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Quality of Irrigation Waters in the Gandak Command of North Bihar

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Waters collected from different sources were found to be good for irrigation purposes in open textured soils. Na+ and HCO_3 – ions, EC, RSC and SSP were relatively higher in ground, well and hand pump waters compared to canal water. The net work of canal system in the porous sandy loam to silt loam textured soils of North Bihar, causing rise in ground water table, might have played a role in the development of salinity in these soils.

If irrigated agriculture is to remain successful, soil salinity should be controlled (Scofield, 1940). In general, water with high salt contents should not be used for irrigation on soils having low infiltration and drainage rates. The quality of Gandak canal water in Bihar has been reported to be good. An attempt has been made in this paper to compare the quality of ground water with different irrigation waters and study the soil characteristics in the salt affected area of the calcareous belt of North Bihar under Gandak Command.

MATERIAL AND METHODS

Soil profile samples were collected from three profiles, one each from upland, medium land and low land. This pattern of physiography is most common in this belt. Ground waters (from each profile site) were also collected. Waters were collected from canal, tubewell, well and hand pump sources (three in numbers from each source). The soil and water samples were analysed in the laboratory by the standard methods suggested by Richards (1954). The analytical data of water samples collected from various locations did not vary much and so their mean values have been reported for each source.

RESULTS AND DISCUSSION

The pH of the irrigation waters studied varied from 7.7 to 7.9 which indicated that they were safe but on the border line (Table I). The electrical conductivity of the water ranged between 620 and 630 micromhos/cm. Thus the water samples have medium amount of salts. Richards (1954) observed that soil may develop 2 to 10 times the conductivity to that of water used for irrigation. A similar pattern was seen in the properties of the soils

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irrigated with these waters since the EC of the surface layers of profiles I, II and III were 6120, 7280 and 3410 micromhos respectively (Table II).

From the critical observation of the data in Table II, it is evident that the problems of salinity and sodicity are more in the upland than in the medium and low lands. This may be due to relatively lighter texture and lower moisture regime for a longer time in upland compared to low land, thus resulting in differential rate of evaporation from the soil surface. The leaching requirement for this group of water is 18.6% (Richards, 1954). Hence, the water used for irrigation should be about 20% in excess of the actual consumptive use to avoid any accumulation of salts. But as the water table was observed to be fluctuating between 60 and 180 cm from the surface, salts may be deposited again on the surface when evapotranspiration increases during summer. Kulkarni (1961) observed a correlation between concentration of salts on the surface soil and that of sub-soil water upto a depth of 120 cm.

The data on ESP of the soil samples indicated higher accumulation of Na^{+} in the exchange complex with favourable conditions for evaporation. Na^{+} concentration in the irrigation waters varied between 1.4 and 4.6 me/l. ESP values were just above the critical limit in profile I, just below the critical limit in profile II and moderate in profile III. This suggested that the ESP was related with the Na^{+} content of ground water and evaporation rate from the soil surface.

The SSP varied from 20.34 (for canal water) to 72.00% (for hand pump water). Any water having SSP more than 75% may lead to sodium hazard. Thus only hand pump water poses the hazard of Na accumulation in soils. The SSP of ground water and hand pump water was, respectively, two and a half and three and a half times higher than that of canal water showing thereby the deterioration in the quality of the ground water.

The SAR of hand pump water was also comparatively high (5.2). This value of SAR for medium salinity water was very close to the upper limit as per the standards fixed by U. S. D. A. (1954). This SAR was seven times higher than that of canal water. Continuous use of hand pump water may lead to sodium hazard in poorly drained and heavy textured soils.

All the waters were rich in bicarbonates which favour precipitation of Ca upon irrigation. Dominance of bicarbonates in the water from calcareous region was reported by Paliwal and Gandhi (1976) and Jha and Mandal (1979). The canal water was best having negative RSC values. Ground water and hand pump waters were unsuitable (RSC 3.5 to 3.8) and well water was doubtful (RSC 2.8). It follows that the use of ground waters may lead to salinisation of soil.

Thus the quality of canal water may be classified as good. However. this water may reach the ground water table by percolation leading to rise in water table. This may bring the salts to surface layer and the salts may get deposited when evaporation is high. This may uetimately lead to salinity and sodicity in the soils of calcareous belt of North Bihar.

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TABLE I. Quality of water samples collected from different irrigation sources (Mean value)

Source	pH	EC	me/1							RSC	SAR	SSP	Irrigation Class
		micromhos/cm.	Na^{+}	$Ca^{++} + Mg^{++}$	K^{+}	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$				
Ground water	7.9	630	3.3	2.9	0.03	Nil	6.72	0.88	0.12	3 8	2.7	53.0	C_2S_1
Caual water	7.8	630	1.4	5.4	0.08	Nil	3.90	1.75	0 32	-1.5	0.77	20.34	C_2S_1
Tubewell water	7.8	620	2.7	3.5	0.08	Nil	8.0	0.92	0.14	4.5	1.49	42.99	C_2S_1
Hand pump water	7.8	630	4.6	1.6	0.20	Nil	7.1	1.57	0 12	4.5	5.2	72.00	C_2S_1
well water	7.7	630	3.5	2.7	0.07	Nil	9.0	1.65	0.20	6.5	3.1	55.83	C_2S_1

Slainity Hazard (Condutivity Micro mhos/cm)

C_1 = Excellent — < 250

C_2 = Good — 250 – 750

C_3 = Doubtful — 750 – 2250

C_4 = Unsuitable — 2250

Sodium hazard (SAR values)

S_1 = Can be used tor irrigation on almost all soils

S_2 = Can be used on coarse textured soil having good permeability

S_3 = Require special soil management

S_4 = Unsatisfactory for irrigation

TABLE II Physical and chemical characteristics of salt affected soils

Depth (cm)	pH	EC (micro mhos/cm)	ESP (estimated)	Free $CaCO_3$ (%)	Textural class	Salinity class
				Upland profile		
0– 20	9.2	6120	17.0	11.17	Sandy loam	Calcareous saline-sodic
20– 55	8.6	3410	8.5	11.35	Sandy clay loam	
55– 90	8.5	3120	8.0	12.50	Clay loam	
90–130	8.5	2750	8.2	13.60	Sandy clay loam	
				Medium land profile		
0– 18	8.5	7280	12.0	12.51	Silt loam	Calcareous saline
18– 41	8.3	3300	4.0	16.25	Silt clay loam	
41– 75	8.1	2120	2.0	17.51	Clay loam	
75–120	8.0	1530	1.5	18.50	Clay loam	
				Low land profile		
0– 16	8.4	3410	5.0	10.60	Sandy clay loam	Calcareous tending towards salinity
16– 36	8.1	1560	3.5	11.25	Clay loa	
36– 75	7.9	1620	2.0	11.35	Clay	
75–110	7.9	1380	1.2	12.63	Clay	