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Seasonal variation in characteristics of underground irrigation waters and their influence on soils

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Abstract

Two sets of well water were collected, one before the monsoon rains in the month of April-May and second after the cessation of monsoon rains in the month of October. After the rains, salt concentration in the well water was reduced. Soil samples were also collected from areas irrigated by water of some of these wells, and analysed to study the effect of continuous use of irrigation water on them. Amount of salt retained in soil after the rains was linearly related to initial salinity in the soil. Being low rainfall in the studied area, the negative values of salt regime constant 'd' were also of very low order indicating very less leaching of salts from the crop root zone and thus, continuous use of higher salinity water might hinder the crop production.

Key words: seasonal variation, underground irrigation waters, influence on soils.

Introduction

The concentration and nature of the salts present in irrigation water determine its quality. The nature of salts in irrigation water, sometimes may be more important than the total amount of salts e.g. if the proportion of sodium in irrigation water is high, the soils may become gradually unproductive. Even water of doubt full quality can be used without serious damage to soils and crops, if the necessary precautions are taken in irrigation and soil management. The limits for maximum permissible salt content of water depend also on the nature of the salts and amount of rainfall. Saline irrigation water is better suited on soils which are permeable and where the water table remains 1.8 to 3 meters below the surface.

A large area in Bikaner district of Rajasthan is irrigated by tube wells. A critical study of the variation in quality of well waters and their influence on soils in long use was under taken.

Materials and methods

Water samples were collected from fifty six tube wells from twenty villages of Bikaner district of Rajasthan. The first set of samples was drawn before the monsoon in April – May 2004 and the second set of after the cessation of monsoon rains in October 2004. For salt balance studies soil samples (0-30 cm depth) from twenty selected sites were also collected in month of April-May and October 2004 and salt balance in irrigated soils was calculated by equation given by Szabolcs (1969) as $d = b - [a+(cv/mds) x 10^{-5}]$ where,

d = salt leached or accumulated, g/100 g soil
b = amount of salt at and of observation, g/100 g soil
a = amount of salt at start of observation, g/100 g soil
c = salt content in rain water, g/L
v = amount of monsoon rains, mm
m = thickness of soil layer, m
ds = bulk density of soil, mg/m^3

Water and soil samples were analysed using standard methods and procedures. Soils of the studied area are aeolian, coarse textured, calcareous and alkaline in nature with low fertility status, low water holding capacity and susceptible to wind erosion

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Results and discussion

The analytical data of tube well waters are presented in table1. Value under A relate to the pre-monsoon period and values under belated post- monsoon period. Calculated valued of SAR, RSC and pH, EC are given in table 2. Soil data are presented in table 3 and 4.

Data presented in table1 indicate that the tube well waters contain relatively high sodium, chloride and bicarbonate barring a few exceptions. Another feature about these waters is that magnesium is generally higher than calcium. After the monsoon rains, salt concentration is the tube well waters were reduced. The ions which have decreased are sodium, Chloride and sulphate while, magnesium, bicarbonate are increased and calcium and carbonate ions not showed much difference. P^{H} values of all irrigation waters were noticed to fluctuate during April-May to October (Table-2). The mean P^{H} value of water samples was increased from 8.30 to 8.44 during April -May to October. The increase in p^{H} of these irrigation waters during rainy season might be due to increase in concentration of neutral salts of calcium and magnesium. The results get support from findings of Gupta *et al.* (1982).

Electrical conductivity of underground irrigation waters of Bikaner district showed decreasing trend from April-May to October (Table 2). The mean value of EC of irrigation waters was decreased from 2.58 to 2.02 dSm^{-1}.Systematic decreasing trends was observed in EC of waters between the periods of April-May to October. The highest and lowest EC values of all the samples were observed during the months of April-May and October, respectively. The EC of irrigation waters was decreased 21.71 per cent during the observation period. Owing to the rain water induced dilution and leaching of salts the electrical conductivity decreased during the rainy season. Similar results were also reported by Kameriya (1977).

It is evident from the data presented in table 2 that a systematic decreasing trend in SAR values was observed in all irrigation waters between the period of April-May to October. The highest SAR values of all waters were observed during the month of April-May, while the lowest values were observed during the month of October. The men SAR value of irrigation waters of Bikaner district was decreased from 14.84. To 9.77 (34.16 per cent) during the study period. The decrease in SAR value during rainy season might be due to a decrease in the salt concentration. This showed that there was improvement in the quality of underground irrigation waters both in salinity and sodium hazards after monsoon rains. Similar finding were also reported by Gupta *et al* (1982).

Residual sodium carbonate contents of all irrigation waters were observed minimum during the month of October and maximum during the months of April-May (Table 2). The decrease in mean RSC values of irrigation waters of Bikaner district was recorded from 1.30 to 0.44 me L^{-1} during April-May to October. This showed that there was improvement in the quality of underground irrigation waters with respect to alkali hazards. This might be due to leaching of soluble salts and increase in neutral salts of calcium and magnesium during raining season. The results of present investigation get support from the findings of Datta and Taygi (1996).

Salt balance in plant root zone is very important. Water evaporates in a pure state leaving salts behind. As water is removed from the soil by evaporation/ evapotranspiration the salt concentration in the soil solution is increased. Each irrigation adds some salts to soil depending upon the water entering the soil and the salt concentration in the water. This salts remains in the soil and accumulates unless it is leached away by rain water or water applied in excess of crop requirement. In the present study, salt removal by rain water was estimated using the equation given by Szabolcs (1969). Results of salts balance studies of soils of Bikaner district given in table 4 and discussed as follows. The negative values of salt regime constant 'd' (Table 4) indicated that the salt added through irrigation water was either leached down to lower layers of the soil profile or washed through the surface run off. It is further clean from the data that amount of salt retained in soil after the rains was linearly related to initial salinity in the soil. In other words, higher was the amount of accumulated salt in soil after the irrigation cycle, greater was the amount of salt leached/washed. However, being low rainfall in the studied area, the negative values of salt regime constant 'd' were also of very low order indicating very lees leaching of salts from the crop root zone and thus continuous use of higher salinity water might hinder the crop production.

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Table 1. Chemical composition of tube well waters before and after monsoon (expressed as me L^{-1}) of Bikaner district

Characters	CO_3^{--}		HCO_3^-		Cl^-		SO_4^{--}		Ca^{++}		Mg^{++}		Na^+	
	A*	B**	A	B	A	B	A	B	A	B	A	B	A	B
Range	0.5-2.0	Nil-2.0	0.75-5.5	1.0-4.0	4.0-52.0	3-42.3	0.49-9.89	0.03-8.0	0.4-7.36	0.15-5.80	0.60-10.20	0.60-10.0	4.34-55.74	3.0-40.9
Mean	1.08	0.90	3.27	2.79	17.28	14.47	3.43	1.93	1.57	1.59	2.76	3.55	20.95	14.59

A * Before monsoon B ** After monsoon

Table 2. Seasonal variations in characteristics of underground irrigation waters of Bikaner district

Characters	EC (dSm^{-1})		pH		SAR		RSC (me L^{-1})	
	A*	B**	A	B	A	B	A	B
Range	0.67-6.52	0.49-5.28	7.30-8.78	7.75-8.90	4.85-34.65	3.16-52.16	Nil-5.50	Nil-3.00
Mean	2.58	2.02	8.30	8.44	14.84	9.77	1.30	0.44

A *Before monsoon B ** After monsoon Nil-Negative RSC values

Table 3. Physico- chemical and fertility parameters of soils of Bikaner district

Characters	Depth (cm)	Bulk density ($Mg\ m^{-3}$)	Permeability index	EC (dSm^{-1})	pH	ESP	Dehydrogenase activity (ug TPF /g soil)	Available nitrogen (Kg/ha)	Available Phosphorus (P_2O_5 kg /ha)	Available Potassium (K_2O kg/ ha)
Range	0.15	1.38-1.60	54.70-136.84	0.10-1.15	8.57-9.21	0.37-4.35	0.90-10.12	62.76-370.85	3.25-62.31	108.78-372.54
	15-30	1.40-1.63	56.08-156.82	0.08-0.95	8.62-9.28	0.66-4.75	0.46-8.33	56.95-307.40	2.20-53.13	100.79-357.50
Mean	0-15	1.49	89.30	0.42	8.74	2.19	4.25	152.82	17.51	209.99
	15-30	1.52	96.16	0.37	8.80	2.42	3.48	127.75	15.16	189.26

Table 4. salt regime constant (d) as related to salt and water characteristics of selected villages of Bikaner district of Rajasthan during 2004

Sample Code	ECe (dSm^{-1}) during April-May-2004 (a)	ECe (dSm^{-1}) during Oct. 2004 (b)	EC_w (dSm^{-1}) (c)	Total rain water (mm) (v)	Soil depth (m) (m)	Bulk density ($Mg\ m^{-3}$) (ds)	Salt regime constant (g 100/g soil) (d)
Pal_2	3.79	2.76	0.01	114	0.30	1.56	-0.0150
Kil_2	3.25	1.92	0.01	114	0.30	1.48	-0.0210
Bam_2	4.18	2.67	0.01	114	0.30	1.57	-0.0220
Pem_1	6.21	4.83	0.01	114	0.30	1.54	-0.0200
Pem_2	5.06	3.81	0.01	114	0.30	1.55	-0.0180
Sud_1	1.80	1.37	0.01	181	0.30	1.54	-0.0070
San_1	2.37	1.86	0.01	181	0.30	1.53	-0.0080
Jet_1	23.23	13.60	0.01	181	0.30	1.62	-0.1310
Thu_1	4.22	2.96	0.01	181	0.30	1.58	-0.0180
Aka_3	3.63	2.02	0.01	123	0.30	1.49	-0.0260
Jha_3	17.10	11.97	0.01	123	0.30	1.51	-0.0810
Cha_1	5.31	3.83	0.01	123	0.30	1.45	-0.0240
Kot	6.33	4.42	0.01	123	0.30	1.53	-0.0290
Mul_1	1.40	0.90	0.01	182	0.30	1.48	-0.0078
She_1	7.09	4.16	0.01	182	0.30	1.49	-0.0460
Kho_1	5.78	4.09	0.01	182	0.30	1.45	-0.0280
$Dhap_1$	7.00	4.04	0.01	182	0.30	1.51	-0.0460
Muk_1	20.20	17.45	0.01	222	0.30	1.49	-0.0420
Muk_2	7.48	4.05	0.01	222	0.30	1.57	-0.0500
Ras	6.06	2.75	0.01	222	0.30	1.44	-0.0540