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A Comparision of Methods of Irrigation Water Quality Rating

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Three systems of irrigation water quality assessment are evaluated in terms of the ratings obtained for 50 irrigation water samples of Delhi villages. It is shown that the U.S.D.A. rating system has limited applicability to Indian conditions whereas the other two methods proposed by Kanwar and Ramamoorthy have wider scope of applicability and agree very well with the field performance of irrigated crops.

Irrigation water has profound impact on the nature and properties of the soil and influences the germination of seeds and crop growth as well (Doneen and Henderson, 1960). Since water is Nature's gift, there is no alternative but to make the best use of available water, irrespective of its quality. Biswas and Jain (1969) have reviewed the various systems proposed for classifying irrigation water quality. Evolution of a suitable system of rating for a given Agro-climatic region depends on the availability of extensive data regarding the chemical composition of water available in the area, recorded effect of their long continued use on both crop growth and soil. Paliwal and Yadav (1976) have critically analysed the available information for the union territory of Delhi on these lines. The case study reported in this paper assessed the suitability of the most widely used water quality rating system of U.S.D.A.(1954) against the methods proposed to suit Indian conditions by Kanwar (1961) and Ramamoorthy (1964).

MATERIALS AND METHODS

Out of a large number of water samples received by the Soil Testing Laboratory, I.A.R.I., New Delhi, from the farmers of Delhi territory, 50 samples sufficient to cover a wide range of salt content were taken up for detailed analysis by standard methods. Using these analytical values, the above mentioned three systems of water quality were compared.

RESULTS AND DISCUSSION

The E.C., RSC, SAR values, water quality rating index and their suitability for irrigation as per the three systems are given in Table I. It is seen that nearly 46 per cent of the samples analysed have E.C. values more than 5 m. mhos/cm which is the upper limit of E.C. covered by the U. S. D. A. rating system (1954). However, these farmers have not reported any deterioration of crop growth due to use of such waters on sandy/sandy loam soils of Delhi territory. Kanwar (1961) has drawn at-

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TABLE. Water quality rating and suitability for irrigation

Sample No.	EC m.mhos/cm	RSC	SAR	Water quality rating index of			Suitability on Sandy/ Sandy loam Soils		
				Rama-moorthy (method I)	U.S.D.A. (method II)	Kanwar (method III)	Method I	Method II	Method III
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1	0.4	—	—	C_2S_1	C_2S_1	C_2S_1	A	A	A
2	0.5	0.1	2.4	C_2S_1	C_2S_1	C_2S_1	A	A	A
3	0.6	2.0	1.8	C_2S_1	C_2S_1	C_2S_1	A	A	A
4	0.8	6.7	1.2	C_3S_1	C_3S_1	C_3S_1	A	A	A
5	0.9	—	0.8	C_3S_1	C_3S_1	C_3S_1	A	A	A
6	0.9	3.6	3.3	C_3S_1	C_3S_1	C_3S_1	A	A	A
7	0.95	—	2.6	C_3S_1	C_3S_1	C_3S_1	A	A	A
8	1.0	0.6	5.3	C_3S_1	C_3S_1	C_3S_1	A	A	A
9	1.1	5.6	3.2	C_3S_1	C_3S_1	C_3S_1	A	A	A
10	1.2	7.0	7.3	C_3S_2	C_3S_2	C_3S_1	ST & T	ST & T	ST & T
11	1.5	0.6	4.7	C_3S_1	C_3S_1	C_3S_1	A	A	A
14	1.8	6.8	6.2	C_3S_2	C_3S_2	C_3S_1	ST & T	ST & T	ST & T
15	2.0	5.4	8.9	C_3S_2	C_3S_2	C_3S_1	ST & T	ST & T	ST & T
16	2.1	—	6.1	C_3S_2	C_3S_2	C_3S_1	ST & T	ST & T	ST & T
17	2.2	—	8.6	C_3S_2	C_3S_2	C_3S_1	ST & T	ST & T	ST & T
12	1.5	8.4	12.9	C_3S_3	C_3S_3	C_3S_2	T	T	ST & T
13	1.7	10.8	11.7	C_3S_3	C_3S_3	C_3S_2	T	T	ST & T
18	2.6	2.2	7.2	C_4S_2	C_4S_2	C_3S_1	ST & T	T	ST & T
19	2.6	—	8.9	C_4S_2	C_4S_2	C_4S_1	ST & T	T	ST & T
22	3.8	—	4.3	C_4S_2	C_4S_2	C_4S_1	T	T	ST & T
25	4.2	—	10.0	C_4S_3	C_4S_2	C_4S_2	NS	NS	ST & T
28	5.0	—	2.7	C_4S_1	C_4S_1	C_4S_1	ST & T	ST & T	ST & T
20	2.8	13.4	18.8	C_4S_4	C_4S_4	C_4S_2	NS	NS	T
21	3.2	—	10.6	C_4S_3	C_4S_3	C_4S_2	NS	NS	T
23	3.8	—	10.2	C_4S_3	C_4S_2	C_4S_2	NS	NS	T
24	4.0	—	13.0	C_4S_4	C_4S_2	C_4S_2	NS	NS	T
26	4.2	2.4	10.5	C_4S_3	C_4S_2	C_4S_2	NS	NS	T
31	5.5	—	5.0	C_4S_2	NP	C_3S_1	T	NS	T
33	6.5	—	2.2	C_4S_1	NP	C_3S_1	ST & T	NS	T
34	6.5	—	7.9	C_4S_3	NP	C_3S_1	T	NS	T
36	6.5	—	3.7	C_4S_2	NP	C_3S_1	NS	NS	T
38	8.0	—	6.2	C_4S_2	NP	C_3S_1	NS	NS	T
39	8.0	—	5.5	C_4S_2	NP	C_3S_1	NS	NS	T

[Contd.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
40	8.5	—	10.1	C_5S_3	NP	C_5S_1	NS	NS	T
41	8.5	—	7.4	C_5S_3	NP	C_5S_1	NS	NS	T
42	9.0	—	9.5	C_5S_3	NP	C_5S_1	NS	NS	T
43	10.0	—	8.6	C_5S_3	NP	C_5S_1	NS	NS	T
44	10.5	—	1.8	C_5S_1	NP	C_5S_1	T	NS	T
45	11.0	—	4.6	C_5S_2	NP	C_5S_1	NS	NS	T
46	11.0	—	16.8	C_5S_1	NP	C_5S_2	NS	NS	T
47	11.5	—	11.2	C_5S_3	NP	C_5S_3	NS	NS	T
48	14.5	—	21.0	C_4S_4	NP	C_5S_3	NS	NS	T
49	16.4	—	6.9	C_5S_4	NP	C_5S_1	NS	NS	T
50	23.0	—	7.7	C_4S_3	NP	C_5S_1	NS	NS	T
27	5.0	8.2	35.6	C_4S_5	C_4S_1	C_4S_4	NS	NS	NS
29	5.5	—	14.2	C_4S_4	NP	C_5S_2	NS	NS	NS
30	6.5	—	10.4	C_4S_3	NP	C_5S_2	NS	NS	NS
32	5.5	—	13.1	C_4S_4	NP	C_5S_2	NS	NS	NS
35	6.5	—	11.1	C_4S_4	NP	C_5S^2	NS	NS	NS
37	7.5	—	20.6	C_5S_4	NP	C_5S_3	NS	NS	NS

A : Suitable for all crops; ST : Semi tolerant crops; T : Tolerant crops; NS : Not suitable; NP : Not possible.

tention to the fact the farmers in Punjab have been successfully cropping for long with waters whose salinity is more than what is permitted by the U.S.D.A. rating system. It is against this background Kanwar(1961) and Ramamoorthy (1964, 68) have proposed systems of water quality rating to suit Indian conditions, taking into account wider range in salt content, texture of the soil and degree of salt tolerance of crops.

Quality rating method of Kanwar : In the system proposed by Kanwar, the E.C. ranges from low to very high with the following intervals. Low, C_1, 0-250, Moderate C_2, 250-750, Medium to high C_3, 750-2250, High C_4, 2250-5000 and very high C_5 5000-20,000 micro mhos/cm at 25°C. The sodium hazard rating limits are the same as those in the U S.D.A. systems, namely, Low S_1, 0-16, Moderate S_2 10-18, High S_3, 18-26 and very high S_4, 26-31 SAR. Classifying the soils into four major textural groups, sand, sandy loam, loam and clay and the crops into three main classes as sensitive, semi-tolerant and tolerant to salts, Kanwar has devised a traingular diagram for determining the suitability of irrigation waters.

Quality rating method of Ramamoorthy : In this system, the E.C. range is wider than that of Kanwar's

method for waters having E.C. values above 2.25 m. mhos/cm. The E. C. ranges are C_1 0-250, C_2 250-750, C_3 750-2250. C_4 2250-6750 and C_5 6750-20250 micro mhas/cm at 25°C. Also the sodium hazard limits employed in this system are more rigid than those of Kanwar's method which makes the sum of salinity-sodium hazard rating indices higher by 1 or 2 units depending upon the SAR value of the water. The sodium hazard limits in this system are S_1 0-6.6, S_2 6.7-11.6, S_3 11.7-16.6 and S_4 above 16.6 SAR. From the nomogram developed by Ramamoorthy and his associates at the Soil Testing Laboratory, I.A.R.I., the SAR value can be interpolated from the E. C. and Ca + Mg values of irrigation water and its quality rating specified The numerical ratings for soil texture and salt tolerance of plants given by Ramamoorthy are as follows : 4 for clay, 3 for clay loams, 3 for loams, 2.5 for sandy loams and 2 for sandy soils; 3 for sensitive crops, 2 for semitolerant and 1 for tolerant crops. Using these values and the water quality rating as judged by the above mentioned nomogram, recommendations for the use of irrigation waters can be given so as the sum of all ratings for soil texture, plant tolerance, salinity and sodium hazard ratings does not exceed nine.

The water quality rating indices and their suitability for irrigation given in Table I reflect the differences in the criteria employed in these three systems as discussed above on water quality rating. This Table shows that out of 50 samples, for 22 samples it is not possible for fixing the numerical indices for salinity and sodium hazard as per the U.S.D.A. rating system, since the E.C. value exceeds 5 m.m. hos/cm in these cases. On the other hand, such a rating is possible for all samples by the other two systems of rating. In terms of their suitability for irrigation on sandy/sandy loam soils, out of 50 samples, 29, 25 and 6 samples are classed as unsafe and unsuitable for irrigation according to the rating system of U.S.D.A., Ramamoorthy and Kanwar respectively. The number of samples that could be used for irrigation without causing salt injury to all types of crops is 15 as per Kanwar's method of rating as against 10 by the other two methods. Similarly the number of samples that could be used for irrigation of salt tolerent crops is 22 as per Kanwar's method as against 6 and 5 by the other two methods. These differences and the experience of most of the farmers who are successfully using these waters without detrimental effect on crop growth despite the high salt content point out that the U.S.D.A. rating system has limited applicability for Indian conditions. The water quality rating systems of Kanwar and Ramamoorthy agree very well with the conditions of choice and field performance of irrigated crops and have wider scope of applicability for Indian conditions particularly for arid and semi arid areas. It is hoped that increasing use of these latter systems will be adopted by the Soil Testing Laboratories in the country.

Recommendation for chemical treatment : Even with the most appropriate system of water quality rating, allowance has to be given for the Residual Sodium Carbonate (RSC) of irrigation water, so that for waters

having more than 2.5 RSC, chemical treatment with the calculated amount of gypsum can be recommended. The importance of taking into account RSC, is seen by the fact that although 10 samples have more than 2.5 RSC, on the basis of water quality rating 9 of them (excepting sample No.27) will be classed as suitable without any chemical treatment of water whereas on the basis of RSC, their quality and use could be further improved (sample Nos. 4, 6, 9, 10, 12, 13, 14, 15 and 20) by gypsum treatment.

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