Soil Fertility Status of Some Villages in Chilika Block of North Eastern Ghat Agroclimatic Zone of Odisha

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Abstract— *The work on the status of soil fertility in Chilika Block of Khurda district in Odisha has not been done extensively. Total 30 surface (0-15cm) soil samples were collected from three villages namely Vellery, Badakul and Chasangara of Chilika Block of Khurda district. The organic carbon content of all the three villages varies from low to very high with a mean value varying from 0.49% to 0.75% and is good enough for crop production and in Vellery village it is found to be highest due to presence of black soil. The available N content of all the three villages are found to be low and is found to be in positive co-relation with the organic carbon content of the lands. The available N content is higher in all the land types of Chasangara village in comparison to similar land types of other two villages. The available P content of all soil in all the three villages is moderate. However the P content of Vellery village is higher than other two villages because of the higher content of organic matter. The available K contents of all the soils of all the three villages are high and especially in Vellery village it is highest. This is a good indication for the high yield of various fruits, vegetables and tuber crops which need a high amount of K. The S content is found to be comparatively higher in the low land soils of all the three villages under study. Again the relatively higher content of S in all the three types of land i.e. upland, medium land and low land of Vellery village in comparison to other two villages has a good co-relation with the other parameters under study. The various results obtained from the different soil tests give information about the nutrients status of the soil of the three villages under study and on the basis of these findings, a balanced recommendation of fertilizers and manures to various crops can be made that will help in increasing the productivity of different food crops for the economical development of the farmers of that area.*

Keywords— soil fertility, Chilika, Soil texture, organic carbon.

I. INTRODUCTION

Use of specified dose of fertilizer in the agricultural field is the most important agricultural input for increasing crop production. Soil testing is now considered as an important tool for the recommendation of the fertilizers doses for various crops in India. Soil testing is based on intimate knowledge of soil-crop-variety-fertilizer-climate-management interaction under a given situation. The fertilizer application by farmers in the field without knowledge of soil fertility status and nutrient requirement of different crops usually leads to adverse effect on soil as well as crops by way of nutrient deficiency or toxicity due to over use or inadequate use of fertilizers. Finally these results in loss of precious financial resources of farmers and lowers the soil productivity and accelerates the soil degradation in long run.

The Soil taxonomy of Odisha has been extensively studied by many workers .The soils of Odisha are divided into four orders such as Inceptisols (49%); Alfisols (35%); Entisols (10%) and Vertisols (6%). Again about soil reaction 69% of the soils of Odisha are acidic in reaction, 6% are saline, rest 25% are neutral and with regards to the fertility status of soils of Odisha on district wise basis nearly 60% soils are medium and 40% soils are low in organic carbon content; 73% are medium and 27% soils are low in available phosphorus. With respect to availability of Potassium, 7% soils are low, 86% are medium and 7% are high. It is concluded that soils of two districts, namely Boudh and Phulbani are having high Potassium status whereas districts of Ganjam and Gajapati are low in available Potassium content (Nanda et. al, 2008). Hence due to such variation in the nutrient status in the different districts of the state and different blocks of districts, certain doses of fertilizer recommendations for different crops in Odisha is necessary to be specified for different areas.

Work on preparation of soil fertility maps have been done for Khurda district of Odisha, but no such work has been done for the villages under study in the present investigation. Therefore, an attempt has been made in the present investigation to prepare soil fertility maps for three different villages of Chilika block and to find out the soil fertility related production constraints of different crops grown and to suggest remedial measures.

Study Area

Three villages namely Badakul, Chasangara and Vellery of Chilika block which belong to Khurda district are included in the present investigation. The block comes under North Eastern Ghat Agroclimatic Zone of Odisha [1] and derives its name from the famous Brackish water Lake *Chilika* which is situated nearby and connected to Bay of Bengal. The Badakul village is very near to Chilika Lake. The Chasangara village is located on the right hand side of NH-5 when one proceeds from Bhubaneswar to Berhampur and is 6 km away from Badakul village. The Vellery village is situated between Balugaon and Badakul on NH-5. The topography of coastal areas of Khurda district, particularly Chilika block is such that the elevation

decreases from west direction that is Eastern Ghat gradually up to Chilika Lake and finally Bay of Bengal. The land type and soil formation of these areas have been greatly influenced by the Eastern Ghats. North Eastern Ghat Agroclimatic Zone consists of four districts namely Khurda, Nayagarh, Kandhamal and Boudh. This zone spreads over an area of 2.85 million hectares. The mean annual rainfall is 1597mm. The mean maximum summer temperature is 370c and mean minimum winter temperature is 10.40 c. The climate is hot and moist sub-humid. Red, Brown and Black, soils are found in this Agroclimatic Zone. As per modern system of soil classification 'Soil Taxonomy', the soils are classified under the orders *Alfisols, Inceptisols and Entisols* [2].

Ten numbers of surface soil samples (0-15cm depth), three from uplands, three from medium lands and four from low lands were collected from each of the three villages. As surface soil contains major portions of plant nutrients in available form and is utilized by the plants for higher production of food, fiber and fuels, nutrient content of surface soil sample is most important for crop production. North Eastern Ghat Agroclimatic Zone consists of undulating topography of hills, hill slopes, uplands, medium lands and low lands. The present investigation will help in knowing the soil fertility status of different land types as three villages selected for study are representative of the Agroclimatic Zone .Though the Badakul village is having gentle slope but the soil sample have been collected from the higher elevation to the lower elevation along the slope. The Agroclimatic Zone mainly consists of red, brown and black soils. In the three villages under study Black soils are found in Vellery village where as the Brown soils are found in the two villages namely Badakul and Chasangara. Soil fertility status of Khurda district has also been studied and block level soil fertility maps have been prepared [3]. The present investigation will further show light on the fertility status of representative villages of Chilika Block of Khurda district.

II. MATERIALS AND METHODS

Thirty surface (0-15 cm) samples in total were collected from selected three villages of Chilika block of Khurda district. These soil samples were air dried, crushed with wooden hammer and passed through two mm sieve and preserved in polythene bottle for laboratory study. Percentage of sand, silt and clay were determined with the help of Bouyoucos hydrometer (Piper, 1950) and the textural classes were determined by the help of textural diagram (International system). The pH of the soil samples was determined in 1:2 soil : water suspension after equilibration for half an hour with intermittent stirring using the Systronics pH meter (Model M K VI). The EC of 1:2 soil : water suspension was determined using the conductivity bridge (Model: Systronics 306). The organic carbon percentage was calculated by wet digestion procedure of Walkley and Black, 1936. Available Nitrogen was determined by using alkaline KMnO4 method (Subbiah& Asija, 1956). Phosphorus content were determined by Brays No-1 method. Available Potassium was analyzed by help of Flame photometer (Model; Systronics 128). The amount of Sulphur in the soil was determined by turbidimetric method (Chesnin and Yien, 1950) and the colour intensity was measured at 410 nm wavelength in Systronics spectrophotometer model 166.

III. RESULT AND DISCUSSION

1. **Soil Texture:** The textures (sand %, clay % and silt %) of soils of three villages under study are given in Table-1. The soil texture of all three villages under study varies from loamy sand to clay loam. In Badakul village, upland soils has Loamy sand, sandy loam and loam textures; only sandy loam texture is found in medium land where as two textures loam and sandy loam are found in low lands. In Chasangara village, sandy loam and loam texture are found in both upland and medium land and clay loam and loam textures are found in low land. In Vellary village, clay loam and sandy loam textures are found in upland soils, sandy loam textures are found in medium land soils and low land soils. Similar finding are observed by earlier workers [4], [5] & [6].

2. **Soil Reaction:** The pH of soils of the three villages under study is given in Table-2. The pH of the soils of village Badakul is slightly acidic to slightly alkaline, the pH of the soils of village Chasangara ranges from moderate acidic to neutral and the pH of the soils of Vellery village are more acidic in comparison to the other two villages.

3. **Electrical conductivity:** The Electrical Conductivity of surface soils of the three villages under study are given in Table-2.The higher Electrical Conductivity in the low land soils of Vellery village is due to the presence of black soils which contains more amount of Montmorillonite type of clay [7].

4. **Organic Carbon:** The Organic Carbon content of surface soils of the 3 villages under study are given in Table-2. The Organic Carbon content of a soil reflects the soil health as the organic matter is decomposed by the activity of micro organisms and almost all the major and minor nutrients required by the plant are released. Therefore, higher the Organic Carbon content of the soil, higher is its fertility. Organic matter also imparts good physical properties of soils like soil structure, water-holding capacity, soil aeration etc. The result shows that Organic Carbon % is lowest in the upland soils and highest in the low land soils of all the three villages. The low land soils because of the availability of water throughout the year because of their lower topographical positions are intensively cropped throughout the year. Because of intensive cropping, more quantities of plant residues are incorporated into the soil every year in the low land which could be the reason for more content ofhigher Organic Carbon in the soils of low land in comparison to upland and medium land. In general, the Organic Carbon content of Vellery village is higher which could again be attributed to the black soils. Similar findings have been observed by earlier worker [7].

5. **Available Nitrogen:** The available Nitrogen content of surface soils of the three villages under study are given in Table-3. As there is a positive correlation between Organic Carbon content and Nitrogen content of the soil, therefore the lowland soils in all the three villages contain more Nitrogen in the increasing order from upland to the medium land and to the lowland. This trend is similar to the content of Organic Carbon in all the three villages under study. Similar findings have been observed by earlier worker [8].

6. **Available Phosphorus:** The available Phosphorus content of surface soils of the three villages are given in Table-3. The comparatively higher value of available Phosphorus in the low land soils in all the three villages is because of the higher content of Organic Carbon in the low land because phosphorus is released from the organic matter in a slow process. Similar findings have been observed by earlier worker [8], [3] & [9].

7. **Available Potassium:** The available Potassium content of surface soils of the three villages are given in Table-4. The comparatively high content of Potassium in Vellery village is due to the presence of black soils in the clay fraction of which the Montmorillonite type of clay dominates. The Montmorillonite clay has the highest cation exchange capacity; similar findings have been observed by earlier workers [7] & [4].

8. **Available Sulphur:** The available Sulphur content of surface soils of all the three villages are given in Table-4. The comparatively higher amount of available Sulphur in the low land soils of all the 3 villages under study are attributed to the higher amount of Organic Carbon in the low land soils because sulphur is mineralized from the organic matter by micro organisms and released to the soils. Again the relatively higher content of Sulphur in all the 3 types of land i.e. upland, medium land and low land of Vellery village in comparison to other two villages is because of the black color of soils which contain more amount of Montmorillonitic type of clay mineral. Similar findings have been observed by earlier worker [4].

Based on the above criteria the Organic carbon content of all the upland surface soils of Badakul village is low; that of medium land soils is medium and that of low land surface soils is high. The Organic carbon content of upland surface soils of Chasangara village is low; that of medium land surface soils is medium and that of low land surface soils is high. The Organic carbon content of upland surface soils of Vellery village is low; that of medium land is medium and that of low land surface soils is high except one sample.

The available Nitrogen content of all the soils of three villages is low. The comparatively higher content of available Nitrogen in the low land of all the three villages in comparison to upland and medium land is due to higher amount of Organic carbon content in the low land.

The available Phosphorus of surface soils of all the three villages is low. The relatively higher content Phosphorus in low land is related to the comparatively higher content of Organic carbon in the soils.

The available Potassium content of upland surface soils of Badakul village is low; that of medium land is also low. However, the available Potassium content of low land surface soils of Badakul village ranges from medium to high. The available Potassium content of upland and medium land soils of Chasangara village is low; that of low land surface soils ranges between low to medium. Similarly he available Potassium content of upland surface soils of Vellery village is low; that of medium land surface soils is low to medium and that of low land is medium to high. The higher amount of available Potassium found in low land soils of all the three villages under study is due to the higher quantity of clay found in the low land. Similar findings have been observed by workers [8] & [3].

The available Sulphur content of upland and medium land surface soils of Badkul village is low, whereas that of low land surface soils is low to medium. The available Sulphur content of all the three land types of Chasangara village is low. Similarly the available Sulphur content of upland and medium land surface soils of Vellery village is low whereas that of low land surface soils is medium to high.

As per the soil test based fertilizer recommendation followed the state of Odisha [10], [11] & [1]; when any nutrient is low or deficient then 25% more than the recommended dose for a particular crop has to be applied. Similarly when the nutrient content is high or excess then 25% of the recommended dose for a particular crop can be reduced while applying fertilizer. Similarly when the nutrient content is medium or just above the critical limit, recommended dose of fertilizer on a particular crop has to be applied.

The present investigation showed the deficiency and sufficiency of available major plant nutrients in soils in representative villages of Chilika block of Khurda district which represent the different types of soils of North Eastern Ghat Agroclimatic zone of Odisha It will go a long way in balanced recommendation of fertilizers to various crops which will help in increasing the productivity of food grains, pulses, oilseeds, vegetables, fruits and fibre crops grown in that area. In addition to helping the farmers in application of balanced nutrition to crops the study will also help to reduce in the cost of cultivation of farmers where they have high or sufficient amount of different plant nutrients.

TABLE – 1: MEAN & RANGE VALUE OF SAND, CLAY AND SILT (%) OF THREE VILLAGES OF CHILIKA BLOCK (FIGURES IN THE PARENTHESIS ARE MEAN VALUE).

Land Type / Village Name	Sand (%)			Silt (%)			Clay (%)		
	Vellery	Badakul	Chasangara	Vellery	Badakul	Chasangara	Vellery	Badakul	Chasangara
Up land (3)	66.4-84.4 (78.06)	73.4.-79.4 (76.73)	68.4-82.4 (73.8)	3.4-7.2 (5.64)	9.8-12.8 (11.13)	13.8-15.8 (14.46)	10.8-21.8 (14.93)	10.8-13.8 (12.13)	13.8-15.8 (20.93)
Medium Land (3)	77.4-80.4 (79.4)	75-77 (76)	61.8-75.4 (69.66)	5.2-9.8 (7.26)	8.2-9.2 (8.86)	6.8-19.8 (12.13)	12.8-14.4 (13.33)	13.8-15.8 (15.33)	17.8-18.4 (18.2)
Low Land (4)	68.4-83.4 (77.15)	72-76 (73.85)	61.8-68.8 (64.7)	4.8-14.2 (9.4)	6.2-11.8 (9.2)	11.8.18.8 (15.55)	9.8-19.8 (15.55)	15.8-17.8 (17.05)	18.4-21.8 (15.55)

TABLE – 2: MEAN & RANGE VALUE OF PH, E.C.(DSM-1) AND O.C. (%) OF THREE VILLAGES OF CHILIKA BLOCK (FIGURES IN THE PARENTHESIS ARE MEAN VALUE).

Land Type/Village Name	pH			E.C.(dsm^{-1})			O.C.%		
	Vellery	Badakul	Chasangara	Vellery	Badakul	Chasangara	Vellery	Badakul	Chasangara
Up land (3)	4.83-5,06 (4.96)	6-6.43 (6.26)	5.43-6.28 (6.11)	0.139-0.252 (0.207)	0.116-0119 (0.118)	0.068-0.089 (0.078)	0.42-0.5 (0.45)	.45-0.48 0.46)	0.34-0.5(0.42)
Medium Land (3)	5.09-5.37 (5.23)	6.61-7.1 (6.91)	6.36-6.43 (6.64)	0.274-0319 (0.291)	0.13-0.141 (0.135)	0.094-0.104 (0.097)	0.53-0.59 (0.56)	0.61-0.63 (0.61)	0.5-0.72 (0.63)
Low Land (4)	5.4-5.59 (5.52)	7.5-7.61 (7.61)	7-7.47 (7.23)	0.91-4.16 (2.28)	0.182-0.302 (0.225)	0.107-.159 (0.128)	0.61-1.12 (0.87)	0.64-0.92 (0.72)	0.8-0.9 (0.85)

TABLE – 3: MEAN & RANGE VALUE OF AVAILABLE NITROGEN AND PHOSPHORUS (KG/HA) OF THREE VILLAGES OF CHILIKA BLOCK (FIGURES IN THE PARENTHESIS ARE MEAN VALUE).

Land Type / Village Name	Available Nitrogen N (kg/ha.)			Available Phosphorus (P_2O_5)(kg/ha.)		
	Vellery	Badakul	Chasangara	Vellery	Badakul	Chasangara
Up land (3)	125-150 (137.5)	125-175 (150)	150-162.5 (158.3)	4.62-6.82 (5.73)	2.24-4.24 (3.36)	3.22-4.18 (3.78)
Medium Land (3)	150-150 (150)	175-187.5 (179.16)	162.5-175 (170.83)	4.98-7.41 (6.29)	3.97-7.61 (5.94)	5.18-6.42 (5.74)
Low Land (4)	162.5-200 (184.37)	187.5-212.5 (200)	187.5-225 (203.12)	8.6-14.6 (11.46)	8.96-12.61 (10.55)	6.32-8.96 (7.77)

TABLE – 4: MEAN & RANGE VALUE OF AVAILABLE POTASSIUM AND SULPHUR (PPM) OF THREE VILLAGES OF CHILIKA BLOCK (FIGURES IN THE PARENTHESIS ARE MEAN VALUE).

Land Type / Village Name	AvailablePotassium (K) (kg/ha.)			Available Sulphur(S) (ppm)		
	Vellery	Badakul	Chasangara	Vellery	Badakul	Chasangara
Up land (3)	91.8-101.9 (96.3)	89.6-110.8 (103)	61.6-84.0 (76.53)	5.82-8.96 (7.53)	2.61-4.69 (3.65)	2-3.48 (2.89)
Medium Land (3)	125.4-161.2 (143.66)	120.9-138.8 (129.1)	91.8-106.4 (98.9)	8.96-9.76 (9.25)	5.04-6.61 (5.76)	3.74-4,43 (3.99)
Low Land (4)	210.5-451.3 (341.5)	193.7-449.1 (325.87)	108.6-204.9 (163.47)	15.57-54.98 (39.04)	6.78-19.23 (10.96)	4.52-5.31 (4.82)

IV. CONCLUSION

As per the experimentation carried out for the soil of Badakul, Chasangara and Vellery villages of Chilika block of Khurda district of Odisha, the results show the deficiency and sufficiency of available plant nutrients in soils in representative villages of Chilika block of Khurda district which represent the different types of soils of North Eastern Ghat Agroclimatic zone of Odisha. It will go a long way in balanced recommendation of fertilizer to various crops. This will help to increase the production of different food crops like paddy, maize, groundnut, sesame, black gram, green gram, papaya, arhar, coriander, garlic, brinjal, tomato, beans, banana, bottle gourd, fibre crops etc which are grown in these villages. This will also help the farmers in applying the balanced nutrition to crops for the better yield.

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