every crop could account for grain and straw yield improvement on par with SSP. However, between the DAP and SSP, the DAP was better than SSP and proved significantly superior to all other sources of P both in respect of grain and straw yield.

REFERENCES

BISWAS, B.C., SATISH MAHESWARI and YADAV, D.S. 1985. Relative efficiency of different types of fertilizers. **Fert.News.30(11):15-23.**

MARWAHA, B.C., KANWAR, B.S. and TRIPATHI, B.R. 1981. Direct and residual effectiveness of Mussorie rock phosphate in wheat-maize rotation. **Indian J. Agric. Sci.51**:870-874.

MENGEL, K. 1986. Turn over in soil and yield response of phosphate rock containing fertilizers. **J.Plant Nutr.Soil Sci.149**(6):674-591.

NIMJE, P.M. and JAGDISH SETH. 1987. Effect of phosphorus and farm yard manure on soybean and their residual effect on succeeding winter maize.**Indian J.Agric.Sci.** 57:404-409.

RAI, R.K., SINHA, M.N. and MAHATIM SINGH. 1982. Studies on direct and residual effect of phosphorus on growth and yield of maize and wheat in sequence.**Indian J.Agron.27**:354-362.

SHARMA J.P. and SAXENA, S.N. 1985. Utilisation of phosphorus by maize as influenced by various sources of organic matter and applied phosphorus.**J.Indian Soc.Soil Sci.**33:561-567.

SINGH, G.P., BHARGAVA, P.N. and RAJENDER KAUR. 1986. Comparative performance of phosphal and SSP in different agro-ecological situations. **Fert.News. 31**(3):33-38.

VED SINGH and MEHTA, M.C. 1982. Manurial requirement of maize-wheat rotation. **Indian J.Argon. 27**:127-136.

Madras Agric. J., 81(8): 429-431 August, 1994

https://doi.org/10.29321/MAJ.10.A01553

SOLUBLE CATIONS AND ANIONS IN RELATION TO SOIL pHs AND ECe IN TYPIC NATRAQUALF

A.K. SRIVASTAVA and O.P. SRIVASTAVA

Department of Soil Science, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi.

ABSTRACT

On an average, soluble CO_3^{2-} + HCO^{3-} and Na^+ constituted 74.2 per cent and 96.8 per cent of total soluble anions and cations respectively and were highly and positively correlated with each other (r = 0.958**), showing the dominance of Na2CO3 in these soils. The amount of various anions and cations followed the sequence as CO_3^{2-} + HCO^{3-} > Cl > SO_4^{2-} and Na^+> Ca^{2+} + Mg^{2+} > K+ respectively. Soil ECe increased by an unit with every 11.6 m.e.L^{-1} increase in soluble cations. Soluable CO_3^{2-} + HCO^{3-} and Na^+ significantly correlated with ECe of soils (r = 0.954** and 0.979**) and pHs (r = 0.535** and 0.518**) respectively, explaining the major role of these ions in regulating the pHs and ECe of salt affected soils.

Electrical conductivity and pH are the two soil parameters for suitably classifying the salt affected soils as saline and sodic from management point of view. Chemically two types of saline - alkali soils are met with, one in which the salinity is due to the presence of soluble salts having chlorides and sulphates and other in which the dominant salts are carbonates and bicarbonates. The present investigation has therefore been undertaken to study the type of cations and anions contributing towards the variation in pH and ECe of some salt affected soils collected under natural environment.

MATERIALS AND METHODS

Thirty soil samples (Family Typic Natraqualfs) ranging in pHs from 7.3 to 10.8 were finally selected out of 600 samples for the study. Soil pHs, ECe, water soluble anions viz., $CO3^{2-}$ + HCO^{3-}, Cl^-, and cations viz., Na^+, Ca^{2+} + Mg^{2+} and K^+ were determined as per methods described by Richards (1954). Soluble $SO4^{2-}$ content was estimated turbidimetrically according to method described by Jackson (1973). To assess the contribution of various cations and anions towards variation in pHs and ECe, regression and multiple correlation analyses were carried out.

RESULTS AND DISCUSSION

The data of analyses are presented in tables 1 to 3. Soil ECe increased from 1.56 to 70.52 dSm^{-1} with increase in water soluble CO32- + HCO3- and Na^+ from 8.00 to 522.00 m.e.L^{-1} and from 6.08 to 800.00 m.e.L^{-1} respectively. There was a significant relationship between ECe and soluble anions or cations. Usually, ECe is increased by 1 dSm^{-1} per 10 m.e.L^{-1} increase in soluble cations (Richards, 1954). But in these soils, an increase in ECe by 1 dSm^{-1} per 11.6 m.e.L^{-1} increase in

Table 1. pHs, ECe and various water soluble cations and anions of some salt affected soils.

Soil pHs	ECe (d Sm^{-1})	Water soluble cations (m.e.L^{-1})			Water soluble cations (m.e.L^{-1})		
		$Ca^{2+}+Mg^{2+}$	Na^{+}	K^{+}	$CO_3^{2-}+HCO_3$	Cl^{-}	SO_4^{2-}
7.3	1.56	6.00	6.08	0.05	8.00	5.50	0.14
7.35	1.78	8.00	7.82	0.05	9.00	4.50	0.28
7.4	1.67	6.00	6.08	0.07	7.00	6.50	0.71
7.55	1.67	6.00	8.69	0.07	11.00	4.00	0.28
7.6	1.52	6.00	9.56	0.07	9.00	4.00	0.28
7.9	1.81	4.00	13.04	0.07	9.00	6.00	0.78
8.25	1.97	4.00	17.39	0.15	10.00	6.50	1.70
8.4	1.87	4.00	8.69	0.15	10.00	8.00	1.21
8.5	3.39	10.00	19.56	0.10	18.00	8.50	2.25
8.6	2.14	4.00	20.00	0.15	10.00	8.50	2.93
8.7	2.30	4.00	20.86	0.10	12.00	8.00	2.05
9.2	2.33	4.00	17.39	0.12	15.00	6.50	2.85
9.25	2.42	4.00	18.26	0.12	17.00	6.50	2.78
9.3	3.07	5.00	26.95	0.12	19.00	8.00	2.75
9.7	3.28	6.00	23.47	0.23	20.00	8.00	2.84
9.7	3.17	6.00	19.13	0.30	19.00	8.50	2.20
9.9	5.34	10.00	41.73	0.33	40.00	8.50	2.98
10.1	70.52	5.00	800.00	0.40	522.00	72.00	98.24
10.1	38.83	6.00	608.00	0.40	332.00	28.00	20.34
10.1	38.62	4.00	373.91	0.12	252.00	40.50	52.77
10.15	29.82	4.00	339.13	0.10	300.00	45.50	34.87
10.2	19.04	4.00	178.26	0.10	232.00	38.50	20.70
10.2	22.72	4.00	189.13	0.17	146.00	20.00	20.48
10.2	35.00	6.00	360.86	0.17	173.00	23.00	24.50
10.4	15.35	4.00	160.86	0.20	121.00	27.00	69.12
10.55	10.20	4.00	79.93	0.28	111.00	22.50	18.05
10.6	22.81	4.00	189.13	0.20	72.00	15.50	12.53
10.6	10.76	4.00	80.00	0.28	82.00	20.00	18.26
10.7	12.42	4.00	156.52	0.27	103.00	26.00	10.81
10.8	18.28	4.00	191.30	0.22	73.00	18.00	13.68

soluble cations has been observed, showing that simple estimation of ECe can be considered as a good index for predicting the soluble cations and anions in salt affected soils. On an average, soluble CO_3^{2-} + HCO^{3-} and Na^{+} constituted 74.2 per cent and 96.8 per cent of total soluble anions and cations respectively, indicating that genesis of these soils has taken place under dominating influence of Na_2CO_3 and $NaHCO_3$. Weathering of aluminosilicate minerals provides a steady supply of alkali bicarbonates which accumulate in the undraioned basin. The amount of different anions and cations followed the following sequence in decreasing order as CO_3^{2-} + HCO^{3-} > C1- > SO_4^{2-} and Na^{+} > Ca^{2+} + Mg^{2} > K^{+} respectively. Soluble Ca^{2+} + Mg^{2}+ are precipitated by Co_3^{2-}+ HCO^{3-} resulting into increase in the ratio of soluble Na^{+} to Ca^{2+} + Mg^{2+} in soil solution.

Soil ECe is more highly, positively and significantly correlated with soluble Na+(r = 0.974**), CO_3^{2-} + HCO3- (r = 0.954**), soluble SO42- (r = 0.846**) and C1- (r=0.910**).

These observations confirm the contribution of all the anions viz., CO_3^{2-} + HCO^{3-}, SO_4^{2-} and Cl^{-} towards variation in ECe and also evident from the regression equation as Y (ECe) = 3.155 + 0.135 X2

Table 2. Correlation coefficient among ECe and different soluble anions.

	ECe	CO_3^{2-} + HCO_3^-	SO_4^{2-}	Cl^-
ECe	1.000	0.954**	0.846**	0.910**
$CO_3^{2-} + HCO_3^-$		1.00	0.838**	0.957**
SO_4^{2-}			1.000	0.892**
Cl^-				1.000

** Significant at 1% level.

Table 3. Correlation coefficient among ECe and different soluble cations.

	ECe	Ca^{2+} + Mg^{2+}	Na^+	K^+
ECe	1.000	-0.464*	0.979**	0.514**
Ca^{2+} + Mg^{2+}		1.000	-0.128	0.035
Na^+			1.000	0.560**
K^+				1.000

** Significant at 1% level. * Significant at 5% level.

Table 4. Correlation coefficient among pHs and different soluble cations and anions.

	pHs	$Ca^{2+} + Mg^{2+}$	Na^+	K^+	$CO_3^{2-} + HCO_3^-$	SO_4^{2-}	Cl^-
pHs	1.000	-0.320*	0.518**	0.471**	0.535**	0.508**	0.505**
$Ca^{2+} + Mg^{2+}$		1.000	-0.128	0.035	-0.172	-0.239	-0.268
Na^+			1.000	0.560**	0.958**	0.800**	0.877**
K^+				1.000	0.504**	0.424**	0.455**
$CO_3^{2-} + HCO_3^-$					1.000	0.838**	0.957**
SO_4^{2-}						1.000	0.892**
							1.000

** Significant at 1% level. * Significant at 5% level.

(CO_3^{2-} + HCO^{3-}) + 0.177 X_3 (SO_4^{2-}) + 0.311 X_4 (Cl^-) (Table 2). Soluble Cl^- and SO_4^{2-} in the present study increased from 5.50 to 72.00 m.e.L^{-1} and from 0.14 to 98.28 m.e.L^{-1} respectively and were also associated with increase in ECe from 1.56 to 70.52 dSm-1. The above relation between Cl^- and SO42- ions is further substantiated by the presence of high correlation between two anions (r = 0.892**).

pHs in relation to soluble cations and anions

pHs was poorly and negatively correlated with Ca^{2+} + Mg^{2+} (r = 0.320*), whereas comparatively higher correlations were observed between pHs and Na+ (r = 0.518**) and pHs and CO_3^{2-} + HCO_3^- (r = 0.535**) (Table 4). Soluble Na+ and CO_3^{2-} + HCO_3^- mainly impart sodic rather than saline characteristics to soils and are highly correlated with each other (r = 0.958**) which normally account for increase in soil pHs. The regression equation between pHs and different cations and anions is as Y (pHs) = 8.259 - 0.144 X_2 (Ca^{2+} + Mg^{2+}) 7.037 X_4 (Na^+) and 0.006 X_5 (CO_3^{2-} + HCO^{3-}) + 0.069 X_7 (Cl^-) and the above cations and anions were responsbile for 81 per cent variation soil pHs.

pHs in relation to ECe

Electrical conductivity of soils ranged between 1.56 to 70.52 dSm^{-1} in the pHs range of 7.3 to 10.8. But 53 per cent of these soils having pHs upto 9.7 were associated with less than 4dSm^{-1}, which indicates the sodic nature of the soils. Rest of the 47 per cent soils were accompanied with ECe more than 4 dSm-1 in the pHs range of 9.9 to 10.8 denoting the saline-sodic nature.

Soil pHs was positively correlated with ECe (r = 0.621**) and according to regression equation, pHs increased at the rate of 0.04 unit per unit increase in the ECe. The increase in pHs due to increase in ECe is attributed to soluble anions and cations dominated by CO_3^{2-} + HCO_3^- and Na^+ respectively through increase in SAR and RSC of soil solution, while ECe can increase even in presence of sodium salt of chloride and sulphate with comparatively lower pHs. The soils under study come under the category of sodic soils interpersed with normal soils.

REFERENCES

JACKSON, M.L. 1973. **Soil Chemical Analysis.** Prentice Hall of India Private Limited, New Delhi.

RICHARDS, L.A. (ed.) 1954. **Diagnosis and Improvement of Saline and Alkali Soils.** United State Department of Agriculture, Handbook 60.