ellis, B.G., Soil fertility, 2nd Ed. Lewis CRC Press LLC., 1997, 290.
4. Gupta, S., Mallick, T., Datta, J.K. andSaha, R.N., Impact of opencast mining on the soil and plant communities of Sonepur-Bajari opencast coal mine area, West Bengal, India.Vista in Geology., 2006, 5: 194-198.
5. Goovaerts,P.,Geo-statistical tools for characterizing the spatial variability of microbiological and physico-chemical soil properties. Biol. Fertil. Soil., 1998, 27: 315-334.
6. Jackson, M. L., Soil chemical analysis. Prentice Hall of India Pvt. Ltd., New Delhi., 1967.
7. Kizza,S.,Totolo,O., erkins, J., and Areola, O., Analysis of persistence soil nutrient status in abandoned cattle kraals in a semi arid area in Botswana. Scientific Research and Essays, 2010, 5 (23): 3613-3622.
8. Lindsay, W.L. and Norvell, W.A., Development of DTPA soil test for zinc, iron, manganese and copper. Soil Science. Society of America Journal., 1978, 42: 421-428.
9. Muhr, G.R., Datta, N.P., Sankarasubramaney, H., Dever, F., Laley, V.K. and Donahue, R.L., Critical test value for available N, P & K in different soils. Soil Testing in India, 2nd edn.U.S. Agency for International Development, New Delhi, 1963, 120.
10. Olsen, S.R., Cole, C.V., Wantanable, F.S. and Dean, L.A., Estimation of available phosphorus in soil by extraction with Sodium bicarbonate. United State Dept. of Agric. CIRC., Washinton, D.C., 1954, 939.
11. Piper, C.S. (1967) Soil and plant analysis. University of Adelaide, Adelaide, Australia.
12. Soil Testing, Perennial Crop Support Series publication no 2008-001 AFG February 8, 2008.
13. Sarah Kizza, Otlogetswe Totolo, Jeremy Perkins and Olusegun Areola, Analysis of Persistence Soil Nutrient Status in Abandoned Cattle Kraals in A Semi Arid Area In Botswana. Scientific Research and Essays, 2010, 5 (23): 3613-3622.
14. Subbaiah, B.V. and Asija, G.L., A rapid procedure for the estimation of available nitrogen in soil.Curr. Sci., 1956, 25: 259.
15. Tandon , H.L.S, Fertilizers in Indian Agriculture- from 20 th to 21st century. FDCO, New Delhi, India., 2004, 240.
16. Wilson, S. D. and David, T. Quadratic variation in old- field species richness along gradients of disturbance and nitrogen.Ecology, 2002, 83: 492–504.

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