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SOIL FERTILITY STATUS OF SOME VILLAGES IN BHAWANIPATNA BLOCK OF WESTERN UNDULATING AGRO-CLIMATIC ZONES OF ODISHA

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Abstract: A field experimentation was carried out in thirty selective villages of Bhawanipatna block of kalahandi, under Western Undulating agro-climatic zone of Odisha for determination of some physico-chemical characteristics of soil. Composite surface soil samples were collected from the villages and processed for different analysis. Results of present study reveal that the texture of that area varies from clay loam to sandy clay loam. The soil is non-saline in nature. The soil reaction varies from slightly acidic to highly alkaline. Organic carbon content of soil varies from low to high and ranging from 3.97 to 12.90 g Kg^{-1}. The available nitrogen status of soil of those sites are low ranging from 25.27 to 248.21 Kg ha^{-1}. Available phosphorus and potassium status of soil vary from medium to high range. The data recorded in the present study will definitely help in evaluation of soil fertility status of the area as well as balanced fertilizer application for sustainable crop production.

Keywords: Soil Fertility, Bhawanipatna Block, Available Nutrients.

INTRODUCTION

Fertility status of soil is considered as the important factor responsible for sustaining crop production. In India, the fertility status of potential agricultural land both under irrigated as well as rainfed conditions got depleted due to imbalanced application of plant nutrients through various fertilizers and manures after commencement of green revolution. Hence restoration of soil fertility is the one and only options to improve the crop production as well as to double the farmers' income in India. Soil testing plays an important role in fertilizer recommendation for various crops therefore soil testing is considered as synonymous to soil health evaluation. Soil health management (SHM) is one of the most important interventions aiming at promotion of location as well as crop specific sustainable soil health management, creating and linking soil fertility maps with macro-micro nutrient management.

Odisha is a state with diversified soil conditions leading to crop diversification in different blocks of various districts. As per soil taxonomy study of Odisha, about 69% of aerable soils are acidic in reaction, 6% are saline and rest 25 % are neutral in reaction. Hence agro-climatic zone specific as well as crop specific fertilizer recommendation for various crops on the basis of available nutrients, pH and EC etc. is essential. The present study deals with soil fertility evaluation of different villages of Bhawanipatna block under Kalahandi district.

STUDY AREA

The present investigation aimed at determining the soil fertility status of 30 different villages of 16 distinct Gram panchayats under Bhawanipatna block in Kalahandi district as depicted in table no.1. Bhawanipatna is located at 19 54'36"N and 83 7'40.8"E latitude and longitude respectively with an altitude of 248m above mean sea

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level. Kalahandi district comes under Western Undulating agro-climatic zone of Odisha**.** The climate is hot and moist sub-humid having three distinct seasons i.e. rainy (mid June to September), winter (October-February) and summer (March to mid June). It receives a mean annual rainfall of **1352** mm of which approximately 90 per cent is received during the rainy season. The mean maximum summer temperature is 37.8°**C** and the mean minimum winter temperature is 11.9°**C**. Red, mixed black and red and black soil are found in this region. Taxonomically the soil of the site is identified under Haplustalfs, Rhodustalfs, Ustorthents and Chromusterts, Ustorthents (Sahu, G.C. and Mishra,A.,2005).

MATERIALS AND METHODS

Total 59 composite surface soil samples were collected from the distinct villages under Bhawanipatna Block. With varying degree of land types and village size, two to three samples per village were collected. Collected samples were air dried in shade and ground with the help of pestle and mortar. These ground samples were then passed through a 2 mm sieve and stored in polyethylene bags for further analysis like texture, pH ,EC , Organic carbon, Nitrogen, Phosphorus and Potassium. Mechanical analysis of soil sample was done by Hydrometer Method as described by Bouyoucos (1962) and the textural classes were determined by the help of textural diagram (International system). The pH of the soil water suspension with a soil water ratio of 1:2 was determined with the help of glass electrode pH meter (Jackson, 1973). The electrical conductivity in the clear extract of soil with a soil: water ratio of 1:2 was determined with the help of Electrical Conductivity Bridge (Bower and Wilcox, 1965).

Table 1: GPS Based Location of Soil Sampling Sites

Gram panchayat	*Village*	*Address*	*Latitude/Longitude*
Medinipur	Medinipur	Bhawanipatna, Kalahandi, Odisha, India	19°92′N/83°20′E
	Kusumsila	Bhawanipatna, Kalahandi, Odisha, India	19°92N/83°21′E
Sripur	Sripur	Bhawanipatna, Kalahandi, Odisha, India	19°92′N/83°19′E
	Kanakpur	Bhawanipatna, Kalahandi, Odisha, India	19°91′N/83°20′E
Kamthana	Borbhata	Bhawanipatna, Kalahandi, Odisha, India	19°94′N/83°12′E
	Kamthana	Bhawanipatna, Kalahandi, Odisha, India	19°94′N/83°14′E
Laxmipur	Laxmipur	Bhawanipatna, Kalahandi, Odisha, India	19°89′N/83°19′E
	Katyayanipur	Bhawanipatna, Kalahandi, Odisha, India	19°89′N/83°19′E
Duarsuni	Beheraguda	Bhawanipatna, Kalahandi, Odisha, India	19°88′N/83°16′E
	Duarsuni	Bhawanipatna, Kalahandi, Odisha, India	19°88′N/83°16′E
Talbelgaon	Palsipada	Bhawanipatna, Kalahandi, Odisha, India	19°87′N/83°18′E
	Talbelgaon	Bhawanipatna, Kalahandi, Odisha, India	19°87′N/83°17′E
Udeypur	Udeypur	Bhawanipatna, Kalahandi, Odisha, India	19°57′N/83°14′E
	Gachkhola	Bhawanipatna, Kalahandi, Odisha, India	19°57′N/83°14′E
Dadpur	Dadpur	Bhawanipatna, Kalahandi, Odisha, India	19°58′N/83°13′E
	Jajaldeipur	Bhawanipatna, Kalahandi, Odisha, India	19°59′N/83°13′E
Deypur	Sohagpur	Bhawanipatna, Kalahandi, Odisha, India	19°58′N/83°14′E
	Deypur	Bhawanipatna, Kalahandi, Odisha, India	19°58′N/83°15′E
Gudialipadar	Ichhapur	Bhawanipatna, Kalahandi, Odisha, India	19°56′N/83°13′E
	Balarampur	Bhawanipatna, Kalahandi, Odisha, India	19°56′N/83°12′E
Kuliamal	Kuliamal	Bhawanipatna, Kalahandi, Odisha, India	19°56′N/83°6′E
	Rojnaguda	Bhawanipatna, Kalahandi, Odisha, India	19°56′N/83°5′E
G. Barjhola	Fukjodi	Bhawanipatna, Kalahandi, Odisha, India	19°55′N/83°4′E
	Tiljodi	Bhawanipatna, Kalahandi, Odisha, India	19°55′N/83°3′E
Kalam	Bargaon	Bhawanipatna, Kalahandi, Odisha, India	19°56′N/83°1′E
	Chandopala	Bhawanipatna, Kalahandi, Odisha, India	19°57′N/83°1′E
Kuturkhamal	Badili	Bhawanipatna, Kalahandi, Odisha, India	19°54′N/83°4′E
	Kuturkhamal	Bhawanipatna, Kalahandi, Odisha, India	19°54′N/83°3′E
Malgaon	Malgaon	Bhawanipatna, Kalahandi, Odisha, India	19°55′N/83°5′E
Risigaon	Risigaon	Bhawanipatna, Kalahandi, Odisha, India	19°54′N/83°7′E

Organic carbon was determined by rapid titration method as described by Walkley and Black (1934). Available N of soil was measured by alkaline $KMnO_4$ method as described by Subbijah and Asija (1956). The available phosphorous content in soil was estimated by Brays No-1 method with the help of spectrophotometer. Available K was estimated with 1N NH_4OAc (pH 7.0) reagent using flame photometer (Merwin and Peech, 1951).

RESULTS AND DISCUSSION

Soil Texture: The relative percent of sand, silt and clay (Texture) of the soils of selective villages has been presented in Table 2. and their relative distribution is represented in fig.1. Present study reveals that the texture of the soil of selective sites varied from sandy clay loam to clay loam. From the figure-1, it is cleared that clay loam (53.33%) is the dominant texture followed by sandy clay loam (33.33%)and silty loam(13.33%). High clay content was found in the soil which is attributed to pedogenic process of soil formation.

Soil Reaction: The pH status of the selected villages are given in the Table.3 and presented in figure 2. The pH of soil varied from 5.45(slightly acidic) to 8.67 (strongly alkaline). The order of dominance of different soil reaction in Bhawanipatna block is Slightly acidic > Strongly alkaline > Neutral > Mild alkaline.

Electrical Conductivity: The electrical conductivity of soils of selected site are enumerated in Table 3. Results of present investigation reveal that the electrical conductivity of soils are lower than $4dSm^{-1}$ indicating that the soils are non-saline in nature. The higher electrical conductivity in some villages like Risigaon, Malgaon, Badili, Fukjodi

Table 2: Mean value of Sand, Silt, Clay (%) of selective villages of Bhawanipatna Block

Gram panchayat	*Village*	*Sand (%)*	*Silt (%)*	*Clay (%)*	*Texture*
Medinipur	Medinipur	42	32	27	Clay Loam
	Kusumsila	42	33	25	Clay Loam
Sripur	Sripur	40	36	24	Clay Loam
	Kanakpur	64	15	21	Sandy Clay Loam
Kamthana	Borbhata	47	28	26	Sandy Clay Loam
	Kamthana	58	15	27	Sandy Clay Loam
Laxmipur	Laxmipur	36	38	26	Clay Loam
	Katyayanipur	70	8	22	Sandy Clay Loam
Duarsuni	Beheraguda	35	39	26	Clay Loam
	Duarsuni	66	9	26	Sandy Clay Loam
Talbelgaon	Palsipada	28	32	41	Clay Loam
	Talbelgaon	62	16	22	Sandy Clay Loam
Udeypur	Udeypur	27	34	40	Clay Loam
	Gachkhola	65	14	21	Sandy Clay Loam
Dadpur	Dadpur	26	36	39	Clay Loam
	Jajaldeipur	26	34	40	Clay Loam
Deypur	Sohagpur	27	35	38	Clay Loam
	Deypur	68	10	23	Sandy Clay Loam
Gudialipadar	Ichhapur	33	58	10	Silty loam
	Balarampur	28	32	40	Clay Loam
Kuliamal	Kuliamal	40	22	39	Clay Loam
	Rojnaguda	27	35	39	Clay Loam
G. Barjhola	Fukjodi	42	26	33	Sandy Clay Loam
	Tiljodi	34	56	10	Silty loam
Kalam	Bargaon	28	32	40	Clay Loam
	Chandopala	50	35	16	Sandy Clay Loam
Kuturkhamal	Badili	34	56	10	Silty loam
	Kuturkhamal	24	35	41	Clay Loam
Malgaon	Malgaon	25	36	40	Clay Loam
Risigaon	Risigaon	19	64	18	Silty loam

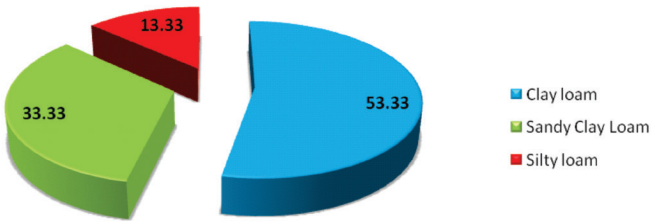

Figure 1. Distribution of different soil texture in Bhawanipatna Block

might be due to presence of black soil having predominance of Montmorillonite clay mineral which has higher cation exchange capacity as compared to other clay minerals. Similar results are also reported by Nayak *et al*. in 2015.

Organic Carbon: The organic carbon content of the soils of selective villages are depicted in Table.3 and presented in figure 3. Soil organic carbon content reflects the soil health status. It plays a vital role in nutrient dynamics, microbial diversity and structural development of soil. Hence soil organic carbon is a key to unlock the potential of the soil. The organic carbon content in Bhawanipatna block varied from 3.97 to 12.90 g Kg^{-1}. In present investigation, the dominance order of soil organic carbon is High (43.3%) = Medium (43.3%)> Low (13.3%). The high organic carbon content of soil might be due to availability of water throughout the crop period that results in intensive cropping leading to decomposition of more organic matter by soil microbes. The high organic carbon content of Kanakpur,Risigaon & Malgaon is attributed to presence of black soil. Similar result was found by Behera *et al*.(2016).

Available Nitrogen: The available nitrogen status of soils of selective villages is presented in Table.4. The result revealed that the available nitrogen status of the soils of the Bhawanipatna block was low. The nitrogen content of soil varied from 25.27 Kg ha^{-1} to 248.21 Kg ha^{-1}. The highest nitrogen content in Katayanipur was under medium range. The lower range of nitrogen in soil might be due to alkaline pH of soils which is conducive for its loss through volatilization.

Available Phosphorus: The available phosphorus status of soil is enumerated in Table.4 and presented in Figure.4.The available phosphorous content was found to be high under all most all sites (93.3%) followed by medium (6.7%). High phosphorus content of soil is attributed to high organic matter content of the soil. Because organic matter is one of the major source of phosphorus in soil. The chemistry behind availability of phosphorus is always pH dependent. In present investigation the phosphorus content of Malgaon(194.23Kg ha^{-1}) was found to be highest followed by Talbelgaon(181.13 Kg ha^{-1}) which might be attributed to the neutral range of pH of these villages. The neutral pH enhances the solubility of phosphorus and increases its availability. The village having relatively less phosphorus content might be due to fixation of phosphorus in acidic as well as alkaline condition.

Available Potassium: The available potassium status of soils of selective villages under Bhawanipatna block is depicted in Table 4 and presented in Figure 6. From figure 6, it was clear that the potassium content of soil was found to be in medium range (53.3%) followed by high (46.7%). The high content of potassium might be due to the presence of black soil in which montmorillonite is the dominating clay mineral. This clay mineral has higher C.E.C. which in turn results in increasing the K content of the soil. K-content in soil is mainly governed by the nature and amount of clay mineral present in soil.

Table 3: pH, EC and Organic carbon content of soils of different villages Under Bhawanipatna Block

Gram panchayat	*Village*	*pH*	*EC (dSm^{-1})*	*Organic Carbon (gKg^{-1})*
Medinipur	Medinipur	**6.42**	**0.592**	**7.93**
	Kusumsila	**6.11**	**0.347**	**8.57**
Sripur	Sripur	**5.45**	**0.522**	**7.40**
	Kanakpur	**5.88**	**0.496**	12.90
Kamthana	Borbhata	**5.93**	**0.369**	**6.77**
	Kamthana	**6.10**	**0.460**	**8.87**
Laxmipur	Laxmipur	**5.85**	**0.326**	**5.97**
	Katyayanipur	**6.23**	**0.404**	4.73
Duarsuni	Beheraguda	**8.18**	**1.240**	**8.13**
	Duarsuni	**8.15**	**1.399**	**7.03**
Talbelgaon	Palsipada	**7.55**	**1.190**	**8.33**
	Talbelgaon	**7.78**	**0.987**	8.83
Udeypur	Udeypur	**7.98**	**1.389**	**6.47**
	Gachkhola	**7.91**	**0.885**	**7.40**
Dadpur	Dadpur	**6.90**	**0.818**	**4.43**
	Jajaldeipur	**6.77**	**0.881**	7.43
Deypur	Sohagpur	**6.95**	**0.541**	**7.60**
	Deypur	**6.71**	**0.632**	**7.77**

Gram panchayat	*Village*	*pH*	*EC (dSm^{-1})*	*Organic Carbon (gKg^{-1})*
Gudialipadar	Ichhapur	**8.32**	**1.315**	**6.17**
	Balarampur	**7.40**	**0.859**	3.97
Kuliamal	Kuliamal	**6.79**	**0.514**	**6.07**
	Rojnaguda	**8.46**	**0.920**	**7.23**
G. Barjhola	Fukjodi	**8.32**	**2.387**	**6.73**
	Tiljodi	**8.14**	**1.367**	6.97
Kalam	Bargaon	**7.05**	**1.582**	**4.60**
	Chandopala	**5.93**	**0.695**	**7.13**
Kuturkhamal	Badili	**7.97**	**2.270**	**8.33**
	Kuturkhamal	**8.67**	**1.638**	8.67
Malgaon	Malgaon	**7.75**	**2.533**	**10.33**
Risigaon	Risigaon	**8.11**	**2.594**	11.33

Table 4: Available Nitrogen, Phosphorus and Potassium content of soils of different villages Under Bhawanipatna Block

Gram panchayat	*Village*	*Available N ($Kg\ ha^{-1}$)*	*Available P ($Kg\ ha^{-1}$)*	*Available K ($Kg\ ha^{-1}$)*
Medinipur	Medinipur	71.08	138.60	206.97
	Kusumsila	29.27	106.33	169.72
Sripur	Sripur	175.61	56.00	132.98
	Kanakpur	117.08	97.53	164.60
Kamthana	Borbhata	91.50	30.33	206.58
	Kamthana	75.73	27.17	351.47
Laxmipur	Laxmipur	37.63	28.60	206.34
	Katyayanipur	248.21	23.00	139.44
Duarsuni	Beheraguda	185.76	48.37	151.71
	Duarsuni	33.28	30.80	205.43
Talbelgaon	Palsipada	63.19	137.27	366.04
	Talbelgaon	37.82	181.13	391.80
Udeypur	Udeypur	37.79	45.13	309.56
	Gachkhola	37.87	33.33	229.07
Dadpur	Dadpur	156.56	35.33	336.73
	Jajaldeipur	47.52	102.73	198.48
Deypur	Sohagpur	37.69	37.10	187.31
	Deypur	87.91	54.20	357.36
Gudialipadar	Ichhapur	50.23	24.50	200.56
	Balarampur	25.27	27.03	142.97
Kuliamal	Kuliamal	61.67	47.00	207.95
	Rojnaguda	65.02	84.47	332.29
G. Barjhola	Fukjodi	87.32	78.80	625.56
	Tiljodi	62.69	39.40	361.56
Kalam	Bargaon	87.62	64.97	204.34
	Chandopala	47.83	77.13	299.28
Kuturkhamal	Badili	174.89	98.27	414.43
	Kuturkhamal	27.80	55.27	576.32
Malgaon	Malgaon	165.68	194.23	476.08
Risigaon	Risigaon	31.55	69.60	570.26

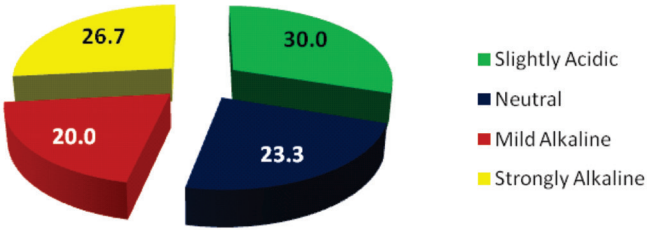

Figure 2: pH status of soils under Bhawanipatna Block

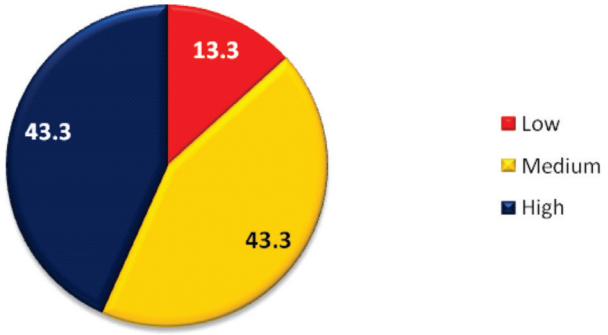

Figure 3: Distribution of Organic Carbon in soils under Bhawanipatna Block

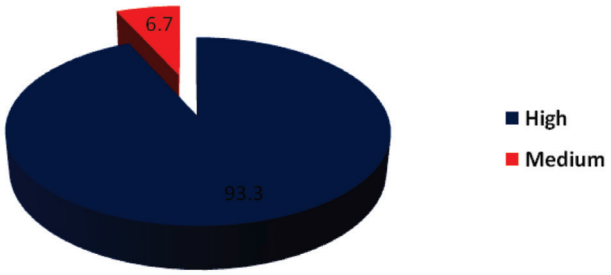

Figure 4: Available phosphorus status of soils under Bhawanipatna Block

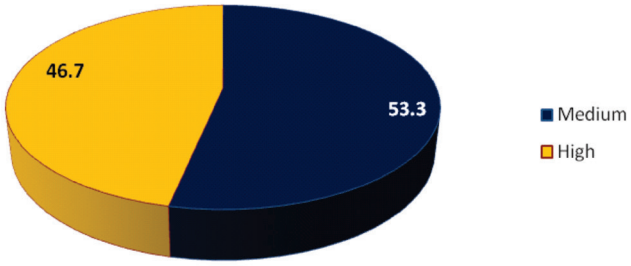

Figure 5: Available Potassium status of soils under Bhawanipatna Block

Soil test based fertilizer recommendation is extensively used in Odisha state as reported by Nayak *et al.*(2015). As per this recommendation, when status of particular nutrient shows low , then we go for application of 25% more of that nutrient than the recommended dose. Similarly when the status of a nutrient is high, then 25% less of that nutrient than the recommended dose

should be applied. The present investigation showed the deficiency and sufficiency of plant nutrients of soil in selective villages of Bhawanipatna block under Kalahandi district of Odisha. It will run a long time with balanced fertilizer recommendation for different crops which will help in enhancing the productivity of crop and fulfilling the growing demand of that area. The present study will also help the farmer in application of balanced dose of fertilizers and thereby reduce their cost of cultivation. Thus present study will be able to give a sound income to the farmers.

CONCLUSION

The present experimentation of study of soil fertility status of 30 different villages of 16 Gram Panchayats under Bhawanipatna block which comes under Western Undulating agro-climatic zone of Odisha reveals the sufficiency and deficieny of particular plant nutrients in that area. As per this study, optimum crop production will be achieved by balanced fertilization. This is also helpful for recommendation of fertilizer for various crops based on the soil test report.

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