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Effect of Water Quality on Moisture Retention in Soils of Different Texture

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ABSTRACT

A study to quantify the effect of sodium adsorption ratio (SAR) and total electrolyte concentration (TEC) of equilibrating solution on water retention characteristics and water constants of clay (Typic Chromustert), clay loam (Vertic Ustropept) and silt loam (Lythic Ustorthent) soils from Rahuri, Maharashtra was carried out. Soil samples were equilibrated with twenty four water quality combinations comprising six levels of sodium adsorption ratio (SAR) viz. 2.5, 5, 10, 15, 20 and 30 m $mol^{1/2}\ L^{-1/2}$ and four levels of total electrolyte concentration (TEC) viz. 5, 10, 20 and 50 meL^{-1} synthesised using chloride salts of calcium, magnesium and sodium at Ca : Mg = 2:1. Water retention by these soil samples was evaluated at suction ranging from 0 - 1500 kPa. Water constants were studied as drainable water (DW), available water (AW) and residual water (RW). Negligible effect of water quality on water retention was noticed near saturation, in the range of 0 to 5 kPa. At an equilibrium suction of 10 kPa, effect of water quality was observed only when SAR was above 15 m $mol^{1/2}\ L^{-1/2}$ in clay and clay loam and at SAR 30 m $mol^{1/2}\ L^{-1/2}$ in silt loam soil. In the range of 20 to 1000 kPa, water retention increased sharply with increase in SAR and decrease in TEC, thereafter increase was slow upto 1500 kPa. A spectacular rise in AW was recorded with increase in SAR and decrease in TEC. Such increase in AW was associated with sharp decline in DW, however influence of water quality on RW was marginal. SAR of the equilibrating solution was found to be highly effective parameter as compared to TEC. Increase in AW and decrease in DW were positively related with the water quality induced changes in dispersion and ESP of the soil. However, the water quality induced changes in soil dispersion marginally affected the RW.

Key words: SAR, TEC, water retention, drainable, available and residual water, dispersions

Introduction

Irrigation is an important input in agricultural productivity. The sustainability of irrigated agriculture, however, is facing a growing risk of salinization and waterlogging. The nature and concentration of cationic species influence water retention characteristics and different water constants in the soils. Researchers observed increase in water retention with increase in SAR and decrease in TEC of the saturating solution (Acharya and Abrol, 1978, Sandhu et al., 1980 and Malik et al., 1992). Most of the reported studies are confined to the Illite dominated alluvial soils, and information is meagre on the Vertisol and associated soils of semi-arid region of India. In view of this, an attempt was made to study the effects of irrigation water quality on water retention characteristics and water constants of major irrigated soils of Maharashtra.

Materials and Methods

The bulk soil samples were collected from upper 30 cm depth of A or Ap horizon of clay, clay loam and silt loam soils representing Vertisol, Inceptisol and Entisol orders respectively from the farm of Mahatma Phule Krishi Vidyapeeth, Rahuri. The basic physico-chemical properties of these soils are presented in Table 1. Twenty four qualities of water were synthesised comprising six levels of sodium adsorption ratio (SAR) viz. 2.5, 5, 10, 15, 20 and 30 m $mol^{1/2}\ L^{-1/2}$ and four levels of total electrolyte concentration (TEC) viz.,

Table 1. Physical and chemical characteristics of soils

Soil Type	Sand	Silt	Clay	pH	EC	$CaCO_3$	Org. C.	CEC	ESP
	%				dSm^{-1}	%	g kg^{-1}	cmol(p^+)kg^{-1}	%
Clay	23.5	21.2	55.3	7.98	0.68	2.75	6.4	55.2	1.92
Clay loam	40.5	23.8	35.7	8.19	0.54	3.32	4.2	36.5	1.52
Silt loam	42.6	34.0	23.4	7.87	0.79	0.96	3.2	18.3	0.59

Table 2. Number of absolute pore volumes needed to equilibrate the soil samples

TEC	SAR (m mol$^{1/2}$ L$^{-1/2}$)					
me L^{-1}	2.5	5	10	15	20	30
	Numbers					
Clay						
5	14	15	16	19	20	22
10	13	14	15	16	19	21
20	12	13	14	15	17	19
50	11	15	16	14	15	18
Clay loam						
5	12	13	14	18	19	20
10	11	13	13	14	18	20
20	11	12	13	14	16	18
50	10	13	15	14	14	17
Silt loam						
5	7	8	10	9	10	11
10	7	8	5	6	8	10
20	6	7	7	6	7	9
50	5	5	5	6	6	8

5, 10, 20 and 50 meL^{-1} using chloride salts of Ca, Mg and Na at Ca:Mg = 1:2. Soil samples were equilibrated with each quality waters using a Buchner funnel. Number of absolute pore volumes required to equilibrate the individual soil sample are specified in Table 2. Water retention in the low suction range of 1 to 5 kPa was determined by using a Sand Box Apparatus. From 10 to1500 kPa, the same was determined by a Pressure Plate Apparatus as described by Bruce and Luxmoore (1986). All determinations were carried out in triplicate. From the complete 'matric suction - water content', values of different water constants viz., drainable, available and residual water were computed which were defined as; Drainable Water= water drained between 0 and 33 kPa, Available Water= water drained between 33 and 1500 kPa and Residual Water = water retained at 1500 kPa. ESP of the soils was determined by alcoholic ammonium chloride method as described by Tucker (1971). DI as defined by Mustafa and Letey (1969) was calculated as DI = [Water dispersible (silt + clay)/ Total (silt + clay)] x 100.

Results and Discussion

The data presented in Tables 3-5 revealed that at any equilibrium suction, water retention was in the order clay > clay loam > silt loam. In general, water retention was high when water quality was characterised by low TEC and high SAR. Effect of water quality on saturation water content in different soils was least and per cent variation ranged between -2.86 and 1.43, 1.7 and -1.7 and -2.2 and 6.7 in clay, clay loam and silt loam soils respectively. In extremely low suction range (0 to 5 kPa) negligible reduction in water retention without any definite trend was observed in clay and clay loam soils. However, reduction in water retention by silt loam soil was noticed. Such reduction increased with progressive increase in SAR. Effect of TEC was not obvious in extremely low suction range. At an equilibrium suction of 10 kPa effect of water quality was noticed above SAR 15 m mol$^{1/2}$ L$^{-1/2}$ in clay and clay loam soils wherein water retention increased by 20 and 29.4 per cent at SAR 15 m mol$^{1/2}$ L$^{-1/2}$, TEC 30 me L^{-1} and 55 and 58.5 per cent at SAR 30 m mol$^{1/2}$ L$^{-1/2}$, TEC 5 me L^{-1} over normal clay and clay loam soils, respectively. However, in silt loam soil increase in water retention was observed only at SAR 30 m mol$^{1/2}$ L$^{-1/2}$ and such increase ranged between 5.7 and 14.3 per cent when TEC varied between 50 and 5 me L^{-1} respectively. Above 20 kPa water retention increased with SAR and decreased with TEC upto 1000 kPa, thereafter increase was slow upto 1500 kPa in clay, whereas, slight reduction in water retention of clay loam soil was observed.

Reduction in DW ranged between 2.8 and 58.3, 3.7 and 48.1 and 6.2 and 75 per cent in clay, clay loam and silt loam soils respectively

Table 3. Effect of water qualities on water retention characteristics of clay soil (SAR in m $mol^{1/2}L^{-1/2}$ and TEC in me L^{-1})

TEC	Equilibrium suction (kPa)														ESP
	0	1	5	10	20	33	50	70	100	300	500	700	1000	1500	(%)
	$cm^3 cm^{-3}$														
SAR 2.5															
5	0.69	0.67	0.61	0.46	0.42	0.40	0.38	0.36	0.32	0.32	0.26	0.23	0.22	0.20	3.94
10	0.70	0.66	0.60	0.54	0.48	0.46	0.42	0.41	0.40	0.32	0.26	0.24	0.19	0.18	3.94
20	0.70	0.65	0.61	0.44	0.42	0.40	0.38	0.36	0.31	0.22	0.21	0.19	0.17	0.17	4.19
50	0.70	0.65	0.62	0.41	0.41	0.37	0.36	0.34	0.30	0.28	0.28	0.25	0.25	0.24	4.25
SAR 5															
5	0.71	0.66	0.62	0.40	0.39	0.38	0.38	0.36	0.34	0.33	0.32	0.28	0.24	0.18	5.21
10	0.70	0.67	0.61	0.44	0.42	0.36	0.36	0.36	0.34	0.34	0.31	0.25	0.22	0.18	5.57
20	0.69	0.65	0.60	0.50	0.43	0.40	0.37	0.35	0.35	0.34	0.30	0.25	0.22	0.17	6.28
50	0.69	0.65	0.61	0.43	0.42	0.40	0.37	0.35	0.34	0.32	0.29	0.24	0.20	0.17	5.21
SAR 10															
5	0.71	0.67	0.62	0.42	0.42	0.41	0.41	0.38	0.38	0.37	0.35	0.29	0.23	0.19	5.75
10	0.71	0.66	0.61	0.41	0.41	0.40	0.40	0.37	0.37	0.36	0.34	0.28	0.22	0.19	7.23
20	0.69	0.67	0.62	0.40	0.40	0.40	0.37	0.36	0.36	0.36	0.32	0.26	0.22	0.18	11.35
50	0.70	0.65	0.60	0.43	0.43	0.38	0.36	0.35	0.35	0.35	0.31	0.25	0.20	0.18	9.50
SAR 15															
5	0.70	0.67	0.62	0.52	0.52	0.46	0.43	0.40	0.38	0.37	0.36	0.31	0.24	0.20	7.06
10	0.70	0.67	0.61	0.50	0.50	0.44	0.42	0.37	0.37	0.36	0.35	0.30	0.23	0.19	8.00
20	0.70	0.65	0.60	0.49	0.49	0.43	0.41	0.36	0.36	0.35	0.35	0.29	0.22	0.19	14.60
50	0.69	0.66	0.60	0.48	0.48	0.42	0.40	0.35	0.35	0.35	0.34	0.28	0.20	0.18	14.67
SAR 20															
5	0.68	0.65	0.60	0.59	0.54	0.49	0.46	0.42	0.42	0.40	0.38	0.35	0.24	0.22	7.32
10	0.69	0.66	0.61	0.58	0.53	0.48	0.44	0.41	0.41	0.38	0.37	0.34	0.23	0.20	8.76
20	0.69	0.67	0.62	0.58	0.52	0.47	0.43	0.41	0.40	0.37	0.36	0.32	0.23	0.19	16.32
50	0.70	0.66	0.61	0.56	0.50	0.46	0.42	0.40	0.37	0.36	0.35	0.31	0.22	0.18	17.35
SAR 30															
5	0.71	0.67	0.62	0.62	0.58	0.54	0.49	0.46	0.42	0.42	0.40	0.36	0.25	0.24	8.67
10	0.68	0.66	0.61	0.60	0.56	0.53	0.48	0.44	0.41	0.41	0.38	0.35	0.24	0.23	11.03
20	0.69	0.66	0.60	0.59	0.56	0.52	0.47	0.43	0.38	0.37	0.37	0.34	0.23	0.22	19.87
50	0.70	0.67	0.61	0.58	0.55	0.50	0.47	0.42	0.37	0.36	0.36	0.32	0.22	0.20	20.57
Normal soil	0.70	0.66	0.62	0.40	0.36	0.34	0.33	0.32	0.29	0.25	0.22	0.19	0.19	0.18	1.92

with progressive increase in SAR from 5 to 30 m $mol^{1/2}$ $L^{-1/2}$ as compared with normal soils (Table 6). Whereas increase in AW ranged between 12.5 and 98, 13.3 and 80 and 11.1 and 61.1 per cent in respective soils. RW in clay soil increased with increasing SAR but in clay loam and silt loam soils it reduced by 4.4 and 11.8 per cent over normal soil with increase in SAR from 2.5 to 15 m $mol^{1/2}$ $L^{-1/2}$. This is possibly because in these soils SAR 30 m $mol^{1/2}$ $L^{-1/2}$ only could raise the water retention at 1500 kPa. Increase in AW of different soils was mainly at the cost of decrease

Table 4. Effect of water qualities on water retention characteristics of clay loam soil (SAR in m $mol^{1/2}L^{-1/2}$ and TEC in me L^{-1})

TEC	Equilibrium suction (kPa)														ESP
	0	1	5	10	20	33	50	70	100	300	500	700	1000	1500	(%)
	cm³ cm⁻³														
								SAR 2.5							
5	0.60	0.55	0.51	0.37	0.33	0.33	0.33	0.30	0.25	0.28	0.19	0.19	0.18	0.17	3.94
10	0.59	0.54	0.49	0.44	0.39	0.38	0.38	0.37	0.33	0.29	0.24	0.18	0.16	0.15	4.40
20	0.59	0.53	0.51	0.49	0.47	0.44	0.42	0.40	0.32	0.30	0.26	0.17	0.16	0.15	4.41
50	0.58	0.54	0.49	0.47	0.46	0.34	0.34	0.34	0.32	0.32	0.32	0.30	0.26	0.17	5.28
								SAR 5							
5	0.59	0.53	0.51	0.37	0.36	0.36	0.35	0.34	0.34	0.34	0.33	0.33	0.29	0.19	5.48
10	0.58	0.53	0.51	0.34	0.36	0.36	0.35	0.34	0.34	0.29	0.28	0.21	0.18	0.16	6.72
20	0.58	0.54	0.50	0.32	0.32	0.31	0.31	0.28	0.26	0.26	0.26	0.19	0.18	0.16	7.75
50	0.59	0.55	0.49	0.40	0.40	0.36	0.30	0.29	0.28	0.26	0.25	0.18	0.17	0.15	6.45
								SAR 10							
5	0.60	0.55	0.50	0.39	0.38	0.37	0.34	0.32	0.32	0.32	0.31	0.29	0.19	0.17	7.92
10	0.59	0.54	0.49	0.37	0.37	0.34	0.34	0.31	0.31	0.31	0.31	0.24	0.18	0.17	10.23
20	0.59	0.54	0.48	0.36	0.36	0.33	0.33	0.32	0.30	0.29	0.28	0.23	0.19	0.16	12.96
50	0.58	0.53	0.49	0.41	0.36	0.33	0.32	0.29	0.29	0.28	0.26	0.22	0.18	0.15	11.89
								SAR 15							
5	0.59	0.55	0.50	0.47	0.46	0.41	0.37	0.33	0.32	0.32	0.31	0.28	0.22	0.17	7.66
10	0.59	0.54	0.50	0.46	0.46	0.41	0.36	0.32	0.31	0.32	0.30	0.26	0.21	0.17	10.39
20	0.59	0.54	0.49	0.45	0.45	0.39	0.34	0.31	0.30	0.31	0.29	0.25	0.19	0.16	17.15
50	0.58	0.53	0.48	0.44	0.44	0.38	0.33	0.30	0.29	0.30	0.28	0.24	0.18	0.16	17.01
								SAR 20							
5	0.60	0.54	0.49	0.53	0.49	0.45	0.39	0.36	0.36	0.33	0.33	0.29	0.23	0.18	8.84
10	0.59	0.55	0.50	0.52	0.48	0.44	0.38	0.36	0.34	0.32	0.32	0.28	0.23	0.17	11.74
20	0.58	0.53	0.51	0.51	0.48	0.42	0.33	0.33	0.34	0.31	0.31	0.26	0.21	0.16	21.07
50	0.59	0.53	0.50	0.49	0.47	0.41	0.36	0.32	0.33	0.30	0.30	0.25	0.19	0.16	12.01
								SAR 30							
5	0.60	0.55	0.51	0.54	0.52	0.46	0.42	0.37	0.34	0.33	0.31	0.26	0.23	0.21	10.95
10	0.60	0.54	0.50	0.52	0.51	0.45	0.41	0.36	0.34	0.32	0.31	0.26	0.22	0.19	16.11
20	0.59	0.53	0.50	0.52	0.49	0.44	0.40	0.34	0.31	0.31	0.30	0.25	0.21	0.18	24.75
50	0.60	0.54	0.49	0.51	0.48	0.42	0.38	0.33	0.28	0.30	0.28	0.24	0.19	0.17	25.15
Normal soil	0.59	0.54	0.50	0.34	0.32	0.32	0.32	0.30	0.25	0.23	0.21	0.18	0.17	0.17	1.52

in DW. In clay loam and silt loam soils marginal reduction in RW also contributed towards increase in available water.

Water retention in different soils did not vary with any definite trend under the studied TEC range of 5 to 50 me L^{-1} when compared irrespective of SAR (Table 7). This indicates that the TEC of 50 me L^{-1} was possibly not adequate to suppress the effect of SAR on water retention in studied soils. On the contrary increase in SAR was found to be positively associated with water retention. This may be attributed to the increased accumulation of hydrated ion-layers in the inter-

Table 5. Effect of water qualities on water retention characteristics of silt loam soil (SAR in m $mol^{1/2}L^{-1/2}$ and TEC in me L^{-1})

TEC	Equilibrium suction (kPa)														ESP
	0	1	5	10	20	33	50	70	100	300	500	700	1000	1500	(%)
	$cm^3 cm^{-3}$														
							SAR 2.5								
5	0.45	0.40	0.37	0.36	0.32	0.30	0.31	0.26	0.22	0.17	0.11	0.10	0.10	0.10	6.63
10	0.45	0.40	0.36	0.36	0.32	0.29	0.27	0.27	0.21	0.16	0.14	0.11	0.10	0.10	7.49
20	0.43	0.40	0.37	0.34	0.31	0.27	0.26	0.21	0.15	0.11	0.07	0.09	0.10	0.10	8.21
50	0.42	0.41	0.37	0.27	0.29	0.26	0.25	0.25	0.25	0.19	0.19	0.14	0.11	0.11	9.39
							SAR 5								
5	0.45	0.39	0.36	0.24	0.35	0.26	0.30	0.27	0.27	0.26	0.24	0.22	0.17	0.10	8.34
10	0.44	0.40	0.35	0.27	0.35	0.32	0.30	0.26	0.29	0.20	0.20	0.11	0.11	0.10	11.03
20	0.43	0.38	0.36	0.34	0.32	0.31	0.29	0.25	0.25	0.19	0.19	0.11	0.11	0.10	9.75
50	0.42	0.39	0.34	0.30	0.31	0.29	0.27	0.25	0.27	0.17	0.19	0.10	0.10	0.09	10.83
							SAR 10								
5	0.44	0.38	0.33	0.26	0.36	0.32	0.32	0.30	0.26	0.22	0.24	0.15	0.14	0.11	10.55
10	0.43	0.39	0.34	0.25	0.36	0.31	0.31	0.29	0.25	0.21	0.22	0.14	0.12	0.11	16.24
20	0.42	0.40	0.33	0.25	0.35	0.31	0.31	0.27	0.24	0.21	0.20	0.12	0.11	0.10	16.46
50	0.43	0.40	0.34	0.26	0.32	0.30	0.30	0.26	0.24	0.19	0.17	0.11	0.10	0.10	15.47
							SAR 15								
5	0.45	0.40	0.33	0.36	0.36	0.39	0.34	0.32	0.31	0.25	0.26	0.22	0.15	0.12	12.20
10	0.43	0.39	0.34	0.34	0.35	0.37	0.32	0.31	0.30	0.25	0.25	0.21	0.14	0.11	18.56
20	0.44	0.40	0.33	0.35	0.34	0.37	0.31	0.30	0.29	0.24	0.25	0.20	0.12	0.10	24.53
50	0.43	0.38	0.34	0.32	0.34	0.36	0.30	0.29	0.27	0.24	0.24	0.19	0.11	0.09	23.25
							SAR 20								
5	0.44	0.40	0.36	0.39	0.37	0.40	0.36	0.35	0.34	0.30	0.29	0.24	0.16	0.12	16.25
10	0.45	0.40	0.35	0.37	0.36	0.39	0.35	0.34	0.32	0.29	0.27	0.22	0.15	0.11	22.90
20	0.43	0.39	0.35	0.35	0.36	0.37	0.34	0.32	0.31	0.27	0.26	0.21	0.14	0.10	27.74
50	0.43	0.38	0.34	0.34	0.35	0.37	0.32	0.31	0.30	0.26	0.25	0.20	0.12	0.09	27.90
							SAR 30								
5	0.45	0.40	0.36	0.40	0.37	0.41	0.39	0.36	0.35	0.30	0.26	0.24	0.16	0.14	23.60
10	0.44	0.40	0.35	0.39	0.36	0.39	0.37	0.35	0.35	0.29	0.25	0.21	0.15	0.12	28.00
20	0.45	0.41	0.36	0.37	0.35	0.40	0.36	0.34	0.30	0.27	0.24	0.20	0.14	0.11	32.02
50	0.43	0.40	0.36	0.37	0.35	0.37	0.34	0.32	0.26	0.26	0.24	0.19	0.12	0.10	33.29
Normal soil	0.45	0.41	0.37	0.35	0.30	0.29	0.29	0.27	0.22	0.19	0.17	0.14	0.14	0.11	0.59

layer spacing of clay minerals. This is in agreement with Rowell et al. (1969) and Pachepsky (1989) and Russo and Bressler (1980) who reported increased space in clay platelets with increases in SAR of equilibrating solution at a given pore suction

Statistically significant linear regression relationship (Table 8) of DW with ESP and DI in silt loam indicated ESP and DI induced pore size reduction was the dominant process in this soil. A highly significant linear regression relationship between AW and ESP and AW and DI was

Table 6. Effect of water quality on distribution of retained water in different ranges

SAR m mol ½ $L^{-1/2}$	TEC me L^{-1}	Clay D.W.	Clay A.W.	Clay R.W.	Clay loam D.W.	Clay loam A.W.	Clay loam R.W.	Silt loam D.W.	Silt loam A.W.	Silt loam R.W.
		cm^3 cm^{-3}								
2.5	5	0.29	0.14	0.26	0.28	0.13	0.19	0.15	0.20	0.10
	10	0.24	0.28	0.18	0.21	0.23	0.15	0.16	0.18	0.11
	20	0.30	0.23	0.17	0.15	0.29	0.15	0.16	0.17	0.10
	50	0.33	0.13	0.24	0.24	0.17	0.17	0.16	0.15	0.11
5	5	0.35	0.18	0.18	0.23	0.17	0.19	0.19	0.16	0.10
	10	0.34	0.18	0.18	0.21	0.21	0.16	0.12	0.22	0.10
	20	0.40	0.12	0.17	0.27	0.15	0.16	0.12	0.21	0.10
	50	0.29	0.23	0.17	0.23	0.21	0.15	0.13	0.20	0.09
10	5	0.30	0.22	0.19	0.23	0.20	0.17	0.12	0.21	0.11
	10	0.31	0.22	0.149	0.25	0.17	0.17	0.12	0.20	0.11
	20	0.29	0.22	0.18	0.26	0.17	0.16	0.11	0.20	0.10
	50	0.32	0.20	0.18	0.25	0.18	0.15	0.13	0.20	0.10
15	5	0.24	0.26	0.20	0.18	0.24	0.17	0.06	0.27	0.12
	10	0.26	0.25	0.19	0.18	0.24	0.17	0.06	0.26	0.11
	20	0.27	0.24	0.19	0.20	0.23	0.16	0.07	0.27	0.10
	50	0.27	0.24	0.18	0.20	0.22	0.16	0.07	0.27	0.09
20	5	0.19	0.27	0.22	0.15	0.27	0.18	0.04	0.28	0.12
	10	0.21	0.28	0.20	0.15	0.27	0.17	0.06	0.28	0.11
	20	0.22	0.28	0.19	0.16	0.26	0.16	0.06	0.27	0.10
	50	0.24	0.28	0.18	0.18	0.25	0.16	0.06	0.28	0.09
30	5	0.17	0.30	0.24	0.14	0.25	0.21	0.04	0.27	0.14
	10	0.15	0.30	0.23	0.15	0.26	0.19	0.05	0.27	0.12
	20	0.17	0.30	0.22	0.15	0.26	0.18	0.05	0.29	0.11
	50	0.20	0.30	0.20	0.18	0.25	0.17	0.06	0.27	0.10
Normal soils		0.36	0.16	0.18	0.27	0.15	0.17	0.16	0.18	0.11

Table 7. Effect of TEC (irrespective of SAR) on soil-water constants

Soil Type	TEC me L^{-1}	DW	AW	RW
			cm^3 cm^{-3}	
Clay	5	0.26	0.23	0.21
	10	0.25	0.25	0.19
	20	0.27	0.23	0.19
	50	0.27	0.23	0.19
Clay loam	5	0.20	0.21	0.185
	10	0.19	0.23	0.17
	20	0.20	0.23	0.16
	50	0.21	0.21	0.16
Silt loam	5	0.10	0.23	0.115
	10	0.095	0.235	0.11
	20	0.095	0.235	0.10
	50	0.10	0.23	0.10

observed in different soils. In clay soil, highly significant regression coefficient of AW with ESP or DI might be attributed to increased total surface area resulting from dispersion of soil colloids. In silt loam soil, due to less clay content R^2 values were lower than that of clay soil. Though the clay content in clay loam soil was 36.5 per cent, yet very poor regression coefficients between water constants and ESP or DI were observed. This is mainly because in clay loam soil when low SAR (2.5 m $mol^{1/2}$ $L^{-1/2}$) water was added it has reduced the DW and increased AW but when SAR of added water was raised to 10 m $mol^{1/2}$ $L^{-1/2}$, per cent decrease in DW was found and also per cent increase in AW. This suggested that in clay loam soil, the salinity of water was more effective than that of the sodicity of water in the SAR range between 2.5 and 10 m $mol^{1/2}$ $L^{-1/2}$. A poor regression of RW with ESP or DI in different soils suggested that the dispersion was not a prominent process at the suction of 1500 kPa or pore size reduction below 2 x 10^{-4} mm hardly occurred within the studied ranges of SAR and TEC.

Table 8. Linear regression relationship between water constants and ESP or DI of soils

Clay	Clay loam	Silt loam
DW = 0.35 - 0.006 ESP R^2 = 0.90**	DW = 0.28 - 0.006 ESP R^2 = 0.83*	DW = 0.22 - 0.008 ESP R^2 = 0.97**
AW = 0.126 - 0.0087 ESP R^2 = 0.98**	AW = 0.152 + 0.005 ESP R^2 = 0.67	AW = 0.114 + 0.0081 ESP R^2 = 0.93**
RW = 0.181 + 0.0014 ESP R^2 = 0.42	RW = 0.128 - 0.003 ESP R^2 = 0.72	RW = 0.093 + 0.0009 ESP R^2 = 0.74
DW = 1.02 - 0.04 DI R^2 = 0.88*	DW = 0.45 - 0.014 DI R^2 = 0.63	DW = 0.726 - 0.067 DI R^2 = 0.97**
AW = 0.033 DI - 0.37 R^2 = 0.96**	AW = 0.009 DI + 0.05 R^2 = 0.42	AW = 0.064 DI + 0.37 R^2 = 0.95**
RW = 0.005 DI + 0.10 R^2 = 0.39	RW = 0.005 DI + 0.07 R^2 = 0.42	RW = 0.007 DI + 0.039 R^2 = 0.75

*Significant at P = 0.05
**Significant at P = 0.01

Conclusions

Sustainability of irrigated agriculture is now facing a growing risk of salinization and waterlogging particularly in the areas where groundwater quality is poor or marginal. Soil-water retention properties are highly sensitive to the characteristics of flowing water. Present study evaluates the effect of SAR and TEC of equilibrating solution on water retention characteristics and water constants of clay (Typic Chromustert), clay loam (Vertic Ustropept) and silt loam (Lythic Ustorthent) soils of Maharashtra. At an equilibrium suction of 10 kPa, effect of water quality was observed only when SAR was above 15 m $mol^{1/2}$ $L^{-1/2}$ in clay and clay loam and at SAR 30 m $mol^{1/2}$ $L^{-1/2}$ in silt loam soil. In the range of 20 to 1000 kPa suction, water retention increased sharply with increase in SAR and decrease in TEC, thereafter increase was slow upto 1500 kPa. A spectacular rise in available water was recorded with increase in SAR and decrease in TEC. Such increase in available water was associated with sharp decline in drainable water; however influence of water quality on residual water was marginal. SAR of the equilibrating solution was found to be highly effective parameter as compared with TEC in influencing the water retention. Increase in available water and decrease in drainable water were positively related with the water quality induced changes in dispersion and ESP of the soil. However, the water quality induced changes in soil dispersion marginally affected the RW. Thus, in fine textured Vertisols and associated soils, salinity and alkalinity of water greatly determines the water retention behaviour.

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