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A Study on Soil Fertility Status of Some Villages in Nimapara block of East and South-Eastern Coastal plain agroclimatic zone of Odisha

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A R T I C L E I N F O

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A B S T R A C T

The soil samples were analyzed in the laboratory and soil fertility status were prepared for soil texture, soil reaction, organic carbon, available 'N', available 'P', available 'K' and available 'S', for identifying the soil nutrient status of the villages. The organic carbon content of all the three villages (Rench, Sainsa and Balanga) of Nimapara block under study area varies from low to very high with a mean value varying from 0.35% to 0.86% and are good enough for crop production whereas in Balanga village the organic carbon content is found to be higher than other two villages. The available N content of all the three villages are found to be low and is in positive co-relation with the organic carbon content of the lands. The available P content of all soils in all the three villages is high in low land soils because of higher content of Organic Carbon in the low land as phosphorus is released from the organic matter in a slow process by actively of micro organisms. The available K content of all the soils of all villages are high because of higher content of clay in the soil. The available S content is found to be comparatively higher in the low land soils of all the 3 villages under study because of comparatively higher clay content. The above investigation focus for the balanced recommendation of fertilizers to various crops which will help in increasing the productivity of food grains, pulses, oil seeds, vegetables, fruits and fiber crops grown in that area.

1. Introduction

Fertilizers play a vital role in enhancing the crop productivity. They are one of the most important agricultural input for increasing the crop yield. However they should be applied on the crops in a proper amount which is required by the crops.

Application of fertilizers beyond the required limit is harmful for the crops. So the method of soil testing has been adopted for balanced fertilization of crops. Soil testing is based on intimate knowledge of soil-crop-variety-fertilizer climate management interaction for a given situation. The knowledge of soil fertility status and the appropriate nutrient requirement of different crops is highly essential.

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The usage of fertilizers without knowing this, leads to adverse effect on soil as well as on crops. Ultimately, in the long run leads to deterioration of precious financial resources of farmers, reduces the soil productivity and accelerates the soil degradation.

Many workers studied "The Soil Taxonomy of Odisha" and they recorded the following conclusions. There are four orders such as Inceptisols (49%), Alfisols (35%), Entisols (10%) and Vertisols (6%) [1]*Mishra & Sahu*. Considering the soil pH, it has been observed that 69% of arable soils of Odisha are acidic in reaction, 6% are saline, rest 25% are neutral and with regards to the fertility status of soils in 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 Phosphorous. On the basis of availability of Potassium, 7% of soils are low, 86% are medium and 7% are high. It is worth mentioning here that out of 30 districts of Odisha, soils of two districts, namely Boudh and Phulbani are having high Potassium status where as districts of Ganjam & Gajapati are low in available Potassium content [2]*Nanda etal*. Hence, as a result of such variation in the nutrient status in the different districts of the state and different blocks of different districts, doses of fertilizer recommendations of different crops in Odisha for different areas is necessary to be specified. It is highly useful to know the vertical distribution of plant nutrients in soil as roots of most of the crop plants go beyond the surface layer and draw part of their nutrient requirements from the sub surface layer. Soil profile characteristics as conditioned by different processes and factors of soil formation have great influence on fertility of soil and productivity of land. Therefore an understanding of morphology and physico-chemical characteristics in relation to added fertilizer is necessary to suggest appropriate fertilizer schedule for different crops for obtaining optimum yield [3]*Mishra*.

Soil fertility maps prepared on the analysis data of soil samples collected on GPS basis has greater use because not only it gives an idea about fertility status of the soil of a particular place under discussion, but also it helps in monitoring the soil health from time to time. Although soil fertility data and maps of Odisha have been made but are not based on geographical positioning system. Work on geographical positioning system based soil fertility maps have been done for Puri district of Odisha [4]Mishra etal, but no such work has been done for Nimapara block of Puri district. As the work has not been done for Nimapara block of Puri district, so an attempt has been taken in present investigation to prepare soil fertility map for some villages of Nimapara block and to find out the soil fertility related production constraints of different crops grown and to suggest remedial measures.

In view of the forgoing facts, the present investigation was conducted with the following objectives:

i) To prepare soil fertility maps of few villages of Nimapara Block of Puri district by collecting samples from three selected villages of Nimapara block.

ii) Collection of profile samples from upland, medium land and lowland from representative catenas of three villages of Nimapara block for preparation of soil fertility status report.

2. Study Area

Three villages of Nimapara Block of Puri district namely Rench, Sainsa and Balanga were included in the present investigation for studying the fertility status of soils. Rench village is located 28kms away from Bhubneswar-Nimapara road ; Sainsa is located 5 kms away from Rench in the south-western location and Balanga is located 7kms away from Rench in the same direction. Nimpara block is situated in Puri district which comes under East and South-Eastern Coastal plain agroclimatic zone of Odisha [2]*Nanda etal*. East and South-Eastern Coastal plain agroclimate zone consists of Cuttack, Jagatsinghpur, Kendrapara, Puri and Ganjam districts. It spreads over an area of 2.04 million hectares. The mean annual rainfall is 1449 mm. The mean maximum summer temperature is 39 degree celcius and the mean minimum winter temperature is 11.5 degree celcius. The climate is hot and humid. Mainly deltaic alluvial, laterite and saline soils are found in this agroclimate zone. As per modern system of soil classification "Soil Taxonomy", the soils are classified under the orders Alfisols, Inceptisols and Entisols [1]*Sahu and Mishra.*

Ten numbers of surface soil samples (0 – 15 cm) were collected from the above 3 villages. The land type of the villages are having slightly sloping topography. Three samples were collected from the higher elevation termed as upland, three samples were collected from the middle elevation termed as medium land and four samples were collected from comparatively lower elevation termed as low land. The surface soil samples were choosen to be collected for analysis because the surface soil contains major portion of plant nutrients in available form and it is utilized by the plants for higher production of food, fibre and fuel. All the three villages receive canal irrigation under rice based cropping system. The majority of soils of all the three villages under study are yellow which would be attributed to their reduced soil condition because of prolonged period of standing water. Rice is the main crop of the area.

However in some upland areas vegetables like brinjal, cabbage, potato, tomato, beans, raddish, cucumber, carrot are widely cultivated. Mustard and black gram are also cultivated in some areas in the upland and medium land during Rabi season. Coconut and banana are the common fruit trees widely grown in these villages. Evaluation of soil fertility status of different land types of an area is of primary importance for a balanced application of fertilizers and manures, to increase the productivity of land, to cater to the growing need for cereals, pulses, oil seeds, fruits and vegetables for the ever growing population.

3. Materials and Methods

Thirty surface (0-6 inch) samples in total were collected from selected three villages of Nimapara block of Puri district. These soil samples were air dried, crushed with wooden hammer to be broken down into smaller pieces and passed through two mm sieve and preserved in polythene bottle for laboratory study. The colour of the moist and the dried soil samples were determined by using Munshell soil colour chart. 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. Available Nitrogen was determined by using alkaline $KMnO_4$ 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.

4. Results and Discussion

Soil Texture:

The textures (sand %, clay % and silt %) of soils of the 3 villages under study are given in Table – 1. The soil texture of Rench village varies from loamysand to loam to sandyloam. In major part of Sainsa village loam texture is found which is the best texture for production of all the crops. In the Balanga village also the soil texture is generally loam. Similar findings have been observed by [5]*Mohanty,* [6]*Nayak and* [7]*Swain.*

Soil Reaction:

The pH of soils of the 3 villages under study are given in Table – 2. The pH of the surface soils of Rench village is slightly acidic to neutral, Sainsa village comes under moderately acidic to slightly acidic and of Balanga village is within medium acidic to neutral. Similar findings have been observed by [3]*Mishra.*

Electrical conductivity:

The Electrical Conductivity of surface soils of the 3 villages under study are given in Table-2. The low lands generally have higher electrical conductivity in comparison to upland and medium land. Similar findings have been reported by [8]*Mishra*.

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's health because as the organic matter is decomposed by the activity of micro organisms and almost all the major and minor nutrients required by the plants 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 data in the table shows that Organic Carbon percentage is lowest in the upland soils and highest in the low land soils. The low land soils because of the availability of water throughout the year due to their lower topographical positions are intensely 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 of Organic Carbon in the soils of low land in comparison to upland and medium land. Similar findings have been observed by [6]*Nayak*.

Available Nitrogen:

The available Nitrogen content of surface soils of the 3 villages under study are given in Table-2. There is a positive correlation between Organic Carbon content and Nitrogen content of the soil in all the villages. Similar findings have been observed by [3]*Mishra,* [6]*Nayak &* [7]*Swain.*

Available Phosphorus:

The available Phosphorus contents of surface soils of the 3 villages are given in Table – 3. The comparatively higher value of available Phosphorus in the low land soils in all the 3 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 [3]*Mishra,* [6]*Nayak &* [7]*Swain &* [9]*Mishra.*

Table – 1: Mean & Range value of Sand, Silt and Clay (%) of three villages of Nimapara Block

(Mean value is mentioned in the bracket)

	Sand (%)			Silt (%)			Clay (%)		
Land Type / Village Name	Rench	Sainsa	Balanga	Rench	Sainsa	Balanga	Rench	Sainsa	Balanga
Up Land (3)	74.8-79.8 (77.4)	71.4-82.8 (77.53)	65.4-73.4 (70.4)	9.4-10.4 (10.06)	7.4-12.8 (10)	11.8-15.8 (13.46)	9.8-14.8 (12.4)	11.8-19.8 (15.8)	13.8-18.8 (16.13)
Middle Land (3)	70.8-72.8 (71.13)	69.4-72.8 (71.66)	64.4-70.4 (67.4)	11.4-16.4 (13.73)	13.4-15.4 (14.2)	17.8-17.8 (17.8)	10.8-15.8 (14.13)	10.8-16.8 (14.13)	11.8-17.8 (14.8)
Low Land(4)	64.8-69.8 (67.55)	654-67.8 (66.85)	61.4-71.4 (65.9)	16.4-19.4 (18.15)	1`6.8-19.4 (18.1)	17.8-10.8 (18.8)	12.8-16.8 (14.3)	13.8-17.8 (15.05)	10.8-17.8 (15.8)

Table 2: Mean and Range value of pH, E.C. (dsm^{-1}) and O.C. (%) of three villages of Nimapara Block

(Mean value is mentioned in the bracket)

	pH			E.C.(dsm^{-1})			O.C.%		
Land Type / Village Name	Rench	Sainsa	Balanga	Rench	Sainsa	Balanga	Rench	Sainsa	Balanga
Up Land (3)	5.74-6.17 (5.93)	5.78-5.83 (5.8	5.06-5.9 (5.39)	0.086-0.125 (0. 104)	0.08-0.093 (0.086)	0.06-0.89 (0.073)	0.34-0.37 (0.36)	0.34-0.37 (0.36)	0.26-0.51 (0.41)
Midium Land (3)	6.2-.631 (6.25)	5.84-588 (5.86)	6.16-6.3 (6.2)	0.13-0.162 (0.142)	0.114-0.141 (0.129)	0.096-0113 (0.104)	0.43-048 (1.34)	0.37-0.4 (0.39)	0.56-0.78 (0.63)
Low Land(4)	6.5-6.81 (6.69)	5.92-6.19 (6.03)	6.4-6.7 (6.56)	0.168-0233 (0.194)	0.156-0.23 (0.204)	0.124-0.21 (0.159)	0.56-0.71 (0.62)	0.45-0.59 (0.52)	0.86-1.29 (1.04)

Available Potassium:

The available Potassium content of surface soils of the 3 villages are given in Table – 3. The comparatively higher content of Potassium in the lowland soils of all the three villages is due to higher content of clay, the low land surface soils contain higher amount of clay which are nothing but the slope washes from the upland & medium land surface soils. As the cation exchange capacity of clay is the highest among all the fractions of soil, the clays are available to adsorb more amount of Potassium ions on their edges and inter-layer spaces. Similar findings have been observed by [8]Mishra & [4]Mishra etal.

Table – 3: Mean & Range value of Nitrogen, Phosphorus and Potassium (Kg/ha) of three villages of Nimapara Block

(Mean value is mentioned in the bracket)

	Nitrogen (kg/ha.)			Phosphorus (kg/ha.)		
Land Type / Village Name	Rench	Sainsa	Balanga	Rench	Sainsa	Balanga
Up Land (3)	150-175 (158.33)	162.5-175 (170.83)	175-187.5 (`183.33)	2.94-4.65 (3.75)	3.9-5.6 (4.88)	3.92-4.65 (4.32)
Midium Land (3)	175-200 (191.66)	175-187.5 (183.33)	200-212.5 (204.16)	5.39-6.12 (5.63)	5.14-7.84 (6.45)	5.39-6.12 (5.63)
Low Land(4)	225-237.5 (231.25)	187.5-200 (196.87)	212.5-300 (250)	6.61-14.21 (9.67)	7.84-11.02 (9.29)	6.61-12.49 (8.38)

Table – 4: Mean & Range value of Potassium(kg/ha.) Sulphur (ppm) of three villages of Nimapara Block
(Mean value is mentioned in the bracket)

	Potassium (kg/ha.)			Sulphur (ppm)		
Land Type / Village Name	Rench	Sainsa	Balanga	Rench	Sainsa	Balanga
Up Land (3)	66.08-86.24 (79.14)	59.26-89.6 (72.42)	64.96-79.52 (70.56)	0.78-1.04 (0.92)	9.3-10 (9.65)	2-11.57 (8.2)
Midium Land (3)	86.24-134.4 (105.28)	105.28-125.44 (113.86)	109.76-143.36 (128.42)	4.61-10 (6.55)	10.52-11.39 (10.81)	11.74-13.31 (12.46)
Low Land(4)	137.76-406.56 (224.31)	146.72-180.32 (158.2)	159.04-259.84 (197.96)	13.22-19.4 (15.46)	12-13.57 (12.52)	13.48-14.61 (14.04)

Available Sulphur:

The available Sulphur content of surface soils of all the 3 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. Similar findings have been observed by [5]*Mohanty,* [6]*Nayak,* [7]*Swain &* [4]*Mishra etal*.

Based on the above criteria, the Organic Carbon content of all the surface soils of Rench village are low to medium. The Organic Carbon content of all the surface soil of Sainsa village are also low to medium. However the organic carbon content of upland surface soil of Balanga village are low to medium; that of medium land are medium to high and that of low land are high.

The available Nitrogen content of all the surface soils of Rench and Sainsa village are low. Similarly the available Nitrogen content of all the surface soils of Balanga village are also low except two samples of low land which are medium in available Nitrogen status. These two low land samples which are medium in available Nitrogen content are due to the high content of soil organic matter.

The available Phosphorous content of all surface soils in all the 3 villages are low except one sample of low land of Rench village. In acidic soil conditions the phosphorous present in soils remain in the fixed form with iron and aluminium which are not available to the plants.

The available Potassium content of upland and medium land surface soils of Rench village are low where as the available potassium content of low land soils are low to high. The available potassium content of upland and medium land surface soils of Sainsa village are low where as that of low land surface soil is medium. The available potassium content of upland surface soil of Balanga village is low; that of medium land is low to medium and that of low land is in the medium category. Taking 10 ppm available Sulphur as the critical limit, all the surface soils of upland and medium land of Rench village is low in Sulphur content where as all the surface soils of low land are medium in sulphur .Similarly the upland surface soils of Sainsa village are deficient in sulphur content where as the medium land and the low land soils are sufficient. All the surface soils of Balanga village are sufficient in available sulphur content except one soil of upland which is low. The comparatively higher content of available sulphur in the low land soils in comparision to the upland and medium land soils is because of the higher content of organic matter,

The present investigation showed the deficiency and sufficiency of available plant nutrients in soils in representative villages of Nimapara block of Puri district which represent the different types of soils of East and South-Eastern Coastal plain Agroclimatic zone of Odisha will go a long way in balanced recommendation of fertilizers to various crops which will help in increasing the productivity of food grains, pulses, oil seeds, 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 the cost of cultivation of farmers where they have high or sufficient amount of different plant nutrients.

5. Conclusion

The experiments were carried by collection of soil samples from the three villages namely, Rench, Sainsa and Balanga. The results give a brief knowledge about the available plant nutrients which are present in sufficient amount and it also throws some light on the nutrients which are present in low quantity. This information is of vital importance and acts as a major tool for balanced recommendation of fertilizer and manures to various crops. This will help in increasing the production of different food crops like, rice, cabbage, cauliflower, beans , tomato, onion, peas, papaya, brinjal , carrot, mustard, black gram, coconut and banana etc. This technique is highly beneficial as it can help in reducing the cost of cultivation by using the desired quantity of fertilizers. This also helps in improving the yield and prevents the degrading of soil to a large extent by avoiding the usage of unwanted fertilizers.

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