The Development of Relations in Different Ways of Ionic Strength and the Proportion of Adsorption Sodium Adj.R_{Na} to Some Soil in Central Iraq

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Abstract: ***The study was carried out on central Iraqi soil and included 28 different saline and texture sites with a depth of 0-30 cm. These included areas of central Iraq governors (Baghdad, Babylon, Karbala, Najaf and Diwaniya). The results indicated that the electrical conductivity values of soil samples ranged between 2.20 - 206.92 dS m^{-1} in Kufa and Shamiya sites respectively. The results indicate that the ionic strength values in the soil according to Lewis and Randol equation and using Abed program ranged from 0.03-2.83 $Moll^{-1}$. The values of ionic strength in the Griffin and Jurinak equation range from 0.03-2.69 $Moll^{-1}$. The following equation was found: y = 0.959x + 0.0131 during which the approximate values of ionic strength and standard error of R^2 = 0.9991. And the SAR values are corrected before the ion pair between 10.29 and 365.97 $Meql^{-1}$ at the sites of Kufa and Kefal districts, respectively. The ion pair (free ions) ranged from 11.08-405.24 $Meql^{-1}$ to the same sites Nilai. In the relationship between SAR values before and after correction, we find the following equation, which can be applied by finding SAR values after correction y = 1.1029x + 0.0984 and the standard error of R^2 = 0.9998. While Adj.R_{Na} values ranged from 10.56-368.28 $Meql^{-1}$ to the same SAR sites above respectively. The following linear equation was found for the relationship between SAR and Adj.R_{Na} y = 1.0038x + 0.4308 was obtained by which the values AdR.R_{Na} can be extracted and by standard error R^2 = 0.9999. The objective of the study to estimate the ionic strength in two ways methods: the first by Lewis and Randull equation using Abed and the second by Griffin and Jurinak. The objective of the study to determine the actual concentrations of ions based on thermodynamic calculations concentrations of the main ions present are corrected and the sodium absorption rate SAR of the free ions is reassessed these values are compared with pre-correction ratios for areas of central Iraq. The objective also of the study finding the relationship between SAR and Adj.R_{Na} for areas of central Iraq.***

Keywords: Ionic Strength, Ion Pairs, Sodium Adsorption Ratio, Adj.SAR, Adj.R_{Na} (Adjusted – adsorption - ratio)

1. Introduction

The soils of central Iraq are located within arid and semi-arid areas, which depend on irrigated agriculture as a common pattern, from the problem of salinity in the absence of natural drainage and to some extent the artificial façade, which leads to a rise in the saline water level and to salinization of soils (1). The ionic strength of a solution is a measure of the concentration of ions in that solution. Ionic compounds, when dissolved in water, dissociate into ions. The total electrolyte concentration in solution will affect important properties such as the dissociation constant or the solubility of different salts. One of the main characteristics of a solution with dissolved ions is the ionic strength. Ionic strength can be molar (Mol/L) or molal (Mol/kg water). It directly affects the efficiency of the ions (2). That the ionic force had an effect on the speed of release and increase in salts with a change in ionic concentration and ionic composition It was also found (3) (4). Sodium is one of the important ions that have an effect on the soil and have an initial effect on the soil through its effect on some physical properties of the soil such as ventilation, low water conductivity, destruction of soil complexes and its role in soil conversion under certain conditions in soils. Adjustment of the value of Adj.SAR noting that this value is excessive and more than expected for the risk of sodium and suggested a coefficient of (0.5) to modify its value (Adj.SAR * 0.5) to accurately assess the effect of bicarbonate on calcium deposition (5) (6). Therefore, the study aims to determine the relationship between ionic strength in two ways and re-evaluate the rate of absorption of sodium SAR after correction and the relationship of SAR Adj.R_{Na} to some soil in central Iraq.

2. Materials and Methods

The current study included the selection of soil from different sites representing most of the soil in central Iraq. Twenty-eight samples were taken from the depth 0-30 cm, and were classified according to the alleles proposed to two levels, namely the level of the desert soil Aridisol and the soil of the modern formation Entisol (7). Some chemical and physical characteristics of the study soil samples were presented in Table 1. According to the methods described by (8) (9) mentioned in ICARDA (10). Ionic strength was estimated in two ways, first according to the equation Lewis and Randull (11) (12). If a value is extracted using Abed (13)

$$I=1/2\sum Ci.Zi^2 \quad \text{.......... (1)}$$

The second method, according to Griffin and Jurinak (14) in Sposito (15) (16):-

$$I = 0.013 * EC \quad \text{......... (2)}$$

EC means the electrical conductivity of the dSm^{1-} equilibrium solution.

I mean the ionic force Moll $^{-1}$. The ratio of sodium adsorption (SAR) is calculated as in the following equation Richards (8) (17):-

$$SAR=Na^{+1}/ ((Ca^{+2}+Mg^{+2}/2)^{\wedge 0.5}) \quad \text{...(3)}$$

The rate of adsorbed sodium adsorption (Adj.R_{Na}) was calculated as in the following equation Suarez (18) (19):-

$$Adj.R_{Na} = Na/((Ca_X+Mg/2)^{\wedge 0.5}) \quad \text{..(4)}$$

Ca_X mean the tabular value of calcium.

Taking into consideration the ratio of HCO_3 / Ca on the basis of Meq^{-l} and the value of electrical conductivity for the purpose of modifying the value of calcium.

3. Results and Discussion

Chemical properties of soil

Table 1. Shows some of the chemical characteristics of the study soil samples. The values of the electrical conductivity ranged from 2.20 to 206.92 dSm-. This is consistent with what reported by (20). The lowest value was found in Kufa and the highest value in al-Shamiya District. The soil electrical conductivity (EC) is a measurement that correlates with soil properties that affect crop productivity, including soil texture, cation exchange capacity (CEC), organic matter level, Salinity, drainage conditions, and subsoil characteristics (21). Soil interaction values ranged from 7.02-7.94. Calcium values ranged between 2.0-81.92 $mmoll^{-1}$ and magnesium values ranging from 3.0-832.0 $mmoll^{-1}$ and the lowest value of calcium found in the Bakr bin Ali area and the lowest value of magnesium found in the Kufa district and found the highest value for calcium and magnesium in the al-Shamiya District, sodium in the study samples ranged from 18.55-1802.21$mmoll^{-1}$, where the lowest value was found in the district of Kufa and the highest value in the area of Ensured.

Ionic Strength

Table 2. Indicates the difference in the measurement of ionic strength in the first two ways, according to Lewis and Randull equation, which depends on the concentration and nature of the ions and the ion charge. It was found that the values of ionic power ranged between 0.03-2.83 $Moll^{-1}$ and the lowest value in the Kufa district and the highest value in the district of Shamiya, and estimated the ionic force in the second method according to the formula Griffin and Jurinak, which depends on the electrical conductivity of the solution and values ranged between 0.03-2.69 $Moll^{-1}$ and the lowest value in the Kufa district and the highest value in the district of Shamiya .The results showed that the ionic force calculated by the Griffin and Jurinak equations was similar to the ionic force equation according to Lewis and Randull equation. It directly affects the efficiency of the ions. The relationship between the ionic force and the electrical conductivity is about application importance in the physico-chemical behavior of ions in the soil and water system as ionic strength represents the strength of the electric field in soil and solution (22). Figure (1) Illustrates the relationship between the ionic force $Moll^{-1}$ according to Lewis and Randall equation and Griffin and Jurinak equation and the shows this relationship by equation $y = 0.959x + 0.0131$ and the standard error $R^2 = 0.9991$.

Sodium adsorption rate (SAR) before and after correction in the soil of central Iraq

Based on thermodynamic calculations, the concentration of the existing major ions was corrected to obtain actual concentrations and thus reassess the SAR ratio of the free ions. These values were compared with pre-correction ratios. The sodium adsorption values of SAR are a function of soil salinity. Increasing the salinity of the soil leads to an increase in sodium, which has a detrimental effect. It works to disperse the soil particles and break down its construction, as well as the impact on the growth of soil minutes and break down the construction as well as the growth and yield of the plant (23).

Table 1: Some chemical characteristics of Middle Euphrates soil samples

Governorate	Site	Sample number	EC dSm^{-1}	pH	Dissolved ions $mmoll^{-1}$								CEC $Cmol\ kg^{-1}$	Soil texture
					Ca^{+2}	Mg^{+2}	Na^{+1}	K^{+1}	$CO3^{-2}$	HCO_3^{-1}	$SO4^{-2}$	Cl^{-1}		
Baghdad	Yousifieh	1	131.48	7.16	16.12	108.75	1184.11	2.82	NIL	11.60	92.45	1207.75	15.38	Si C
Babylon	Abo Gharaq Village	2	8.60	7.61	9.00	8.00	58.00	0.53	NIL	8.00	6.22	59.22	17.04	S L
		3	81.51	7.64	10.00	78.43	614.74	2.35	NIL	1.86	95.76	582.62	18.31	S L
		4	14.39	7.91	5.00	36.67	89.00	1.29	NIL	15.00	6.43	111.34	15.28	L
	The denominator area	5	9.78	7.67	3.00	23.00	62.00	0.37	NIL	5.00	10.85	70.24	16.33	Si L
	Awfi Village	6	13.61	7.91	4.00	25.00	92.61	0.30	NIL	6.00	24.94	87.42	13.23	C L
	Mahaweel district	7	92.94	7.26	22.00	131.00	780.60	1.90	NIL	3.00	42.46	886.12	20.44	L
	Kefal area	8	196.20	7.06	14.00	83.00	1802.21	0.85	NIL	4.00	88.35	1770.84	18.48	Si C
	Bakr bin Ali area	9	4.23	7.42	2.00	14.00	20.62	2.19	NIL	7.00	6.87	25.26	15.25	C
		10	63.51	7.13	23.84	109.00	488.73	1.11	NIL	2.00	6.54	613.72	17.26	Si C
	Village of the skull	11	22.61	7.11	6.00	42.00	172.30	0.54	NIL	4.00	15.73	198.81	16.82	Si C L
		12	16.15	7.71	4.17	32.84	112.44	1.31	NIL	7.00	20.49	121.26	13.68	C
	Nile area	13	15.02	7.73	11.00	8.42	124.66	0.21	NIL	3.00	22.32	112.47	15.32	Si L
	Sinjar area	14	22.05	7.60	14.29	30.72	138.95	0.82	NIL	2.00	29.45	146.70	14.71	S L
	Central Shehabism	15	6.76	7.91	4.00	19.00	38.37	0.36	NIL	5.00	6.92	49.22	12.49	Si C L
	Shomali	16	188.51	7.12	28.40	385.96	1466.20	2.72	NIL	7.25	184.91	1691.12	18.16	Si L
Holy Karbala	Good area	17	122.11	7.17	7.50	116.5	1072.35	2.10	NIL	6.00	113.57	1102.45	18.72	C
		18	5.37	7.72	10.00	8.00	32.30	0.37	NIL	4.00	22.72	19.74	18.2	C
	Free area	19	2.41	7.94	4.00	7.00	21.00	0.41	NIL	7.00	6.35	16.74	17.67	Si C L
	Husseiniya area	20	124.25	7.48	10.00	190.00	1032.00	4.19	NIL	12.00	111.53	1102.62	19.39	L
	Ibrahimia area	21	141.38	7.13	16.00	164.42	1202.36	2.20	NIL	14.00	151.23	1184.98	17.96	S L
Holy Najaf	Kufa district the village of Albuhamdari	22	7.96	7.51	3.81	7.50	65.20	0.32	NIL	4.00	6.12	65.88	18.97	Si L
	Kufa district The village of Hassawiya	23	23.71	7.47	10.00	25.00	179.52	1.80	NIL	14.00	12.54	188.02	16.96	S L
		24	2.20	7.49	10.00	3.00	18.55	0.25	NIL	14.00	6.14	11.30	18.66	C
Diwaniya	Al-Sudair area	25	22.95	7.34	5.85	36.17	182.00	3.03	NIL	8.00	84.23	129.72	15.90	C
		26	25.82	7.57	12.00	39.00	157.00	1.48	NIL	8.00	12.34	186.12	15.43	S L
		27	49.70	7.02	34.00	152.00	302.00	1.78	NIL	16.00	31.55	437.32	17.84	Si C L
	Al-Shamiya district	28	206.92	7.08	81.92	528.63	1456.17	1.68	NIL	9.16	104.51	1954.73	18.44	C

Table 2: Ionic Strength values of $Moll^{-1}$ by equation of Lewis, Randull, Griffin equation, and Jurinak

Governorate	Site	Sample number	Ionic force according to equation Lewis and Randall $Moll^{-1}$ $I=1/2\sum Ci.Zi^2$	Ionic force according to the Griffin equation and Jurinak $Moll^{-1}$ $I=0.013*EC$
Baghdad	Yousifieh	1	1.80	1.71
Babylon	Abo Gharaq Village	2	0.10	0.11
		3	1.08	1.06
		4	0.19	0.19
	The denominator area	5	0.13	0.13
	Awfi Village	6	0.17	0.18
	Mahaweel district	7	1.23	1.21
	Kefal area	8	2.60	2.55
	Bakr bin Ali area	9	0.07	0.05
		10	0.84	0.83
	Village of the skull	11	0.29	0.29
		12	0.20	0.21
	Nile area	13	0.21	0.20
	Sinjar area	14	0.25	0.29
	Central Shehabism	15	0.10	0.09
	Shomali	16	2.58	2.45
Holy Karbala	Good area	17	1.61	1.59
		18	0.08	0.07
	Free area	19	0.05	0.03
	Husseiniya area	20	1.64	1.62
	Ibrahimia area	21	1.92	1.84
Holy Najaf	village of Albuhamdari	22	0.10	0.10
	Kufa district	23	0.31	0.31
	The village of Hassawiya	24	0.03	0.03
Diwaniya	Al-Sudair area	25	0.30	0.30
		26	0.27	0.34
		27	0.66	0.65
	Al-Shamiya district	28	2.83	2.69

Table 3. Indicates SAR values before correction ranging from 10.29 - 365.97 $Meql^{-1}$ in Kufa and Kifil sites respectively, while SAR values after correction of ions (free ions) in Table 3. Ranged from 11.08 to 405.24 $Meql^{-1}$ the lowest value in Kufa and the highest value in kafil Conclude from the results that correction of the non-double ionic has increased the values of sodium adsorption ratio SAR and therefore changes the critical limits within this indicator, which may shift soil classification according to the ratio of sodium absorption SAR from one category to another, this is very important in the reclamation of soils, especially high concentration of sodium. Pointed out that the correction of the ionic activity and the ion pair changed the mathematical relationships between adj.SAR and adj.R_{Na} and between EC and ionic strength in both water and soil, as well as increasing SAR values by by (1. 3 to 1.44) times, respectively compared to uncorrected values (24). The relationship between SAR values before and after correction is shown in Figure (2). The linear equation y = 1.1029x + 0.0984 is obtained from which the SAR values can be extracted after correction (after ion Pair) at an error rate of approximately $R^2 = 0.9998$.

Sodium adsorption ratio SAR and Adj.R_{Na} modified adsorption rate in the soil of central Iraq

Table 4. Indicates that SAR values range from 10.29-365.97 $Meql^{-1}$ lowest value in Kufa and the highest value in the Kefal area due to the increase in the ratio of sodium ions to calcium and magnesium. We conclude that the sodium adsorption behavior corresponds to the conductivity values of electrical conductivity, Preference to use the modified sodium adsorption ratio Adj.R_{Na} to express sodium damage.

Table 4. Indicates the values of Adj.R_{Na}, which ranged from 10.56 to 368.28 $Meql^{-1}$for the same locations above, respectively. It can be concluded that the values of Adj.R_{Na} are higher than the SAR values. This may be due to the calcium ion concentration in the equation being a modified concentration according to HCO_3 / Ca^{+2} as well as the fact that calcium tends to precipitate as calcium carbonate which reduces its concentration and this leads to a relative increase in the values of Adj.R_{Na} and these results are consistent with (25). Figure (3) indicates the relationship between the sodium adsorption ratio and the modified sodium ratio. From the results the following linear equation y = 1.0038x + 0.4308 was obtained by which the values Adj.R_{Na} can be extracted and by standard error $R^2 = 0.9999$.

4. Conclusions

We conclude from the study that the ionic force at the rate of Lewis and Randull gave a similar value of the ionic force values of the Griffin and Jurinak equation and shows this relation in an equation y = 0.959x + 0.0131.

We conclude from the study that the values of sodium adsorption ratio SAR before correction less than values after correction because the correction of ion pair increased the rate of sodium adsorption rate SAR and thus change the critical limits within this indicator and shows this relationship in an equation y = 1.1029x+ 0.0984.

We conclude from the study that Adj.R_{Na} values are higher than SAR values due to the calcium ion concentration in the equation being a modified concentration according to HCO_3/

Ca^{+2} as well as the fact that calcium tends to precipitate as calcium carbonate, which reduces its concentration and this leads to a relative increase in values from Adj.R_{Na} illustrates this relationship in an equation y = 1.0038x + 0.4308.

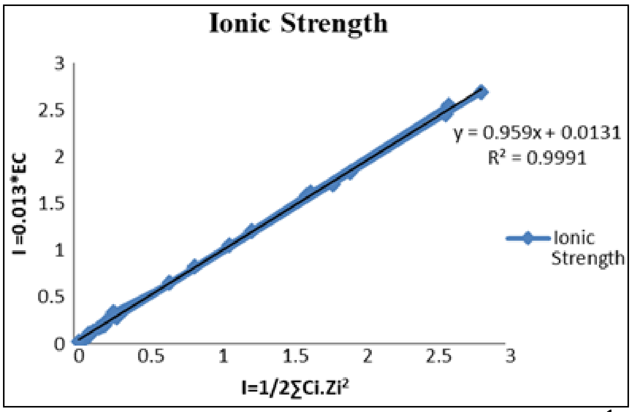

Figure 1: The relationship between ionic strength $Moll^{-1}$, according to the equation Lewis and Randull and according to the equation Griffin and Jurinak

Table 3: Sodium adsorption ratio SAR before correcting ionic pair and after correcting $Meql^{-1}$

Governorate	Site	Sample number	Before correcting SAR	After correcting SAR
Baghdad	Yousifieh	1	211.93	232.06
Babylon	Abo Gharaq Village	2	28.13	29.70
		3	130.74	144.56
		4	27.57	29.15
	The denominator area	5	24.32	26.44
	Awfi Village	6	34.39	40.29
	Mahaweel district	7	126.22	139.71
	Kefal area	8	365.97	405.24
	Bakr bin Ali area	9	10.31	14.41
		10	84.81	94.00
	Village of the skull	11	49.74	53.34
	Village of the skull	12	36.97	41.43
Babylon	Nile area	13	58.77	66.18
	Sinjar area	14	41.42	44.50
	Central Shehabism	15	16.00	17.08
	Shomali	16	144.06	157.38
Holy Karbala	Good area	17	192.60	212.72
		18	15.23	18.59
	Free area	19	12.66	13.99
	Husseiniya area	20	145.95	161.17
	Ibrahimia area	21	116.64	128.73
Holy Najaf	village of Albuhamdari	22	38.77	41.78
	Kufa district	23	60.69	67.52
	The village of Hassawiya	24	10.29	11.08
Diwaniya	Al-Sudair area	25	56.15	62.15
		26	43.97	49.06
		27	44.29	49.09
	Al-Shamiya district	28	117.86	129.09

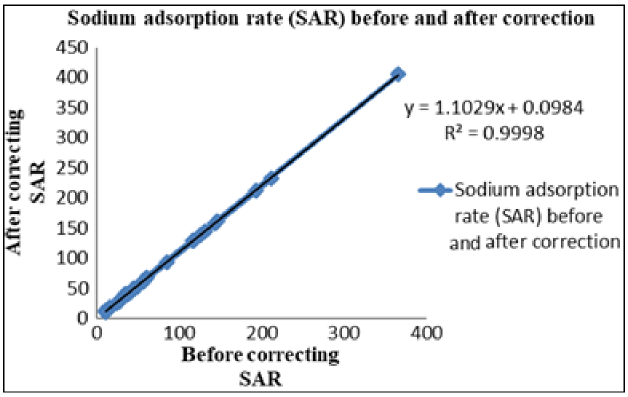

Figure 2: The relationship between Sodium adsorption ratio SAR before correcting ionic pair and after correcting $Meql^{-1}$

Table 4: Sodium adsorption ratio SAR and Adj.R_{Na} modified adsorption rate in the central Iraqi soil

Governorate	Site	Sample number	SAR	Adj.R_{Na}
Baghdad	Yousifieh	1	211.93	214.79
Babylon	Abo Gharaq Village	2	28.13	28.48
		3	130.74	131.16
		4	27.57	27.78
	The denominator area	5	24.32	24.743
	Awfi Village	6	34.39	35.14
	Mahaweel district	7	126.22	126.48
	Kefal area	8	365.97	368.28
	Bakr bin Ali area	9	10.31	10.56
		10	84.81	85.27
	Village of the skull	11	49.74	51.34
		12	36.97	37.39
	Nile area	13	58.77	59.09
	Sinjar area	14	41.42	41.64
	Central Shehabism	15	16.00	17.68
	Shomali	16	144.06	144.26
Holy Karbala	Good area	17	192.60	193.52
		18	15.23	15.43
	Free area	19	12.66	14.63
	Husseiniya area	20	145.95	146.18
	Ibrahimia area	21	116.64	117.06
Holy Najaf	village of Albuhamdari	22	38.77	39.03
	Kufa district	23	60.69	61.11
	The village of Hassawiya	24	10.29	11.14
Diwaniya	Al-Sudair area	25	56.15	58.18
		26	43.97	44.17
		27	44.29	44.41
	Al-Shamiya district	28	117.86	118.06

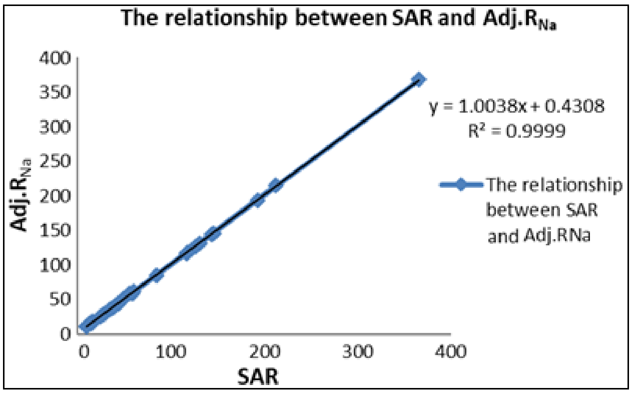

Figure 3: Relationship between sodium adsorption ratio SAR and Adj.R_{Na} modified adsorption ratio in the central Iraq soil

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