Himachal Journal of Agricultural Research Vol. 33 (1): 22-26, 2007

Characterization of rice growing soils of Paonta Valley of Himachal Pradesh

Pardeep Kumar, Sanjay K. Sharma and V. K. Sharma
Department of Soil Science
CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur-176 062.

Abstract

A reconnaissance soil survey was conducted in the rice growing soils of Paonta Valley of Himachal Pradesh for their characterization. Soils were deep to very deep having yellowish brown (10YR5/4) to dark yellowish brown colour (10YR3/4) and clay loam to loamy sand texture. Mottles were observed only in Jamniwala and Kollar soils while the calcareousness was recorded in Paonta Sahib and Puruwala soils only. Increasing trend of bulk density with depth is noticed and it ranged from 1.29 to 1.68. The soils retained fairly good amount of water at field capacity as well as at permanent wilting point. The surface horizons of all the soils exhibited higher values of MWD. The reaction of the soil was found to be slightly acidic to slightly alkaline (6.1 to 7.9). The cation exchange capacity (CEC) of the soils of the area varied from 6.8 to 12.2 cmol (p^+)kg^{-1}. Organic carbon content, available N, P and K decreased with increasing profile depth.

Key words: Paonta valley, characterization, rice soils.

Introduction

The Paonta Valley is one of the most productive valleys of Himachal Pradesh and represents the sub-montane, low hills and sub-tropical agro- climatic situations. The major portion of the cropped area (about 70%) in this valley is under rice- wheat sequence. In order to sustain crop productivity, it becomes essential to generate soil- site specific technologies for which a sound knowledge about soil properties and characteristics is essential. Presently, very limited information is available on this aspect. Keeping these factors in view, the study has been undertaken to characterize the rice growing soils of Paonta Valley of Himachal Pradesh.

Material and Methods

The Paonta Valley is located between 30°26'15" and 30°31'30" N latitude and 77°19'30" and 77°49'15" E longitude and elevation ranges from 300 to 480m above mean sea level. Total annual precipitation of the area is 1000 mm. The valley lies in the South- Western part of the state; phsiographically called the outer Himalayan region and have deeply dissected topography composed of highly unconsolidated deposits of sandstones, shales and conglomerates. A reconnaissance survey was conducted in cropped area of the valley representing soils under rice- wheat sequence and six pedons were exposed. Apart from studying the morphological characteristics, horizon- wise soil samples were collected and analyzed for different soil properties viz., soil texture (International Pipette method), bulk density (Core method), water stable aggregates by using undisturbed ring samples (Yoder, 1936), water retention (Pressure Plate Apparatus), infiltration using double ring infiltrometer and soil pH, organic carbon content, CEC, available N, P and K using standard procedures (Black *et.al.*1965).

Results and Discussion

Morphological characteristics

The soils are deep (45-90 cm) to very deep (>90 cm) and well drained. The soil colour is yellowish brown (10YR5/4 M) to dark yellowish brown (10YR3/4 M). The soils are well drained. The soil colour is an indicator of drainage conditions and organic matter status of the soils. The soil colour appears to be the function of chemical and mineralogical composition as well as textural make up of soils and conditioned by topographic position and moisture regime (Walia and Rao, 1977). The soils of the study area showed wide textural variations (clay loam to loamy sand) caused by parent material, topography, in- situ weathering and translocation of clay. Presence of very dark grayish brown (10YR3/2 M) and strong brown (7.5YR 5/6 M) to yellowish red (5YR 5/8 M) mottles in Jamniwala and Kollar soils reflects impeded drainage in the sub-soil (Table 1). The consistence of the soils varied with the texture from loose to slightly hard (dry), loose to firm (moist) and non-sticky non-plastic to very-sticky very plastic depending on the clay content. All the pedons had fine to very fine roots extending up to

Table 1. Morphological characteristics of the soils studied

Horizon	Depth (m)	Soil colour (M)	Texture	Consistency			Roots		Mottles		Effervescence
				D	M	W	S	Q	C	Q	
					Ganguwala Entisol						
Ap	0.00-0.24	10YR 5/4	sil	sh	fl	vsvp	f	c	-	-	-
AC_1	0.24-0.42	10YR 5/4	cl	sh	fl	vsvp	vf	f	-	-	-
C_2	0.42-0.76	10YR 5/4	cl	sh	fl	vsvp	-	-	-	-	-
C_{31}	0.76-1.14	10YR 5/4	cl	sh	fl	vsvp	-	-	-	-	-
C_{32}	1.14-1.80	10YR 5/4	cl	sh	fl	vsvp	-	-	-	-	-
					Jamniwala Entisol						
Ap	0.00-0.22	10YR 5/3	sil	sh	fl	sp	f	c	10YR 3/2 5YR 5/8	p	-
C_1A	0.22-0.40	10YR 4/4	sil	sh	fl	sp	vf	f	10YR 3/2 5YR 5/8	p	-
C2	0.40-0.63	10YR 5/4	scl	sh	fl	sp	-	-	10YR 3/2 5YR 5/8	p	-
C_{31}	0.63-1.16	10YR 5/4	sil	sh	fl	vsvp	-	-			-
C_{32}	1.16-1.60	10YR 5/4	sl	l	l	sopo	-	-			-
					Paonta Sahib Inceptisol						
Ap	0.00-0.17	10YR 5/2	sl	sh	vfr	ss	f	c			e
AB	0.17-0.39	10YR 4/3	l	sh	fr	sp	vf	f			e
Bw_1	0.39-0.67	10YR 4/3	cl	sh	fl	vsvp	-	-			e
Bw_2	0.67-0.83	10YR 4/3	cl	h	fl	vsvp	-	-			e
CB_1	0.83-1.17	10YR 4/3	cl	h	fl	vsvp	-	-			e
CB_2	1.17-1.60	10YR 4/3	cl	h	fl	vsvp	-	-			e
					Puruwala Inceptisol						
Ap	0.00-0.16	10YR 5/2	sil	sh	vfl	ss	f	c	-	-	e
Bw_1	0.16- .32	10YR 5/3	sic	sh	fl	vsvp	vf	f	-	-	e
Bw_2	0.32-0.48	10YR 5/3	sic	sh	fl	vsvp	vf	f	-	-	e
CB	0.48-0.67	5Y 4/2	sicl	sh	fl	vsvp	-	-	-	-	e
	0.67-0.87	5Y 4/1	ls	l	l	sopo	-	-	-	-	-
					Kollar Alfisol						
Ap	0.00-0.16	10YR 5/4	cl	sh	fl	vsvp	f	c	-	-	-
Bt_1	0.16-0.42	10YR 5/2	sil	sh	fl	vsvp	-	-	-	-	-
Bt_2	0.42-0.75	10YR 5/4	sil	sh	fl	vsvp	-	-	7.5YR5/6	p	-
Bt_3	0.75-1.50	10YR 5/4	cl	sh	fl	vsvp	-	-	7.5YR5/6	p	-
					Dhaulakuan Entisol						
Ap	0.00-0.13	10YR 3/4	sil	sh	fl	fl	f	c	-	-	-
CA	0.13-0.35	10YR 4/2	sl	l	l	sopo	vf	f	-	-	-
C_1	0.35-0.55	10YR 4/2	sl	l	l	sopo	-	-	-	-	-
C_2	0.55-0.71	10YR 4/2	ls	l	l	sopo	-	-	-	-	-
	0.71-1.30	-	Gravels	-	-	-	-	-	-	-	-

50cm depth. Root distribution is important in relation to water and nutrient uptake by plants. Slight effervescence with dilute HCl was observed in Paonta Sahib and Puruwala soils which exhibit vertic properties such as 2 to 5 mm wide cracks extending upto 25 to 30 cm depth.

Physical characteristics

The analysis reveals that the clay content varied from 5.5 to 28.5 per cent (Table 2). Clay content increased in lower horizons of Ganguwala, Jamniwala and Kollar soils which could be attributed to vertical migration or translocation of clay (Sarkar *et al.* 2002). The distribution of clay in the soils of Paonta Sahib, Puruwala and Dhaulakuan was found to be irregular which might be due to variability in weathering in different horizons. Silt content of all the six pedons exhibited an irregular distribution trend with depth and the values varied from 22.3 to 42.5 per cent. Coarse fraction (sand) constituted the bulk of mechanical fractions and the values varied from 34.9 to 64.4 per cent, which could be attributed to the dominance of alluvial sandy parent material.

The bulk density of soils varied from 1.29 to 1.68 Mgm^{-3} and increased with depth. This may be attributed to more compaction of finer particles in sub-surface horizons (Table 2) caused by over head weight of the surface soils (Jewitt *et al.* 1979), while the surface soils are low in bulk density probably due to high amounts of organic matter and root concentration. Water retention values at field capacity (33 kPa) of all the sites varied from 25.7 to 38.3 per cent. In general, all the soils retained fairly good amount of water at field capacity. Similarly water retained at permanent wilting point (1500 kPa) varied from 7.5 to 19.8 per cent. The differences in water retention might be due to the variation in the depth and clay, silt and organic carbon content.

Surface horizons (Ap) of all the pedons exhibited higher values of soil aggregates and the values of mean weight diameter (MWD) varied from 0.28 to 2.14 mm. In all the pedons MWD values decreased with depth. The higher values of MWD in the surface horizons might be due to higher organic carbon content in the corresponding horizons whereas, the low values in the sub-surface layers might be attributed to dominance of sand fraction and low organic carbon content. All the soils under study exhibited higher values of infiltration and values varied from 0.85 to 0.96 cm hr^{-1} which could be due to sandy texture of the soils.

Chemical characteristics

The pH of the studied soils ranges from 6.1 to 7.9 suggesting that the soils are slightly acidic to slightly alkaline in reaction (Table 3). The data on organic carbon show that soils are low to high and values ranges from 1.5 to 10.9 g kg^{-1}. The organic carbon content decreased with depth in all the soils under study except Puruwala and Jamniwala soils which might be due to the stratification in alluvial soils. This could be attributed to the addition of farmyard manure and plant residues to the surface horizons than in the lower horizons. Similar results have also been reported by Sharma *et al.* (2004).

The CEC of the soils ranged between 6.8 to 12.2 cmol $(p^+)kg^{-1}$ and the values did not follow any regular distribution pattern with depth which corresponds to the clay content in the respective horizons. Similar results for paddy soils have also been reported by Bhaskar *et al.* (2005).

The available nitrogen content of the soils varied from 125.4 to 376.2 kg ha^{-1} (Table 3). However, available nitrogen content was found to be maximum in surface horizons and decreased regularly with depth which might be due to decreasing trend of organic carbon with depth. These observations are in accordance with the findings of Prasuna Rani *et al.* (1992) and Thangasamy *et al.* (2005).

The available phosphorus content in the horizons of all the soils under study varied from 8.9 to 20.2 kg ha^{-1}. However, the highest available phosphorus was observed in the surface horizons of all the soils and the values decreased regularly with increasing depth. The reason for higher P content in the surface horizons might possibly due to the confinement of crop cultivation to the rhizosphere and supplementing the depleted phosphorus through external sources i.e. manures and fertilizers. These results are in conformity with the findings of Thangasamy *et al.* (2005).

The content of available K in all the soils varied from 47.1 to 176.2 kg ha^{-1} and showed a more or less decreasing trend with depth. This could be attributed to more intensive weathering, release of labile K from organic residues, application of K fertilizers and upward translocation of K from lower depth alongwith capillary rise of ground water (Hireburaban *et al.* 2000; Thangasamy *et al.* 2005).

Table 2. Physical characteristics of the soils studied

Horizon	Depth	Sand	Silt	Clay	Bulk density	Water retention (%)		MWD	Infiltration rate
	(m)	(%)	(%)	(%)	(Mgm^{-3})	(33kPa)	(1500kPa)	(mm)	($cm\ hr^{-1}$)
					Ganguwala Entisol				
Ap	0.00-0.24	61.1	32.3	5.5	1.45	36.3	14.2	0.68	0.85
AC_1	0.24-0.42	53.4	31.3	14.2	1.47	37.9	10.4	0.60	
C_2	0.42-0.76	62.4	26.4	10.1	1.49	30.7	11.9	0.40	
C_{31}	0.76-1.14	55.2	26.6	17.2	1.50	33.4	11.9	0.30	
C_{32}	1.14-1.80	60.2	33.1	5.6	1.50	28.4	8.6	0.30	
					Jamniwala Entisol				
Ap	0.00-0.22	60.1	31.5	7.2	1.41	34.0	16.5	0.90	0.85
C_1A	0.22-0.40	47.7	35.4	15.8	1.50	27.5	14.6	0.64	
C2	0.40-0.63	57.6	31.2	10.3	1.64	28.9	14.1	0.55	
C_{31}	0.63-1.16	60.3	29.4	9.3	1.61	25.7	10.7	0.50	
C_{32}	1.16-1.60	64.4	26.0	9.1	1.65	25.7	9.9	0.37	
					Paonta Sahib Inceptisol				
Ap	0.00-0.17	50.6	32.7	15.2	1.54	33.4	18.3	2.14	0.95
AB	0.17-0.39	53.1	30.4	15.3	1.55	32.2	17.3	0.61	
Bw_1	0.39-0.67	55.2	26.1	17.5	1.57	33.0	18.5	0.53	
Bw_2	0.67-0.83	56.1	26.4	16.2	1.60	33.6	19.8	0.52	
CB_1	0.83-1.17	61.1	27.6	10.3	1.62	33.9	14.3	0.49	
CB_2	1.17-1.60	56.4	28.1	14.6	1.60	33.8	14.0	0.30	
					Puruwala Inceptisol				
Ap	0.00-0.16	34.9	40.6	22.8	1.29	31.8	18.4	1.61	0.96
Bw_1	0.16- .32	35.6	39.2	24.2	1.31	30.3	13.9	0.61	
Bw_2	0.32-0.48	40.5	34.3	24.2	1.34	23.2	11.8	0.51	
CB	0.48-0.67	53.0	30.6	15.4	1.47	32.1	17.3	0.29	
	0.67-0.87	-	-	-	-	-	-	-	
					Kollar Alfisol				
Ap	0.00-0.16	51.6	34.2	13.7	1.47	29.9	15.1	0.70	0.86
Bt_1	0.16-0.42	52.3	26.1	20.4	1.50	30.7	14.0	0.41	
Bt_2	0.42-075	48.2	22.3	28.5	1.58	28.9	11.2	0.42	
Bt_3	0.75-1.50	48.3	23.5	27.2	1.68	32.3	13.7	0.28	
					Dhaulakuan Entisol				
Ap	0.00-0.13	52.4	32.1	14.5	1.46	38.3	14.6	1.65	0.84
CA	0.13-0.35	45.2	42.5	11.3	1.63	31.5	11.2	1.14	
C_1	0.35-0.55	60.6	31.2	7.2	1.64	33.1	9.7	1.12	
C_2	0.55-0.71	64.3	28.1	9.0	1.65	33.7	7.5	0.37	
C_3	0.71-1.30	-	-	-	-	-	-	-	

Table 3. Chemical characteristics of the soils studied

Horizon	Depth (m)	pH (1:2.5)	OC (gkg^{-1})	CEC ($cmol(p^+)\ kg^{-1}$)	Available N	P ($kgha^{-1}$)	K
			Ganguwala Entisol				
Ap	0.00-0.24	6.7	4.8	6.8	219.5	18.4	84.1
AC_1	0.24-0.42	6.4	3.9	9.9	219.5	18.4	62.8
C_2	0.42-0.76	6.1	3.6	9.1	156.8	18.4	110.0
C_{31}	0.76-1.14	6.1	3.1	10.6	156.8	17.0	70.7
C_{32}	1.14-1.80	6.1	2.7	6.8	125.4	15.7	61.7
			Jamniwala Entisol				
Ap	0.00-0.22	6.1	5.7	7.8	344.9	18.4	86.9
C_1A	0.22-0.40	6.7	3.9	9.4	125.4	18.4	56.1
C2	0.40-0.63	6.9	2.4	8.3	156.8	17.0	56.1
C_{31}	0.63-1.16	7.2	2.5	8.1	156.8	13.4	56.1
C_{32}	1.16-1.60	6.9	1.5	8.0	125.4	13.4	51.6
			Paonta Sahib Inceptisol				
Ap	0.00-0.17	7.6	9.4	9.6	344.9	20.2	53.8
AB	0.17-0.39	7.3	7.3	9.4	376.2	17.0	61.7
Bw_1	0.39-0.67	7.3	7.0	9.7	282.2	15.7	50.5
Bw_2	0.67-0.83	7.4	6.4	9.6	282.2	15.7	83.0
CB_1	0.83-1.17	7.3	5.5	9.2	219.5	12.5	58.3
CB_2	1.17-1.60	7.2	3.0	9.6	188.1	8.9	47.1
			Puruwala Inceptisol				
Ap	0.00-0.16	7.6	9.4	10.4	344.9	18.4	83.0
Bw_1	0.16- .32	7.9	6.3	11.6	219.5	18.4	65.1
Bw_2	0.32-0.48	7.9	4.6	11.5	250.8	13.4	75.2
CB	0.48-0.67	7.9	5.8	8.9	219.5	12.5	76.3
	0.67-0.87	-	-	-	-	-	-
			Kollar Alfisol				
Ap	0.00-0.16	6.3	7.5	8.5	376.2	18.4	176.2
Bt_1	0.16-0.42	6.7	4.3	10.6	282.2	18.4	96.5
Bt_2	0.42-075	6.7	2.8	12.2	219.5	17.0	50.5
Bt_3	0.75-1.50	6.5	2.7	12.0	188.1	11.2	65.1
			Dhaulakuan Entisol				
Ap	0.00-0.13	6.5	10.9	9.2	313.6	17.0	105.5
CA	0.13-0.35	7.2	9.1	8.8	188.1	15.7	67.3
C_1	0.35-0.55	7.4	3.9	7.3	156.8	12.5	125.7
C_2	0.55-0.71	7.4	3.1	7.8	125.4	11.2	112.2
C_3	0.71-1.30	6.5	1.5	6.7	125.4	17.0	65.1

References

Bhaskar B P, Baruah Utpal, Vedivelu S and Bhutte P S 2005. Characterization of soils in the 'Bil' environs of Brahmaputra Valley in Jorhat district, Assam for land use interpretation. J. Indian Soc. Soil Sci. **53**: 3-10.

Black C A, Evans D D, Ensininger L E, White J L and Clark, F E 1965. *Methods of Soil Analysis*. Part I. Amer. Soc. Agron. Madison,Wisconsin, pp 902-913.

Hirekurabar P M, Satyanarayana T, Sarangmati P A and Majunatham H M 2000. Forms of potassium and their distribution in soils under cotton-based cropping system in Karnataka. J. Indian Soc.Soil Sci. **48**: 604-608.

Jewitt T N, Law R D and Virgo K J 1979. Outlook on Agriculture as quoted by WA Blockhuis. Morphology and Genesis of Vertisols. In *Vertisols and Rice Soils of Tropics*, Symposia of 12th International Congress of Soil Science, New Delhi.

Prasuna Rani P, Pillai R N, Bhanu Prasad V and Subbaiah G V 1992. Nutrient status of some red and associated soils of Nellore district under Somasila project in Andhra Pradesh. Andhra Agril.J. **39**: 1-5.

Sarkar Dipak, Baruah U, Gangopadhyay S K, Sahoo A K and Velayuthum M 2002. Characteristics and classification of some soils of Loktak command area of Manipur for sustainable land use planning. J. Indian Soc. Soil Sci. **50**: 196-204.

Sharma S S, Totawat K L and Shyampura R L 2004. Characterization and classification of salt- affected soils of southern Rajasthan. J. Indian Soc.Soil Sci. **52**: 209-214.

Thangasamy A, Naidu M V S, Ramavatharam N and Raghava Reddy C 2005. Characterisation, classification and evaluation of some soil resources in Sivagiri micro- watershed of Chittoor district in Andhra Pradesh for sustainable land use planning. J.Indian Soc. Soil Sci.**53**: 11-21.

Walia C S and Rao Y S 1997 Characteristics and classification of some soils of Trans-Yamuna plains. J.Indian Soc.Soil Sci.**45**: 156-162.

Yoder R E 1936. A direct method of aggregate analysis and study of the physical nature of soil erosion losses. J.Amer.Soc. Agron.**28**: 337-351.