Agropedology 2013, 23 (2), 59-64

Characterization of major cashew-growing soils of Dakshina Kannada district of Karnataka

R. SRINIVASAN[1], A. NATARAJAN[2], K. S. ANIL KUMAR[2] AND D. KALAIVANAN[3]

[1]National Bureau of Soil Survey and Land Use Planning (ICAR), Regional Centre, Kolkata-700 091, India
[2]National Bureau of Soil Survey and Land Use Planning (ICAR), Regional Centre, Bangalore-560 024, India
[3]Directorate of Cashew Research, Puttur D.K -574 202, India

Abstract: Six typical pedons representing major cashew-growing soils developed from charnockite in Dakshina Kannada district were studied for their morphological, physical and chemical properties. The soils were deep to very deep, sandy clay loam to clay in texture, and sub-angular blocky in structure. The soils had large amounts of coarse fragments, high organic carbon but low in cation exchange capacity with calcium as dominant cation on exchange complex. These soils were classified as Ustic Haplohumults, Oxic Dystrustepts, Typic Rhodustults and Ustic Palehumults at subgroup level.

Additional key words: *Cashew-growing soils, soil characterization, classification*

Introduction

Cashew is an important plantation crop and cultivated extensively in Kerala, Maharashtra, Goa, Karnataka, Tamil Nadu, Andhra Pradesh, Odisha and to some extent in West Bengal, Chhattisgarh, Gujarat and North East Hilly Regions. Cashew is grown on a wide variety of soils in India barring waterlogged and saline soils (Bhat 2007). Though sporadic information is available on characterization and classification of cashew growing soils in India (Bhat 2007), but lacking for the soils of Dakshina Kannada District, Karnataka and hence the present investigation was carried out to know the potential and constraints of cashew-growing soils.

Materials and Methods

Based on the information collected from the available sources and interpretation of imagery and toposheets (1: 50,000 scale), six pedons representing major cashew-growing areas were identified (12°57' and 13°50' N; 74° and 75°50' E). The district geography consists of sea shore in the west and Western Ghat in the east. The mean annual rainfall ranges from 3592 to 3842 mm. The mean maximum and minimum temperatures are 36°C and 20°C, respectively. The area has *ustic* soil moisture regime and *isohyperthermic* temperature regime respectively. Six pedons *viz.,* Pala hillock (Bulerikatta village – P1); Shantigodu (P2); Muchipadavu (P3); Mulia (P4) from National Research Centre for Cashew; Ullal (P5) and Palikudel (P6) from Agricultural Research Station were exposed and studied for morphological characteristics and horizon-wise soil samples were collected, air-dried, ground and sieved using 2 mm sieve. Particle-size analysis of the sample was carried out by using International Pipette Method. Soil reaction (pH), organic carbon, exchangeable cations, exchangeable acidity and cation exchange capacity were determined following standard methods (Page *et al.* 1982: Jackson 1973 and Sarma *et al.* 1987). The soils were classified as per guidelines given in Key to Soil Taxonomy (Soil Survey Staff 2006).

Results and Discussion

Soil morphology

The relevant morphological features of the pedons are presented in table 1. These deep to very deep soils had texture varying from sandy clay loam to clay. The wide textural variation might be due to different processes of soil formation, *in-situ* weathering and translocation of clay. Pedons had their Munsell colour notation in the hue of 10YR/7.5YR/5YR/2.5YR with value 3 to 4 and chroma 4 to 8. Pedons 1, 2, 4 and 6 had dark brown colour in surface and dark red to red colour in sub-surface. In pedon 3 and 5, the surface horizons exhibited yellowish red and dark reddish brown colour but the sub-surface colour was red. The pedons contained large proportions of gravel, which increased with depth. The structure of soils was sub-angular blocky type barring surface horizons of P1, P2 and P5.

Physical characteristics

The clay content in different horizons varied from 24.5 to 66.4 per cent and increased with depth (Table 2). This might be due to the illuvation or translocation of clay from the surface to sub-surface horizon. The silt content in all the pedons was low (4.3-22.2%) and had an irregular trend of distribution with depth. Sand constituted the bulk of mechanical fractions except pedon 3 and 4, which could be attributed to their parental lecacy. The bulk density of different pedons varied from 1.13 to 1.67 Mg m^{-3} and showed an increasing trend with depth (also for particle density) except pedon 3 and 4 which might be due to compaction, low organic matter and less aggregation. Similar results were also reported by Bhaskar and Subaiah (1995). Porosity of different pedons varied from 36 to 54 per cent. The irregular trend of porosity with depth was due to the illuviation and eluviation of finer fractions in different horizons (Chadha and Nair 1998) and might have influenced root distributions and nutrient uptakes.

Table 1. Morphological characteristics of soils

Pedon 1. Pala Hillock : Loamy- skeletal, mixed Ustic Haplohumult (Moderate slope)						D M W
0-21	A1	7.5 YR 3/4	cl	10	f 2 gr	sh vf s p
21-41	Bt1	7.5 YR 3/4	c	20	f 2 sbk	sh vf vs p
41-68	Bt2	5 YR 3/4	sc	50	m 2 sbk	sh vf vs p
68-95	Bt3	2.5 YR 3/6	c	40	m 2 sbk	sh vf vs p
95-123	Bt4	2.5 YR 3/6	cl	60	c 2 sbk	sh vf vs p
Pedon 2. NRCC-Shathigodu: Clayey-skeletel, mixed Oxic Dystrustept (Gentle slope)						
0-19	Ap	7.5 YR 3/4	c	35	f 2 gr	sh vf s p
19-42	Bw1	2.5 YR 3/6	c	35	m 2 sbk	sh vf s p
42-71	Bw2	2.5 YR 3/6	c	80	m 2 sbk	sh vf s p
71-90	BC	2.5 YR 3/6	c	80	m 2 sbk	sh vf s p
Pedon 3. NRCC-Muchipadavu : Fine, mixed Oxic Dystrustept (Gentle slope)						
0-25	Ap	5 YR 4/6	c	35	m 2 sbk	h vf s p
25-50	Bw1	2.5 YR 3/6	c	25	m 2 sbk	sh vf s p
50-84	Bw2	2.5 YR 3/6	c	20	m 2 sbk	sh vf s p
84-128	Bw3	2.5 YR 3/6	c	15	m 2 sbk	sh vf s p
128-160	Bw4	2.5 YR 3/6	c	15	m 2 sbk	sh vf s p
Pedon 4. NRCC-Mulia : Clayey-skeletal, mixed Ustic Haplohumult (Gentle slope)						
0-17	A	7.5 YR 3/4	c	40	m 1 sbk	sh vf s p
17-41	Bt1	7.5 YR 3/4	c	60	m 1 sbk	sh vf vs p
41-60	Bt2	2.5 YR 3/6	c	70	m 1 sbk	sh vf vs p
60-90	Bt3	2.5 YR 4/6	c	70	m 2 sbk	sh vf vs p
90-155	BC	2.5 YR 4/6	sc	70	m 2 sbk	sh vf vs p
Pedon 5. ARS-Ullal : Clayey-skeletal, mixed Typic Rhodustult (Very gentle slope)						
0-20	Ap	5 YR 3/4	cl	35	m 1 gr	sh vf s p
20-40	Bw	2.5 YR 3/6	c	40	m 1 sbk	sh vf vs p
40-70	Bt1	2.5 YR 3/6	c	60	m 2 sbk	sh vf vs p
70-99	Bt2	2.5 YR 3/4	c	60	m 2 sbk	sh vf vs p
99-127	Bt3	2.5 YR 4/8	c	70	m 2 sbk	sh vf s p
127-165	Bt4	10 R 4/8	c	60	m 2 sbk	sh vf s p
Pedon 6. ARS-Palikudel : Clayey-skeletal, mixed Ustic Palehumult (Moderately sloping upper land)						
0-28	A	7.5 YR 3/4	scl	35	m 1 sbk	sh vf ss p
28-55	Bt1	5 YR 3/6	c	35	m 2 sbk	sh vf s p
55-90	Bt2	2.5 YR 3/6	c	40	m 2 sbk	sh vf s p
90-130	Bt3	2.5 YR4/6	c	40	m 2 sbk	sh vf s p
130-180	Bt4	2.5 YR4/6	c	50	c2 sbk	sh vf s p

Table 2. Physical properties of soils

Depth (cm)	Horizon	Sand (2.0-0.05 mm)	Silt (0.05-0.002 mm)	Clay (<0.002 mm)	Bulk density (Mg m^{-3})	Particle density (Mg m^{-3})	Pore space (%)
Pedon 1. Loamy-skeletal, mixed Ustic Haplohumult							
0-21	A1	58.9	15.6	25.5	1.42	2.48	43
21-41	Bt1	55.1	9.4	35.5	1.33	2.57	48
41-68	Bt2	62.2	6.4	31.4	1.38	2.60	47
68-95	Bt3	57.8	9.9	32.3	1.38	2.64	48
95-123	Bt4	59.5	11.3	29.2	1.57	2.69	42
Pedon 2. Fine, mixed Oxic Dystrustept							
0-19	Ap	38.6	8.9	52.5	1.44	2.54	43
19-42	Bw1	36.8	12.6	50.6	1.49	2.52	41
42-71	Bw2	33.6	15.3	51.2	1.45	2.52	42
71-90	Bc	44.0	13.9	42.1	1.50	2.59	42
Pedon 3. Fine, mixed Oxic Dystrustept							
0-25	Ap	26.7	10.2	63.0	1.27	2.56	50
25-50	Bw1	21.4	13.6	65.1	1.21	2.55	52
50-84	Bw2	23.3	14.6	62.1	1.13	2.49	54
84-128	Bw3	16.3	17.3	66.4	1.13	2.48	54
128-160	Bw4	21.2	20.5	58.3	1.14	2.49	54
Pedon 4. Clayey-skeletal, mixed Ustic Haplohumult							
0-17	A	37.2	22.2	40.6	1.31	2.48	47
17-41	Bt1	28.0	19.6	52.4	1.23	2.48	50
41-60	Bt2	29.4	9.4	61.2	1.36	2.50	45
60-90	Bt3	37.1	5.0	57.9	1.23	2.54	51
90-155	BC	50.3	10.9	38.8	1.20	2.51	52
Pedon 5. Clayey-skeletal, mixed Typic Rhodustult							
0-20	Ap	61.0	6.8	32.2	1.33	2.58	48
20-40	Bw	56.8	7.4	35.8	1.36	2.62	48
40-70	Bt1	49.6	6.2	44.2	1.52	2.52	40
70-99	Bt2	41.1	6.8	52.1	1.60	2.53	37
99-127	Bt3	46.8	5.0	48.2	1.60	2.49	36
127-165	Bt4	50.3	4.3	45.4	1.58	2.53	37
Pedon 6. Clayey-skeletal, mixed Ustic Palehumult							
0-28	A	66.8	8.7	24.5	1.30	2.50	48
28-55	Bt1	50.5	12.3	37.2	1.44	2.60	45
55-90	Bt2	48.7	11.2	40.1	1.44	2.65	45
90-130	Bt3	43.5	12.5	44.0	1.47	2.57	43
130-180	Bt4	43.5	11.3	45.2	1.43	2.68	46

Table 3. Chemical characteristics of soils

Depth (cm)	Hori-zon	pH (1:2.5)	O.C. (%)	Exchan-geabale acidity	$BaCl_2$-TEA Acidity	Exchangeable cations				Sum of cations	CEC			B.S.(%)		Ratio to clay CEC NH_4 OAc
						Ca	Mg	Na	K		NH_4 OAc	Sum of cations	ECEC	NH_4 OAc	Sum of cations	
				cmol (p+) kg^{-1}												
Pedon 1. Loamy-skeletal, mixed, hyperthermic Ustic Haplohumult																
0-21	A1	5.4	3.07	0.89	47.89	1.90	1.60	0.24	0.15	3.90	15.5	51.79	4.78	25	7.5	0.60
21-41	Bt1	5.3	1.53	1.91	31.96	0.57	0.27	0.19	0.04	1.08	14.7	33.04	2.98	7	3.2	0.41
41-68	Bt2	5.6	0.38	1.00	17.90	0.81	0.64	0.19	0.03	1.69	13.1	19.59	2.67	12	8.6	0.41
68-95	Bt3	5.6	0.32	0.53	16.92	0.50	0.50	0.18	0.03	1.22	11.9	18.14	1.49	10	6.7	0.37
95-123	Bt4	5.7	0.13	0.17	11.75	0.49	0.58	0.18	0.03	1.29	7.7	13.04	1.46	16	9.8	0.26
Pedon 2. Fine, mixed, isohyperthrmic Oxic Dystrustept																
0-19	Ap	5.5	1.68	0.41	24.13	0.82	0.90	2.00	0.17	3.88	12.4	28.01	3.88	31	13.8	0.23
19-42	Bw1	5.6	0.97	0.18	19.60	0.36	0.81	0.21	0.05	1.43	11.0	21.03	1.43	13	6.8	0.21
42-71	Bw2	5.7	0.70	0.06	15.96	0.57	0.80	0.21	0.04	1.64	8.6	17.60	1.64	19	9.3	0.16
71-90	BC	6.0	0.14	0.06	14.43	0.65	1.05	0.26	0.03	2.00	7.6	16.43	2.00	26	12.1	0.18
Pedon 3. Fine, mixed, isohyperthermic Oxic Dystrustept																
0-25	Ap	5.5	0.97	0.83	21.63	1.37	0.52	0.15	0.05	2.09	10.2	23.72	2.59	20	8.8	0.16
25-50	Bw1	5.3	0.82	0.62	23.73	2.11	0.39	0.17	0.04	2.71	8.0	26.44	3.04	34	10.2	0.12
50-84	Bw2	5.5	0.50	0.26	20.88	0.82	0.39	0.16	0.04	1.41	7.8	22.29	1.41	18	6.3	0.12
84-128	Bw3	5.3	0.40	0.33	18.82	0.32	0.84	0.18	0.03	1.37	10.2	20.19	1.37	13	6.8	0.15
128-160	Bw4	5.4	0.26	0.10	14.60	0.63	0.60	0.14	0.02	1.39	9.8	15.99	1.39	14	8.7	0.16
Table 4. Clayey-skeletal, mixed, isohyperthermic Ustic Haplohumult																
0-17	A	5.5	2.80	1.44	41.99	1.24	0.60	0.33	0.08	2.25	19.8	44.24	3.48	11	5.0	0.48
17-41	Bt1	5.4	2.04	1.73	38.58	1.38	0.61	0.22	0.06	2.27	14.8	40.85	3.23	15	5.5	0.28
41-60	Bt2	5.5	1.42	1.19	29.32	1.46	0.82	0.20	0.07	2.55	14.3	31.87	3.62	18	8.0	0.23
60-90	Bt3	5.5	0.65	0.83	27.78	1.54	1.12	0.22	0.08	2.96	9.1	30.74	3.35	32	9.6	0.15
90-155	BC	5.3	0.43	0.29	19.83	1.09	0.73	0.13	0.03	1.98	10.7	21.81	1.98	18	9.0	0.27
Pedon 5. Clayey-skeletal, mixed isohyperthermic Typic Rhodustult																
0-20	Ap	4.9	1.56	2.18	22.95	0.43	0.36	0.06	0.13	0.98	11.3	23.93	2.59	9	4.0	0.35
20-40	Bw	4.8	0.83	2.01	19.43	0.13	0.19	0.06	0.06	0.44	10.3	19.87	1.83	4	2.2	0.28
40-70	Bt1	5.1	0.53	2.20	19.03	0.73	0.62	0.06	0.08	1.49	12.0	20.52	3.11	12	7.2	0.27
70-99	Bt2	5.2	0.45	1.25	17.57	1.75	1.05	0.10	0.13	3.03	13.8	20.60	3.76	21	14.7	0.26
99-127	Bt3	5.3	0.36	1.01	13.93	1.59	1.13	0.10	0.06	2.88	11.2	16.81	3.49	25	17.1	0.23
127-165	Bt4	5.1	0.27	0.53	24.55	1.09	0.93	0.10	0.05	2.17	10.4	26.72	2.56	21	8.1	0.22
Pedon 6. Clayey-skeletal, mixed, isohyperthermic Ustic Palehumult																
0-28	A	5.7	1.79	0.23	15.26	1.58	0.67	1.01	0.11	3.37	11.8	18.63	3.34	28	18.0	0.48
28-55	Bt1	5.5	1.30	0.41	15.76	0.74	0.49	1.01	0.02	2.26	11.2	18.02	2.40	20	12.5	0.30
55-90	Bt2	5.6	0.73	0.23	10.66	0.58	0.60	1.01	0.02	2.21	8.8	12.87	2.21	25	17.1	0.22
90-130	Bt3	5.4	0.36	0.00	8.16	0.76	0.78	1.02	0.01	2.57	9.4	10.73	2.57	27	23.9	0.21
130-180	Bt4	5.6	0.28	0.05	10.68	0.84	0.56	1.01	0.02	2.43	9.5	13.11	2.43	25	18.5	0.21

Chemical characteristics

The pedons were moderately to very strongly acidic (pH 4.9 to 6.1). The acidic pH of the soil might be attributed mainly to the leaching of the bases due to the high rainfall and acidic parent material. Shivaprasad *et al.* (1998) while characterizing the soils of Karnataka observed that the soils derived from granite-gneiss parent materials were slightly acidic to near neutral in soil reaction. The organic carbon content of the soils was found to be high in surface and low in sub-surface soils. Cation exchange capacity and base saturation varied from 7.6 to 33.6 cmol (p^+) kg^{-1} and 7 to 34 per cent respectively and decreased with depth. The effective cation exchange capacity (ECEC) and ratio to clay varied from 4.23 to 1.37 cmol (p^+) kg^{-1} and 0.60 to 0.12 and decreased with depth. The exchangeable acidity with KCl extract varied from 0.06 to 2.20 cmol (p+) kg^{-1}. Extractable acidity ($BaCl_2$-TEA) ranged from 8.16 to 47.89 cmol (p+) kg^{-1} and decreased with depth (Table 3).

Conclusion

It may be concluded that in study area, major limitation for cashew production is heavy rainfall, undulating landscape, gravelly texture, acidity and low cation exchange capacity. Good cashew production could be achieved through adding lime, fertilizers and manures. Based on the site and soil characteristics it is possible to adopt proper soil conservation measures to reduce the run-off for sustainable cashew production in long term.

Acknowledgements

I sincerely thank Dr. L.G.K. Naidu, Principal Scientist and Head, Regional centre, National Bureau Soil Survey and Land Use Planning (ICAR), Bengaluru for permitting me to use the facilities at the centre and his encouragement during the investigation and Mrs. Arti Koyal, Chief Technical Officer, for her help during soil sample analysis.

References

Bhaskar, B.P. and Subaiah, G.V. (1995). Genesis, characterization and classification of laterites and associated soils along the east coast of Andhra Pradesh. *Journal of the Indian Society of the Soil Science* **43**, 107-112.

Bhat, M.G. (2007). Annual *Report.* National Research Centre for Cashew, pp. 37- 44.

Chadha, K. L. and Nair, M. K. (1998). Suitability of red and laterite soil landscapes for coconut, citrus, mango, cashew and tree spices. *In*: Red and Lateritic Soils Volume 1: Managing red and lateritic soils for sustainable agriculture 179-189.

Jackson, M, L. (1973). *Soil Chemical Analysis.* Prentice-Hall of India Pvt. Ltd, New Delhi, pp. 40.

Page, A.L., Miller R.H. and Keeney D.R., (1982). Methods of Soil Analysis. **2**nd Edn., *American Society of Agronomy*, Madison, WI., USA.

Sarma, V.A.K., Krishnan, P. and Budihal, S.L. (1987). *Laboratory Methods*. NBSS pub.**14**, Technical Bulletin, National Bureau of Soil Survey and Land Use Planning, Nagpur, pp. 49.

Shivaprasad, C.R., Reddy, R.S., Sehgal, J. and Velayutham, M. (1998). Soils of Karnataka for optimizing land use. National Bureau of Soil Survey and Land Use Planning, Nagpur, publ., **47**, pp. 15.

Soil Survey Staff. (2006). *Keys to Soil Taxonomy (Tenth edition).* USDA-SCS, Washington DC, USA.

Received : July 2012; Accepted :February 2013