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Soil fertility status of some villages in Astaranga block of Puri district of east and south-eastern coastal plain agroclimatic zone of Odisha

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ABSTRACT

A soil fertility status inventory work was carried out in few villages of Astaranga block in Puri district. Results show that soil texture of the soils under investigation varied from loamy sand to clay loam and soil colour from brownish yellow (10YR 6/8), reddish yellow (7.5YR 6/6), yellowish brown (10YR 5/4) to brown (10 YR 5/3). Clay content in all the soils varied from 8.8 to 30.8 per cent. Soil pH value ranged between 5.12 and 6.57 and electrical conductance remained <0.22 dSm^{-1}. Soil organic carbon (SOC) content ranged between 2.5 and 10.9 g kg^{-1}. Available nitrogen content in these soils was found to be low as it ranged between 87.5 and 187.5 kg ha^{-1}. Available phosphorus (P_2O_5) content varied widely from 3.38 to 259.2 kg ha^{-1}. Available potash (K_2O) content varied from 59.1 to 446.0 kg ha^{-1}. $CaCl_2$ extractable soil sulphur varied from 0.43 to 8.53 mg kg^{-1} renders the soil deficient in S. Hot water soluble boron content ranged from 0.12 to 7.6 mg kg^{-1}. All the figures in lower range were found in upland soils while the higher values of all the parameters were found in low land. There was an increasing trend with respect to soil reaction, SOC, N, P, K, S and B from upland to lowland which is due to the washing down of basic cations, organic matter and plant nutrients from uplands and subsequent deposition in low land give rise to the higher value in low lying areas. Clay content was found to be positively correlated with all the parameters except phosphorus. Significant positive correlation of OC, N, K and B with soil reaction. Similarly, SOC was positively correlated with clay, macro and micro nutrients.

Keywords: Soil fertility, soil physico-chemical, Astaranga propertied, Puri, Odisha

INTRODUCTION

Puri is one of the nine coastal districts of eastern Odisha with a geographical area of 3479 sq. km. The district is famous in the world for temple of Lord Jagannath, the Sun Temple at Konark and sea beach of Bay of Bengal. The district has one of the largest brackish water lakes in India that is Chilika Lake. Puri district falls in the Mahanadi river basin and the main drainage is formed by the rivers Daya, Devi, Kushabhadra, Bhargavi, and Prachi, which have southerly, south-easterly and south westerly courses. Soil, land and water are essential resources for the sustained quality of human life and the foundation of agricultural development. Sound knowledge about soil fertility status is very much relevant for identifying constraints in crop husbandry for attaining sustained productivity and facilitating agro technology transfer programme. It is a function of crop nutrient needs, supply of nutrients from indigenous sources and the short- and long term fate of the applied fertilizer nutrients as Indian agriculture is operating on a net negative balance of plant nutrients at the rate of 10 million tonnes per annum (Ramakrishna and Munawery, 2012). Long term experiments indicated that imbalanced use of nutrients through fertilizers has a deleterious effect on soil health leading to unsustainable productivity. One of the reasons for lower production is imbalanced use of fertilizers by the farmers without knowing soil fertility status and nutrient requirement of crops which causes adverse effect on soil and crop both in terms of nutrient toxicity and deficiency (Ray *et al.,* 2000). A soil resource inventory provides an insight into the potentialities and limitations of soils for its effective exploitation (Manchanda *et al.,* 2002). Keeping the above facts in view a soil resource inventory work was undertaken to study the soil fertility status of three villages of Astaranga block in Puri district, Odisha. The study has generated a lot of information related to the soil physico – chemical properties and their interrelationship for better understanding of soil fertility which would provide the basis for implementing the advanced technologies for sustainable crop production with higher profitability.

MATERIALS AND METHODS

Surface (0-15 cm) soil samples were collected from the selected villages namely, Inaetpur, Nuagarh and Sudakeshar of Astaranga block of Puri district under east and south – eastern coastal plain agroclimatic zone (ESECPZ) of Odisha. As per modern system of soil classification (Soil Taxonomy) the soils come under *Alfisols*, *Inceptisols* and *Entisols*. The collected soil samples were processed and analyzed in the laboratory for soil reaction (1:2), electrical conductivity (1:2), oxidisable organic carbon (Walkley and Black, 1934), available nitrogen (Subbiah and Asija, 1956), phosphorus (Bray's No. 1 method) and potassium (Hanway and Heidel, 1952). Available ($CaCl_2$ extractable) soil sulphur (Chesnin and Yien, 1950) and hot water soluble boron (John *et al.,* 1975), soil colour (Munsell colour chart), textural class (Bouyoucos, 1962) were also determined. The analytical methods were followed as per the procedure laid down by Jackson (1973).

RESULTS AND DISCUSSION

Physico – chemical properties

Most of the soils of these villages are water logged in rainy season because of inundation of standing water from flood which created the anaerobic condition in the soil that imparts the yellow colour to the soil due to reduced iron. Soil colour of Inaetpur village ranged within brownish yellow (10YR 6/8) to brown (7.5YR 5/4) whereas in Nuagarh village the colour varied from brownish yellow (10YR 6/6) to brown (10YR 5/3) and in Sudakeshar village it came under very pale brown (10YR 7/4) to yellowish brown (10YR 5/4) in colour. Soil texture of Inaetpur and Sudakeshar villages was sandy loam but in Nuagarh village soil texture varied from loamy sand, sandy clay loam (upland) and clay loam (medium and lowland). Higher amount of clay content was found in lowland as clay particles are washed down from the up and medium land during rainfall and their subsequent deposition in the low land because of the pedogenic process of colluviation. Similar findings have been observed by Nayak *et al.* (2015), Mishra *et al.* (2014).

Table 1: Soil Physico – chemical properties and fertility status of Inaetpur village, Astaranga block of Puri district

Land Type	Soil Colour	Soil Texture	pH (1:2)	EC (dsm^{-1})	OC ($g\ kg^{-1}$)	Major nutrients ($kg\ ha^{-1}$)			S (mg kg^{-1})	B (mg kg^{-1})
						N	P_2O_5	K_2O		
Up Land	Brownish Yellow	Sandy Loam	5.73	0.05	5.1	100.0	30.4	190.9	2.82	0.12
Up Land	Reddish Yellow	Sandy Loam	5.80	0.07	6.1	125.0	42.8	194.9	3.13	0.18
Up Land	Reddish Yellow	Sandy Loam	5.95	0.07	6.3	125.0	63.1	221.7	3.22	0.24
Medium Land	Reddish Yellow	Sandy Loam	6.00	0.08	6.4	137.5	63.1	221.7	3.57	0.84
Medium Land	Reddish Yellow	Sandy Loam	6.08	0.08	6.6	150.0	69.2	236.5	4.08	1.26
Medium Land	Reddish Yellow	Sandy Loam	6.18	0.08	6.8	150.0	81.7	266.1	4.7	2.16
Low Land	Reddish Yellow	Sandy Loam	6.31	0.09	6.9	162.5	82.3	288.9	5.13	2.22
Low Land	Light Brown	Sandy Loam	6.36	0.09	7.2	162.5	87.9	305.1	5.13	6.66
Low Land	Strong Brown	Sandy Loam	6.41	0.11	7.3	170.0	107.6	318.5	5.26	6.68
Low Land	Brown	Sandy Loam	6.57	0.18	8.2	175.0	122.8	400.5	8.53	6.92

Surface soils of Inaetpur village were slightly acidic to neutral which varied from 5.73 to 6.57 (Table 1). In Nuagarh soil pH varied from 5.46 to 6.52 which come under moderately acidic to neutral. Similarly, in Sudakeshar soil pH ranged from 5.12 to 6.07 which indicates the soils are moderately to slightly acidic. The result clearly indicated that higher pH value towards neutral in low land compared to up and medium land soils. Soil pH is significantly and negatively correlated with sand (r=-0.65*) but positively with silt (r=0.53*), clay (r=0.67*), OC (r=0.68*), N (r=0.77**), K (0.58*), S (r=0.43) and B (r=0.63*). Similar findings have been observed by Mishra (2005). EC value of soils of Inaetpur village ranged from 0.05 to 0.18 dSm^{-1}. Similarly the E.C of surface soils of Nuagarh village varied from 0.022 to 0.22 dSm^{-1}. The E.C of Surface soils of Sudakesar village ranged from 0.03 to 0.17 dSm^{-1}. The low lands generally have higher

Table 2: Soil Physico – chemical properties and fertility status of Nuagarh village, Astaranga block of Puri district

Land Type	Soil Colour	Soil Texture	pH (1:2)	EC (dsm^{-1})	OC ($g\ kg^{-1}$)	Major nutrients ($kg\ ha^{-1}$)			S (mg kg^{-1})	B (mg kg^{-1})
						N	P_2O_5	K_2O		
Up Land	Brownish Yellow	Loamy sand	5.46	0.02	2.5	87.5	3.4	59.1	0.43	0.12
Up Land	Brownish Yellow	Loamy sand	5.59	0.05	3.1	112.5	4.5	60.5	0.95	0.12
Up Land	Light Yellowish Brown	Sandy clay loam	5.9	0.05	6.2	125.0	8.5	182.8	1.48	0.3
Medium Land	Light Yellowish Brown	Clay loam	6.05	0.06	6.4	125.0	10.7	235.2	1.83	0.48
Medium Land	Light Yellowish Brown	Clay loam	6.06	0.07	6.6	137.5	11.3	247.3	1.91	0.78
Medium Land	Light Yellowish Brown	Clay loam	6.11	0.07	6.8	137.5	21.4	254.0	2.44	0.84
Low Land	Light Yellowish Brown	Clay loam	6.18	0.09	6.8	137.5	25.9	263.4	3.22	0.96
Low Land	Yellowish Brown	Clay loam	6.19	0.10	7.2	150.0	27.1	291.6	3.32	1.02
Low Land	Yellowish Brown	Clay loam	6.22	0.11	7.2	150.0	27.6	311.9	3.82	4.2
Low Land	Brown	Clay loam	6.52	0.22	8.2	150.0	29.9	318.5	4.7	5.1

EC value in comparison to upland and medium land but the values remain within the safe limit for crop production.

In Inaetpur mean SOC content was found 5.8, 6.6 and 7.4 g kg^{-1} in up, medium and lowland soils, respectively. Similarly, in Nuagarh mean SOC content varied from 3.9, 6.6 and 7.4 g kg^{-1} in up, medium and lowland respectively. Whereas in Sudakeshar mean SOC content varied from 4.2, 5.8 and 8.6 g kg^{-1} in up, medium and lowland soils respectively. Higher SOC content in low land soils of all the villages is because of the lower topographical position due which they receive runoff washing of upland and a medium land soils which is decomposed by microorganisms giving rise to higher content of SOC. Soil organic carbon is negatively correlated with sand (r=-0.50*) but significantly and positively correlated with N (r=0.88**), available K (r=0.91**). Similar findings have been reported earlier by and Mishra *et al.* (2015).

Table 3: Soil Physico – chemical properties and fertility status of Sudakeshar village, Astaranga block of Puri district

Land Type	Soil Colour	Soil Texture	pH (1:2)	EC (dsm^{-1})	OC ($g\ kg^{-1}$)	Major nutrients ($kg\ ha^{-1}$)			S (mg kg^{-1})	B (mg kg^{-1})
						N	P_2O_5	K_2O		
Up Land	Very Pale Brown	Sandy loam	5.12	0.03	3.9	87.5	54.1	168.0	2.61	0.24
Up Land	Very Pale brown	Sandy loam	5.12	0.04	4.0	112.5	54.6	173.4	2.69	0.24
Up Land	Brownish Yellow	Sandy loam	5.19	0.05	4.7	112.5	64.8	185.5	3.57	0.60
Medium Land	Reddish Yellow	Sandy loam	5.26	0.08	4.9	125	66.5	202.9	3.91	0.72
Medium Land	Brownish Yellow	Sandy loam	5.37	0.08	6.0	125	105.9	212.4	4.17	0.78
Medium Land	Reddish Yellow	Sandy loam	5.47	0.09	6.4	125	189.3	247.3	4.96	0.78
Low Land	Reddish Yellow	Sandy loam	5.68	0.09	6.4	137.5	222.6	349.4	4.96	0.9
Low Land	Brownish Yellow	Sandy loam	5.77	0.11	6.8	150	232.2	374.9	5.04	1.80
Low Land	Light Yellowish Brown	Sandy loam	5.95	0.15	10.1	162.5	250.8	415.3	5.30	5.20
Low Land	Yellowish Brown	Sandy loam	6.07	0.17	10.9	187.5	259.2	446.0	6.00	7.60

Major nutrients

An increasing trend of average soil nitrogen content was observed in all the villages from upland to lowland. Soils of low land contained more N in comparison to the medium and upland. Soil available nitrogen is negatively correlated with sand but positively correlated with pH (r=0.77**), K (r=0.87**), S (r=0.76**) and B (r=0.81**). Similar findings have been observed by Behera *et al.* (2016) and Mishra *et al.* (2016).The P_2O_5 content in all the soils of Inaetpur village was found to be medium to high. Soils of Nuagarh village were low in available P_2O_5 content. Similarly, soils of Sudakeshar were medium to high which indicate a very good index of soil fertility. Mean available P_2O_5 content in soils of all the villages increased from upland

to lowland. Higher value of available phosphorus in low land soils may be due to higher content of SOC as phosphorus is released from the organic matter slowly. Soil available phosphorus is negatively correlated with clay but positively correlated with OC, N, K, S and B (Table 4). Similar findings have been observed by Mishra *et al.* (2016).Mean available soil potassium content in all the villages increased according to land situation from upland to lowland. Comparatively higher content of potassium in the lowland soils may be due to the presence of higher content of clay in the lowland surface soil. Soil available potassium was negatively correlated with sand but positively correlated with clay (r=0.38), pH (r=0.58*), OC (r=0.91**), N (r=0.87**), P_2O_5 (r=0.71*), S (r=0.82**) and B (r=0.75*). Similar finding has been observed by Mohanty (2012), Behera *et al.* (2016) and Mishra *et al.* (2016).

Table 4: Correlation study on different physico-chemical properties

	Sand	Silt	Clay	pH	EC	OC	N	P_2O_5	K_2O	S	B
Sand	1.00										
Silt	-0.92**	1.00									
Clay	-0.98**	0.82**	1.00								
pH	-0.65*	0.53*	0.67*	1.00							
EC	-0.38	0.26	0.42	0.62*	1.00						
OC	-0.50*	0.44	0.50*	0.68*	0.81**	1.00					
N	-0.43	0.36	0.44	0.77*	0.78	0.88**	1.00				
P_2O_5	0.24	-0.17	-0.26	-0.01	0.49	0.56*	0.50*	1.00			
K_2O	-0.40	0.37	0.38	0.58*	0.82**	0.91**	0.87**	0.71*	1.00		
S	-0.01	0.01	0.01	0.43	0.76**	0.69*	0.76**	0.69*	0.82**	1.00	
B	-0.21	0.11	0.25	0.63*	0.79**	0.73*	0.81**	0.46	0.75*	0.74*	1.00

*(Significant at → ** 1% and * 5% level)*

Secondary and micro nutrients

The results show that, all the soils under investigation were low in S content which can limit the crop production specially oilseed crops. Comparatively higher amount of available S in low land soils may be attributed to the higher amount of organic carbon in the low land soil (Das *et al.,* 2012). Low concentration of sulphur in upland soil may be characterised by the leaching or surface runoff loss and subsequent accumulation of sulphur in low land (Paul and Mukhopadhyay, 2014). Similar findings have been reported by Mohanty (2012), Mishra *et al.* (2016) and Singh (2017). Available sulphur was positively correlated with pH (r=0.43), OC (r=0.69*), N (r=0.76**), P_2O_5 (r=0.69), K (r=0.82**) and B (r=0.74*). Similar significant positive correlation of S was also observed by Ali *et al.* (2014) and Das *et al.* (2012).Mean hot water soluble boron content was found to be increased from upland to lowland situation. Thus, higher levels of B was found in low land soils compared to the upland and medium land soils. This might be attributed to the higher amount of OC present in low land soil and washing down of B from up and medium lands. Hot water soluble boron was positively correlated with pH (r=0.36), OC (r=0.73*), N (r=0.81**), P_2O_5 (r=0.46), K (r=0.75*) and S (r=0.74*). Similar findings were observed by Mohanty (2012), Mishra *et al.* (2014), Behera *et al.* (2016).

The present study helps to build up the database for evaluation, planning and monitoring of soil fertility status which can serve the farming community for higher profitability with a balanced recommendation of fertilizer in sustainable manner for present and in future.

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