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EFFECT OF DILUTION ON SOLUBLE IONS AND EXCHANGEABLE CATIONS IN SOME SOILS OF THE NORTH WEST FRONTIER PROVINCE, PAKISTAN

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Abstract. Three salt affected soils containing various amounts of carbonates, chlorides, and sulfates, were selected from the North West Frontier Province, Pakistan. The main objectives of the study were to examine the effect of dilution in saturated extract and 1:5 and 1:100 soil water extracts on soluble ions and exchangeable cations.

With the exeption of CO_3 the amounts of all other ions increased in soil solution, with increase in the moisture content of soil. The amounts of exchangeable monovalent cations decreased while that of divalent cations increased with dilution. The ESP and SAR of all soils also decreased subject to increasing moisture in the soils.

The distribution of soluble and exchangeable ions in salt affected soils has been extensively investigated.[4,6,8] The extent to which these paramenters change with change in soil moisture provides a basis for the reclamation and management of such soils. While relationships involving ion equilibria and solubility have been clearly identified for soils containing low to medium levels of salts [2,5] at higher salt levels with different dominating anions such relationships may not hold. Several areas in Pakistan are severely affected by salt accumulation. The soils in the present study were representative of such soils and contained varying amounts of sulfates, chlorides and carbonates. These were on the basis of previous characterization by Khan.[3]

The main objectives of the experiment were to study the effect of dilution on soluble salts and exchangeable ions in saturation extracts and 1:5 and 1:100 soil water ratios.

Reitemelier [4] extracted soil at four moisture levels, field capacity, saturation percentage, 200 and 500% moisture and found that the amounts of dissolved anions and cations generally increased with dilution.

The relationship between the soluble and exchangeable cations in salt affected soils has been extensively studied by Benerjee,[1] and Sinauwong and Swaify.[5] The calculated ESP by Gapon's equation did not give correct estimates. However, the use of the United States Salinity Laboratory formula to predict ESP based on SAR values gave more accurate estimates.

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Materials and Methods

Soil samples were collected from three locations, i.e. (1) Azakhail, (2) Shir Khan Kaley and (3) Kotka Azim Khan in the North West Fontier Province, Pakistan. Each sample was collected at a depth of 0-15 cm. The samples were air dried, ground and passed through 2 mm sieve for analysis.

Water Extract. The soil extract, i.e. saturation, 1:5 and 1:100 were taken. The saturation past and extracts were prepared according to the procedure in USDA Handbook-60.[9] All the extract were prepared on oven dry basis, shaken for one hour and the filtrate taken for analysis.

Chemical Analysis. Soluble ions determinination: Chloride, carbonate, bicarbonate and sulfate were determined according to the method of USDA Handbook 60.[9]

Soluble cations Na and K were determined by the atomic adsorption method using a Perkin Elmer Model 303 Atomic Adsorption Spectrophtometer, whereas Ca and Mg were determined by titration with ethylene diamine tetra acetate(EDTA).

Exchangeable Cation Determination. Exchangeable Na and K were determined by subtraction from total Na and K determined by NH_4Cl extraction as described by Tucker.[7] Calcium and Mg were found out by subtraction of exchangeable Na+K from cation exchange capacity.

The CEC was determined by the method (neutral ammonium acetate) prescribed by Chapman *et al.* (1961). Sodium adsorption ratio (SAR) and exchangeable sodium percentage(ESP) were calculated using the equations of USDA Handbook 60[9].

Results and Discussion

Effect of Dilution on Soluble Ions. Results of soluble ions of the three water contents have been presented in Table 1. The amounts of all ions except carbonates

TABLE 1. ION SOLUBILITY AS A FUNCTION OF SOIL WATER RATIOS.

Treatments. soils/ water	Meq/100 g soil				meq/100 g soil			
	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	Na^+	K^+	Ca^{++}	Mg^{++}
Sat.ext.*	14.10	2.94	3.87	7.14	27.32	0.45	0.05	0.05
1:5	9.05	3.81	3.54	15.26	29.51	0.71	1.25	0.10
1:100	4.07	5.49	6.07	39.89	29.85	1.88	6.07	1.01
Sat.ext.*	-	0.12	34.23	3.85	25.53	0.26	4.70	9.12
1:5	-	0.80	34.29	20.48	33.50	0.46	9.00	8.75
1:100	-	8.32	41.40	67.41	33.76	0.92	20.67	14.49
Sat.ext.*	-	0.32	18.60	48.15	59.89	1.44	1.58	3.38
1:5	-	1.46	18.81	111.84	60.29	1.42	11.99	2.96
1:100	-	12.52	18.77	153.87	61.49	2.40	74.74	4.15

*Saturation extract.

TABLE 2. EXCHANGEABLE CATIONS, ESP AND SAR.

Treatments. soil/ water.	meq/100 g soil				ESP	SAR	CEC meq/100 g
	Exch. Na	Exch. K	Exch. Na+K	Exch. Ca+Mg			
Sat.ext.	3.24	2.37	5.61	4.71	88.79	538.00	10.32
1:5	1.05	2.11	3.16	7.16	60.47	104.64	-
1:100	0.71	0.94	1.65	8.67	7.50	6.36	-
Sat.ext.	9.25	1.61	10.86	4.08	37.85	41.32	14.94
1:5	1.28	1.41	2.69	12.25	17.90	15.63	-
1:100	1.02	0.95	1.97	12.97	2.34	2.50	-
Sat.ext.	7.50	2.30	9.80	4.35	81.78	244.43	14.13
1:5	7.10	2.32	9.42	4.71	42.86	51.76	-
1:100	5.90	1.35	7.25	6.88	6.37	5.46	-

increased with increase in the moisture content of all the soils. Carbonates, which were present in Aza Khail soil decreased several fold. However, no plausible explanation is available for the decrease in the carbonate content. Increase with dilution in the amount of Cl and Na^+ ions was not as much as that of other ions due to high solubility of these salts. The results achieved are in confirmity with the previous workers.[4,5]

Effect of Dilution on Exchangeable Cations, ESP/and SAR. The data in Table 2 indicate that the decrease in the exchangeable monovalent and increase in divalent cations is the main feature of replacement of former by the later with increase in the moisture content. This exchange consequently affected the values of exchangeable sodium percentage and sodium adsorption ratios. The exchange reaction has been extensively studied by Benerjee,[1] Sinauwong and Swaify[5] and US Salinity Laboratory Staff.[9]

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