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Morphological and Physico-chemical Characterization of Salt-Affected Soils of Muktsar District of Punjab

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Abstarct : Nine representative salt-affected (P1 to P9) soils from Muktsar district of Punjab were studied for their morphological and physico-chemical characteristics. Pedons (P1, P2, P3) belong to saline soils, pedons (P4, P5 and P6) belong to sodic soil and pedons (P7, P8 and P9) represent the saline-sodic. These pedons had weak to moderate, fine to medium subangular blocky structure and massive structure in C horizons. The calcretes in saline-sodic soils were comparable to saline soils but higher than sodic soils. The texture of these soils varied from silty clay loam, silt, silt loam through loam to sandy loam The pH of the soil ranged from 8.3 to 10.2, 8.6 to 10.0 and 8.2 to 9.4 in the saline, sodic and saline-sodic soils, respectively. Electrical conductivity in surface horizon varied from 4.96 to 19.1 dS m^{-1} in saline soils, 0.44 to 2.25 dS m^{-1} in sodic soils and 2.30 to 11.8 dS m^{-1} in saline-sodic soils. Organic carbon content ranged from 0.02 to 0.87 per cent in saline soils, 0.01 to 0.29 per cent in sodic soils and 0.01 to 0.68 per cent in saline-sodic soils and decreased with depth. Calcium and magnesium cations were dominated on the exchange complex and their content varied from 3.2 to 6.4 cmol(+) kg^{-1} and that of Na^+ and K^+ varied from 0.09 to 2.87 and 0.06 to 2.33 cmol(+) kg^{-1}, respectively. Suggested management practices to improve the productivity of these soils are growing of crops on ridges/mounds, application of gypsum, organic manures and residues, planting of salt-tolerant crops, agroforestry, leaching and drainage.

Keywords : *Salt affected soils, characterization , gypsum , calcretes*

Introduction

Salt-affected soils in India cover nearly 6.37 Mha of which 2.5 Mha is in the Indo-Gangetic plain (Mandal and Sharma 2016). In recent years, the severe impact has been noticed in the southwest parts of Punjab and Haryana states, where, extensive pockets of waterlogged and salt-affected soils have developed over the years (Sharma *et al*. 2016). Furthermore, very high water requirements of rice-wheat cropping system make it more vulnerable to sodicity hazard as evident from almost 2-fold higher soil pH and ESP values compared to the soils cultivated for low water requiring crop rotations such as millet/maize-wheat under similar conditions (Minhas and Bajwa 2001). Sodic water constitutes about 25% of the total groundwater in Punjab (Kaledhonkar *et al*. 2012). GIS-based mapping indicated that good quality, marginally suitable and unsuitable groundwater is 45.7, 46.1 and 8.2 per cent area of Punjab state, respectively. Unsuitable groundwater zones occurred in the reclaimed sodic areas of the central alluvial plain and south-western alluvial plain (Kumar *et al*. 2014). The area under salt affected soils in Punjab has been reduced substantially with the adoption of reclamation technology in the past. Now, out of the total geographical area of 5.03 Mha, about 0.06 Mha of land is still affected by salinity or sodicity in Punjab (Sharma *et al.* 2009).

Hence, keeping in view the deterioration in soil quality, in particular, and ecosystem, in general, due to the salt-affected soils, the present study was carried out in Muktsar district of Punjab.

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Materials and Methods

The study area falls in Muktsar district of Punjab which is a part of the Sutlej sub-basin of Indo-Gangetic alluvial plain (Fig.1). The flat alluvial plain, covering the major part of the district, is often traversed by sand dune complexes constituting nearly 14 per cent of the district (Sharma *et al*. 2004). The annual rainfall of the area is 380 mm, mostly, concentrated in 3-4 months. The summer air temperatures ranged from 45-48 °C in May and June. The major parts of the area

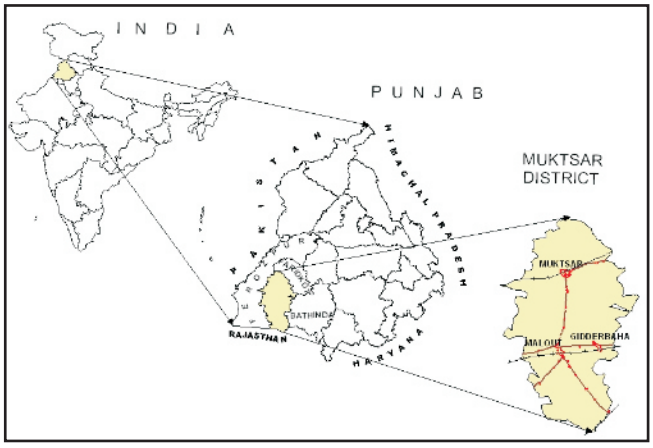

Fig. 1. Location map of Muktsar district

have an aridic (torric) moisture regime, whereas, the soil temperature regime is hyperthermic. The climate of the area is semi-arid (dry) hot.

Nine salt-affected pedons (P1 to P9) were exposed in barren and farmer fields and studied for their morphological characteristics. Out of which pedons P1, P2 and P3 grouped as saline; P4, P5 and P6 as sodic and P7, P8 and P9 as saline-sodic soils (Fig. 2).

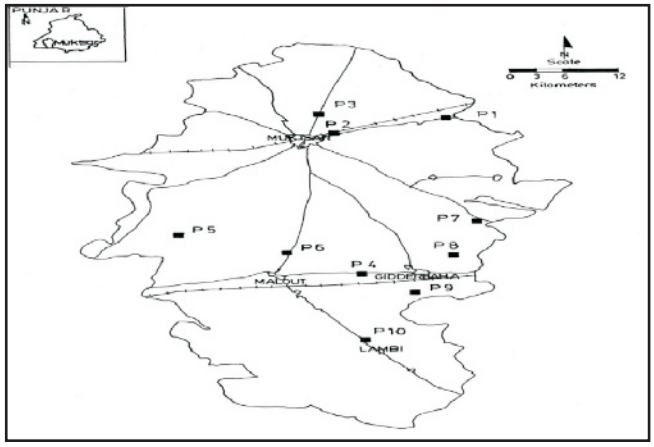

Fig. 2. Location of soil profiles in Muktsar district

The horizon wise soil samples were collected up to a depth of 150 to 200 cm. The samples were dried, processed (2 mm size) and analyzed for various physico-chemical properties following standard procedures (Puri 1930; Walkely and Black 1934, Richard 1954; Simpson 1962; Barrows and Belyayeva 1967; Jackson 1973; Page *et al* 1982).

Results and Discussion

Morphological properties of salt-affected soils

Saline soils

The saline soils, represented by pedons P1, P2 and P3, had soil colour with hues of 10YR and 2.5Y (Table 1). The pedon P1 had hues of 10YR throughout the depth, whereas, the lower horizons of profiles P2 and P3 had hue of 2.5Y. The value varied from 3 to 6 and the chroma was in the range of 2 to 6. The yellower hue (2.5 Y) and lower chroma (2) in the lower horizons of the P2 and P3 indicated the reduced condition due to waterlogging. Owing to a sequence of deposition from different sources of sediments, the soils had varied textural composition in different horizons with coarser texture in upper horizons and finer texture in underlying horizons.

The soil structure was weak to moderate, fine to medium subangular blocky except in the surface horizons of some pedons with granular structure. The lowermost horizons (C horizons), however, had massive structure. These soils had very fine to coarse calcium carbonate concretions in most of the horizons. The P2 soils had more developed concretions than other two saline soils (P1 and P3).

Sodic soils

The profiles P4, P5 and P6 represent the sodic soils with soil colour of 10YR and 2.5Y hues (Table 2). The pedon P6 had hues of 10YR throughout the depth, however, lower horizons of pedons P4 and P5 had hue of 2.5Y indicating poor drainage condition. The value and chroma varied from 3 to 6 in the different horizons. The soils had varied textural composition in different horizons in these soils and the soil texture varied from silt, silty clay loam, silt loam, loam and sandy loam. The sodic soils (P5, P6) were relatively finer texture (silty clay loam to loam) compared to saline soils (P1, P2). The sub-surface argillic horizon was observed in P5, whereas, P4 showed a change in texture with depth suggesting the stratified nature of the parent material.

Table 1. Morphological characteristics of saline soils

Horizon	Depth (cm)	Colour (moist)	Texture	Structure	Consistence (moist)	Conca	Reaction	Roots	Boundary
Profile 1									
Ap	0-19	10YR 4/3	l	1 f sbk	fr	f,f	es	c,vf	c,s
AB	19-30	10YR 4/4	l	1-2 f sbk	fm	o,f	es	f,vf	c,s
Bw	30-52	10YR 4.5/6	l	2 m sbk	fm	-	ev	f,vf-f	g,s
Bk	52-83	10YR 4.5/6	sil	2 m sbk	fm	fr,m	ev	f,vf	g,s
BCk	83-110	10YR 5/6	sil	1 f-m sbk	fm	o,vf	ev	o,vf	c,s
Ck	110-150	10YR 6/6	sil	M	fr	o,vf	ev	-	-
Profile 4									
Ap	0-17	10YR 3/3	sl	1 sbk-gr	fr	c,m	es	c,fm	c,s
Bw1	17-36	10YR 4/4	sl	1 sbk	fr	-	ev	c,fm	c,s
Bw2	36-51	10YR 4/4	sl	1 sbk	fr	c,m	ev	f,f	c,s
Bw3	51-68	2.5Y 4/2	sicl	2 m sbk	fm	c,m	ev	f,f	g,s
BC	68-90	2.5Y 4/2	l	1 f-m sbk	fm	fr,cr	ev	o,vf	g,s
C	90-125	2.5Y 4/3	l	M	fm	fr,cr	ev	-	-
Profile 5									
Ap	0-14	10YR 4/3	l	1 f sbk	fr	-	es	f,f	c,s
Bw1	14-30	2.5Y 5/4	l	1 sbk	fm	-	ev	f,ff	c,s
Bw2	30-45	2.5Y 4/4	l	1 f-m sbk	fm	f,f	ev	o,vf	c,s
Bw3	45-66	2.5Y 4/4	l	1 f-m sbk	fm	f,f	ev	f,f	g,s
Bw4	66-90	2.5Y 4/4	l	1 f-m sbk	fm	f,f	ev	-	g,s
C	90-120	2.5Y 5/4	sil	M	fm	fr,f	ev	-	-

Abbreviation used as per Soil Survey Staff (1951)

Table 2. Morphological characteristic of sodic soils

Horizon	Depth (cm)	Colour (moist)	Texture	Structure	Consistence (moist)	Conca	Reaction	Roots	Boundary
Profile 4									
A	0-15	10YR 3/3	Sl	1 sbk-gr	fr	-	ev	c,vf-f	c,s
AB	15-30	10YR 3/3	Sl	1 sbk	fr	-	ev	c,fm	g,s
Bw1	30-43	10YR 4/4	L	1 f sbk	fm	c,f	ev	f,f	g,s
Bw2	43-66	2.5Y 5/4	Sil	2 m sbk	fm	c,f	ev	f,vff	d
2C1	66-85	2.5Y 5/4	L	2 m sbk	fm	Cf	ev	o,vf	c,s
3C2	85-115	2.5Y 6/4	Sil	M	fm	-	ev	--	-
Profile 5									
A	0-18	10YR 4/4	L	1 f sbk	fm	-	ev	c,fm	c,s
Bt1	18-50	10YR 4/4	Sil	1 f-m sbk	fm	-	ev	c,fm	c,s
Bt2	50-70	10YR 4/4	Sil	2 m sbk	fr	f,f	ev	f,fm	c,s
Btk1	70-86	10YR 4/4	Sicl	2 m sbk	fr	o,vf	ev	f,f	g,s
Btk2	86-106	2.5Y 5/4	Sil	1 f sbk	fr	-	ev	o,vf	g,s
C	106-130	2.5Y 5/4	Sil	M	fr	-	ev	-	-
Profile 6									
A	0-18	10YR 3/6	Sil	1 f gr-sbk	fm	-	es	f,f	c,s
Bw1	18-38	10YR 3/6	Sil	1-2 m sbk	fm	o,vf	es	o,vf	c,s
Bw2	38-68	10YR 4/4	Sil	2 m sbk	fr	-	ev	f,f	c,s
Bw3	68-80	10YR 4/4	Sil	2 m sbk	fr	-	ev	-	g,s
BC	80-96	10YR 4/4	Sil	2 m sbk	fm	-	ev	-	c,s
C	96-128	10YR 4/4	Si	M	fm	-	ev	-	-

Abbreviation used as per Soil Survey Staff (1951) given at pages 139-140.

The soils had weak to moderate, fine to medium, granular to subangular blocky structure in different horizons with massive structure in the lowermost horizons. The calcium carbonate concretions were found to be less in sodic soils compared to other soils and its accumulation was observed at 70-106 cm.

Saline-sodic soils

The saline-sodic soils are represented by P7, P8 and P9 profiles and most of the horizons of these soils had soil colour of 10YR hue but some horizons also had 7.5YR and 2.5Y hues (Table 3). The soils of pedon P7 had relatively redder colour (7.5YR) in the lower

horizons suggesting better arable and drainage conditions. The value varied from 3 to 5 and the chroma was in the range of 2 to 6. These soils had relatively better drainage than the saline and sodic soils. The textural composition was relatively uniform in different horizons of these soils and the soil texture varied from silt through silt loam to loam. No textural variation was observed with depth suggesting uniform nature of parent material.

The pedons of saline-sodic soils had weak to moderate, fine to medium subangular blocky structure with massive structure in the C horizon. The horizons of P8 and P9 had very fine to medium sized calcretes, however, in only one horizon of pedon P7, the calcretes was observed.

Physical and chemical properties of salt-affected soils

Saline soils

Sand content in the soils of P1, P2 and P3 varied from 6.9 to 68.4 per cent (Mean = 40.4 %), silt and clay contents were in the range of 20.6 to 83.7 per cent (Mean = 45.9 %) and 8.2 to 21.6 per cent (Mean = 13.6 %), respectively (Table 4). The texture varied from silty clay loam to sandy loam. Distribution of sand, silt and clay fractions was irregular with depth.

Organic carbon content ranged from 0.02 to 0.87 per cent (Table 4) and decreased with depth. The soils were alkaline in reaction with pH varied from 8.3 (moderately alkaline) to 10.2 (very strongly alkaline). Electrical conductivity varied from 1.23 to 19.1 dS m^{-1} being higher in surface horizon owing to upward movement of soluble salts through the capillary rise of water. Calcium carbonate content of the soils varied from 2.10 to 19.55 per cent and increased with depth. The P1 showed the development of the calcic horizon. In general, $CaCO_3$ content is lower in the coarse-textured horizons than in the fine-textured horizons. Cation exchange capacity varied from 4.51 to 8.03 cmol (+) kg^{-1} and high CEC of the soils is due to high silt content. Calcium and magnesium cations (Ca^{2+} + Mg^{2+}) were dominated on the exchange complex and their content varied from 3.6 to 6.4 cmol(+)kg^{-1}, respectively followed by Na^{+} and K^{+} (Table 4).

Sodic soils

The data on the particle-size distribution of soils indicated that sand, silt and clay content varied from 3.7 to 74.2, 21.8 to 92.9 and 1.8 to 27.6 per cent, respectively (Table 5). In general, due to illuviation process, clay increased with depth in P5, however, in pedon P4, it was found to be irregularly distributed with depth.

Table 3. Morphological characteristic of saline-sodic soils

Horizon	Depth (cm)	Colour (moist)	Texture	Structure	Consistence (moist)	Conca	Reaction	Roots	Boundary
Profile 7									
A	0-18	10YR 4/3	L	1 f sbk	fr	-	es	c,fm	c,s
BA	18-40	10YR 3/6	L	1 sbk	fr	-	es	c,fm	c,s
Bw1	40-57	7.5YR 4/4	L	2 m sbk	fm	-	ev	f,f	c,s
Bw2	57-82	7.5YR 4/4	L	1 f-m sbk	fm	c,m	ev	f,vf-f	g,s
Bw3	82-110	7.5YR 3.5/4	L	1 f-m sbk	fm	-	ev	o,vf	g,s
C	110-130	7.5YR 4/4	L	M	fr	-	ev	-	-
Profile 8									
A	0-16	10YR 4/6	Sil	1 f gr-sbk	Fr	c,m	es	c,fm	c,s
Bw1	16-28	10YR 4.5/6	Sil	1 f sbk	Fr	c,f	es	c,f	c,s
Bw2	28-42	10YR 4.5/4	Sil	2 f-m sbk	Fr	c,m	ev	f,f	c,s
Bk1	42-70	10YR 4/4	Sil	2 m sbk	Fm	c,f	ev	f,f	c,s
Bk2	70-105	10YR 4/4	Sil	2 m sbk	Fm	o,vf	ev	-	g,s
Ck	105-125	10YR 5/4	Si	M	Fm	o,f	ev	-	-
Profile 9									
A	0-15	10YR 3/6	Sil	1 f sbk	Fm	o,f	ev	c,f	c,s
AB	15-24	10YR 4/4	Sil	1 f sbk	Fm	o,f	ev	c,fm	g,s
Bw1	24-38	10YR 4/4	Sil	1 f-m sbk	Fm	f,f	ev	f,f	c,s
Bw2	38-60	10YR 5/4	Sil	1 f-m sbk	Fm	c,m	ev	-	g,s
Bw3	60-120	10YR 3/3	Sil	1 f sbk	Fm	-	ev	-	c,s
C	120-140	2 5Y 4/2	Sil	M	Fm	o vf	ev	-	-

Abbreviation used as per Soil Survey Staff (1951) given at pages 139-140.

Table 4. Physical and chemical properties of saline soils

Depth (cm)	Sand	Silt	Clay	pH (1:2)	EC (dS m^{-1})	OC (%)	$CaCO_3$ (%)	Exchangeable cations (cmol(+)kg^{-1})			CEC (cmol kg^{-1})
	------%----							$Ca^{2+} + Mg^{2+}$	Na^{+}	K^{+}	
						P_1					
0-19	39.7	48.7	11.6	8.8	14.50	0.87	3.30	6.4	1.00	0.63	8.03
19-30	41.3	44.3	14.4	9.4	4.09	0.80	4.53	4.0	1.36	0.48	5.84
30-52	31.4	55.8	12.8	10.2	1.68	0.40	10.35	5.6	1.45	0.23	7.28
52-83	19.8	68.8	11.4	10.2	1.45	0.44	17.95	4.0	1.44	0.19	5.63
83-110	13.3	78.5	8.2	9.7	1.45	0.33	19.55	4.0	1.40	0.36	5.76
110-150	6.9	83.7	9.4	9.5	1.23	0.32	18.05	4.0	1.42	0.45	5.87
						P_2					
0-17	58.6	30.2	11.2	8.6	19.10	0.26	3.50	4.6	0.90	0.61	6.11
17-36	68.4	20.6	11.0	8.5	5.81	0.13	4.93	3.8	1.07	0.68	5.55
36-51	57.5	28.8	13.8	8.6	5.03	0.10	3.25	4.4	0.88	0.47	5.75
51-68	49.8	28.6	21.6	8.4	6.59	0.04	5.03	5.6	0.82	0.43	6.85
68-90	47.2	34.6	18.2	8.4	4.71	0.05	9.25	6.4	0.73	0.64	7.77
90-125	47.7	35.3	17.0	8.3	4.90	0.04	9.03	4.8	0.88	0.64	6.32
						P_3					
0-14	41.8	47.6	10.6	8.9	4.96	0.28	7.00	3.6	0.10	0.81	4.51
14-30	48.1	38.1	13.8	8.6	4.32	0.16	9.00	4.0	1.42	0.64	6.06
30-45	48.1	38.9	13.0	8.8	3.89	0.17	7.20	4.4	1.34	0.53	6.27
45-66	37.2	44.2	18.6	9.0	4.22	0.03	2.10	4.8	0.13	0.45	5.38
66-90	39.8	42.8	17.4	9.0	3.88	0.02	2.90	6.4	0.17	0.32	6.89
90-120	30.5	57.7	11.8	8.8	2.73	0.03	9.70	4.4	0.15	0.06	4.61

Organic carbon content varied from 0.01 to 0.29 per cent and increased with depth. It was observed that the sodic soils had low organic carbon content as compared to the saline soils. The sodic soils were highly alkaline in reaction with pH ranging from 8.6 to 10.0 and the pH increased with depth. The electrical conductivity ranged from 0.31 to 3.87 dS m^{-1} indicating deposition of salts in different depths of the soils. The electrical conductivity was lower in these soils as compared to the saline soils due to low amounts of soluble and leaching of salts. The soils of pedons P4 and P5 had normal EC values (< 0.8 dS m^{-1}) at the surface horizon, whereas, P6 had appreciable amounts of salts (2.25 dS m^{-1}). Calcium carbonate content of the sodic soils varies from 1.3 to 19.4 per cent. The soils of pedon P5 shown presence of calcic sub-surface diagnostic horizon. Cation exchange capacity varied from 5.22 to 7.36 cmol(+)kg^{-1} and CEC had a positive relationship with clay. Calcium and magnesium cations ($Ca^{2+} + Mg^{2+}$) were dominated on the exchange complex followed by Na^{+} and K^{+} (Table 5).

Saline-sodic soils

The sand, silt and clay content in soils varied from 7.6 to 50.8 per cent (P2), 30.8 to 80.4 (P8) per cent and 1.6 to 13.6 (P7) per cent, respectively (Table 6) and the content were irregularly distributed with depth due to stratified nature of parent material.

Organic carbon content varied from 0.01 to 0.68 per cent in the soils (Table 6) and decreased with depth. The P8 showed a definite trend of variation (barring last two horizons) in organic carbon with depth, however, it was irregular in P7 and P9 soils. Irregular distribution of organic matter suggested their fluventic nature of parent material. Like the saline soils, the saline-sodic soils had comparable organic carbon content. The saline-sodic soils were alkaline in reaction with pH ranging from 8.2 to 9.2. Slightly irregular increasing trend of pH with depth was observed in these soils. The electrical conductivity ranged from 0.55 to 11.8 dS m^{-1} and it was lower as compared to the saline soils but higher than sodic soils. Calcium carbonate content of the soils varied from 0.63 to 17.1 per cent and increased with depth being lower in coarse-textured horizons than the fine textured horizons. The pedon P8 had a development of calcic horizon below 42 cm depth.

Table 5. Physical and chemical properties of the sodic soils

Depth (cm)	Sand (%)	Silt (%)	Clay (%)	pH (1:2)	EC (dS m^{-1})	OC (%)	$CaCO_3$ (%)	Exchangeable cations (cmol(+)kg^{-1})			CEC (cmol kg^{-1})
								$Ca^{2+} + Mg^{2+}$	Na^+	K^+	
						P_4					
0-15	74.2	21.8	4.0	9.3	0.44	0.23	1.3	3.6	1.43	2.33	7.36
15-30	73.3	22.5	4.2	9.1	0.77	0.20	1.5	3.6	0.89	1.68	6.17
30-43	51.1	44.1	4.8	9.5	3.87	0.17	7.8	3.6	1.40	0.57	5.57
43-66	39.2	54.0	6.8	9.7	2.94	0.18	11.9	5.2	1.42	0.23	6.85
66-85	46.6	28.4	25.0	10.0	2.29	0.15	9.3	6.0	2.45	0.31	9.76
85-115	27.0	66.2	6.8	9.9	3.13	0.14	18.9	4.8	1.41	0.43	6.64
Mean	51.9	39.5	8.6	9.6	2.24	0.18	8.4	4.1	1.30	0.92	6.39
						P_5					
0-18	50.9	43.7	5.4	8.6	0.47	0.29	5.0	4.0	2.09	0.08	6.17
18-50	30.1	50.3	19.6	8.9	0.97	0.08	16.2	4.0	1.14	0.21	5.35
50-70	23.6	54.8	21.6	8.8	1.27	0.05	7.6	5.4	0.09	0.35	5.84
70-86	19.1	53.3	27.6	8.9	1.48	0.01	19.4	6.0	0.70	0.39	7.09
86-106	24.1	64.5	11.4	8.8	1.87	0.03	14.3	4.4	1.43	0.46	6.29
106-130	43.9	50.6	5.4	8.8	2.08	0.01	9.6	4.2	1.29	0.48	5.97
Mean	31.9	52.9	15.2	8.8	1.36	0.08	12.0	4.7	1.12	0.33	6.12
						P_6					
0-18	26.9	70.7	2.4	9.9	2.25	0.18	3.4	4.0	0.66	0.56	5.22
18-38	30.3	66.5	3.2	9.6	0.97	0.04	1.3	4.0	1.33	0.19	5.52
38-68	31.8	65.6	2.6	9.3	0.54	0.03	1.2	4.4	1.00	0.63	6.03
68-80	29.6	68.6	1.8	9.2	0.41	0.04	1.9	4.8	1.27	0.62	6.69
80-96	7.9	89.9	2.2	9.1	0.31	0.02	15.1	4.0	1.40	0.41	5.81
96-128	3.7	92.9	3.4	8.7	0.49	0.09	15.4	5.6	1.43	0.23	7.26
Mean	21.7	75.7	2.6	9.3	0.83	0.06	6.4	4.5	1.18	0.44	6.09

Cation exchange capacity varied from 4.26 to 7.71 cmol(+)kg^{-1} and it followed the trend of clay distribution. Calcium and magnesium cations (Ca^{2+} + Mg^{2+}) dominated the exchange complex followed by Na^+ and K^+ (Table 6).

Conclusions

The particle-size distribution showed a higher proportion of silt followed by sand and clay in the soils and their distribution was irregular with depth. Surface horizon had higher organic carbon than the underlying horizon. The soil pH ranged from 8.3 to 10.2 in saline soils, 8.6 to 10.0 in sodic soils and 8.2 to 9.4 in saline-sodic soils. Calcium and magnesium were the dominant cations followed by Na^+ and K^+ on the exchange complex and the soil was highly alkaline and calcareous in nature. The present investigation emphasizes the need for proper management practices such as application of gypsum, leaching of salts using subsurface drainage and application of green manures etc.

Table 6: Physical and chemical properties of saline-sodic soils

Depth (cm)	Sand (%)	Silt (%)	Clay (%)	pH (1:2)	EC (dSm^{-1})	OC (%)	$CaCO_3$ (%)	Exchangeable cations ($cmol(+)kg^{-1}$)			CEC ($cmol\ kg^{-1}$)
								$Ca^{2+} + Mg^{2+}$		Na^{+} K^{+}	
						P_7					
0-18	45.3	42.5	12.2	8.9	2.30	0.68	0.68	4.4	1.45	0.43	6.28
18-40	44.0	42.4	13.6	8.7	2.45	0.35	0.63	4.0	1.43	0.64	6.07
40-57	48.8	38.0	13.2	9.0	1.71	0.17	1.83	4.4	1.42	0.28	6.10
57-82	43.5	43.9	12.6	9.0	1.18	0.50	1.65	3.2	1.18	0.26	4.64
82-110	43.6	45.7	10.8	9.4	0.55	0.25	1.85	4.0	1.23	0.10	5.33
110-130	50.8	42.6	6.6	9.2	0.77	0.35	4.98	4.8	1.12	0.09	6.01
Mean	46.0	42.5	11.5	9.0	1.49	0.38	1.94	4.1	1.30	0.30	5.74
						P_8					
0-16	26.5	70.3	3.2	8.7	11.8	0.17	5.78	4.8	1.21	0.24	6.25
16-28	27.8	68.5	3.6	8.8	4.05	0.04	7.70	4.0	1.44	0.62	6.06
28-42	23.7	69.1	7.2	8.6	3.86	0.04	11.90	3.6	0.41	0.63	4.64
42-70	21.2	69.8	9.0	8.7	3.19	0.03	15.30	4.0	0.15	0.63	4.78
70-105	17.4	73.2	9.4	8.8	2.67	0.01	17.10	3.2	0.43	0.63	4.26
105-125	7.60	80.4	12.0	8.7	2.72	0.03	15.80	3.6	2.87	0.64	7.11
Mean	20.7	71.9	7.4	8.7	4.71	0.05	12.30	3.9	1.08	0.56	5.52
						P_9					
0-15	25.2	71.9	2.8	8.8	9.70	0.18	4.12	4.0	1.02	0.21	5.23
15-24	26.0	70.9	3.0	8.7	4.78	0.15	4.05	4.8	1.45	0.85	7.10
24-38	28.4	70.0	1.6	8.4	4.03	0.17	2.81	5.2	1.44	0.22	6.86
38-60	27.2	70.2	2.6	8.8	3.27	0.13	3.25	5.6	1.15	0.36	7.11
60-120	24.7	71.3	4.0	9.0	3.11	0.17	2.35	4.0	1.34	0.52	5.86
120-140	30.9	66.7	2.4	9.0	3.19	0.16	4.30	4.8	1.45	0.62	6.87
Mean	27.1	63.5	2.7	8.8	4.68	0.16	3.48	4.7	1.31	0.46	6.51

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