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Nutrient Status of Some Coastal Soils of Guntur District, Andhra Pradesh

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Coastal soils of Guntur district in Andhra Pradesh are developed from marine sediments. Nutrient status was evaluated for four soil profiles of a coastal village to have information on the nutrient supplying capacity of these soils which is necessary for making accurate fertilizer recommendation in the study area. The nutrient status of the soils indicated that they were low in organic carbon (0.007 to 0.058 g kg^{-1}), available nitrogen (28 to 247 kg ha^{-1}), medium to high in available phosphorus (6.60 to 90.10 kg ha^{-1}) and high in available potassium (241 to 2016 kg ha^{-1}) while concentration of total nitrogen, phosphorus and potassium varied from 100 to 560, 37 to 325 and 625 to 7500 ppm, respectively. Similar trend in sub-surface distribution of organic carbon and total nitrogen revealed the soils were old alluvial soils except profile 2. Sufficiency in available micronutrient content existed except for zinc. Distribution of total micronutrient within the profile showed lower values on surface than subsurface layers indicating fluvial nature of deposition. Relationship of nutrients with organic carbon and clay content were positive while the acidity of the soils resulted in negative affect on micronutrients except copper. Contribution of parent material was significant in case of total potassium.

(***Key words:*** *Coastal soils, Nutrient status, Macronutrient, Micronutrient*)

Soil is at the heart of terrestrial ecology and is the most important reservoir of essential nutrients for completing life cycle of not only plants but human as well; however this critical resource base of nutrients is finite and non-renewable. For the rational exploitation of soil fertility, judicious and economic management of land, systematic study of the nature and type of soils, their constraints, potentials and their suitability is necessary. Knowledge of depth wise distribution of elements in soil is helpful in understanding the inherent capacity of soil to supply these nutrients to plants and their downward movement in soil.

Indian coast line covers a length of about 7500 km, of which 972 km is in Andhra Pradesh. Coastal agro-ecosystem, more than any ecosystem, plays a significant role in controlling the overall ecological balance on earth. It is biologically highly productive and physically variable in space and time. However, it is highly fragile, comprising complex geo-morphological and ecological systems that faces problems of multidimensional nature. Therefore knowledge regarding amount and availability of nutrients is a pre-requisite before planning cultivation of any crop as an essential land use of the ecosystem. Also owing to factors such as crop removal and soil erosion, it is essential to know the nutrient supplying capacity through soil testing for macro and micronutrients for making accurate fertilizer recommendations to increase crop production. As precise information on the nutrient status of the coastal soils of Guntur district represented by Pedapuluguvaripalem village is virtually lacking, hence the present investigation was undertaken.

MATERIALS AND METHODS

The study area is a coastal village *i.e.* Pedapuluguvaripalem belonging to Karlapalem Mandal in Guntur District of Andhra Pradesh situated between 15° 95´ and 80° 65´ E. It is associated with sandy and inland black soils. The soils were derived from coastal marine sediments. The topography of the selected area was dominantly plain with slopes of 0 to 1% (Table 1). The profiles were selected according to drainage evident from the textural classes. The initial on field inspection of texture was done through feel method. The soil samples collected horizon-wise were tested for available nitrogen by alkaline potassium permanganate method (Subbaiah and Asija, 1956), available phosphorus by Watanabe and Olsen's method and available potassium by Jackson (1973). Soil available micronutrients were estimated using standard procedures as described by Lindsay and Norvell (1978). Total micronutrients were determined by method described by Hesse (1971). Correlation studies between nutrients with other properties as per procedure described by Snedecor and Cochran (1980).

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Table 1. *Site characteristics of the sampling locations*

Profile No.	Climate	Slope (%)	Topography	Drainage	Parent material	Natural vegetation	Land use
1	Semi-arid	0-1	Plain	Poorly	Coastal marine sediments	*Acacia spp., grasses, Borassus spp.*	paddy
2	Semi-arid	0-1	Plain	Moderately well	Coastal marine sediments	*Acacia spp., grasses, Borassus spp.*	paddy
3	Semi-arid	0-1	Plain	Excessively	Coastal marine sediments	*Neem, Acacia spp., grasses, Borassus spp.*	paddy
4	Semi-arid	0-1	Plain	Moderately well	Coastal marine sediments	*Neem, Acacia spp., grasses, Borassus spp.*	paddy

RESULTS AND DISCUSSSION

Physical and chemical characteristics of the soils

The soils were derived from coastal marine sands (Table 1). The soils varied in their depth according to their location and topography. The soils exhibited variable texture with depth from coarse to fine except few where coarse texture existed throughout the depth. The profile 1 was poorly drained, profiles 2 and 4 were moderately drained whereas 3 was excessively drained. The textural variations could be due to the differential deposition of sediments at various periods (Rao *et al*., 2004). The surface horizons in most of the soils of the profiles were neutral to slightly alkaline which may be due to cumulative effect of vegetation, parent material and climate (Leelavathi *et al*., 2009). The sub-surface horizons recorded relatively higher pH due to presence of high amount of exchangeable sodium and relatively high proportion of soluble salts dominating with sodium bicarbonate and carbonate (Mydhili, 2006). The electrical conductivity varied from 0.41 to 8.12 dS m^{-1} with wide variation in most of the profiles (Table 2). The high EC values could be due to the seepage of brackish water from the aquaponds present in the vicinity (Trivedi *et al*., 2010). The distribution of salt content varied widely in all the profiles due to variation in texture and structure of the soils. The organic carbon content of the soils ranged from 0.075 to 0.585 g kg^{-1} (Table 2). Organic carbon content was higher at the surface because of addition of organic residues to the surface soil. Variable texture and fluvial nature of sediments resulted in irregular deposition of organic carbon in sub-surface (Garg *et al*., 2000). Calcium carbonate content ranged from nil to 2.1%.

Available macronutrients and micronutrients

The available nitrogen content ranged from 28 to 247 kg ha^{-1} (Table 3). High contents were observed in the surface than in sub-surface layers which could be attributed to high organic carbon at the surface and its subsequent decrease with depth. Overall status of available nitrogen was low and irregular in most of the soils. It showed positive and significant correlation (r =+0.62**) with organic carbon (Table 5). The available phosphorus ranged from 6.6 to 90.10 kg ha^{-1} (Table 3). Profile 1 being heavy textured in subsurface recorded higher values of this nutrient than profiles 2, 3 and 4. High values were recorded in surface than sub-surface which may be due to confinement of crop cultivation to the rhizosphere and supplementation of the depleted phosphorus through phosphatic fertilizers (Chaudhary *et al*., 2008). Contribution of available phosphorus was significant from (r=+0.59**) organic carbon and less by clay content (r=-0.07) (Table 5). Wide variations within a profile were observed. The available potassium content ranged from 241.0 to 2016.0 kg ha^{-1} (Table 3). Profile 1 having clayey texture in subsurface recorded higher values of this nutrient than profiles 2, 3 and 4. The high values of potassium could be attributed to intense weathering of potash bearing minerals (r=+0.87**), release of K, application of K fertilizers and upward translocation of K from lower depths with capillary rise of ground water. No specific trend was observed in coastal soils of Guntur district, which may be ascribed to the nature and distribution of parent material and its degree of weathering (Mydhili, 2006).

Available zinc values varied from 0.12 to 0.82 mg kg^{-1} (Table 3) among different profiles. Irregular distribution was observed in all the profiles. Most of

Table 2. Physical and chemical properties of soils

Profile no. & horizon	Depth (m)	texture	Clay (%)	pH	E.C (dS m^{-1})	Organic carbon (g kg^{-1})	$CaCO_3$ (%)
Profile – 1							
Ap	0.00-0.17	ls	7.64	7.03	0.49	0.0420	-
2B	0.17-0.33	c	36.50	9.26	1.61	0.0295	0.3
2Bw1	0.33-0.51	c	36.30	9.54	2.00	0.0225	0.3
2Bw2	0.51-0.74	c	37.20	9.63	2.00	0.0225	0.5
2Bw3	0.74-1.00	c	42.80	9.56	1.68	0.0195	0.4
2Bw4	1.00+	c	43.82	9.60	1.68	0.0150	2.1
Profile-2							
Ap	0.00-0.14	ls	9.29	7.53	0.41	0.0325	-
A2	0.14-0.29	ls	11.49	9.06	0.64	0.0106	-
2Bw1	0.29-0.49	scl	24.50	9.36	1.66	0.0160	-
2Bw2	0.49-0.72	scl	21.50	9.86	1.96	0.0075	-
2BC	0.72-0.96	sl	18.42	9.89	1.60	0.0300	-
3C	0.96+	ls	10.20	9.86	0.97	0.0180	-
Profile-3							
Ap	0.00-0.12	ls	6.89	7.78	0.54	0.0585	-
AC	0.12-0.29	ls	7.50	8.12	2.88	0.0225	-
C1	0.29-0.40	ls	9.20	7.92	3.56	0.0196	-
C2	0.40-0.67	ls	9.10	8.06	3.44	0.0165	-
C3	0.67+	ls	8.10	8.06	3.54	0.0150	-
Profile-4							
Ap	0.00-0.20	ls	8.10	7.83	0.43	0.0270	-
2Bw1	0.20-0.50	scl	25.57	8.86	4.93	0.0150	1.2
2Bw2	0.50-0.71	scl	28.23	8.70	8.12	0.0165	1.1
2Bw3	0.71-0.90	scl	27.42	8.68	6.71	0.0136	0.5
3C1	0.90-0.96	sl	10.20	8.88	6.89	0.0075	0.1
3C2	0.96-1.10	sl	9.20	8.93	8.07	0.0075	-

the profiles were deficient in available Zn with content less than the critical limit of 0.8 mg kg^{-1} (Lindsay and Norvell, 1978). It showed positive correlation (r=+0.35) with organic carbon and negative correlation with (r=-0.20) with pH (Table 5). The other DTPA extractable cations (Cu, Fe and Mn) were above the critical limit and were irregularly distributed. The available copper content varied from 0.38 to 5.72 mg kg^{-1} and was significantly influenced by clay (r=+0.55**). Iron and manganese ranged from 2.60 to 35.36 and 0.89 to 14.79 mg kg^{-1}, respectively. These cations were positively and significantly influenced by organic carbon (r=+0.67**, r=0.54**) and negatively influenced by pH (r =-0.69**, r=-0.61**), respectively (Table 5) (Verma *et al*., 2005).

Total macronutrients and micronutrients

The total nitrogen content of the samples varied from 100 to 560 mg kg^{-1} (Table 4). In all the profiles, the total N content showed a distinct declining trend with depth which closely followed the same pattern as organic carbon except few profiles where it was irregular. This declination may be attributed to presence of higher organic carbon in the surface due to addition of organic matter through plant residues and fertilizers (Ramalakshmi *et al*., 2001). Total N showed positive and significant correlation (r=+0.85**) with organic carbon (Table 5).

The total P content ranged from 37 to 325 mg kg^{-1} which increased with increase in fineness of the soil. Except profiles 1 and 3 other two profiles showed declining trend with depth which might be due to build up of annually applied phosphatic fertilizers in the form of insoluble phosphates. The profiles exhibited high total K content ranging from 625 to 7500 mg kg^{-1}. Highest values were found in surface layers except

Table 3. *Available macro and micronutrient contents of the soils*

Profile no. & horizon	Depth (m)	Available macronutrients (kg ha^{-1})				Available micronutrients (mg kg^{-1})			
		N	P_2O_5	K_2O	S (mg kg^{-1})	Zn	Cu	Mn	Fe
Profile 1									
Ap	0.00-0.17	185	90.10	470	9.75	0.50	5.36	9.22	10.80
2B	0.17-0.33	116	20.50	1344	15.25	0.26	5.00	4.30	4.08
2Bw1	0.33-0.51	97	41.00	1846	12.00	0.40	5.72	3.93	5.40
2Bw2	0.51-0.74	100	37.00	1680	16.25	0.34	5.38	3.57	4.76
2Bw3	0.74-1.00	94	32.80	2016	8.75	0.48	4.80	3.45	3.20
2Bw4	1.00+	78	20.50	1680	10.75	0.62	5.00	4.85	2.60
Profile 2									
Ap	0.00-0.14	247	85.00	295	9.75	0.82	2.10	9.96	8.70
A2	0.14-0.29	103	20.51	322	13.00	0.12	1.40	5.66	8.10
2Bw1	0.29-0.49	81	14.60	510	7.75	0.20	2.84	2.10	6.00
2Bw2	0.49-0.72	53	10.00	497	18.50	0.24	0.94	0.89	5.82
2BC	0.72-0.96	65	8.40	483	14.00	0.32	0.80	1.28	6.32
3C	0.96+	43	6.60	295	10.50	0.12	0.48	3.13	5.70
Profile 3									
Ap	0.00-0.2	122	35.64	241	7.25	0.30	1.98	14.79	35.36
AC	0.12-0.29	75	13.85	403	17.00	0.30	1.60	7.75	11.16
C1	0.29-0.40	72	14.88	376	21.75	0.26	1.10	5.78	8.68
C2	0.40-0.67	50	17.44	322	21.25	0.24	0.82	3.62	18.08
C3	0.67+	62	15.39	302	19.00	0.28	0.74	3.26	24.16
Profile 4									
Ap	0.00-0.20	153	20.51	288	7.75	0.14	2.50	11.71	20.80
2Bw1	0.20-0.50	112	12.31	268	13.00	0.16	2.40	3.96	10.16
2Bw2	0.50-0.71	72	10.00	840	9.00	0.22	1.62	1.90	3.56
2Bw3	0.71-0.90	40	9.50	336	8.00	0.24	0.66	2.58	4.74
3C1	0.90-0.96	28	8.40	336	6.75	0.24	0.38	8.64	6.92
3C2	0.96-1.10	40	10.00	336	8.75	0.18	5.28	2.95	6.92

for profile 1 and 2. The distribution of K throughout the profiles did not follow any trend. Total P and K had a positive correlation with clay content (r=+0.20 and +0.56, respectively) (Table 5).

The total Zn content varied from 16.73 to 58.48 mg kg^{-1}. The surface of all profiles had lower Zn content than the sub-surface. The distribution of Zn was apparently variable with variable texture. Increase in Zn content with increase in clay was observed. The total copper content varied from 17.5 to 107.5 mg kg^{-1}. The total Cu increased with increase in clay content. Total Mn concentrations were low in surface than sub-surface and total Fe also followed similar trend. The distribution and content of total micronutrient were influenced by texture which is attributed to the type of parent material. They showed significant positive correlation with clay with r values of +0.81** for Zn, +0.86** for Cu, +0.55** for Mn and +0.86** for Fe, respectively (Table 5.) Swaminathan and Chandrasekharam (2003) reported similar results in coastal soils of Raigad district of Maharashtra.

In this study, we can conclude that the distribution of macro and micronutrients were dependent on organic carbon, clay content and parent material. The pivotal

Table 4. *Total macro and micronutrient contents of the soils*

Profile no. & horizon	Depth (m)	Total macronutrients (mg kg^{-1})			Total micronutrients (mg kg^{-1})			
		N	P	K	Zn	Cu	Mn	Fe
Profile 1								
Ap	0.00-0.17	420	155	2500	23.62	47.5	261	2.45
2B	0.17-0.33	320	262	3750	54.07	92.5	397	5.40
2Bw1	0.33-0.51	280	250	4500	56.13	103.5	398	5.90
2Bw2	0.51-0.74	280	300	4570	58.48	105.0	398	6.27
2Bw3	0.74-1.00	140	312	5750	58.10	107.5	357	6.96
2Bw4	1.00+	100	212	3250	55.10	100.0	297	6.26
Profile 2								
Ap	0.00-0.14	560	162	1125	18.23	27.5	135	1.59
A2	0.14-0.29	140	137	1875	20.93	32.5	217	2.00
2Bw1	0.29-0.49	280	75	3750	34.70	60.0	274	2.10
2Bw2	0.49-0.72	140	37	3000	25.13	37.5	170	2.68
2BC	0.72-0.96	560	100	2500	23.80	45.0	171	2.77
3C	0.96+	280	150	1750	16.73	27.5	196	3.65
Profile 3								
Ap	0.00-0.12	560	87	1750	34.20	42.5	125	2.59
AC	0.12-0.29	280	325	1500	37.98	50.0	202	3.50
C1	0.29-0.40	280	287	895	35.72	51.5	216	2.48
C2	0.40-0.67	140	287	875	32.43	52.0	232	2.36
C3	0.67+	140	262	625	17.23	17.5	120	1.58
Profile 4								
Ap	0.00-0.20	280	162	7500	29.10	47.5	237	2.21
2Bw1	0.20-0.50	140	175	6500	37.70	70.0	257	4.22
2Bw2	0.50-0.71	140	212	5875	43.45	77.5	326	4.48
2Bw3	0.71-0.90	120	112	2500	24.20	35.0	148	2.33
3C1	0.90-0.96	100	175	1500	23.58	22.5	218	2.05
3C2	0.96-1.10	100	225	1875	24.88	32.5	474	2.02

Table 5. *Correlation coefficients(r) between nutrient content and physico-chemical properties*

Variables	'r'value	Variables	'r'value
Available N vs O.C.	0.62**	Available Zn vs pH	-0.20
Total N vs O.C.	0.85**	Total K vs clay	+0.56**
Available P_2O_5 vs O.C.	0.59**	Total Fe vs clay	+0.86**
Total P vs clay	0.20	Total Mn vs clay	+0.55**
Available Zn vs O.C.	0.35	Available P_2O_5 vs clay	-0.07
Total Zn vs clay	0.81**	Total Cu vs clay	+0.86**
Available K_2O vs clay	0.87**	Available Cu vs clay	+0.55**
Available Fe vs O.C.	0.67**	Available Mn vs O.C.	+0.54**
Available Fe vs pH	-0.69**	Available Mn vs pH	-0.61**

**Significant at 1%

role of pH, EC, and organic carbon indicates that for long term availability of nutrients, these parameters can be improved or changed as per requirement. The coastal soils exhibited low nutrient status in available and total nitrogen, low to high in available and total phosphorus and high in available and total potassium. Hence, application of appropriate amounts of organic matter from time to time as they influence the weathering process through acidic leachates and formation of soil through binding, and maintenance of organic residues through reduced tillage could be few of the options for the sustenance of nutrient supplying power of the soil. Micronutrients are equally important in maintaining soil health and completing the life cycle of a crop. The availability and distribution of micronutrients exhibited dependence on pH, organic carbon and clay content with low levels at the surface and increment with depth. Therefore maintaining these factors as per requisite with an aim for long term availability of micronutrients can play a huge role in improving the deficit of essential nutrients in the human food chain.

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