The Andhra Agric. J 68 (1): 96-101, 2021

Assessment of Soil Physical Properties in Rice Growing Areas of Bapatla Mandal of Guntur district

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ABSTRACT

A study was conducted to assess the physical properties of rice growing soils in four different prominent rice based cropping systems of Bapatla mandal, Guntur district, Andhra Pradesh during 2018-19. A total number of 120 surface soil samples (0-15 cm) were collected from Bapatla mandal covering four rice based cropping systems namely rice-pulse, rice-groundnut, rice-maize and rice-sorghum using GPS co-ordinates and were analysed for different physical properties. Majority of the soils were clayey in texture followed by sandy and sandy clay loam. The range of WHC in rice growing soils of Bapatla mandal was varied from 12.00-57.90 per cent with mean values of 14.69 and 55.26 per cent. The highest (57.90%) WHC was observed in Etheru village of Rice-pulse cropping system whereas lowest (12.00%) was observed in Nandirajuthota village of Rice-groundnut cropping system. The range of bulk density in soils of rice growing areas of bapatla mandal was 1.11-1.68 Mg m^{-3}. The highest bulk density (1.68 Mg m^{-3}) observed in soils of Pandurangapuram village in Rice-groundnut cropping system and lowest (1.11 Mg m^{-3}) bulk density was observed in Etheru village in Rice-sorghum cropping system. The highest mean value (1.54 Mg m^{-3}) was observed in Rice-groundnut cropping system and lowest mean value (1.26 Mg m^{-3}) was observed in Rice-sorghum cropping system. In the study area, very high aggregation (70.47%) was reported in Rice-pulse cropping system whereas very low (13.42%) was reported in Rice-sorghum cropping system whereas no aggregation was reported in all the soils of Rice-groundnut cropping system. The variations in physical properties might be due to the varied textures of the soils.

Key words: *Cropping systems, rice growing soils, texture, bulk density and water holding capacity*

Rice (*Oryza sativa* L.) is the most important food crop and occupies one-third of the world's crop land planted to cereals and provides 30-60% of the calories consumed by nearly three billion people (Gurra *et al*., 1998). Rice is the most important cereal food crop as two-thirds of the global population depends. More than 90% of the world's rice is grown and consumed in Asia. In Andhra Pradesh, rice is grown in an area of 23.30 lakh hectare with annual production of 104.88 lakh tons and productivity of 2,820 kg/ha (Indiastat, 2016-17). According to FAO, the global rice requirements in 2020 will be 800 MT while the present production is 600 MT and an additional 200 million tonnes needs to be produced by increasing productivity per hectare to meet the future requirements (Swaminathan, 2006). A declining trend in the productivity of rice even when grown under adequate application of N, P and K was reported by Nambiar and Abrol (1989). To meet the demands of the growing population, there is a need to produce higher yields by maintaining the soil quality and sustainability of the productivity at the same time.

Monocropping of rice is the main drawback for deterioration of soil fertility. It also involves use of exhaustive high yielding varieties of rice and indiscriminate use of fertilizers which results in heavy uptake of nutrients from the soil and deterioration of soil health, respectively. To overcome this, suitable rice based cropping systems are to be evaluated to sustain soil health, profitability and productivity. Soil physical properties of any cultivable soil is the primary indicator of productivity. Hence, the present study was carried to assess the physical properties of the soil to know the best possibilities to improve the soil health and certain management practices to attain profitable yields particularly in rice based cropping systems.

MATERIAL AND METHODS

Survey was conducted in rice growing areas of Bapatla mandal, Guntur district covering 13 villages and 120 representative surface soil samples (0-15 cm) were collected from farmer's fields covering four rice based cropping systems namely rice-pulses, rice-maize, rice-sorghum and rice-groundnut. The samples were air dried under shade in room temperature. Roots and other debris present in soil samples were removed before grinding the soil samples using wooden pestle and mortar to pass through 2 mm sieve. Processed soil samples were analysed for different parameters *viz*., texture (Bouyoucos, 1962), bulk density (Dastane, 1967), water holding capacity (Sankaram 1966) and aggregate stability (Yoder's apparatus).

RESULTS AND DISCUSSION

Particle Size Distribution and Texture

Critical analysis of soil data indicated that 59% of soil samples were found to be clay, 33% were sand in texture and 8% of soils were found to be sandy clay loam. As a whole, clay is the dominant textural class in the study area. Similar textural classes were also observed by Sudharani and Jayashree (2012) in rice growing soils of Nalgonda district.

Overall range of sand, silt and clay present in Rice-pulse cropping system was 23.4-26.6, 2.5-4.9 and 58.9-63.4 with their mean values of 28.17, 7.96 and 61.75 respectively (Table 4.1). The dominant textural class of Rice-groundnut cropping system was sandy in texture with overall range of sand, silt and clay was 80.0-86.0, 6.5-14.0 and 3.2-10.0 and overall mean values of 83.90, 9.87 and 6.19, respectively. The dominant textural classes were clay and sand with overall per cent sand, silt and clay content varied from 25.0-2.0-16.0 and 3.2-65.2 with overall mean values of 47.03, 9.29 and 43.67 in Rice-maize cropping system. The dominant textural classes were clay and sandy clay loam with overall per cent sand, silt and clay content which varied from 20.0-65.0, 4.7-20.0 and 20.0-66.0 with overall mean values of 20.58, 11.95 and 50.79, respectively in Rice-sorghum cropping system.

The lowest sand content (20.0%) was observed in Poondla village of Rice-sorghum cropping system whereas highest sand content (86.0%) was observed in Nandirajuthota village of Rice-groundnut cropping system. The lowest silt (2.0%) content was observed in Gudipudi village of Rice-maize cropping system whereas highest silt (6.5%) content was observed in Vedullapalli village of Rice-groundnut cropping system. The lowest clay (32%) content was observed in Pandurangapuram village of Rice-groundnut cropping system whereas highest clay (66.0%) content was observed in Rice-sorghum cropping system. Black soils are the most dominant group in the study area. Rice-pulse cropping system exhibited clayey in texture, whereas Rice-groundnut cropping system exhibited sandy in texture. Rice-maize cropping system exhibited clayey and sand in texture whereas Rice-sorghum cropping system exhibited sandy clay loam and clayey in texture. Uniformity in

Table 1. Range and Mean values of particle size distribution of soils under different cropping systems of rice in Bapatla mandal of Guntur district(village-wise).

S. No	Name of the village		Mechanical composition(%)			Textural class
			Sand	Silt	Clay	
A. Rice-Pulse cropping system						
1	Jillelamudi	Range	23.4-31.0	4.8-13.1	58.9-65.0	C
		Mean	26.94	9.83	56.9	
2	Etheru	Range	26.2-31.0	4.9-11.4	63.4-65.0	C
		Mean	27.91	7.61	64.48	
3	Appikatla	Range	26.6-35.2	2.5-4.2	59.2-65.0	C
		Mean	29.67	6.45	63.88	
Overall range			23.4-26.6	2.5-4.9	58.9-63.4	C
			28.17	7.96	61.75	
B. Rice-Groundnut cropping system						
4	Asodivaripalem	Range	80-85	6.4-13	5.0-10.0	S
		Mean	83.14	9.93	6.93	
5	Maruproluvaripalem	Range	81-85	13-Aug	4.0-8.5	S
		Mean	83.6	10.6	5.74	
6	Vedullapalli	Range	83-84	6.5-10	4.0-9.3	S
		Mean	84.68	8.9	6.42	
7	Nandirajuthota	Range	80-86	6.4-14	3.2-9.5	S
		Mean	84.2	10.08	5.68	
Overall range			80-86	6.5-14	3.2-10	S
Overall mean			83.9	9.87	6.19	
C. Rice-Maize cropping system						
8	Gudipudi	Range	26.8-33.2	2.0-8.2	64.4-65.2	C
		Mean	29.1	6.11	64.79	
9	Bhartipudi	Range	25.0-32.1	6.9-16.0	56.0-65.0	C
		Mean	28.15	12.19	59.66	
10	Pandurangapuram	Range	80.0-83.0	6.5-12.0	6.1-9.5	S
		Mean	83.84	9.58	7.27	
[Overall range			25.0-83	2.0-16.0	6.1-65.2	C&S
Overall mean			47.03	9.29	43.9	
D. Rice-Sorghum cropping system						
11	Etheru	Range	50.0-65.0	5.8-20.0	20.0-39.7	Scl
		Mean	55.82	14.93	29.22	
12	Appikatla	Range	25.0-33.0	4.8-16.4	54.4-66.0	C
		Mean	27.85	11.97	60.18	
13	Poondla	Range	20.0-30.8	4.7-14.8	56.2-65.8	C
		Mean	28.07	8.96	62.97	
Overall range			20.0-65.0	4.7-20.0	20.0-66.0	Scl&C
Overall mean			20.58	11.95	50.79	

Table 2. Range and mean values of Water holding capacity and Bulk density of soils under different rice based cropping systems in Bapatla mandal of Guntur district

S. No	Name of the village	Water holding capacity (%)		Bulk density (Mg m^{-3})	
		Range	Mean	Range	Mean
A. Rice-Pulse cropping system					
1	Jillelamudi	48.90-56.34	54.04	1.25-1.39	1.33
2	Etheru	49.34-57.90	55.26	1.22-1.45	1.34
3	Appikatla	47.44-56.78	53.01	1.20-1.45	1.32
Overall range & mean		47.44-57.90	54.1	1.20-1.45	1.33
B. Rice-Groundnut cropping system					
4	Asodivaripalem	14.10-18.90	16.41	1.40-1.62	1.53
5	Maruproluvaripalem	13.00-18.34	15.33	1.45-1.61	1.52
6	Vedullapalli	13.00-18.26	15.3	1.50-1.55	1.52
7	Nandirajuthota	12.00-18.40	14.69	1.50-1.67	1.59
Overall range & mean		12.00-18.90	15.43	1.40-1.67	1.54
C. Rice-Maize cropping system					
8	Gudipudi	45.00-53.00	49.46	1.12-1.38	1.25
9	Bhartipudi	39.16-56.18	47.4	1.14-1.33	1.23
10	Pandurangapuram	13.00-18.00	15.61	1.40-1.68	1.55
Overall range & mean		13.00-56.18	37.49	1.12-1.68	1.34
D. Rice-Sorghum cropping system					
11	Etheru	22.00-38.00	30.42	1.11-1.26	1.17
12	Appikatla	4 4.00-53.88	50.12	1.22-1.39	1.3
13	Poondla	49.00-56.00	50.03	1.24-1.38	1.33
Overall range & mean		22.00-56.00	43.52	1.11-1.39	1.26

different textures of soils might be due to the pedogenic process of argillo-pedoturbation operating in these soils. Similar textural class and uniformity with depth in black soils and sandy soils were noticed by Jejenaik (2009) and Tantujanandy (2010).

Water Holding Capacity

The range of WHC in the soils of Bapatla mandal varied from 12.00-57.90 per cent with mean values of 14.69 and 55.26 per cent. The highest WHC (57.90%) was observed in Etheru village of Rice-pulse cropping system whereas lowest (12.00%) was observed in Nandirajuthota village of Rice-groundnut cropping system (Table 2). The large variation in WHC values might be due to variation in clay, silt sand and organic carbon contents. Similar findings were also observed by Venkata Subbaiah *et al.* (2012) and pulakeshi *et al.* (2014). Clay particles have the ability to physically and chemically hold water molecules to the particle more tightly than sands or silts. Sands give up the water between the pores much easier than silts or clays. So, sandy soils has much less water holding capacity than a silt or clay soils. Due to the size of the soil particles, the cohesive properties are much different between a sand particle and a clay or silt particle. The amount of organic matter in the soil also affects water holding capacity to a degree.

Table 3. Range and mean values for Aggregate stability of soils under different rice based cropping systems of Bapatla mandal in Guntur district

S.No	Name of the village	Total Water Stable Aggregates(%)	
		Range	Mean
A. Rice-Pulse cropping system			
1	Jillelamudi	65.12-70.47	67.52
2	Etheru	50.05-65.31	56.94
3	Appikatla	50.47-62.41	55.63
Overall range & mean		50.05-70.47	60.03
B. Rice-Groundnut cropping system			
4	Asodivaripalem	-	-
5	Maruproluvaripalem	-	-
6	Vedullapalli	-	-
7	Nandirajuthota	-	-
Overall range & mean		-	-
C. Rice-Maize cropping system			
8	Gudipudi	51.36-62.08	56.8
9	Bhartipudi	52.12-64.26	57.1
10	Pandurangapuram	-	-
Overall range & mean		51.36-64.26	56.95
D. Rice-Sorghum cropping system			
11	Etheru	13.42-19.02	16.88
12	Appikatla	50.29-57.16	53.3
13	Poondla	51.14-62.10	55.1
Overall range & mean		13.42-62.10	41.76

Bulk density

The range of bulk density in soils of rice growing areas of bapatla mandal was 1.11-1.68 Mg m^{-3}. The highest bulk density (1.68 Mg m^{-3}) observed in soils of Pandurangapuram village in Rice-groundnut system while the lowest (1.11 Mg m^{-3}) was observed in Etheru village in Rice-sorghum cropping system. The highest mean value (1.54 Mg m^{-3}) was observed in Rice-groundnut cropping system and lowest mean value (1.26 Mg m^{-3}) was observed in Rice-sorghum cropping system (Table 2). In the present study area, large variations in bulk density was observed. Higher bulk density was reported in sandy soils whereas lower bulk density was reported in clay soils. These variations might be due to differences in texture and mechanical components in soil and also organic matter. Generally, loose, well-aggregated and porous soil have lower bulk density. Sandy soils have relatively higher bulk density since total pore space in sands is less than silt or clay soils. Similar results were also reported earlier by Pravin *et al*. (2013).

Aggregate Stability

In the study area, very high aggregation (70.47%) was reported in Rice-pulse cropping system whereas very low (13.42%) was reported in Rice-sorghum cropping system and no aggregation in all the soils was reported in Rice-groundnut cropping system

(Table 3).The large variation in stability of aggregates might be due to the pore space, type of clay mineral, per cent clay+silt and organic matter decomposition in the soil. Similar results were also reported by Lalithakumari *et al*. (2013).

CONCLUSION

The present study concluded that majority of the rice growing soils of Bapatla mandal are clayey in texture followed by sandy and sandy clay loam. WHC was found to be high while the bulk density was low in clay soils (Rice-pulse, Rice-maize and Rice-sorghum cropping systems)whereas WHC was low and bulk density was high in sandy soils (Rice-groundnut cropping system). Aggregate stability per cent was very high to high in clay textured soils and no aggregation in sandy soils.

LITERATURE CITED

Bouyoucos G J 1962 Hydrometer method improved for making particle size analysis of soil. *Agronomy Journal*. 54 (5): 464-465.

Dastane N G 1967 *A Practical Manual for water use research*, Navabharat, Prakashan Publication, Poona (India). 120.

Lalithakumari B, Rojarani M, Sudhakar P, Hanumasri M and Satyasree K P N V 2013 Analisation of soil water quality in and around the saltpans of Prakasam (Dt.) A.P. *International Journal of Recent scientific Research.* 4 (3): 198-201.

Pravin R C, Dodha V A, Vidya D A, Manab C and Saroj M 2013 Soil bulk density as related to soil texture, organic matter content and available total nutrients of Coimbatore soil. *International Journal of Scientific and Research Publications*. 3 (2): 1-8.

Pulakeshi H B P, Patil P L and Dasog G S 2014 Characterization and classification of soil resources derived from chlorite schist in northern transition zone of Karnataka. *Karnataka Journal of Agricultural Sciences*. 27 (1): (14-21).

Sankaram A 1966 *A laboratory manual for agriculture chemistry*. Published by Jaya Singer, Asia Publishing House, Bombay pp. 56-57.

SudhaRani Y and Jayashree G 2012 Fertility status of Rice growing soils of Nalgonda district in Andhra Pradesh. *Journal of Research, ANGRAU*. 40(3): 14-17.

Swaminathan M S 2006 An evergreen revolution. *Crop science*. 46(5): 2293-2303.

Tantujanandy 2010 Characterization and classification of soils in coastal ecosystem of Guntur district, Andhra Pradesh and their evaluation for rice suitability. *M.Sc (Ag.)*

Received on 17.01.2021 and revised on 25.03.2021