



SOIL-SITE SUITABILITY EVALUATION FOR THE MAJOR CROPS GROWN IN PAKALA MANDAL OF CHITTOOR DISTRICT, ANDHRA PRADESH

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ABSTRACT

A Survey was undertaken in Pakala mandal of Chittoor district to evaluate the suitability of soils for rice, groundnut, sorghum, pigeonpea and sugarcane crops. These soils were classified as to Entisols and Inceptisols. Pedons 1 and 6 (Typic Ustorthent), showed organic carbon and shallow depth as major limitations. Organic carbon and pH are the major limitations in pedon 3 (Typic Haplustept). Pedons 4, 5 and 7 (Typic Haplustept) exhibited organic carbon and poor nutrient status were the major limitation whereas pedon 2 (Typic Ustifluvents) had texture, erosion and organic carbon as major limitations. The limitation levels of the land characteristics varied from crop to crop. The soil-suitability classes can be improved if the correctable limitations were altered through soil amelioration measures. On the basis of soil potentials and constraints, suitable management practices were suggested to achieve sustainable yields in crops grown on these soils.

KEY WORDS: Crop suitability, Land Evaluation, Limitations, Potentials.

INTRODUCTION

The performance of any crop was largely dependent on soil parameters (depth, texture, drainage *etc.*) as conditioned by climate and topography. Soil-site characterization for predicting the crop performance of an area forms land evaluation. The yield influencing factors for important crops have to be evaluated and the results obtained may be applied for higher production of these crops through proper utilization of similar soils occurred elsewhere in the same agro-climatic sub-region under scientific management practices (Khadse and Gaikwad, 1995). Studies on soil-site suitability evaluation is not available for crops in Pakala mandal, in particular and Chittoor district of Andhra Pradesh, in general. Hence, an attempt has been made to evaluate the soil suitability for five major crops *viz.*, rice, groundnut, sorghum, redgram and sugarcane grown on Entisols and Inceptisols in Pakala mandal of Chittoor district in Andhra Pradesh.

MATERIAL AND METHODS

Study area

The study area comprising of 26,786 ha lies in between 13°27' and 13.46' North latitudes and 79°07' and 79°12' East longitudes with an altitude ranging from 320 to 461m. The soils have been developed from granite-gneiss parent material. The area qualifies for semi-arid

monsoonic climate with distinct summer, winter and rainy seasons. The area experienced mean annual precipitation recorded for the last ten (2005-2014) years was 990.35 mm. The mean annual temperature was 28.54°C with mean summer temperature 33.92°C and the mean winter temperature of 23.12°C. The soil moisture regime has been computed as ustic regime as isohyperthermic (Soil Survey Staff, 1999). The natural vegetation comprises of *Parthenium hysterophorus*, *Calotropis gigantia*, *Tridax procumbens*, *Croton* species, *Pongamia pinnata*, *Lantana camera*, *Cyprus rotundus*, *Prosopis julifera*, *Achyranthus* species, *Cynodon dactylon*, *Azadiracta indica*, *Acacia nelotica*, *Tephrosia purpurea* *etc.*,

Methodology

Seven typical pedons were studied on different landforms (plains and uplands) for their morphological characteristics following the procedure given by Soil Survey Staff (1951). Horizon-wise soil samples were collected from the typifying pedons and analyzed for their physical, physico-chemical and chemical properties following the standard procedures (Table 2). Soils were classified according to keys to Soil Taxonomy (Soil Survey Staff, 2014). These pedons were selected for evaluation and their suitability assessed using limitation method regarding number and intensity of limitations (Sys *et al.*, 1991).

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The land scape and soil requirements for these crops (Sys *et al.*, 1991) were matched with generated data at different limitation levels: no (0), slight (1), moderate (2), severe (3) and very severe (4). The number and degrees of limitations suggested the suitability of class of each soil for a particular crop (Sys *et al.*, 1991). The potential land suitability (Table 3) sub-classes were determined after considering the improvement measures to correct these limitations (Sys *et al.*, 1993). The present suitability classes can be improved if the correctable limitations such as pH, organic carbon and fertility status are corrected / altered through soil amelioration measures.

RESULTS AND DISCUSSION

Soil characteristics were given in table 1 and the site and weighted means of soil characteristics were given in table 2. These soils were developed from granite-gneiss parent material. The kind and degree of limitations for the five commonly growing crops were presented in table 3. Soils with more than four slight limitations, and / or with more than three moderate limitations were grouped under moderately suitability class (S2); the soil with more than three moderate limitations, and / or one or more severe limitation (s) was grouped under marginally suitability (S3) class; the soils with very severe limitations which can be corrected was categorized as N1 (temporarily not suitable); the soils with very severe limitations which cannot be corrected grouped under unsuitable class N2 (Sys *et al.*, 1991). This method also identifies the dominant limitation that restricts the crop growth in the sub-class symbol such as climatic (c), topographic (t), wetness (w), physical soil characteristics (s), soil fertility (f) and soil salinity / alkalinity (n). The suitability classes and sub-classes were decided by the most limiting soil characteristics. The soils vary in their suitability for different crops according to the criteria for the determination of the land suitability classes (Table 3).

Pedons 1 and 6 were grouped under Typic Ustorthents. Pedon 1 was highly suitable (S1) for rice and sorghum, moderately suitable (S2) for sugarcane and marginally suitable (S3) for groundnut and pigeonpea. Pedon 6 was highly suitable (S1) for rice, groundnut and sugarcane, moderately suitable (S2) for sorghum and marginally suitable (S3) for pigeonpea. (Table 4). Soil fertility characteristics *viz.*, pH and organic carbon and soil physical characteristics like texture, improper drainage and shallow depth were the moderate limitations for all five crops in both the pedons. Further, erosion is the major limiting factors for growing of all these crops in pedon 1.

Soil pH (slightly alkalinity) can be corrected by application of organic manures and application of suitable amendments. Organic carbon in these soils can be improved by the application of farm yard manure and green manuring and inclusion of legumes in rotation. Shallow depth in these soils can be increased by adopting ploughing or breaking up of soil, texture can be improved by addition of tank silt year after year and erosion can be controlled by suitable soil and water conservation practices. Kumar and Naidu (2012) reported that Typic Ustorthents were marginally suitable for growing rice crop in Vadamalapeta mandal of Chittoor district in Andhra Pradesh.

Pedons 3, 4, 5 and 7 were grouped under Typic Haplustepts. Pedons 3 and 4 were highly suitable (S1) for sorghum and sugarcane, moderately suitable (S2) for groundnut. Pedon 4 was moderately suitable (S2) for rice and pigeonpea. Pedons 5 and 7 were moderately suitable (S2) for sugarcane, where as pedon 5 was moderately suitable (S2) and pedon 7 was highly suitable (S1) for growing of sorghum crop. Pedon 7 was highly suitable (S1) and pedon 5 was moderately suitable (S2) for growing of rice, groundnut and pigeonpea crops. Pedon 3 was marginally suitable (S3) for crops like rice and pigeonpea (Table 4).

Soil Physico-chemical characteristics *viz.*, pH and organic carbon and soil physical characteristics like texture were the moderate limitations (Pedons 3, 4, 5 and 7) for all five crops. Besides these, depth and improper drainage were major limitations for growing of pigeon pea in all the pedons. Erosion is the major limitation for pedons 4 and 7 for all five crops. Organic carbon in these soils can be improved by the application of farm yard manure, green manuring and inclusion of legumes in rotation. Shallow depth in these soils can be increased adopting deep ploughing or breaking up of soil and erosion can be controlled by practicing conservations techniques. Texture can be improved by addition of tank silt year after year in these soils. These results were in accordance with the findings of Sekhar *et al.*, (2014). Leelavathi *et al.* (2010) reported that Typic Haplustepts were marginally suitable (S3) for growing paddy crop in Yerpedu mandal of Chittoor district in Andhra Pradesh.

Pedon 2 which is grouped under Typic Ustifluvents was highly suitable (S1) for sorghum, moderately suitable (S2) for rice, groundnut and pigeonpea and marginally suitable (S3) for sugarcane (Table 4). These soils showed

Table 1. Landscape characteristics of pedons

Pedons	Villages	Location	Elevation above mean sea level (m)	Physiography	Slope	Drainage	Parent material
P1	Srinivasapuram	13°26'46.7" N 79°09'30.4" E	361	Upland	3-5%	Moderately well drained	Weathered gneiss
P2	Adannapalli	13°26'50.0" N 79°09'39.2" E	357	Upland	3-5%	Moderately well drained	Weathered gneiss
P3	Suryanarayanapalli	13°27'42.9" N 79°06'13.2" E	389	Plain	0-1%	Moderately well drained	Weathered gneiss
P4	Maddinayanapalli	13°30'40.3" N 79°07'54.3" E	459	Upland	3-5%	Moderately well drained	Weathered gneiss
P5	Kavetigaripalli	13°30'42.2" N 79°07'45.8" E	461	Plain	0-1%	Moderately well drained	Weathered gneiss
P6	Sankampalli	13°26'45.1" N 79°07'07.2" E	360	Upland	1-3%	Somewhat poorly drained	Weathered gneiss
P7	Nantragunta	13°26'45.1" N 79°07'07.2" E	320	Upland	3-5%	Moderately well drained	Weathered gneiss

Table 2. Depth wise soil characteristics used in assessing crop suitability

Pedon No.	Location	Horizon	Depth (m)	Soil physical characteristics (s)				Fertility characteristics (f)						Salinity and alkalinity (n)	
				Texture				CEC [cmol (p+) kg ⁻¹ soil]	Sum of basic cations [cmol (p+) kg ⁻¹ soil]	BSP	pH (1:2.5 H ₂ O)	OC (%)	EC (dSm ⁻¹)	ESP	
				Sand (2-0.05%)	Silt (0.05 - 0.002)	Clay (<0.002)	CaCO ₃ (%)								
— % of <2 mm soil —															
1	Srinivasapuram	Ap	0.00-0.20	52.40	22.30	25.30	14.50	10.40	5.55	53.46	7.70	0.64	0.10	0.09	
		A1	0.20-0.39	53.25	20.63	26.12	17.00	10.24	5.43	53.32	7.74	0.48	0.09	0.29	
		A2	0.39-0.50	90.10	5.75	4.15	11.00	8.48	4.31	51.06	7.47	0.17	0.04	0.24	
		Cr	0.50+	Weathered gnesis mixed with lime											
2	Adannapalli	Ap	0.00-0.20	53.35	20.33	26.32	14.00	9.54	6.23	65.72	7.47	0.57	0.16	0.42	
		A1	0.20-0.37	52.10	19.95	27.95	13.00	9.67	5.30	55.43	7.69	0.46	0.15	0.62	
		A2	0.37-0.67	53.55	20.23	26.22	15.50	9.26	5.32	57.99	7.80	0.37	0.05	0.54	
		A3	0.67-0.89	50.30	21.35	28.35	13.50	9.87	6.49	65.96	7.72	0.39	0.05	0.20	
		2A4	0.89-1.17	90.00	6.30	3.70	6.00	6.50	3.81	59.53	7.54	0.16	0.16	0.92	
		2A5	1.17-1.50	92.50	5.00	2.50	6.50	4.60	2.88	62.83	7.43	0.14	0.15	0.22	
		Cr	1.50+	Weathered gnesis											
3	Suryanarayanapalli	Ap	0.00-0.18	55.40	19.30	25.30	7.50	15.22	10.75	70.83	7.37	0.52	0.10	0.19	
		Bw1	0.18-0.48	53.60	19.80	26.60	9.50	17.94	11.57	64.54	7.39	0.47	0.12	0.06	
		Bw2	0.48-0.77	40.00	28.00	32.00	13.20	18.80	13.13	70.05	7.61	0.40	0.11	0.21	
		Bw3	0.77-1.10	36.00	28.00	36.00	12.90	16.30	11.47	70.49	7.56	0.35	0.12	0.12	
		Cr	1.10+	Weathered gnesis											

Cont...

Table 2. Cont...

Pedon No.	Location	Horizon	Depth (m)	Soil physical characteristics (s)			Fertility characteristics (f)						Salinity and alkalinity (n)	
				Texture			CaCO ₃ (%)	CEC [cmol (p+) kg ⁻¹ soil]	Sum of basic cations [cmol (p+) kg ⁻¹ soil]	BSP (1:2.5 H ₂ O)	pH	OC (%)	EC (dSm ⁻¹)	ESP
				Sand (2-0.05%)	Silt (0.05 - 0.002)	Clay (<0.002)								
— % of <2 mm soil —														
4	Maddinayanapalli	Ap	0.00-0.16	54.00	16.50	29.50	7.40	12.52	9.76	78.27	7.30	0.54	0.15	0.32
		Bw1	0.16-0.37	52.90	20.70	26.40	8.80	10.70	8.24	77.57	7.52	0.50	0.17	0.09
		Bw2	0.37-0.68	50.70	22.65	26.65	6.20	10.22	7.53	77.10	7.56	0.49	0.12	0.49
		Bw3	0.68-0.97	49.40	23.30	27.30	4.90	9.80	7.41	75.82	7.50	0.25	0.11	0.20
		Bw4	0.97-1.53	51.80	23.10	25.10	3.10	7.33	5.52	75.57	7.40	0.15	0.10	0.27
		Cr	1.53+	Weathered gneiss										
5	Kavetigaripalli	Ap	0.00-0.20	54.80	23.40	21.80	3.20	9.50	6.65	70.11	7.75	0.62	0.11	0.11
		Bw1	0.20-0.43	53.00	21.90	25.10	8.00	9.20	6.82	74.35	7.72	0.50	0.11	0.22
		Bw2	0.43-0.66	49.50	24.25	26.25	9.50	9.13	7.19	78.86	7.31	0.47	0.12	0.11
		Bw3	0.66-0.94	48.00	26.50	25.50	3.50	8.41	6.27	75.03	7.48	0.38	0.17	0.48
		Bw4	0.94-1.10+	50.20	27.40	22.40	4.50	7.41	5.46	73.95	7.43	0.14	0.12	0.27
6	Sankampalli	Ap	0.00-0.16	39.15	26.43	34.42	12.00	10.30	7.32	71.26	7.45	0.65	0.13	0.19
		A1	0.16-0.35	28.70	38.65	32.65	13.50	10.60	6.97	65.85	7.32	0.53	0.15	0.09
		A2	0.35-0.50	91.50	5.25	3.25	6.50	8.80	4.89	55.68	7.70	0.23	0.13	0.11
		Cr	0.50+	Weathered gneiss										
		Ap	0.00-0.17	49.50	24.25	26.25	7.00	11.80	7.94	68.05	7.40	0.66	0.14	0.76
7	Nantragunta	Bw1	0.17-0.35	51.50	21.25	27.25	7.50	21.60	14.93	50.27	6.67	0.63	0.98	0.32
		Bw2	0.35-0.70	17.10	48.50	34.40	5.50	15.00	11.37	73.60	6.71	0.58	0.14	0.53
		Bw3	0.70-0.85	18.20	48.40	33.40	12.00	16.20	11.94	67.65	7.65	0.45	0.15	0.12
		Bw4	0.85-1.20	19.60	47.80	32.60	10.50	21.00	16.50	50.29	7.83	0.37	0.73	0.43
		Cr	1.20+	Weathered gneiss mixed with feldspars										

Table 3. Limitation levels of the land characteristics and land suitability classes

Soil	Crop	Wetness (w) drainage	Soil Physical characteristics (s)			Soil fertility characteristics (f)				Alkalinity (n) Esp	Actual land suitability sub-class	Potential land suitability sub-class
			Texture	Coarse fragments (Vol. %)	Soil depth (cm)	CaCO ₃ (%)	Sum of basic cations [cmol (p+) kg ⁻¹ soil]	pH 1:2.5	OC (%)			
Typic Ustorthents	Rice Ground nut Sugar cane Sorghum Pigeon pea	1 1 1 1 2	2 0 1 1 1	0 0 0 0 0	2 1 1 0 1	0 0 0 0 0	1 2 2 1 1	2 2 1 1 2	0 0 0 0 0	S1wsf S3wsf S2wsf S1wsf S3wsf	S2s S3s S2s S1 S3ws	
Typic Ustifluvents	Rice Ground nut Sugar cane Sorghum Pigeon pea	1 1 0 1 2	2 0 0 1 1	0 0 0 0 0	2 2 1 1 0	0 0 0 0 0	1 1 2 1 1	2 2 3 1 2	0 0 0 0 0	S2wsf S3wsf S2wsf S3sf S1sf	S2ws S2ws S1 S1s S1s	
Typic Haplustepts	Rice Ground nut Sugar cane Sorghum Pigeon pea	2 1 1 1 1	1 0 0 1 1	0 0 0 0 0	1 2 0 0 0	0 0 0 0 0	1 1 1 1 1	2 3 2 1 1	0 0 0 0 0	S2wsf S3wsf S2wsf S1ws S1ws	S2ws S2s S1 S1 S1	
Typic Haplustepts	Rice Ground nut Sugar cane Sorghum Pigeon pea	2 1 1 1 1	1 2 0 1 1	0 0 0 0 0	0 2 0 0 0	0 0 0 0 0	1 1 1 1 1	2 2 2 1 1	0 0 0 0 0	S3wsf S2wsf S2wf S1wsf S1ws	S3ws S2s S1 S1 S1	
Typic Haplustepts	Rice Ground nut Sugar cane Sorghum Pigeon pea	2 1 1 1 1	1 2 0 1 1	0 0 0 0 0	0 1 0 0 0	0 0 0 0 0	1 1 2 2 2	2 2 2 1 1	0 0 0 0 0	S2wf S2wsf S2wf S2wsf S1wsf	S1w S2s S1 S1s S1s	
Typic Ustorthents	Rice Ground nut Sugar cane Sorghum Pigeon pea	2 0 0 0 0	1 1 1 0 0	0 0 0 0 0	1 1 0 0 0	0 0 0 0 0	0 1 2 2 1	2 2 2 1 1	0 0 0 0 0	S2wsf S2sf S2sf S2sf S1sf	S1ws S2s S2s S2s S1s	
Typic Haplustepts	Rice Ground nut Sugar cane Sorghum Pigeon pea	1 1 1 1 2	1 2 0 1 1	0 0 0 0 0	0 1 0 0 0	0 0 0 0 0	1 1 1 1 3	2 2 1 1 2	0 0 0 0 0	S3wsf S2sf S2wsf S2wsf S2wsf	S3s S2s S1 S1s S2s	

Table 4. Soil-site suitability for growing major crops

Pedon/Village	Crops				
	Rice	Groundnut	Pigeonpea	Sorghum	Sugarcane
P1 / Srinivasapuram	S1	S3	S3	S1	S2
P2 / Adannapalli	S2	S2	S2	S1	S3
P3 / Suryanarayanapalli	S3	S2	S3	S1	S1
P4 / Maddinayanapalli	S2	S2	S2	S1	S1
P5 / Kavetigaripalli	S2	S2	S2	S1	S2
P6 / Sankampalli	S1	S1	S3	S2	S1
P7 / Nantragunta	S2	S2	S2	S1	S1

S1: Very suitable, S2: Moderately suitable, S3: arginally suitable.

limitations *viz.*, Soil physical characteristics (texture and drainage), soil physic-chemical characteristics (organic carbon). The texture can be improved by mixing with tank silt year after year. So the organic carbon status in these soils can be improved by the application of farm yard manure, green manuring and inclusion of legumes in rotation. Selvaraj and Naidu (2013) stated that Typic Ustifluvents were moderately (S2) suitable for rice and groundnut crops in Renigunta mandal of Chittoor district in Andhra Pradesh.

CONCLUSION

The soil-site suitability for different crops like rice, groundnut, sorghum, pigeon pea and sugarcane revealed that all the pedons (1, 2, 3, 4, 5, 6 and 7) exhibited low organic carbon as a severe limitation. Shallow depth was a major limitation for pedons 1 and 6, Erosion is moderate limitation for pedons 1, 2, 4 and 7 whereas texture was a moderate limitation for growing rice crop in pedon 1, 2, 3 and 4. pH is a slight limitation in all pedons. Organic carbon status in these soils can be improved by the application of farm yard manure, green manuring and inclusion of legumes in rotation and pH can be controlled by application of organic manures and suitable amendments. Soil texture can be improved by mixing with tank silt year after year. Shallow depth in these soils can be improved by deepening of soil. Erosion can be controlled by adopting suitable conservation techniques. By correcting the above limitations sustainable yields can

be achieved in rice, groundnut, sorghum, pigeonpea and sugarcane crops. Hence, green manuring, addition of crop residues and organic manures in combination with chemical fertilizers in balanced form not only helps to achieve sustainable yields of crops but also sustains the soil health.

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