Soil characteristics of inland salines in Indian desert

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ACCUMULATION of excess of salts in soils and consequent development of saline and sodic conditions is a common feature in arid and semi-arid regions. Inland saline lands are typical and an integral parts of such regions. In Rajasthan, where 0.2 million sq km is under arid climatic conditions, salinity and alkalinity in soils have posed a big problem. The semi-arid climate of Rajasthan greatly favours salt accumulation in soils. In arid regions, sites with a basin-shaped topography forms typical concentric salines because of the inflow of saline water from the surroundings or as a result of a rise of saline underground water with extraordinary salt concentration in the saline areas like Sambhar, Pachpadra, Didwana, Phalodi, Lunkaransar, Bap, etc. which are being exploited to yield over a million tonnes of common salt and bye-products. Nevertheless, inland salines are inundated mostly during part of the year only, when the active monsoon commences. During the rest of the season such salines remain with a dry salty surface.

To solve the salinity problem and to reclaim the saline soils for agricultural purpose, it is necessary to study the various chemical properties of these soils so that utilization plan for conversion of these areas into agricultural lands can be devised. For the present investigation, two saline sites- Pachpadra (site-I; 110 km away from Jodhpur) of south-western Rajasthan and Didwana (site-III; 240 km away from Jodhpur) of north-east Rajasthan were selected for the detailed study. To differentiate the properties of salt affected and non-salt affected soils, a non-saline site, Jodhpur (site-II; New Campus, Botanic Garden) was also undertaken for comparative study.

For the analyses, soil water extracts were prepared at 1:5 (soil : water) dilution (USDA Handbook No. 60, 1954) and samples were collected from the fixed spots at two depths: surface and 20 cm, in triplicate. Analyses of soil samples collected from sites-I & II were done monthly and these are presented seasonally, and from sites-III, seasonally. For various analyses, standard methods were adopted. Electrical conductance (EC) and pH were measured with the help of Systronics Conductivity meter and Digital pH meter, respectively. Soluble Na^{+}, K^{+} and Ca^{++} ions were measured flame photometrically (Allen *et al.* 1976), while soluble CO_3^{--}, HCO_3^{-} and Cl^{-} ions titrametrically (Reitemeier 1943; Piper 1950). Exchangeable cations of sites-I & II were measured seasonally with flame photometer (Bower *et al.* 1952).

The obtained data were statistically analysed after Gomez and Gomez (1984).

The seasonal variations in electrical conductivity (EC) , pH and soluble ions in soils at three sites are given in Table 1. Results reveal that the higher values of EC prevailed during dry period (summer season), while lower during moist period (monsoon season) at all three sites. However, much higher values were observed at site-I followed by site-III, and least at site-II. The pH values were found to be slightly less at site-I as compared to sites-II and III, being maximum at site-III. The maximum value of CO_3^{--} was recorded at site-II as compared to sites-I and III. There was no definite

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trend in CO_3^{--} content. The HCO_3^- was comparatively more at site-II as compared to sites-I and III. No definite trend and much variations were seen in HCO_3^- values at all sites. The results revealed that the Na^+, Ca^{++} at site-I and Na^+, K^+ at sites-II and III were among the major cations, while Cl^- among anions at all the three sites. All ions in soils were maximum at site-I followed by site-III and least at site-II (Table 1). It is evident from Table 2 that maximum exchangeable sodium at sites-I and II was observed during dry period (summer season), while exchangeable potassium in moist period (rainy season). Exchangeable Ca^{++} at site-I was higher during winter season, while at site-II during rainy season. However, much higher values were observed at site-I as compared to site-II.

A considerable seasonal variation in the total soluble salts was recorded in the present investigation. Salinity of the surface was lowest in rainy months (season), as rain leached down the salts from close environments to deeper layers of

Table 1. Seasonal variations is electrical conductivity (EC), pH and soluble ions in soils at sites I-III. Values given in parentheses represent 20 cm depth.

Sites	Season	EC (mmhos/cm)	pH	Soluble ions (mg/g dry soil) Na^+	K^+	Ca^{++}	Cl^-	CO_3^{--}	HCO_3^-
	Rainy	5.36	7.56	5.74	0.28	0.47	4.80	0.019	0.022
		(4.02)	(7.80)	(3.04)	(0.19)	(0.24)	(3.73)	(0.009)	(0.034)
Pachpadra	Winter	10.81	7.50	25.62	0.73	1.27	29.75	0.020	0.048
(I)		(6.37)	(8.55)	(4.90)	(0.36)	(1.17)	(5.00)	(0.013)	(0.062)
	Summer	11.98	8.45	41.62	0.71	1.30	39.00	0.029	0.075
		(7.70)	(9.25)	(18.08)	(0.34)	(1.28)	(9.55)	(0.024)	(0.085)
	CD at 5%	10.34**	2.92*	15.39**	9.36**	10.48**	13.98**	3.05*	8.32**
		(8.32**)	(7.38**)	(9.85**)	(7.19**)	(9.18**)	(8.75**)	(7.42**)	(10.92**)
	Rainy	0.35	8.30	1.06	0.110	0.038	0.85	0.039	0.040
		(0.19)	(8.50)	(0.87)	(0.032)	(0.026)	(0.45)	(0.019)	(0.052)
Jodhpur	Winter	0.61	9.35	1.90	0.170	0.054	0.96	0.041	0.092
(II)		(1.14)	(9.45)	(1.26)	(0.050)	(0.023)	(0.62)	(0.026)	(0.104)
	Summer	1.71	9.55	2.31	0.180	0.130	1.05	0.048	0.185
		(0.97)	(9.45)	(2.03)	(0.140)	(0.030)	(0.78)	(0.022)	(0.180)
	CD at 5%	6.98**	6.95**	9.37**	10.92**	11.45**	4.35*	4.02*	10.92*
		(15.24**)	(2.32*)	(10.42**)	(12.72**)	(3.12*)	(6.98**)	(4.92*)	(11.34**)
	Rainy	6.33	9.20	0.96	0.16	0.060	0.42	0.037	0.048
		(2.10)	(9.70)	(1.13)	(0.27)	(0.040)	(4.10)	(0.043)	(0.022)
Didwana	Winter	9.08	9.55	1.02	0.03	0.006	4.50	0.046	0.062
(III)		(6.33)	(9.63)	(1.20)	(0.24)	(0.007)	(7.10)	(0.062)	(0.054)
	Summer	9.52	9.01	12.80	0.12	0.010	17.50	0.044	0.058
		(3.58)	(9.43)	(6.03)	(0.45)	(0.030)	(13.10)	(0.059)	(0.044)
	CD at 5%	10.91**	N.S.	15.92**	9.32**	9.92**	15.12**	3.25*	3.47*
		(15.31**)	(N.S.)	(9.32**)	(8.14**)	(10.25**)	(10.24**)	(7.29**)	(8.32**)

N.S. = non-significant ; and * & **= significant at 5% & 1% probability levels, respectively.

Table 2. Seasonal variations in exchangeable ions (mg/g dry soil) at sites-I & II

Sites	Depth (cm)	Na^+				K^+				Ca^{++}			
		R	W	S	CD at 5%	R	W	S	CD at 5%	R	W	S	CD at 5%
I	0	76.72	53.90	77.34	15.34**	3.40	1.19	0.79	25.37**	7.06	10.06	7.38	10.32**
	20	13.59	22.34	25.47	9.87**	1.03	0.98	0.56	11.92**	8.60	6.97	6.78	6.42**
II	0	4.27	5.47	6.50	13.92**	1.11	0.70	0.55	9.34**	2.16	0.78	0.43	34.21**
	20	2.77	4.70	5.08	7.97**	0.45	0.27	0.29	7.31**	0.59	0.44	0.37	3.02*

R= rainy; W= winter; S= summer; and * & ** = significant at 5% & 1% probability levels, respectively.

soils. It increased tremendously during post-monsoon (winter), being maximum during summer season with depletion of soil moisture due to evaporation and upward movement of salts by capillary action of soil profile (Sharma & Tongway 1973; Rajpurohit 1980; Sen & Mohammed 1994 a, b). The maximum value of ions was recorded on the surface than at 20 cm depth. The higher values were observed during dryness of atmosphere (summer season), and lower during precipitation (rainy season) at all the spots.

The present investigation was aimed to study the nature and chemical composition of soil at the saline (sites-I & III) and non-saline (site-II) sites. Prior to the discovery of the phenomenon of base exchange, the determination of total soluble salts and their composition used to be the only guidelines for appraising all kinds of saline and alkali soils. The U.S. Salinity Laboratory (USDA 1954) developed the concept of saturation percentage as a characteristic property of each soil which depends on its texture and EC. The ion analyses of the soils revealed that the Na^+, Ca^{++} were among the major cations at site-I, while Na^+, K^+ at sites-II and III. Among anions, Cl^- was maximum at all sites. However, all ions were maximum at site-I, followed by site- III, and least at non-saline site-II. Soil at site-I is saline in nature having higher value of electrical conductance (>4 mmhos/cm), soluble and exchangeable ions and pH less than 8.5 at 1:5 dilution. At site-II soil is non-saline alkali because of lower EC (<4mmhos/cm), less soluble and exchangeable ions and high pH (>8.5). The higher values of carbonate (CO_3^{--}) and bicarbonate (HCO_3^-) were observed at site-II as compared to sites-I and III also attributed to non-saline alkali soils. Site-III showed saline-alkali soils because EC is more than 4 mmhos/cm and pH also remained more than 9.0. Since saline soils contain higher amount of Na^+ and Ca^{++} as a major cations, as observed at site-I. However, at sites-II and III K^+ was the major cation with Na^+, instead of Ca^{++}. This may be due to the anthropogenic activities or/ and by local inhabitants, that affect the soil properties of the habitats very much.

Soils differ in their recognizable characteristics and acquire their individual properties from the forces which act upon them in their specific environment. From the data presented, it may not be possible to assess the exact contribution of individual factors to know the nature and composition of such soils, so methods to be adopted for reclamation are to be examined further on the cause of the problem.

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