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Soil Chemistry of Erravagu Sub-basin of Guntur District, Andhra Pradesh

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Abstract

To identify the fertility status of soil in Erravagu sub-basin, soil samples were collected particularly in Reddigudem and Nekarikallu villages of Guntur District, Andhra Pradesh.About thirty four soil samples were collected covering the entire study area laterally (15 cm to 30 cm (depth)) and vertically (0-120 cm (depth)). The study area consists of both red and black soils which are moderate to strong alkaline in nature and non-saline. On the soil complex the dominant cation is calcium. The physical properties were normal as the Bulk Density was normal. The Water Holding Capacity of the soils is high. The overall fertility status of the soils was low, medium and high in nitrogen, phosphorus and potassium respectively. As the soils were calcareous and strongly alkaline, there is need for application of any acid forming amendment(S containing amendments) and organic materials to alleviate the nutrient deficiency and improve productivity.

Key Words :*Soil Chemistry, Fertility status, Reddigudem, Nekarikallu, alkaline.*

INTRODUCTION

Adequate crop growth and its production mainly depend on the appropriate nutrition;if there is nutrient deficiency in soil it effects the growth rate of plants.The crucial nutrient soil elements which are required for the plant growth and development are Phosphorus (P), Calcium (Ca+2), Nitrogen (N), Magnesium (Mg+2)andPotassium (K+). Nitrogen occupies the first position in the plant requirement among the nutrient elements, followed by phosphorus and potassium (Samuel and Ebenezer, 2014; Solanki and Chavda, 2012; Potassium is a major nutrient which plays a major role in different physiological processes of plants helping plants to resist against diseases and improving physical characteristics of plant(Buchholz and Brown, 1993). Sodium content is very important factor which affect soil quality and plant growth (Pandit et al. 2005). High sodium content in the soil leads to reduction in permeability and soil drying which will effect more in fine textured soils than in coarse textured soils (NRCS, 2007). Magnesium is necessary for the synthesis of chlorophyll pigment in green plants and its deficiency causes the loss of healthy green colour of leaves (Mahajan and Billore, 2014).Calcium ion is the key element in reducing the soil salinity,

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erosion content and as well as phosphorous loss through flowage. Phosphorus is a most important element because the growth of plant depends on the availability of Phosphorous content in the soils (Foth and Ellis, 1997). Nitrogen and nitrate are the most important and critical elements in an ecosystem (Chandaluri et al. 2010). Fertilizers which contain inorganic nitrogen and organic nitrogen (wastes), decomposes to give ammonia and when further oxidizes gives Nitrates and Nitrites in the soil (Ali and Mohammad, 2018). Nitrogen is essential for plants as it involves in the production of chlorophyll and part of different proteins which grow enzymatic and also regulate and catalyse plant-growth processes (Sinfield, 2010). To increase the crop production farmers supply high N which becomes hazardous to human health causing various diseases likemethahemoglobinaemia, gastric and bladder cancer from the leafy vegetables (Parks et al. 2012). Phosphorus is essential element in the soil for the general health and vigour of all plant. For the better cropyield alongside the nutrients the presence of moisture content in the soil is essential, which depends on the Bulk Density of the soil which plays vital role for water holding capacity. Since the water holding capacity reduces when the Bulk Density increases. It is the most effecting factor for the forming of wet type crops (ex: Paddy, Cotton etc.). To identify the fertility status of the selected area, various soil samples were collected from pre-determined locations and were analysed for physical properties (water holding capacityandbulk density) and physico-chemical properties (pH and electrical conductivity) chemical characteristics including fertility parameters like available nitrogen, phosphorous, potassium and exchangeable basic cations constituting calcium, magnesium, potassium and sodium. Soil samples were collected at 15 to 30 intervals to a depth of 120 cm and 150 cm to observe the changes in the soil properties from Reddigudem and Nekarikallu villages respectively. About thirty four samples (fourteen surface soils from Reddigudem and twenty surface soils from Nekarikallu villages) were collected and analyzed.

STUDY AREA

The Erravagu sub-basin is located in between North latitudes of 16020'20"-16027'45" and East longitudes of 790 52' 06" - 800 04' 30" in the central portion of the Guntur District, Andhra Pradesh state (Fig. 1). The study area experiences semi-arid climatic conditions with an average annual temperature varying from 18.50C (winter) to 430C (in summer). The study area receives an average annual rainfall of 782 mm. The Erravagu originates from the hill ranges which are located in the southwest direction and also in northwest direction; the flow is towards the northeast. The drainage pattern in the study area is characterized as dendrite to sub-dendritic. The area is experiences undulating topography, with sloping towards north-east direction. The altitude varies from 95 m amsl (in the north-eastern part) to 349 m amsl (in the south-west part).Geologically the major part of the area is covered by gneiss. Grey pink granites are exposed in north-eastern part while quartzites, shales and phyllitesexposes in the south-eastern and south-western parts of the area respectively. The shalesandLimestones also occur in the north-western and south central portions of study area. The granites and gneisses in the study area are highly fractured and weathered resulting in the formation of soil.

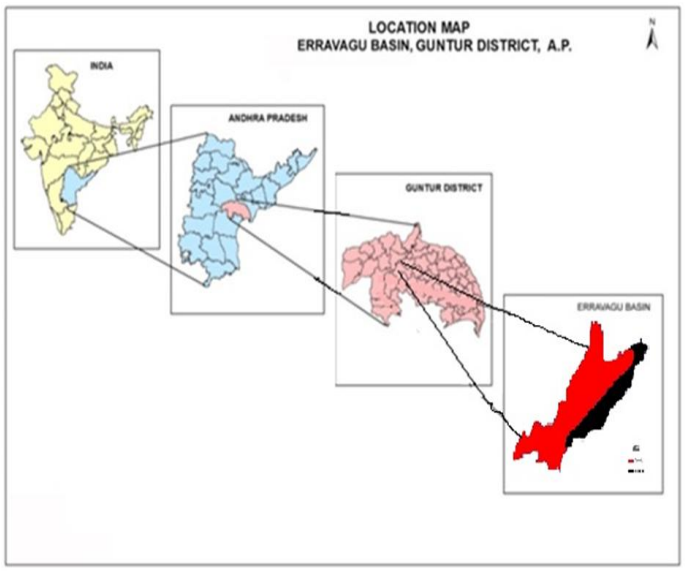

Fig.1 Location map of the study area

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MATERIALS AND METHODS

pH meter (glass electrode) was utilised for the determination of pH in the soil, Electrical Conductivity was calculated by with conductivity meter (Jackson 1973), Available nitrogen was determined by alkaline KMnO4 method (Subbaiah and Asija 1956), Available phosphorus was extracted by 0.5N NaHCO3 solution buffer at pH 8.5 (Olsen et al., 1954) and phosphorus in the extract was determined by ascorbic acid method (Watanabe and Olsen 1965), available potassium was extracted by shaking with neutral normal ammonium acetate for 5 minutes (Hanway and Heidel 1952) and then K in the extract was determined by flame photometer and available calcium carbonates micronutrients Fe, Mn, Cu, and Zn, determined by DTPA extractable method (Lindsay and Norvell,1978) using Atomic Absorption Spectrophotometer. Calcium and Magnesium is measured by Versenate (EDTA) method.

Results and Discussion : The results of profile studied at Reddigudem village (Table 1) are a red soil, while the profile studied at Nekarikallu (Table 2) is a black soil belt. The results of Surface soils samples in the Reddigudem village and Nekarikallu are presented in Tables 3 and 4 respectively.

Profile characteristics of Reddigudem (Table 1) and Nekarikallu village (Table 2):The bulk density values in the of Reddigudem soil profile ranges from 1.09 to 1.21 with a mean of1.14Mg m-3whereas in Nekarikallu it ranges from 1.12 to 1.25 with a mean of 1.20 Mg m-3. The B.D. values in the lower layers are low compared to top (upto 30 cm) which might bedue to more of coarse fraction in the profile (Tranter et al., 2007). The WHC was ranging from 50.0 to 67.6% with a mean value of 55.3% in theReddigudem village. The free lime content rangesfrom 11.6 to 23.4% witha mean of 14.8% in Reddigudem village whereas it in between 13.7 and 24.5% with a mean of 16.6% indicating strong calcareous nature which may be due to lithogenic origin (Leytem and Mikkelsen, 2005).The availability of phosphorous in calcareous soils decreases due to fixation by CaCO3 into unavailable and insoluble form. The soils are strongly alkaline in both profiles exhibiting the pH values from8.40 to 9.09 and 8.49 to 9.09 with a mean of 8.85 and 8.80 respectively. This may be due to calcareous nature of soils in both locations (Breemen et al. 1983).The EC values ranges from 0.300 and 1.920 with a mean of 0.963 dS m–1in Reddigudem village whereas in Nekarikallu it is in between 0.384 and 3.000, with a mean of 1.544dS m–1indicating the soils are non-saline at any depth in the profile. The low E.C. valuesmay be due to low to moderate permeability (Ghosh and Tran,2014).The exchangeable Ca2+ ranges from 25.5 to 39.0 cmo (p+) / kg soil in Reddigudem and 20.0 to 29.5 cmol (p+) /kg soil in Nekarikallu villages respectively.

Table 1 Soil Profile characteristics at Reddigudem village

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REDDYGUDEM SOIL (PROFILE)												
Depth Level (In Cms.)	pH Units	E.C. dSm^{-3}	B.D. Mgm^{-3}	$CaCO_3$ %	N	P_2O_5 Kg/ha	K_2O	Ca^{+2}	Mg^{+2}	Na^{+}	K^{+} Cmol (P^{+}) Kg^{-1}	WHC (%)
0-15	8.40	0.420	1.15	12.8	336	30.2	420	39.0	3.0	2.72	0.40	50.0
15-30	8.82	0.300	1.20	14.7	204	32.4	336	31.5	8.0	4.08	0.32	56.9
30-45	8.99	0.420	1.11	15.0	190	38.8	504	33.5	4.0	6.25	0.48	54.0
45-60	9.09	0.564	1.13	13.6	165	34.6	252	34.5	1.5	10.87	0.24	67.6
60-90	8.84	1.440	1.13	12.6	146	28.8	168	29.0	5.0	16.03	0.16	50.0
90-120	8.85	1.920	1.09	23.4	137	20.4	126	25.5	1.5	17.93	0.12	-
Range	8.4 - 9.09	0.300 - 1.920	1.09 - 1.21	11.6 - 23.4	137 - 336	20.4 - 38.8	84 - 504	25.5 - 390	8.0 - 4.4	2.72 - 17.93	0.08 - 0.48	50.0 - 67.6
Mean	8.85	0.963	1.14	14.8	185	29.7	270	30.1	-	10.10	0.25	55.3

Table 2 Soil Profile characteristics at Nekarikallu village

NAKARIKALLU SOIL (PROFILE)												
Depth Level (In Cms.)	pH Units	E.C. dSm^{-3}	B.D. Mgm^{-3}	$CaCO_3$ %	N	P_2O_5 Kg/ha	K_2O	Ca^{+2}	Mg^{+2}	Na^{+}	K^{+} Cmol (P^{+}) Kg^{-1}	WHC (%)
0-15	8.62	0.384	1.25	15.6	272	32.4	252	22.5	6.5	3.91	0.24	
15-30	8.93	0.600	1.23	16.0	179	36.8	302	27.5	10.0	4.50	0.29	
30-45	9.09	0.948	1.23	13.7	168	40.2	336	26.0	7.0	4.80	0.32	
45-60	9.09	0.564	1.13	13.6	165	34.6	252	34.5	1.5	10.87	0.26	
60-90	8.80	1.920	1.21	16.7	146	28.4	269	25.0	11.0	6.20	0.16	
90-120	8.49	3.000	1.12	14.4	81	22.0	269	27.5	4.4	7.24	0.26	
120-150	8.65	2.760	1.18	24.5	78	18.4	202	20.0	10.5	7.46	0.19	
Range	8.49 - 9.09	0.384 - 3.000	1.12 - 1.25	13.7 - 24.5	78 - 272	18.4 - 40.2	202 - 336	20.0 - 29.5	4.4 - 11.0	3.91 - 7.46	0.19 - 0.32	
Mean	8.80	1.544	1.20	16.6	156	30.9	276	25.8	8.2	5.76	0.26	

The sequence of dominance the cations in all the layers of the both profile locations is Ca2+> Mg2+> Na+> K+ which might be due to strong alkaline nature.

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The available N content is medium inbothsurface layers and gradually decreased with depth because of presence of organic matter on thesurface compared to sub-surface layers. The N value ranges from 78 to 272 kg/ ha with an average of 156 kg/ ha in Reddigudem and 137 to 336 kg/ ha with a mean of 185 kg/ ha in Nekarikallu villages respectively.The available phosphorous content ranges from 20.4 to 38.8, 18.4 to 40.2 kg/ha with an average of 29.7 kg /ha and 30.9 as P2O5in Reddigudem and Nekarikallu villages respectively. The phosphorus content decreased from surface to depth this might be due to application of P fertilizers and / or release of P from fixed form.The available potash content in the soils was medium to high in both locations (ie. 84 to 504 kg/ha in Reddigudem and 202 to 336 kg /ha in Nekarikallu) due to release of K-bearing minerals like orthoclase and micas due to weathering of rocks.

SURFACE SOIL CHARACTERISTICS

REDDIGUDEM VILLAGE SOIL CHARACTERISTICS (Table 3)

The surface soil data in the Reddigudem village revealsthat soils are moderately to strongly alkaline (8.32 to 8.94) reaction and non-saline with low EC values (0.18 to 0.28 dSm–1). The Bulk Density is normal with values ranging from 1.07 to 1.19 mg m–3. The soils are calcareous in nature exhibiting the lime content from10.5 to 13.5% with a mean of 11.7% which causes deficiency of many nutrients. In all the fourteen locations of the Reddigudem village, Ca2+ is the main exchangeable cation followed by Mg2+, Na+ and K+. The available nutrient of soils can be classified as low or medium with values ranging from 185 to 241 with a mean of 217 Kg/ha. It is quite expected that high temperatures cause rapid decomposition of organic matter. The nutrient index value computed from all locations indicated that the overall available N status of the soils of village was low. The available P2O5 content varies from 20.2 to 38.4 kg/ha with an average of 29.0Kg/ha. Most of the samples contained medium level of available phosphorus. The overall nutrient index for this nutrient is medium. The average K2O content in this area is 244 kg/ ha. In different fields, the potash content was medium or high. The overall nutrient index value for potash of the area is high. The Water Holding Capacity of the soil ranges from 45.7 to 64.1% with a mean value of 51.2%.

NEKARIKALLU VILLAGE SOIL CHARACTERISTICS (TABLE 4)

The soils present in the Nekarikallu village were moderately alkaline to strongly alkaline in reaction and non- saline with low EC values (0.216 to 0.624 dSm–1). The BD values were normal with values ranging from 1.12 to 1.23Mg m–3. The soils are calcareous in nature and lime content ranges from11.1 to 16.6% which causes deficiency many nutrients. In all the twenty locations, the Ca2+ is the main exchangeable cation followed by Mg2+, Na+ and K+on the soil complex. The available N content of soils was low or medium (202 to 266 kg/ha). It is quite expected that high temperature causing rapid decomposition of organic matter. The nutrient index value computed from all locations indicated that the overall available N status of the soils of village is low. The available P2O\content was within the range of 7.9 to 62.9 kg/ha. Most of the samples show medium level of available phosphorus. In few locations, the availability was high, which might be due to application of more P-fertilizers by the farmers. The overall nutrient index for this nutrient is medium. The average K2O content in this area is 300 kg/ha. In different fields, the potash content was medium or high. The overall nutrient index value for potash of the area was high.

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Table 3 Surface soil characteristics of Reddigudem village

REDDYGUDEM - SURFACE SOILS (0-15 CM)												
S.No.	pH	E.C.	B.D. (g/cc)	$CaCO_3$ %	N	P_2O_5	K_2O	Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	WHC (%)
					Kg/ha			Cmol (P^{+}) Kg^{-1}				
1	8.71	0.240	1.15	10.7	224	32.6	235	34.0	7.0	1.96	0.22	45.7
2	8.68	0.180	1.09	11.1	241	30.4	202	36.0	5.5	1.19	0.19	48.4
3	8.52	0.168	1.07	11.7	213	28.6	252	35.5	4.0	1.19	0.24	47.5
4	8.59	0.168	1.11	11.0	196	30.4	252	40.5	5.5	1.30	0.24	48.2
5	8.66	0.228	1.12	12.6	204	24.6	252	28.5	11.0	1.85	0.24	53.2
6	8.60	0.216	1.12	10.0	221	20.6	252	35.0	7.5	1.52	0.24	64.1
7	8.54	0.276	1.08	12.0	235	35.2	268	36.5	4.5	1.85	0.26	52.0
8	8.86	0.216	1.13	12.6	202	30.2	252	33.5	6.5	2.17	0.24	57.1
9	8.94	0.252	1.15	13.1	185	28.4	235	29.0	5.5	2.61	0.22	47.5
10	8.70	0.276	1.19	13.1	202	22.6	268	35.0	1.0	1.95	0.26	48.3
11	8.70	0.288	1.12	11.9	216	38.4	218	29.5	5.0	2.17	0.21	-
12	8.32	0.252	1.12	11.2	210	36.6	286	34.5	8.5	1.63	0.27	-
13	8.38	0.216	1.10	11.6	241	28.4	242	36.0	5.5	1.52	0.21	-
14	8.41	0.204	1.15	11.5	227	20.2	202	38.5	5.5	1.19	0.19	-
Range	8.32 - 8.94	0.180 - 0.280	1.07 - 1.19	10.5 - 13.5	185 - 241	20.2 - 38.4	202 - 286	28.5 - 40.5	1.0 - 11.0	1.19 - 2.61	0.19 - 0.27	45.7 - 64.1
Mean	8.61	0.227	1.12	11.7	217	29.0	244	34.4	5.9	1.72	0.23	51.2

Table 4 Surface soil characteristics of Nekarikallu village

NAKARIKALLU - SURFACE SOILS (0-15 CM)												
S.No.	pH	E.C.	B.D. (g/cc)	$CaCO_3$ %	N	P_2O_5	K_2O	Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	WHC (%)
					Kg/ha			Cmol (P^{+}) Kg^{-1}				
1	8.80	0.360	1.20	11.5	263	23.6	302	32.5	9.0	3.70	0.29	
2	8.90	0.408	1.22	12.6	266	31.5	302	33.5	6.0	4.57	0.29	
3	8.70	0.360	1.20	15.1	258	55.0	504	45.5	4.5	3.04	0.48	
4	8.92	0.360	1.18	14.4	241	15.9	319	33.0	12.0	5.00	0.30	
5	8.72	0.360	1.14	14.2	252	39.3	403	30.0	12.0	4.24	0.38	
6	8.62	0.360	1.12	11.1	230	15.4	353	35.5	15.0	3.70	0.34	
7	8.70	0.336	1.12	13.3	235	15.7	353	37.0	10.5	4.78	0.34	
8	8.72	0.336	1.19	12.2	218	7.9	370	37.5	10.5	4.46	0.35	
9	8.64	0.408	1.19	13.3	224	15.7	235	32.0	12.5	3.04	0.22	
10	8.46	0.300	1.18	14.0	232	15.7	252	32.5	15.0	2.39	1.24	
11	8.86	0.216	1.17	12.6	246	15.7	235	37.5	10.5	1.41	0.22	
12	8.82	0.372	1.20	11.1	224	15.7	286	30.0	13.5	5.33	0.27	
13	8.90	0.528	1.17	12.9	213	7.9	319	31.5	9.5	6.09	0.30	
14	8.90	0.468	1.21	13.3	207	62.9	252	27.0	14.5	5.33	0.24	
15	9.00	0.516	1.23	15.0	227	23.6	286	27.0	12.0	5.43	0.27	
16	8.90	0.624	1.23	14.4	207	62.9	302	27.0	12.0	7.28	0.29	
17	8.73	0.480	1.18	15.0	202	23.6	319	36.0	12.5	6.09	0.30	
18	8.72	0.408	1.18	14.6	232	39.3	218	30.5	16.0	3.91	0.21	
19	8.60	0.384	1.15	15.3	213	39.3	202	33.0	9.5	3.70	0.19	
20	8.68	0.396	1.21	16.6	241	47.1	185	34.5	9.5	3.15	0.18	
Range	8.46 - 9.00	0.216 - 0.624	1.12 - 1.23	11.1 - 16.6	202 - 266	7.9 - 62.9	185 - 504	27.0 - 45.5	4.5 - 16	1.91 - 7.28	0.18 - 0.48	
Mean	8.76	0.470	1.18	13.6	231	28.7	300	33.1	11.3	4.38	0.28	

CONCLUSIONS

It is concluded that both the red soils and black soils were moderately tostrongly alkaline in reaction and non-saline. On the soil complex the dominant cation is calcium. The physical properties of both surficial and sub-surficial soils are normal as the bulk density value is normal. The Water Holding Capacity of the Reddigudem soils is high. The overall fertility status of the soils was low, medium and high in nitrogen, phosphorus and potassium respectively. As the soils were calcareous and strongly alkaline, there is need for application of any acid forming amendment(S containing amendments) and organic materials to alleviate the nutrient deficiency and improve productivity.

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