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STUDY OF MACRO-MORPHOLOGICAL AND PHYSICO-CHEMICAL CHARACTERISTICS OF SOIL OF KAPURTHALA IN PUNJAB, NW-INDIA

Jaihoon Rafie and Raj-Kumar*

School of Agriculture, Department of Soil Science and Agriculture Chemistry, Lovely Professional University, Phagwara (Punjab) India

Abstract

An investigation was carried out in the Kapurthala district in Punjab, NW-India, the Kapurthala district lies between the latitudes of $31^0$072 303 N and $75^0$542 603 E, it's the smallest district of Punjab, and as per provisional population figures of 2011 Census it covers a total of 1670sq. km area. The aim of the study was to evaluate the macro morphological, physical and chemical characteristics of the soil of Kapurthala district, five profile samples were collected from five villages, the macro morphological characteristics of samples such as soil colour, structure, consistency, effectiveness wit HCl, boundary were studied in the field, location of all the samples were recorded with help of GPS, and horizon wise samples were collected for further study in laboratory, the pH of theses soils were alkaline, these soils have a pH of greater than 8.5. The electrical conductivity (EC) of these soils was below 1 dS m^{-1}. Organic carbon percentage of these soils was medium in surface ranged from 0.63 per cent to 0.79 per cent, where in subsurface horizons the soils were low to medium in organic carbon. Calcium carbonate percentage of these soils was less. The available nitrogen in soil of Kapurthala district was varied from low to medium ranged between 275 kg/ha and 476 kg/ha in surface, while in subsurface its ranged from 50.1 kg/ha to 489.2 kg/ha. Available phosphorus in these soils were varied from high to very high and ranged from 24.6 kg/ha to 84.2 kg/ha. Available potassium of all the samples was high in these soil varied from 313.6 kg/ha to 452.6 kg/ha. CEC of all the samples were calculated in me/100g of soil, ranged from 2.69 to 28.24 in surface and 2.03 to 10.67 in subsurface respectively. Accordingly exchangeable cations (Ca, Mg, Na and K) were evaluated in me/100g of soil. Exchangeable sodium percentage of these soils was ranged between 6.5 and 66.0. Soil texture of all the samples was studied in the laboratory by the use of international pipit method. Soil texture in these profiles varied from silty clay loam, silty clay, clay loam, loam, sandy loam and sand.

Key word: soil characterization, Macro morphological properties, physicochemical properties

Introduction

Soils are crucial life supporting natural resource since they produce food, fiber and fodder which are basic for our very existence. They link the earth's rock core to all forms of life on the earth (Sehgal *et al.,* 1992). The 1980s became the decade of awareness, as the productivity of agricultural soils world-wide was in general on the decline. Per capita food grain production decreased significantly. This decline was attributed to periodic droughts, poor management and exploitative agriculture coupled with degradation process Richard (1999). The soils of Punjab developed largely on alluvium, very widely and exhibit differences in their nature, properties and profile development as dictated by differential climatic and topographic conditions (Sehgal *et al.,* 1992). The Kapurthala district is occupied by Indo-Gangetic alluvium; the major portion of this region lies in the river tract falling between the Beas and Black Bein and is called "Bet". The Kapurthala district comprises two units, namely Kapurthala and Phagwara which are separated by a part of the Jalandhar district. The Kapurthala unit occupies a major part of the district. There are three tehsils, vis. Kapurthala, Sultanpur Lodhi and Phagwara (Sharma *et al.,* 1982).

Most of the studies on the macro morphological and physicochemical characteristics of soils of Kapurthala

Author for correspondence :

district have been done in the initial years of intensive farming owing by green revolution. Now after forty five years of intensive cultivation, the present study was conducted to understand the macro morphological and physico-chemical characteristics of soil of Kapurthala district. As such it is of highest importance that these soils were studied in the field, characterized in the laboratory on the light of new observation about soil characteristics for effective transfer of technology to the farms.

Materials and Methods

Geographical location: the study was conducted at the Kapurthala district in Punjab, NW-India. The Kapurthala district is situated at latitude of 075° 42' 33.126'3 E and longitude of 31°16' 40.548"N with altitude of 218m above mean sea level. The investigation on Macro morphological and physico-chemical characteristics of district Kapurthala involved study of five profiles soil samples.

Climate: This area is characterized by hot dry sub-humid to semi-arid transition with dry summers and cool winters. The mean annual air temperature ranges from 24 to 26°C. The mean maximum summer (May to July) temperature ranges from 34°C to 38°C rising to a maximum of 40°C in May and June. The mean winter (December to February) minimum temperature ranges from 5°C to 7°C dropping to a minimum of 3°C to 4°C during December and January. In this area mean annual rainfall ranging between 700 to 1000 mm covering 52-60 per cent of mean annual PET ranging between 1300 to 1500 mm. The monsoon rains set in the last week of June and end in the month of September covering 75-80 per cent of the total annual rainfall. The months of July to September show the peak period of the rainfall with a low variability of 50 to 60 per cent. There is little rainfall during October and November and its variability is more than 200 percent. Brief spell of winter rain during.

Soil sampling and soil analysis: The survey was carried out by the standard soil survey procedure as described in the Soil Survey Manual (USDA, 2017). Five profile samples were collected using Garmin GPS. The macro morphological characteristics of the soils were studied in the field, and the physical and chemical characteristics of the soils were studied in laboratory. Samples were analysed for pH, EC using soil: water 1:2 (Jackson, 1967 and Bates, 1954). Organic carbon was determined by wet digestion method of Walkley and Black (1965). Calcium carbonate was determined by Puri, (1930). Available nitrogen was estimated by Subbiah and Asija, (1965). Available phosphorus was determined by using the procedure of extracting the sample with 0.05 M sodium bicarbonate (Olsen *et al.,* 1954). For available potassium samples were extracted with 1N ammonium acetate (Merwin *et al.,* 1950). CEC of these soils determined by using the method described by (Jackson, 1967), exchangeable cations were determined as per procedure described in practical soil science and agriculture chemistry manual Tolanur, (2018), and particle size distribution was analysed as per Sing *et al.,* (2013) manual.

Place the sample were collected from

Soil profile observations have been taken from the five village of Kapurthala, which are Rawalpindi, Domeli, Samana, Ucha and Natpur.

Results and Discussion

Five profile samples were collected from the five village of Kapurthala district in Punjab, NW-India for their macro morphological, physical and chemical characteristics. Locations of all the profiles were recorded with the help of global positioning system (GPS). The results for the pedons are discussed below and presented in tables.

Table 1: Site characteristics of the studied soil profiles.

Pedon	Name of Series	Depth Cm	GPS Reading		Elevation (M)	Erosion	Vegetation	Land form	Slop %	Drainage
			Longitude	Latitude						
1	Rawalpindi	130	31°17.534'	075°.42.126'	223	ei	Wheat, Paddy	piedmont plain-alluvium	1-3	MWD
2	Domili	108	31°20.33.654	075°.39.276'	222	ei	Wheat	piedmont plain	1-2	PD
3	Samana	142	31°11.683"	075° 42 .115'	234	ei	Wheat, paddy		1-2	WD
4	Ucha	142	31°10.592"	075° 42 .132'	129	ei	wheat, paddy		1-2	WD
5	Natpur	120	31°37.119'	075° 28 .290'	213	-	Wheat, paddy	alluvial plain	1	WD

December to February covering 11 to 12 per cent of the total rain is generally seen in this area.

Table 2: Location of profile samples

S.No	Villages	Location
1	Rawalpindi	the north site of W.Bein about 45 km to Rawalpindi, Phagwara the, Kapurthala district
2	Domeli	Phagwara tehsil, Kapurthala district
3	Samana	Dakh Darweshpind on Phagwara- Jadiala road
4	Ucha	Near to Ucha pind in the village of Ucha
5	Natpur	In the old bed of beas river- Nangal Labana village

Soil Macro-Morphological properties: Macro morphological characteristics of soil are showed in Table 3. The study soils are moderate will drained in profile 1, poorly drained in profile 2 and will drained in profile 3, 4 and 5 respectively, it might be due to high amount of iron in soil. In general soil morphological and physicochemical characteristics and the availability of water and air by organism influence soil drainage. This can affect soil productivity (Asgari *et al.,* 2018). Profiles were very deep, ranged from 108 cm in Domeli series to 142 cm in Samana and Ucha respectively with 5 and 6 horizons. Soil colour is measured Munsell soil color charts. Profiles number 1 and 2 have a colour of gray which is changed to grayish brown in profile number 3, 4 and 5 at surface horizons when the soils are dry. Soil colour depends on many factors mainly on the amount of organic matter, iron oxide as well as amount of air and water in soil pores, in general dark soils have high organic matter content, gray soils are waterlogged or anaerobic, brown soils are well drained (Patiram *et al.,* 2007). Soil structure and its variation with depth are evaluated visually as part of the soil profile description. The description of soil structure is mainly related to its grade, size and the shape of aggregates (Rabot *et al.,* 2018). Moderate medium and moderate coarse sub angular blocky structures were seen in all the horizons of the profiles except BC horizons of Rawalpindi and Domeli which were massive and surface horizon of Ucha and Natpur series. Also the structure in subsurface horizons of Natpur was medium. The sub angular blocky structure especially in subsurface may be due to the presence of higher clay fractions (Tsozue, 2015) When the soils are dry the material is strongly resistance in the surface horizon of profile 1 which is change to strongly resistance in profile number 2 and soft in profile number 3, 4 and 5 respectively. When the soils were moist all the horizons of all the profile were weakly coherent consistence expect Domeli series, and when the soils were wet sticky, plastic and sticky and plastic consistence were recorded. These soils have a strong, moderate and slight effectiveness with HCl Table 3.

Soil physical and chemical characteristics:

Particle size distribution: soil texture of all the samples were studied in laboratory by the use of international pipit method. Result obtained from all the horizons of profiles presented in the tables. Clay is an intrinsic soil property whose depth distribution is influenced by parent material topography and hydraulic conductivity (Keshavarzi *et al.,* 2018). In the present study the clay percentage of surface horizons was ranged from 4.7 percent in profile 5 to 35.4 percent in profile 3, and in the subsurface horizon it's ranged between 0.8 in C3 horizon of profile 5 Natpur series to 39.7 in AB profile 1 Rawalpindi series. The clay content increase by depth in pedon 2 except B21 horizon, this is may be due to consequence of eluviation-illuviation processes as well as contributions of the under lying geology through weathering (Kumar *et al.,* 2016). Profile 2 Domeli series had the maximum silt percentage 36.3 percent in its surface horizon 2, and the minimum was recorded in profile 4 Ucha series which is about 16.1 percent, and in subsurface horizons the silt percentage is ranged between 0.9 in C3 horizon of profile 5 to 58.4 in B1 horizon of profile 1. Sand percentage in surface horizons of the profiles ranged from 33.4 percent in profile 3 to 77.5 percent in profile 5. In subsurface horizon sand percentage ranged between 12.7 percent B1 horizon of profile 1 to 98.3 in C3 horizon of profile 5 in. soil texture is one of the most important properties for classification and genetic characterization it can help as to find the age of soil and reclaim scientific practical problems (Hristov, 2013), Accordingly soil texture in these profiles varied from silty clay loam, silty clay, clay loam, loam, sandy loam and sand.

Soil reaction, EC, OC, $CaCO_3$: soil reaction (pH) and electrical conductivity (EC) of all the profiles were determined in a 1:2 soil to water ratio suspension. Soil of Kapurthala district is alkaline, ranged from 8.5 in profile 1 to 10.3 in profile 2 in the surface horizons. Accordingly it's ranged between 8.6 in AB horizon of profile 1 to 10.2 in B21 horizon of profile 2 in subsurface horizons. Increase in pH with depth in some of the profiles was visible which may be due to increase in content of exchangeable and soluble sodium and calcium (Pulakeshi *et al.,* 2014). The electrical conductivity (EC) value of the Kapurthala district were recorded bellow 1 dS m^{-1}, which is normal soil, no harmful effect on crops as per soil salinity and crop tolerance (Tolanur, 2018). The electrical conductivity values obtained in surface horizons of the profiles in Kapurthala district ranged from 0.05 dS m-1 in profile 2 to 0.8 dS m^{-1} in profile 3. In the subsurface horizon the obtained electrical conductivity

ranged between 0.02 dS m^{-1} in B1, B22, and BC horizons of Domili series, accordingly C2 and C3 horizons of Natpur series respectively to 0.55 dS m^{-1} in B23 horizon of Samana series. Soil organic carbon is the most often reported attribute and is chosen as the most important indicator of soil quality and agricultural sustainability and it is a complex mixture which contributes positively soil fertility, crop and plant production and soil sustainability (Liu *et al.,* 2006). The organic carbon percentage of soil of Kapurthala district was ranged from low to medium. this is might be due to long term cultivation and burning of crop residues which is common land clearing in this area, (Alemayehu *et al.,* 2014) also noticed that burning and removal of crop residues had significantly reduced OC% under the cultivated land as compere to uncultivated land. Organic carbon percentage in the surface horizons of these soils were medium ranged from 0.63 percent in profile 5 to 0.79 percent in profile 2. It may be due to

Table 3: Macro morphological characteristics of soil of Kapurthala district

Horizon	Depth	Color	Structure	Consistence			Re-action	Bound ary
				Dry	Moist	wet		
Ab	0-26	5/2 10YR	2m sbk	dh	Mfr	ws	es	qs
AB	26-42	4/4 10YR	2m sbk	dh	Mfr	wp	e	iw
B1	42-58	4/4 10YR	2c sbk	dh	Mfr	Ws,wp	es	iw
B21	58-74	5/4 10YR	2c sbk	dh	Mfr	Ws,wp	ev	qs
B22	74-105	5/5 10YR	2c sbk	dh	Mfr	Ws,wp	ev	gs
BC	105-130	6/4 10YR	massive	dh	Mfr	Ws,wp	ev	-
Profile No.2 (Domeli)								
Ap	0-18	5/2 10YR	2m sbk	dvh	Mfi	ws	es	ds
AB	18-35	4/4 10YR	2m sbk	dvh	Mfi	wp	ev	gs
B1	35-55	4/4 10YR	2c sbk	dvh	Mfi	Ws,wp	ev	gs
B21	55-70	5/4 10YR	2c sbk		Mfi	Ws,wp	ev	gs
B22	70-95	5/5 10YR	2m sbk		Mfr	Ws,wp	e	gs
BC	95-108	6/4 10YR	massive		Mfr	Ws,wp	e	-
Profile No.3 (Samana)								
Ap	0-30	4/1 10YR	2m sbk	dsh	Mfr	Ws,wp	ev	cs
AB	30-50	6/6 10YR	2m sbk		Mfr	Ws,wp	es	gs
B1	50-69	5/4 10YR	2m sbk		Mfr	Ws,wp	es	gs
B21	69-90	5/6 10YR	2c sbk		Mfr	Ws,wp	e	gs
B22	90-114	5/4 10YR	2c sbk		Mfr	Ws,wp	e	gs
B23	114-142	6/4 10YR	2msbk		Mfr	Ws,wp		
Profile No.4 (Ucha)								
Ap	0-22	4/2 10YR	1m sbk	dsh	Mfr	Ws,	es	cs
AB	22-45	5/6 10YR	2m sbk		Mfr	wp	es	gs
B1	45-73	5/4 10YR	2m sbk		Mfr	Ws,wp	e	gs
B2	73-108	4/6 10YR	2c sbk		Mfr	Ws,wp	e	ds
B3	108-142	4/4 10YR	2c sbk		Mfr	Ws,wp	e	
Profile No.5 (Natpur)								
Ap	0-26	4/3 10YR	1m sbk	dsh	Mfr	Wss,wsp	ev	ci
AB	26-50	4/6 10YR	1m sbk		Mfr	Wss,wsp	es	ci
AC	50-73	4/6 10YR	m		Mfr	Wss,wsp	es	ds
C2	73-96	5/2 10YR	m		Mfr	Wss,wsp	e	ds
C3	96-120	5/1 10YR	m		Mfi	Wss,wsp	e	ds
C4	120+	5/2 10RY	m			Wss,wsp	e	-

Key: m-medium, c- course, sbk- sub angular blocky, mfr- weakly coherent, mfi- non coherent, ws- sticky, wp- plastic

adoption of plant residues, FYM and compost. In the subsurface horizons the organic carbon percentage was ranged between 0.12 percent in C4 horizon of profile 5 to 0.69 percent in AB horizon of profile 1. Soil organic content is one of the key properties of soil associated, increase in soil organic carbon stock increase crop production in high input commercial agriculture and low input degraded land (FAO, 2017). with many soil function More than this the organic carbon percentage in profile 1, 2 and 3 recorded medium in surface horizon and AB and B1 horizons. In profile 4 Ucha series the organic carbon percentages obtained were not in the regular range. Calcium carbonate present in the soil of Kapurthala district in less amount. Calcium carbonate percentage in the surface horizons of all the profile ranged from 0.1 percent in profile 5 to 0.9 per cent in profile 1. This is suitable for citrus and other crops (Sing *et al.,* 2013).

Available nitrogen, phosphorus and potassium: the available nitrogen in the soils of Kapurthala district varied from low to medium with could be attributed with the amount of organic carbon in these soils (Raju *et al.,* 2005). Available nitrogen in the surface of these soils was ranged from 275.9 kg/ha in profile 5 to 476.6 kg/ha in profile 2 where most of the crops root are located. In subsurface its ranged between 50.1 kg/ha in AB horizon of profile 4 and C3 horizon of profile 5 to 489.2 kg/ha in AB horizon of profile 2. In profile 1, 4 and 5 the available nitrogen is in medium range in surface horizon (0-26 cm) then it decrease to low in the rest of the horizons, it reflects the rapid rate of organic matter mineralization in these soils. Similar findings were reported by (Pulakeshi *et al.,* 2014), For chlorite schist in northern transition zone of Karnataka. In profile number 2 its medium in all the horizons, The available nitrogen was in medium range in AP, AB and B1 horizons of profile 3 it might be due to additional of FYM, Compost, and used of nitrogen fertilizers. The available phosphorus was varied from high to very high in all the horizons of profiles. In surface horizons the maximum value of available phosphorus obtained in profile 5(84.2 kg/ha) and the minimum was recorded in profile 1 (24.6 kg/ha). The available phosphorus content in the subsurface of the profiles ranged between 42.5 kg/ha B21 and B22 horizons of profile 2 and 122.3 kg/ha in B3 horizon of profile 4. The available phosphorus was recorded very high in profile 1 except surface horizon (0-26 cm), which is in profile 3 except AB horizon (30-55 cm). The available phosphorus range is very high in all the horizons of profile 4 and 5 respectively. The high phosphorus content in these soils could be due to use of phosphorus fertilizers by farmers (Kukal, 2012). The available potassium content was high in all the horizons of the profiles. This might be attributed to more intensive weathering, potassium release for plant residues and animal waste, addition of potassium fertilizers and upward translocation of potassium from lower depth (Raju *et al.,* 2005). It's ranged from 453.6 kg/ha in profile 1 to 313.6 kg/ha in profile 2 in surface. And in sub surface it was ranged between 184.8 kg/ha in C3 and C4 horizon of profile 5 and 364.0 kg/ha in AB horizon of profile 5. Muscovite and biotite are the dominant potassium containing minerals in sand and silt fraction in Punjab soil and most dominant minerals in the clay faction are illite and vermiculite (Benbi and Brar, 2009).

CEC, exchangeable cations (Ca, Mg, Na, K) and E.S.P: the capacity of negatively charged soil colloids (clay, organic matter and Fe/Al oxides) to adsorb cations

Table 4: Study of Physicochemical characteristics of Rawalpindi series

Horizon	Depth (cm)	pH (1:2)	EC ($dS\ m^{-1}$)	OC (%)	$CaCO_3$ (%)	Available Nitrogen Kg/ha	Available Phosphorus Kg/ha	Available Potassium Kg/ha
Ab	0-26	8.5	0.40	0.72	0.9	376.2	24.6	453.6
AB	26-42	8.6	0.12	0.69	0.2	263.4	103.0	240.8
Bl	42-58	8.7	0.07	0.63	0.3	213.2	60.4	263.2
B21	58-74	8.8	0.09	0.33	1.0	170.0	82.8	263.2
B22	74-105	9.0	0.04	0.36	1.1	62.72	62.7	240.8
BC	105-130	9.7	0.03	0.35	0.5	75.26	51.5	246.4

Horizon	CEC(me /100g)	Exchangeable cations (me/100g)				Particle size distribution (%)				Texture classes (USDA)
		Ca	Mg	Na	K	E.S.P	Sand	Silt	Clay	
Ab	3.82	0.4	1.6	1.21	0.61	31.6	42.4	26.7	30.9	silty clay loam
AB	10.67	6.2	2.0	1.91	0.56	17.9	14.6	45.7	39.7	silt clay
Bl	8.56	4.2	2.2	1.47	0.71	17.1	12.7	58.4	28.9	silt clay
B21	10.47	6.4	1.8	1.56	0.71	14.8	19.1	49.5	31.4	silt clay
B22	11.63	7.0	2.4	1.47	0.16	12.6	15.3	47.0	37.7	silt clay
BC	9.85	5.4	2.4	1.39	0.66	14.1	14.1	34.8	45.1	clay loam

by simple physical, attractive forces is called the Cation exchange capacity of a soil. The CEC of these soils in the surface horizons ranged from 2.69 me/100g in profile 5 to 8.24 me/100g in profile 4. In subsurface horizon the CEC ranged between 2.03 in C3 horizon of profile 5 and 10.67me/100g in AB horizon of profile 1. Profile 1, 2 and 5 were very low in CEC and profile 4 and 6 were low in cation exchange capacity. In profile 1 the minimum amount of CEC was recorded in surface horizon then its increase in AB horizon to 10.67 me/100g. Exchangeable Ca was ranged from very low to medium in Kapurthala soils, more than this in profile 1 and 4 CEC decreased consistently from surface to subsurface. The decrease in CEC with depth could be due to the strong association between organic carbon and cation exchange capacity (Tsozue, 2015). The minimum exchangeable Ca was obtained in 0.4 me/100g in surface (0-26) horizon of profile 1 and in BC horizon of profile 2, and the Maximum exchangeable calcium 8.2 me/100g was obtained in B23 horizon of profile 3. The exchangeable magnesium in surface of all the profiles was ranged from 0.4 me/100g in profile 2 to 1.6 me/100g in profile 1. The rating for Mg in Kapurthala soil was range from very low to medium. Exchangeable Na and K were ranged from medium to high except B22 horizon of profile one, that exchangeable K was obtained low (0.16 me/100g). The maximum amount of exchangeable Na was recorded in AB horizon of profile 1 and the minimum amount of exchangeable Na was recorded in B1 and B3 horizons of profile 4, for exchangeable K 0.78 me/100g in B1 horizon of profile 4

Table 5: Study of physico chemical characteristics of Domili series

Horizon	**Depth (cm)**	**pH (1:2)**	**EC ($dS\ m^{-1}$)**	**OC (%)**	**$CaCO_3$ (%)**	**Available Nitrogen Kg/ha**	**Available Phosphorus Kg/ha**	**Available Potassium Kg/ha**
Ap	0-18	10.3	0.05	0.79	0.8	476.6	42.5	313.6
AB	18-35	10.1	0.05	0.42	0.2	489.2	71.6	212.8
Bl	35-55	10.1	0.02	0.39	0.4	439.0	47.0	212.8
B21	55-70	10.2	0.05	0.45	0.3	388.8	42.5	263.2
B22	70-95	10.1	0.02	0.33	0.6	301.5	42.5	240.8
BC	95-108	8.6	0.02	0.36	0.3	213.2	58.2	263.2

Horizon	CEC(me /100g)	Exchangeable cations (me/100g)				Particle size distribution (%)				Texture classes (USDA)
		Ca	Mg	Na	K	E.S.P	Sand	Silt	Clay	
Ap	5.77	3.4	0.4	1.56	0.41	27.0	44.8	36.3	18.9	Loam
AB	3.53	0.8	0.8	1.47	0.46	41.2	45.1	33.8	21.1	Loam
Bl	3.51	0.6	1.2	1.30	0.41	37.0	41.7	36.0	22.3	Loam
B21	3.70	0.6	1.2	1.39	0.51	37.5	38.4	42.1	19.5	Loam
B22	4.17	1.0	1.4	1.21	0.56	29.0	36.2	41.0	22.8	Loam
BC	6.19	0.4	4.2	1.13	0.46	18.2	37.3	38.2	24.5	Loam

Table 6: Study of physicochemical characteristics of pedon 3 (Samana series)

Horizon	Depth (cm)	pH (1:2)	EC ($dS\ m^{-1}$)	OC (%)	$CaCO_3$ (%)	Available Nitrogen Kg/ha	Available Phosphorus Kg/ha	Available Potassium Kg/ha
Ap	0-30	8.8	0.80	0.66	0.5	401.4	83.7	372.4
AB	30-50	9.1	0.17	0.43	0.5	338.6	37.6	291.2
Bl	50-69	9.8	0.50	0.54	0.4	426.4	93.4	268.8
B21	69-90	9.6	0.45	0.34	0.4	150.5	104.8	291.2
B22	90-114	8.7	0.44	0.38	0.4	175.6	104.1	246.4
B23	114-142	9.6	0.55	0.24	0.2	200.7	79.0	212.8

Horizon	CEC(me /100g)	Exchangeable cations (me/100g)				Particle size distribution (%)				Texture classes (USDA)
		Ca	Mg	Na	K	E.S.P	Sand	Silt	Clay	
Ap	7.19	5.0	0.8	0.78	0.61	10.8	33.4	31.2	35.4	Clay loam
AB	8.54	6.2	1.0	0.78	0.56	9.1	68.8	16.4	14.8	Sandy loam
Bl	8.55	6.4	1.0	0.69	0.46	8.0	63.5	22.1	14.3	Sandy loam
B21	8.91	7.2	0.6	0.60	0.51	6.7	63.7	25.1	11.2	Sandy loam
B22	10.84	8.0	1.6	0.78	0.46	7.1	52.4	37.4	10.2	Sandy loam
B23	10.5	8.2	1.2	0.69	0.41	6.5	54.0	33.9	12.1	Sandy loam

and 0.35 me/100g in profile 4 respectively. The ESP all the profiles ranged from 6.5 in B23 horizons of profile 3 to 66.0 in AB (26-50 cm) horizon of profile 5.

Conclusion

A study was under taken to characterize and understand the soil resource of Kapurthala district. Kapurthala district is located in the Punjab state in North West of India. Five profile samples were collected from five village of district. The villages are Rawalpindi, Domili, Samana, Ucha and Natpur. Silty clay loam, silty clay, clay loam, loam, sandy loam and sand texture classes were found in these soils. these soils have a pH of alkaline, electrical conductivity of these soils were below 1 dS m^{-1} and were low to medium in organic carbon percentage and available nitrogen, high to very high in available phosphorus, high in available phosphorus. Less amount of calcium carbonate were found in these soils. CEC of all the samples were calculated in me/100g of soil. Accordingly exchangeable cations (Ca, Mg, Na and K) were evaluated in me/100g of soil. Exchangeable sodium percentage of these soils was ranged between 6.5 and 66.0.

References

Alemayehu, Y., H. Gebrekidan and S. Beyene (2014). Pedological characteristics and classification of soils along landscapes at Abobo, southwestern lowlands of Ethiopia. *Journal of Soil Science and Environmental Management,* **5(6):** 72–82. https://doi.org/10.5897/JSSEM13.0432.

Asgari, N., S. Ayoubi, and J.A.M. Dematte (2018). NU SC. *Geoderma Regional,* **1(3):** #pagerange#. https://doi.org/10.1016/j.geodrs.2018.03.003.

Benbi, D.K. and Brar, J.S. (2009). A 25-year record of carbon

Table 7: Study of physicochemical characteristics of profile 4 (Ucha series)

Horizon	Depth (cm)	pH (1:2)	EC (dS m^{-1})	OC (%)	$CaCO_3$ (%)	Available Nitrogen Kg/ha	Available Phosphorus Kg/ha	Available Potassium Kg/ha
Ap	0-22	9.5	0.09	0.69	0.4	301.0	84.0	392.0
AB	22-45	9.4	0.10	0.39	0.2	50.1	77.9	336.0
B1	45-73	9.1	0.36	0.39	0.2	75.2	84.6	313.6
B2	73-108	9.5	0.51	0.43	0.2	213.2	78.6	268.8
B3	108-142	9.4	0.10	0.40	0.2	275.9	122.3	291.2

Horizon	CEC(me /100g)	Exchangeable cations (me/100g)				Particle size distribution (%)				Texture classes (USDA)
		Ca	Mg	Na	K	E.S.P	Sand	Silt	Clay	
Ap	8.24	3.2	1.0	0.69	0.35	8.3	73.2	16.1	10.4	sandy loam
AB	6.39	4.0	1.2	0.78	0.41	12.2	66.1	19.6	14.3	sandy loam
B1	6.50	4.2	1.0	0.52	0.78	8.0	64.1	24.7	11.2	sandy loam
B2	6.21	3.8	1.4	0.60	0.41	9.6	62.6	22.3	15.1	sandy loam
B3	5.23	2.6	1.6	0.52	0.51	9.9	48.1	35.6	16.3	loam

Table 8: Study of physico chemical characteristics of Natpur series

Horizon	Depth (cm)	pH (1:2)	EC (dS m^{-1})	OC (%)	$CaCO_3$ (%)	Available Nitrogen Kg/ha	Available Phosphorus Kg/ha	Available Potassium Kg/ha
Ap	0-26	8.7	0.07	0.63	0.1	275.9	84.2	420.0
AB	26-50	9.0	0.04	0.34	0.4	175.6	77.9	364.0
AC	50-73	9.3	0.03	0.13	0.0	112.8	74.1	313.6
C2	73-96	9.7	0.02	0.15	0.5	163.0	79.7	336.0
C3	96-120	9.5	0.02	0.24	0.1	50.1	69.2	184.8
C4	120+	9.9	0.03	0.12	0.2	75.2	84.8	184.8

Horizon	CEC(me /100g)	Exchangeable cations (me/100g)				Particle size distribution (%)				Texture classes (USDA)
		Ca	Mg	Na	K	E.S.P	Sand	Silt	Clay	
Ap	2.69	0.6	0.8	0.78	0.51	28.9	77.5	17.8	4.7	loamy sand
AB	2.65	0.8	0.6	0.69	0.56	66.0	80.3	10.3	9.4	loamy sand
AC	2.96	1.0	0.8	0.60	0.56	20.2	91.7	5.2	3.1	sand
C2	2.29	0.6	0.8	0.43	0.46	18.7	90.8	4.6	4.2	sand
C3	2.03	0.8	1.2	0.52	0.51	25.6	98.3	0.9	0.8	sand
C4	2.85	1.0	0.6	0.69	0.56	24.2	88.9	9.8	1.4	sand

sequestration and soil properties in intensive agriculture. *Agronomy for Sustainable Development, Springer Verlag,* **(2):** pp.257-265.

D. Basava, Raju, M.V.S. Naidu, N. Ramavatharam, K. Venkajah, R.G.R. and R.K. (2005). Characterization, classification and evaluation of soils in Chandragiri mandai of Chittoor district, Andhra Pradesh. *Agropedology,* **15(1):** 55–62.

FAO. (Food and Agriculture Organization) (2017). Soil organic carbon the hidden potential. FAO, Rome.

Hristov, B.E. (2013). Importance of soil texture in Soil Classification systems. *Journal of Balkan Ecology,* **16(2):** 137–139.

Jackson, M.L. (1967). Soil Chemical Analysis, New Delhi, Prentice-Hall of India Private Limited,. Pp.10-37.

Keshavarzi, A., H. Oppong, A. Bagherzadeh and D. Vasu (2018). Spatial and Fractal Characterization of Soil Properties across Soil Depth in an Spatial and fractal characterization of soil properties across soil depth in an agricultural field, Northeast Iran. *Eurasian Journal of Soil Science,* **7(2):** https://doi.org/10.18393/ejss.339032.

Kukal, S.S. (2012). Soil Organic Carbon, Phosphorous and Potassium Status in Rice – Wheat Soils of Different Agro-climatic Zones in Indo-Gangetic Plains of India. *Communications in Soil Science and Plant Analysis,* 5(MAY), 1449–1467. https://doi.org/10.1080/00103624.2012.670341.

Kumar, R., R. Kumar, S. Mittal and M. Arora (2016). Role of soil physicochemical characteristics on the present state of arsenic and its adsorption in alluvial soils of two agri-intensive region of Bathinda, Punjab, India. *Springer Verlag Berlin,* **16(8):** 605–620. https://doi.org/10.1007/s11368-015-1262-8.

Liu, X., S.J. Herbert, A.M. Hashemi, X. Zhang, and G. Ding (2006). Effects of agricultural management on soil organic matter and carbon transformation – a review. *Plant Soil Environ.,* **52(12):** 531–543.

Marvin, H.D. and M. Peech (1950). Exchangeability of soils potassium in the sand, silt and clay fractions as influenced by the nature of the complementary exchangeable cations. *Soil Sci. Soc. Amer. Pro.,* **15:** 125- 28.

Olsen, S.R., C.Y. Cole, F.S. Watanabe and Dean (1954). Estimation of phosphorus by extraction with sodium bicarbonate, U.S.D.A. Circular 939-19.

Patiram, N.S. Branjendra, A. Thakur and T. Ramesh (2007). Soil testing and analysis, plant, water and pesticide residues. New India publishing agency, Pitam Pura, New Delhi.

Puri, A.N. (1930). A new method of estimating total carbonates in soils. Imp. Agr. Pusa Bull. 206, pp.7.

Pulakeshi H.B.P. and P. Patil (2014). Characterization and classification of soil resources derived from chlorite schist in northern transition zone of Karnataka. *Karnataka J. Agric.,* **27(1):** 1–8.

Rabot, E., M. Wiesmeier, S. Schlüter, and H. Vogel (2018). Geoderma Soil structure as an indicator of soil functions/:A review. Geoderma, 314 (November 2017), 122–137. https://doi.org/10.1016/j.geoderma.2017.11.009.

Subbiah, B.V. and H.L. Asija (1950). A rapid procedure for the estimation of the available nitrogen in soil, *Current Sci.,* **25:** 259-60.

Sharma, P.K., Charanjit Singh, L. Jawahar, H.S. Sehgal and Kanwal (1982). The soil of Kapurthala District for Land use Planning.

Sehgal, J., M.S. Bajwa and P.K. Sharma (1992) Soil of Punjab, research Bulletin, NBSS Publ, 31. Nagpur, India.

Singh, K., J.S. Manchanda and U.S. Sadana (2013). Experiential Learning on Evaluating Soil Health and Irrigation Water. Kuwait Printers. Sant Nagar. Opp. Govt. College for Boys. Civil Lines, Ludhiana.

Soil Survey Manual (2017). Soil Survey Staff. United States Department of Agriculture (USDA). Washington, D.C.

Tolanur Shivanand (2018). Second edition practical soil science and agriculture chemistry. CbS publishers and distributors Pvt. Ltd. New Delhi, India.

Tsozue, D., P.A.T. and S.M.N.B. (2015). Morphology, Physicochemical Characteristics and Land Suitability in the Western Highlands of Cameroon Morphology, Physicochemical Characteristics and Land Suitability in the Western Highlands. *International Journal of Plant and Soil Science,* 7(April), 29–44. https://doi.org/10.9734/IJPSS/2015/17147.

Walkley, A. and C.A. Black (1934). An examination of the Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. *Journal of Soil Sci.* **37:** 27-38.