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Soil fertility Status of Some Villages under East and South Eastern Coastal Plain Agroclimatic Zone of Odisha

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A field investigation was carried out in some villages of Ganjam district for soil physico-chemical characteristics under East and South Eastern Coastal Plain Agro-climatic zone of Odisha. Thirty surface (0-15cm depth) soil samples were collected from three villages namely Jagannathpur, Lakshmanpur and Raghunathpur in Ganjam block of Ganjam district under East and South Eastern Coastal Plain Agro-climatic zone of Odisha. Results reveal that, the soil texture varies from loamy sand to clay loam. The soil reaction was found to be positively and significantly correlated with OC (r=0.95*), N (r=0.84*), S (r=0.75*) and B (r=0.86*). The organic carbon content varies from low to very high with a mean value varying from 1.1 to 22.6 g kg^{-1} and the values increased from upland to lowland. The available nitrogen content varies from low (87.5 kg ha^{-1}) to medium (337. 5 kg ha^{-1}). The available phosphorous content varies from low to very high (12.4 to 293.6 kg ha^{-1}). The available potassium content varies from low to very high (73.9 to 510.7 kg ha^{-1}). The available soil sulphur content varies from deficient to sufficient (0.97 to 76.4 mg kg^{-1}). Hot water soluble boron content was found to vary from 0.36 to 3.26 mg kg^{-1}. The generated field data will be useful for the planning, monitoring and evaluation of the soil fertility status of the area for sustainable crop production.

(***Key words:*** *Coastal soils, Ganjam, Odisha, Soil fertility*)

Among ten agro-climatic zones of Odisha, East and South Eastern Coastal Plain zone (ESECPZ) comprises of five districts *viz.* Cuttack, Jagatsingpur, Kendrapara, Puri and Ganjam which covers the area of 2.04 mha. It experiences mean winter and summer temperature of 11.5 to 39^{0}C respectively with a mean annual rainfall of 1449 mm. Soils are mainly deltaic alluvial, saline and lateritic in nature (*Haplaquepts, Fluvaquents, Ustochrepts, Haplustalfs*) (Nanda *et al.*, 2008).

Ganjam district of Odisha is located between 19.4 to 20.17^o North Latitude and 84.7 to 85.12^o East Longitude. It covers an area of 8070.6 km^2. The district is broadly divided into two divisions, the Coastal plain area in the East and hill and table lands in the West located on the boarder of Andhra Pradesh. The plain area lies between Eastern Ghat and the Bay of Bengal. This area contains fertile lands. The east and north frontiers of coastal plains are covered with thick forests, mostly containing Sal trees wood. Towards the centre and south it is hilly with beautiful well-watered and fertile valleys extending towards the sea. The south eastern portion is fertile and contains vast multi cropped areas, well served by major and minor irrigation projects. The extreme north-east is occupied by a portion of Chilika lake, the largest fresh/saline water lake of Asia, its immediate vicinity being good for fishery and salt manufacture (Mohanty, 2012). There is no detailed investigation on soil fertility status conducted in Ganjam district under East and South Eastern Coastal Plain Zone. Therefore an attempt was taken to study the soils of three selected villages of Ganjam district of ESECPZ in detail.

MATERIALS AND METHODS

Total 30 numbers of surface (0-15cm) soil samples were collected from three selected villages of Ganjam block of Ganjam district under ESECPZ. The collected soil samples were processed and analysed in the laboratory for soil reaction (1:2), electrical conductivity (1:2), organic carbon (Walkley & Black, 1934), available nitrogen (Subbiah and Asija, 1956), available phosphorus (Bray's No. 1 method), available potassium (Hanway and Heidel, 1952). Available sulphur ($CaCl_2$ extractable) soil sulphur (Chesnin and Yien, 1950) and hot water soluble boron (John *et al.*, 1975) was also determined. Textural class (Boyoucos, 1962) was determined as per the procedure laid down by Jackson (1969).

RESULTS AND DISCUSSION

Soil texture

The soil texture under investigation varies from loamy sand to clay loam (Table 1). Sandy loam soil texture was found only in the low lands. Likewise loamy sand texture was found in one upland field. The results

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Table 1. *Soil physical properties of Jagannathpur, Laxmanpur and Raghunathpur village of Ganjam block in Ganjam district*

Land form	Sl. No.	Jagannathpur				Laxmanpur				Raghunathpur			
		Sand*	Silt	Clay	Textural class	Sand*	Silt	Clay	Textural class	Sand*	Silt	Clay	Textural class
Upland	1.	85.0	4.4	10.6	Sandy loam	87.0	2.8	10.2	Loamy sand	81.8	8	10.2	Sandy loam
	2.	83.0	6.4	10.6	Sandy loam	82.0	4.8	13.2	Loam	81.8	7	11.2	Sandy loam
	3.	88.0	1.4	10.6	Sandy loam	77.0	4.8	18.2	Sandy loam	78.8	9	12.2	Sandy loam
Medium land	4.	85.0	2.4	12.6	Sandy loam	79.0	1.8	19.2	Sandy loam	77.8	10	12.2	Sandy loam
	5.	83.0	3.4	13.6	Sandy loam	70.0	9.8	20.2	Sandy loam	75.8	10	14.2	Sandy loam
	6.	84.0	1.4	14.6	Sandy loam	75.0	3.8	21.2	Sandy clay loam	76.8	9	14.2	Loam
Low land	7.	73.0	11.4	15.6	Loam	71.0	5.8	23.2	Sandy clay loam	78.8	7	14.2	Sandy loam
	8.	74.0	9.4	16.6	Sandy loam	62.0	13.8	24.2	Clay loam	77.8	4.2	18	Sandy loam
	9.	76.0	1.4	22.6	Sandy clay loam	68.0	4.8	27.2	Sandy clay loam	76.8	5	18.2	Sandy loam
	10.	62.0	15.4	22.6	Loam	64.0	7.8	28.2	Sandy clay loam	73.8	6	20.2	Sandy clay loam

*Sand, silt and clay in %

reveal that, lowest clay content was found in the upland soil and highest clay content was found in the lowland soils. This is attributed to the pedogenic processes of colluviation in which the fine clay particles of the soil washed and transported by the rain water and deposited in the lowland soils. Study further shows that sand fraction is negatively correlated with all the soil parameters, whereas silt fraction did not show correlation with other parameters but clay fraction shows positive correlation with P and K (Table 5). Similar findings have been observed by Nayak *et al.* (2014) and Satpathy *et al.* (2015).

Soil reaction (1:2)

Result reveals that the soil is acidic in all the villages except some lowland soils which are neutral to slightly alkaline. Soil pH is positively and significantly correlated with OC (r=0.95*), N (r=0.84*), S (0.75*) and B (r=0.86*) (Table 5).

Electrical conductivity (EC_2)

The EC varies from 0.011 to 0.012 dSm^{-1}. It indicates that the soils of the villages under study are not saline even if being situated in coastal plain zone which signifies their study for production of all types of crops. Similar findings have been reported by Nayak *et al.* (2015). The electrical conductivity of surface soils of the three villages under study is presented in Table 2, 3 and 4.

Organic carbon

The oxidisable organic carbon content for all the upland surface soils was found to be low compared to the medium land. Highest oxidisable organic carbon was found in low land soils. Organic carbon is positively and significantly correlated with N (r=0.85*), K (r=0.83*), S (r=0.78*) and B (r=0.86*) (Table 5). The oxidisable organic carbon content of the surface soils of the three villages under study are given in Table 2, 3 and 4.

Available nitrogen

The available soil nitrogen content for all the soils was found to be low. Highest available soil nitrogen content was found in low land which still remains within the medium range. It is positively and significantly correlated with OC (r=0.95*), P (r=0.75*), K (r=0.79*), S (r=0.72*) and B (r=0.84*) (Table 5). The available nitrogen content of surface soils of three villages under study are given in Table 2, 3 and 4**.**

Available phosphorous

In general soil available phosphorous content was found to increase gradually from upland to lowland. This phenomenon may be explained better as lower soil pH at the upland raised towards neutral range in case of lowland and there by less phosphorus fixation in neutral soil reaction. Soil available P is positively correlated with clay (r=0.61), OC (r=0.52), N (r=0.75*) and K (r=69) & B (r=0.51) (Table 5). Similar findings have been observed by Satpathy *et al.* (2015).

Available potassium

The soil available potassium was found in increasing order from the upland to lowland. The higher amount of available potassium found in lowland soils under study area is due to higher quantity of clay found in the lowland soils. Soil available K is positively and significantly correlated with OC (r=0.83*), N (0.79*), P (r=0.69) S (r=0.72) and B (r=0.85*) (Table 5). The available potassium content of surface soils of the three villages is given in Table 2, 3 and 4.

Table 2*. Soil chemical properties of Jagannathpur village of Ganjam block*

Sl. No.	Land type	pH (1:2)	EC (dSm^{-1})	OC ($g\ kg^{-1}$)	N ($kg\ ha^{-1}$)	P_2O_5 ($kg\ ha^{-1}$)	K_2O ($kg\ ha^{-1}$)	S ($mg\ kg^{-1}$)	B ($mg\ kg^{-1}$)
1.	Up land	4.9	0.01	2.8	87.5	28. 7	73. 9	0.97	0.36
2.	Up land	5.5	0.01	5.8	112.5	29.9	100.8	1.65	0.48
3.	Up land	5.7	0.01	6.8	125.5	37.2	107.5	2.02	0.48
4.	Medium land	5.8	0.01	7.5	150.0	40.0	120.9	2.25	0.84
5.	Medium land	5.9	0.01	7.9	150.0	55.8	188.2	2.47	0.9
6.	Medium land	5.9	0.01	10.4	175.0	56.6	215.0	3.22	1.44
7.	Low land	6.2	0.01	10.9	175.0	56.9	248.6	4.80	1.26
8.	Low land	6.2	0.01	11.3	187.5	82.8	288.9	5.92	1.26
9.	Low land	6.5	0.01	12.5	250.0	209.1	315.8	8.62	1.26
10.	Low land	6.7	0.01	14.5	337.5	293.6	369.6	13.27	1.74

Table 3. *Soil Chemical and fertility status of Laxmanpur village of Ganjam block*

Sl. No.	Land type	pH (1:2)	EC (dSm^{-1})	OC ($g\ kg^{-1}$)	N ($kg\ ha^{-1}$)	P_2O_5 ($kg\ ha^{-1}$)	K_2O ($kg\ ha^{-1}$)	S ($mg\ kg^{-1}$)	B ($mg\ kg^{-1}$)
1	Up land	5.2	0.01	3.9	100.0	12.4	118.1	0.97	0.42
2	Up land	5.2	0.01	5.6	112.5	23.1	154.6	1.35	0.48
3	Up land	5.3	0.01	6.0	112.5	24.2	180.4	2.25	0.48
4	Medium land	5.5	0.01	6.4	125.0	28.2	201.6	2.25	0.54
5	Medium land	5.5	0.01	6.5	125.0	28.7	215.0	2.70	0.66
6	Medium land	5.5	0.01	7.7	125.0	34.9	235.2	2.92	0.72
7	Low land	5.6	0.01	9.7	150.0	35.5	280.2	3.52	0.84
8	Low land	5.9	0.01	10.7	150.0	58.6	288.9	3.75	1.02
9	Low land	6.0	0.01	11.3	162.5	103.1	342.7	4.05	1.14
10	Low land	6.3	0.01	13.5	175.0	236.1	362.9	6.75	1.32

Table 4. *Soil chemical properties of Raghunathpur village of Ganjam block*

Sl. No.	Land type	pH (1:2)	EC (dSm^{-1})	OC ($g\ kg^{-1}$)	N ($kg\ ha^{-1}$)	P_2O_5 ($kg\ ha^{-1}$)	K_2O ($kg\ ha^{-1}$)	S ($mg\ kg^{-1}$)	B ($mg\ kg^{-1}$)
1	Up land	5.2	0.01	1.1	137.5	19.2	154.6	2.7	0.66
2	Up land	5.8	0.01	7.9	137.5	19.8	188.2	3.1	0.78
3	Up land	6.3	0.01	9.9	150.0	31.6	188.2	6.5	0.96
4	Medium land	6.5	0.01	10.2	162.5	33.2	188.6	7.8	1.08
5	Medium land	6.8	0.01	12.8	175.0	50.7	215.0	8.0	1.26
6	Medium land	6.9	0.01	14.3	212.5	51.8	215.0	17.9	1.36
7	Low land	7.3	0.01	16.8	225.0	52.9	235.2	18.5	1.38
8	Low land	7.6	0.01	19.0	237.5	54.7	288.2	18.8	1.74
9	Low land	7.6	0.01	20.9	237.5	55.2	443.5	39.6	3.12
10	Low land	7.7	0.01	22.6	325.0	200.6	510.7	76.4	3.26

Available sulphur

$CaCl_2$ extractable soil sulphur has followed the same trend as gradual increase of available sulphur from upland to lowland. Soil available sulphur is positively and significantly correlated with pH (r=0.75*), OC (r=0.78*) N (r=0.72), K (r=0.72) and B (r=0.88*) (Table 5).

Available boron

Hot water extractable soil boron has been found to be in gradual increment towards lowland from upland. Hot water extractable soil boron is positively and significantly correlated with pH (r=0.86*), OC (r=0.91*), N (r=0.84*), P (r=0.51), K (r=0.85*) and S (r=0.88*) (Table 5). Similar findings were observed by Mohanty (2012) and Nayak (2013). Taking 0.5 $mg\ kg^{-1}$ as the critical limit, most of the soils are sufficient in available B content.

Soil test based fertiliser recommendation extensively followed in the state of Odisha as reported by the previous workers (Muhur *et al*., 1965; Mitra *et al*., 1980). Twenty five percent more plant nutrient is applied when that particular nutrient status shows low or deficient in soils. Similarly when the nutrient content is high or excess then 25% less than the recommended dose for a particular crop is applied and when nutrient content is medium or just above the critical limit recommended dose of fertiliser on a particular crop is applied (Nanda *et al*., 2008). The present investigation showed the deficiency and sufficiency of available plant nutrients in soil in representative villages of Ganjam block of Ganjam district which represent the different types of soils of East and South Eastern Coastal Plain zone of Odisha. It will go a long way in balanced recommendation of fertilisers 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 in reducing the cost of cultivation of farmers.

Table 5. *Correlation and coefficient of different parameters of soils*

	Sand	Silt	Clay	pH	OC	N	P	K	S	B
Sand	1									
Silt	-0.66*	1								
Clay	-0.85*	0.18	1							
pH	-0.29	0.23	0.23	1						
OC	-0.43	0.19	0.42	0.95*	1					
N	-0.44	0.29	0.39	0.84*	0.85*	1				
P	-0.60	0.26	0.61	0.45	0.52	0.75*	1			
K	-0.69	0.25	0.73	0.70	0.83*	0.79*	0.69	1		
S	-0.17	0.05	0.18	0.75*	0.78*	0.72	0.40	0.72	1	
B	-0.34	0.16	0.32	0.86*	0.91*	0.84*	0.51	0.85*	0.88*	1

(*Significant at 0.5% level)

CONCLUSION

Field investigation for soil fertility status of east and south eastern coastal plain agro-climatic zone reveals that the soils of Jagannathpur, Lakshmanpur and Raghunathpur villages of Ganjam block of Ganjam district ranges from deficiency and sufficiency in available plant nutrients. This information is of vital importance and acts as a major tool for the balanced recommendation of fertiliser to various crops.

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