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CHARACTERIZATION OF SALT AFFECTED SOILS OF PESHAWAR DISTRICT

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Salt affected soils of Peshawar district were studied in the field and 34 composite soil samples upto 25 cm. depth were collected for physico-chemical characterization. These soils were either barren or having sporadic cultivation. Out of these samples 15 per cent were saline, 62 per cent saline-sodic and 23 per cent non saline-non-sodic. Most of the soils were found in active process of salinization and alkalization. These soils were strongly calcareous and silty clay loam to sandy loam in texture.

INTRODUCTION

The province of N.W.F.P. is mostly arid and semi arid and thus productive agriculture requires irrigation water. Canal irrigation has caused a general rise in water table and this has resulted in water-logging and salt accumulation over a large area of the region.

Salty soils are common in Peshawar, Mardan, Bannu and D.I. Khan districts. Recently, it was estimated by Hussain (1970) that 9,827 acres of irrigated land in Peshawar district suffered from salinity and 2,546 acres were affected by waterlogging. The salt affected soils contained excessive concentration of either soluble salts or exchangeable sodium or both. The presence of excessive salt produces harmful effects and causes poor plant growth of cultivated crops which are sensitive to salts mainly because of the increase in osmotic pressure in soil solution and also due to the specific ion effect which ultimately reduces the agricultural production.

It has been noted that little information is available on soil characteristics of the salty areas of the Peshawar district. Keeping the above facts in mind, it was contemplated to study quantitatively the characteristics of salt affected soils of Peshawar district.

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MATERIALS AND METHODS

Characterization of the soils of salt affected areas of Peshawar district was completed in the Soil Science Laboratories, University of Peshawar during 1973-74. The surface soil samples were collected from the three tehsils Peshawar, Nowshera and Charsadda of the district. These soils are represented as P, N and C, respectively in the tables. Location and number of samples are shown in the location map. A total of thirty four composite soil samples were collected from the upper 25 cm depth. The samples were air dried, ground and passed through 2 mm sieve. Analysis of particle size distribution was carried out by the methods described by Moodie *et al.* (1954). Saturation percentage, pH of the saturated paste, electrical conductivity of saturation extract, water soluble cations and anions, sodium adsorption ratio, cation exchange capacity, exchangeable cations, ESP, gypsum requirement and alkaline-earth carbonates were determined according to the methods given in U.S.D.A. Hand Book–60 (1954). Organic matter was determined as described by Piper (1950).

RESULTS AND DISCUSSION

The salt affected soils have been classified on the basis of analytical data into three classes i.e. normal-nonsodic, saline and saline-sodic soils following the classification criteria outlined by U.S. Salinity Lab. Staff with respect to electrical conductivity, pH and exchangeable sodium status. None of the sample was found to be non saline-sodic.

Non Saline-Non Sodic soils (Normal soils))

Eight samples in the Tables 1 and 2 were classified as normal soils with respect to salinity and sodicity according to U.S.D.A. Hand Book–60 (1954). Total soluble salts were variable and lower than 0.1 per cent in these soils. However, samples N–5, N–6, P–6, C 10, C 13 and C–18 had soluble sodium greater than calcium plus magnesium. All the samples have low sodium adsorption ratio except sample C–9 and C 18. The pH of the soils was alkaline (pH 7.8 to 8.2). Soluble carbonates were absent while bicarbonates were found to be dominant anions. Contents of chloride and sulphate were also variable. These soils were moderately to strongly calcareous, textural class was silt loam except C–19 which was silty clay loam. Organic matter was greater than one percent. Colliods' saturation with sodium ranged from 4 to 18 per cent. Similar results were found by Saeed *et al.* (1974) and Nawaz (1975).

Saline soils

Seven samples were classified as saline soils as shown in Tables 1 and 2 according to U.S.D.A. Hand Book–60 (1954). Total soluble salts ranged from 0.3 to 1.0 per cent. Soluble sodium was less than 50 per cent of soluble cations except sample C 4. Magnesium was more than calcium except sample P-2. Sodium adsorption ratio was low except C 4. The pH ranged from 7.7 to 8.0. Soluble carbonates were absent, while bicarbonates ranged from 5.72 to 22.00 m/l. in these soils. Chlorides and sulphates were the dominant anions present in these soils. Cation exchange capacity was lower than normal soil. Exchangeable sodium percentage was greater than 15. These soils were medium textured, sandy loam to loam with 6 to 14 per cent alkaline-earth carbonates. Organic matter was less than one per cent except sample P–5. Colliods' saturation with sodium ranged from 10 to 15 percent. These results are in conformity with those of Jan (1974) and Khattak (1976).

It is obvious from the data that the only hazard in these soils was high salt accumulation which affected adversely the plant growth. Reclamation of these soils would need leaching of soluble salts or growing salt tolerant crops on these soils, provided the drainage was adequate.

Saline-Sodic Soils

Majority of the samples were classified as saline-sodic soils as presented in Tables 1 and 2 according to U.S.D.A. Hand Book–60 (1954). The electrical conductivity of the saturation extract ranged from 5 to 100 mmohs/cm. Soluble sodium was more than soluble calcium plus magnesium. Only three samples P-1, P 4 and C–21 had pH less than 8.5, while other sixteen had above 9.0 and the maximum was 9.9 in sample C 6. Sodium adsorption ratios were also higher. Quantity of soluble carbonates was extremely variable which were absent in six saline-sodic soil samples. Bicarbonates were variable and sulphates were in excess than bicarbonates, but their concentration was not consistent. All saline-sodic soils were moderate to strongly calcareous having texture of loam, silt loam and silty clay loam. Organic matter contents were low. Colloids saturation was high with sodium ranging from 26 to 84 per cent. Both replacement of exchangeable sodium and leaching of soluble salts were required for the reclamation of these soils.

Being calcareous in nature, biological reclamation of these soils might be also a help in addition to the application of chemical amendments like gypsum,

Table 1. *Physico-chemical characteristics of some salt affected soils of Peshawar District.*

Sample number	CEC me/100g	Exchangeable Cations Na+	K+	Ca++ + Mg++	ESP	G.R. tons/acre	Alkaline earth carbonate %	Organic matter %	Clay %	Silt %	Sand %	Textural Class
		me/100 g										
*N-5	8.00	0.54	0.43	7.82	6.16		16.29	1.11	12.2	61.5	26.3	Silt loam
N-6	13.80	1.40	0.61	11.77	10.21		16.32	1.14	22.0	56.1	21.9	Silt loam
*P-6	13.80	0.68	0.53	12.57	5.83		13.50	1.45	32.2	59.8	18.0	Silt loam
*C-10	20.00	3.69	0.78	15.52	18.47		8.30	1.45	31.8	61.6	6.6	Silty clay loam
C-13	25.20	1.08	1.00	23.11	4.29		12.81	2.19	28.1	64.2	7.7	Silt loam
C-18	12.40	1.71	0.89	9.78	13.81		8.35	1.01	21.8	66.0	12.2	Silt loam
C-19	11.00	0.19	0.43	10.31	1.75		10.39	1.42	21.8	23.0	55.2	Sandy clay loam
C-20	13.00	0.54	0.72	11.72	4.20		10.46	1.42	24.0	55.9	20.2	Silt loam
P-2	5.20	0.80	0.54	3.85	15.38		6.17	0.40	6.0	49.1	49.9	Loam
P-3	5.20	0.80	0.37	4.02	15.38		7.90	0.33	5.8	24.6	69.6	Silty loam
P-5	8.80	0.90	0.29	7.60	10.22		10.79	1.42	10.2	49.2	40.6	Loam
C-1	8.20	1.20	0.60	6.39	14.63		12.69	1.04	13.6	27.8	58.6	Sandy loam
C-2	7.20	0.80	0.42	5.97	11.11		9.43	0.77	9.4	32.5	58.1	Sandy loam
C-3	7.40	1.00	0.48	5.91	13.51		13.81	0.64	9.6	30.4	52.0	Sandy loam
C-4	7.00	0.80	0.80	5.38	13.3		10.62	0.71	9.4	38.5	52.1	Sandy loam

Contd.

N-1	13.80	10.27	0.77	2.74	74.50	7.22	9.36	0.91	28.7	44.5	26.8	Loam
N-2	10.00	7.50	0.78	1.71	75.00	7.53	8.38	0.61	18.7	42.0	39.3	Loam
N-3	13.00	8.00	4.00	1.00	61.60	18.54	16.85	0.50	22.5	56.7	20.6	Silty loam
N-4	15.00	4.86	1.16	8.96	32.44	3.21	16.01	1.25	30.8	42.9	26.3	Clay loam
N-7	11.00	8.80	1.28	0.91	80.00	9.67	13.63	0.43	18.7	43.7	37.7	Loam
P-1	23.00	5.60	0.50	13.89	28.00		20.24	0.81	28.9	64.6	6.5	Silty loam
P-4	14.40	3.78	1.94	8.66	26.26		8.38	1.08	22.4	60.7	16.9	Silt loam
C-5	24.30	11.31	0.65	12.33	46.56	10.02	8.39	0.57	31.6	18.3	50.1	Sandy clay loam
C-6	14.40	8.36	0.45	5.58	58.09	6.64	14.42	0.43	25.8	24.0	50.2	Sandy clay loam
C-7	11.70	5.56	0.48	5.65	47.56	1.51	12.47	0.30	18.1	22.4	59.5	Sandy loam
C-8	11.00	9.25	0.93	0.81	84.09	6.63	12.48	0.40	18.2	22.6	59.2	Sandy loam
C-9	14.40	7.18	0.66	6.55	49.86	4.23	6.51	0.23	24.8	59.2	16.0	Silt loam
C-11	18.20	11.96	0.77	5.46	65.75	8.32	11.27	0.27	31.5	61.4	7.1	Silty clay loam
C-12	11.80	6.11	0.50	5.08	52.24	4.57	10.27	0.27	25.0	60.1	13.9	Silt loam
C-14	13.00	8.09	1.55	3.34	62.29	4.23	10.16	0.20	21.8	50.1	28.1	Silt loam
C-15	16.00	9.50	0.89	6.00	57.22	10.71	5.42	0.47	30.4	59.3	10.3	Silty clay loam
C-16	13.80	8.97	0.43	4.30	62.29	5.93	5.06	0.43	22.4	41.1	36.5	Loam
C-17	13.80	9.24	0.83	4.30	66.98	8.66	11.37	0.43	22.6	57.3	20.1	Silt loam
C-21	8.80	4.05	0.40	9.29	30.02	8.44	13.59	0.98	22.3	57.2	20.5	Silt loam

*Nowshera

*Peshawar

*Charsadda

Table 2 *Chemical characteristics of some salt affected soils of Peshawar District.*

Sample No.	ECx10^3,	pH$_s$	Salts %	Soluble Cations me/l				Soluble Anions me/l				SAR
				Na^+	K^+	Ca^{++}	Mg^{++}	$CO_3^=$	HCO_3^-	Cl^-	$SO_4^=$	
N-5	3.14	7.8	0.09	14.35	0.50	6.03	4.95	—	16.50	11.00	3.90	6.13
N-6	3.65	8.0	0.11	20.11	0.50	6.03	3.27	—	21.05	11.20	4.25	9.30
P-6	1.73	8.2	0.05	6.00	0.50	2.08	0.90	—	7.25	2.20	7.84	4.91
C-10	1.80	8.0	0.05	15.00	0.40	2.66	0.82	—	8.00	3.00	7.00	11.36
C-13	1.44	8.1	0.05	6.25	0.00	2.28	1.67	—	6.60	2.20	5.60	4.46
C-18	2.14	8.3	0.05	16.25	0.50	3.12	0.54	—	9.24	7.40	4.76	12.01
C-19	1.48	7.9	0.05	2.00	0.40	6.25	0.90	—	7.30	3.40	4.10	1.12
C-20	1.58	7.9	0.04	3.00	0.75	4.16	0.95	—	6.82	3.70	5.28	2.05
P-2	13.81	7.7	0.30	62.50	4.00	50.10	21.96	—	7.04	114.40	16.66	10.41
P-3	27.01	8.0	0.55	95.00	17.00	23.71	134.69	—	8.80	110.40	150.93	10.67
P-5	10.64	7.8	0.30	43.20	3.80	29.12	38.32		5.72	65.40	35.28	8.06
C-1	39.03	7.7	1.01	125.00	27.75	21.84	95.97	—	14.08	155.40	170.82	14.07
C-2	17.90	7.9	0.42	93.10	6.35	20.80	91.08	—	6.16	56.20	116.64	12.44
C-3	16.36	8.0	0.39	42.50	13.75	22.88	31.57	—	11.00	102.40	50.20	8.14
C-4	42.72	8.0	0.99	288.00	23.00	27.04	112.35	—	22.00	270.80	134.40	34.49

Contd.

N-1	56.74	9.5	1.90	518.75	2.25	2.08	0.29	37.50	80.30	102.80	360.80	476.36
N-2	65.31	9.4	1.53	590.00	5.99	2.74	0.78	345.40	132.00	88.60	87.10	445.16
N-3	99.07	9.5	3.20	950.00	39.00	2.18	0.52	546.20	320.00	102.00	22.00	822.75
N-4	6.85	9.1	0.25	67.00	1.25	2.39	0.58	6.16	25.96	14.40	21.98	54.91
N-7	88.00	9.6	2.23	900.00	17.00	1.24	0.14	228.80	187.00	118.50	345.70	1084.33
P-1	23.01	9.2	0.65	221.20	1.50	24.54	16.04	—	6.28	138.50	65.32	49.15
P-4	4.98	9.4	0.17	36.85	3.50	2.28	3.25	—	10.12	18.40	21.18	22.10
C-5	21.82	9.8	0.57	162.50	0.75	2.28	0.19	91.52	66.00	26.80	33.88	147.74
C-6	23.35	9.9	0.53	170.00	0.25	2.28	0.08	98.20	72.50	30.00	32.80	156.00
C-7	5.38	9.2	0.11	47.75	0.50	3.22	0.14	8.40	33.00	11.00	1.40	35.00
C-8	30.68	9.7	0.76	237.50	2.00	3.32	1.41	120.30	100.60	84.80	1.08	154.22
C-9	5.26	9.3	0.12	42.62	0.33	3.29	0.89	-	20.20	29.04	3.36	29.60
C-11	27.72	9.6	0.69	206.20	0.75	2.28	0.69	96.80	66.00	112.20	2.20	169.01
C-12	6.43	9.1	0.15	55.00	—	2.08	0.29	—	31.83	26.10	6.37	50.50
C-14	13.09	9.7	0.29	122.50	1.25	2.08	0.69	34.32	42.24	42.40	11.94	104.16
C-15	28.02	9.8	0.78	340.00	0.50	2.08	0.49	158.84	79.64	39.70	2.02	299.82
C-16	16.38	8.9	0.54	134.00	0.50	2.80	0.95	—	22.80	82.40	58.60	97.81
C-17	33.13	9.4	0.79	278.00	1.50	2.74	0.33	154.44	129.36	49.40	7.10	224.91
C-21	20.41	8.1	0.56	224.00	1.40	19.96	2.84	—	8.80	119.36	76.44	63.37

sulphur or sulphuric acid etc. With the exception of samples P-1, and P-4, all samples of this class would need gypsum, which ranged from 1.51 to 18.54 tons per acre as gypsum requirement. These conclusions resemble to those drawn by Jan (1974), Khattak (1976) nad U.S. Salinity Lab. Staff (1954).

Table 4. *Summary of Properties of salt affected soils of Peshawar, Nowshera and Charsadda Tehsils.*

Properties	Peshawar	Nowshera	Charsadda
Electrical conductivity (mmhos/cm)	13.53	46.10	16.73
pH_s	7.72	8.98	8.78
Na^+ -me/l	84.86	437.15	137.10
Ca^{++} me/l	19.97	3.24	3.76
K^+ –me/l	9.32	9.44	7.15
Mg^{++}–me/l	45.66	1.49	0.81
SAR	14.55	414.10	77.26
$CO_3^{=}$ -me/l		166.29	35.42
HCO_3–me/l	7.40	111.90	31.60
Cl^-–me/l	74.88	64.07	61.80
$SO_4^{=}$–me/l	52.87	118.60	35.52
CEC–me/100gm	10.10	12.20	15.28
ES Na–me/100gm	1.42	5.91	7.07
Exch $Ca^{++}+mg^{++}$me/100gm	8.44	4.99	7.74
Exch. K me/100gm	0.70	1.30	0.70
Gypsum requirements, tons/acre	—	9.2	5.86
Alkaline-earth carbonate %	11.24	13.89	10.70
Organic matter %	0.96	0.85	0.64
Textural class*	Si, Sil, Siel	L, Sil, Cl	Sl, Sil, Scil
Clay %	15.92	21.94	22.14
Normal soils	1	2	5
Saline soils	3	—	4
Saline-sodic soils	2	5	12

N B. Each property represents the average values of 6 Peshawar, 7 Nowshera, and 21 Charsadda salt affected soils.

Sl = Sandy loam
Sil = Silty loam
Sicl = Silty clay loam
L = Loam
Cl = Clay loam

Characteristics of salt affected soils of Peshawar, Nowshera and Charsadda Tehsil

Tehsilwise information is given in Table 4. The variations in the hazards of salinity and alkalinity and other characteristics could be accounted for by the nature of parent material and its physiographic position, climate, and source and quality of irrigation water as also indicated by Soil Survey Staff (1967), Fraser (1953) and Fireman *et al.* (1950).

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