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Evaluation of irrigation water quality of buksha block of Jaunpur district of eastern Uttar Pradesh

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ABSTRACT
Evaluation of irrigation water quality of Jaunpur district of eastern uttar pradesh were slightly alkaline to moderate alkaline with carbonate content of irrigation water were ranged from 60 mgL^{-1} to 180 mgL^{-1}. The bicarbonate content were ranged from 183.0 mgL^{-1} to 732.0 mgL^{-1} with calcium + Magnesium content of 109.4 mgL^{-1} to 431.4 mgL^{-1} and average calcium of irrigation water were ranged from 20 mgL^{-1} to 60 mgL^{-1}. However, in case of magnesium, it was ranged from 49.4 mgL^{-1} to 377.4 mgL^{-1}. The analysis of residual sodium carbonate of irrigation water were calculated as -20.76 to 4.93 while sulphate was absent in all irrigation water samples. The range of electrical conductivity was 0.47 dSm^{-1} to 1.60 dSm^{-1} at 25^0C with potassium content of 3.0 mgL^{-1} to 11.0 mgL^{-1}. The range of sodium content and Sodium adsorption ratio of irrigation water were 0.5 mgL^{-1} to 5.0 mgL^{-1} and 0.24 to 2.79 respectively. From the calculation of the above mentioned ion content in the irrigated water indicated that the water is suitable for the irrigation.
Keywords: *Irrigation water, water quality, Sodium Absorption Ratio, Residual Sodium Carbonate*

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INTRODUCTION

The quality of irrigation water is one of the major factors that affects the growth and development of any crops by influencing the physiological activity. It is estimated about 45% of irrigation water requirement is met from ground water sources. The quality of ground water varies from place to place along with the depth of water table. Irrigation water consists of (a) surface water and (b) ground water (1). Whatever may be source of irrigation water, viz. river canal, tank, open well, or tube well or hand pump, some soluble salts are always dissolved in it. However, the nature and quantity of dissolved salts depend upon the source of water and its course before use. Among the soluble constituents calcium, magnesium, sodium, chloride, sulphate, bicarbonate and boron are of prime importance in determining the quality of irrigation water and its suitability for irrigation purposes. However, other factors such as texture, structure of the soil, its drainage characteristics, nature of the crop grown and climatological conditions are equally important in determining the suitability of irrigation water in agriculture.

The determination of ground water quality and their rate of depletion as well as water levels are concern in most of the country because of large scale disposal of urban and industrial due to wastes and use of chemical fertilizers and pesticides in agricultural fields (2). The poor quality of water can be flexible and water polluted up to certain extent in general sense can be regarded as pure (*3*). Bello (4) also reported that the poor quality of irrigation water should must affects the both soil quality as well as crop production due to dissolve salt were supported by the findings of Michael (3). The widespread consumption of the fertilizers influenced the quality of groundwater in the rural areas was reported by Stuart and Milne (6) in Leon, Mexico, from irrigation with wastewater. While in other hand several studies of with small differences between rural and urban nitrate concentrations observed in the non-agricultural sources of nitrogen. The water born diseases like cholera, dysentery, gastroenteritis and typhoid fever was reported by Bodhankar and Chatteljee (7) by using ground water as a drinking water

due to the highly influence of dissolve unnecessary minerals. The dissolve ions like calcium (Ca^{2+}), sulphate (SO_4^{2+}) , nitrate (NO_3^{2-}), chloride (Cl^-), boron (Br), carbonate (CO_3^{2-}) and bicarbonates (HCO_3^-) should must be determine the suitability of water for irrigation (8).

METHODOLOGY

The present investigation was carried out during 2004 - 05 at Department of Agricultural Chemistry and Soil Science, Tilak Dhari Postgraduate College, Jaunpur. The details of experimental materials used and methods followed are presented here as under:

Area of study: Fifty sites for irrigation water sampling were selected. These sites are situated around the Buksha Block, Jaunpur district. Jaunpur lies on 25^0 46' N latitude and 82^0 40' E longitudes and altitude is 30 M msl. The water samples corresponding to village/sites are listed below.

Collection of water samples: The irrigation water samples were collected from 50 villages/sites around the Buksha Block, Jaunpur. The samples were taken in 500 ml polythene bottles (stoppered). The tube-wells were in continuous discharge for about 10 to 20 minute prior to sampling. Water samples were protected against bacterial growth by adding 2-3 drops of pure toluene.

Analysis of the irrigation water:

Chemical analysis:

pH: pH value of any solution is defined as the negative logarithms of its hydrogen ion concentration (9). pH of irrigation water samples were determined by digital pH meter using glass electrode in water samples **(**10)

Electrical conductivity (E.C.): All E.C. measurements of irrigation water samples were made with digital E.C. meter using conductivity cell (10).

Carbonate and bicarbonate: Carbonate and bicarbonate in irrigation water samples were determined by titration the water samples with standard sulphuric acid (0.1N. H_2SO_4) using phenolphthalein and later on methyl red as indicators (10).

Sulphate: Sulphate of water samples was determined in water sample by turbidimetric method (11).

Calcium and magnesium: Calcium and magnesium of water sample were determined by the versenate method (EDTA) Ethylene diamin tetra acetic acid (11).

Sodium and Potassium: Na^+ & K^+ concentration in water samples were determined flame photometrically (10).

Sodium adsorption ratio (S.A.R): S.A.R. of water was determined by the following formula (12).

$$S.A.R. = \frac{Na^{+}\ meq/l}{\sqrt{\frac{Ca^{++}\ meq/l + Mg^{++}\ meq/l}{2}}}$$

Residual sodium carbonate (R.S.C.): R.S.C. of water was determined by the following formula (12).

$$R.S.C. = (CO_3^{2-} + HCO_3^-) - (Ca^{2+} + Mg^{2+})$$

Statistical analysis: The statistical analysis in this study were calculated from the below mentiontioned formulas

Mean: Mean of the collected data were calculated as the given formula

$$\textbf{Mean} = \frac{\sum x}{n}$$

Where as,

Sum of all observation = $\sum x$

No. of samples = n

Standard deviation: Standard deviation the collected data were calculated as the given formula

$$\text{Standard deviation (S.D.)} = \sqrt{\frac{\sum(x - \mu)^2}{N}}$$

Where,

An observation or variate value = x

Arithmetic mean of the population = μ
Number of given observations. = N
The results of the experiment are presented under following sections.

RESULT AND DISCUSSION

Fifty groundwater samples were drawn from the wells, which included hand pumps, and tube-well was analyzed for physicochemical parameters. The results of the physicochemical analysis are presented in tables-1. The Indicated parameters in various pint of view are mentioned head wise.

pH: Observation of pH is one of the important factor of ground water analysis. The data pertaining to pH of irrigation water have been presented in table-1. The perusal of data indicates that pH of irrigation water samples ranged from 7.2 to 8.2 with a mean value of 7.61. The data revealed that most of irrigation water samples were slightly alkaline in nature. The 10% of irrigation water samples are very slightly alkaline in reaction while 74% of irrigation water samples are slightly alkaline in reaction only 16% samples are alkaline in reaction. The similar observation related to pH of irrigated water were mentioned in *Bureau of Indian Standards (13).* However, in generally pH values for normal irrigation should be between 6.00 and 7.00, while values above 7.00 are considered as of increasing hazard substances (14 and 15).

Electrical Conductivity (EC): Conductivity is the measure of capacity of a substance to conduct the electric current. Most of the salts in water are present in their ionic forms and capable of conducting current and

conductivity is a good indicator to assess groundwater quality. E.C. of irrigation water samples are given in Table-1 ranged from 0.47 dSm^{-1} to 1.60 dSm^{-1} with mean value 0.89 dSm^{-1} at the 25^0C. It means that all the irrigation water is safe for irrigation. The division based on conductivity values suggest that any 26.66 % of the wells are below the safe limit of 1500 micromohs/cm while 46.68 % of the wells are in the range of 1500-3000 micromohs/cm and 26.66 % of the wells are above 3000 micromohs/cm range (16)

Carbonate (CO_3^{--}) and Bicarbonate (HCO_3): The data regarding CO_3^{--} water is presented in table-1. It was observed from the data that CO_3^{--} content of irrigation water samples ranged from 60-180 mgL^{-1} with mean value of 68.4 mgL^{-1}. The presence of CO_3^{--} was observed in only 37 water samples.

HCO_3^- content of irrigation water samples are presented in Table-1. HCO_3^- content of irrigation water samples ranged from 183.0 mgL^{-1} to 732.0 mgL^{-1} with mean value of 415.8 mgL^{-1}. Irrigation waters rich in bicarbonate content tend to precipitate in soluble calcium and magnesium in soil as their CO_3^{--}. The bicarbonate anion is an important in irrigation water as regards calcium and to a lesser degree also of magnesium as their carbonates in the soil. This brings about a change in the soluble sodium percentage in the irrigation water and therefore, an increase of the sodium hazard (1). The findings of Trivedy R.K. et al., (17) indicates that Alkalinity in the water is generally imparted by the salts of carbonates, silicates, etc. together with the hydroxyl ions in free State and bicarbonate alkalinity varies from 325 to 400 mg/l

Sulphate (SO_4): The sulphates were absent in almost samples collected from the different villages of the buksha block of Jaunpur district is mentioned in the table 1.

Calcium + magnesium ($Ca^{++} + Mg^{++}$), Calcium (Ca^{++}): Calcium is almost naturally present in water. Calcium is a determinant of water hardness, because it can be found in water as Ca ions. $Ca^{++} + Mg^{++}$ content of irrigation water samples are given in table-1. The data revealed that $Ca^{++} + Mg^{++}$ content of irrigation water samples ranged from 109.4 mgL^{-1} to 431.4mgL^{-1} with mean value of 187.0mgL^{-1}. Where as, calcium content of irrigation water samples were presented in Table-1. Ca^{++} content of irrigation water samples ranged from 20.0 mgL^{-1} to 80.0 mgL^{-1} with mean value 42.2 mgL^{-1}. If the calcium concentration is greater than 35 per cent of the total cations the water is fit for irrigation **(**18). Calcium content in the groundwater varies from 112.22 to 168.33 mg/l. All samples were within maximum permissible limit prescribed by the *Bureau of Indian Standards.,* (*13).*

Magnesium (Mg^{++}): Magnesium has many different purposes and consequently may end up in water in many different ways. Mg^{++} content of irrigation water samples are presented in Table-1. Mg^{++} content of irrigation water samples ranged from 49.40 mgL^{-1} to 377.4 mgL^{-1} with mean value 146.10 mgL^{-1}. The saline ground water contains magnesium higher than Ca^{++}, the mean Mg^{++} : Ca^{2+} ratio of the water lies between 1 to 9, while a few samples have even higher Mg^{++} : Ca^{++} ratio with increase in Mg^{++} : Ca^{++} ratio and SAR of the leaching water the degree of soil dispersion increased significantly (18). The range of magnesium were calculated from 96.00 to 153.17 mg/l prescribed by *Bureau of Indian Standards.,*(13).

Mg^{++}/Ca^{++}: Mg^{++}/Ca^{++} content of irrigation water samples are presented in Table-1. The Mg^{++}/Ca^{++} content of irrigation water samples ranged from 0.82 to 10.76 with mean value 3.72. The four samples are less than 4 in Mg: Ca ratio and sixteen water samples are more than 4. Soil sodicity would increase more at the same SAR if the water contains a higher proportion of magnesium to calcium. It is more important if the Mg: Ca ratio in irrigation water happens to be more than 4.

Table 1: Physico-chemical parameters of ground-irrigated water of Buksha block of Jaunpur district of eastern Uttar Pradesh.

S.N.	pH	E.C. (dSm^{-1} at 25^0C)	(CO_3^{--}) (mgL-1)	(HCO_3^-) (mgL-1)	(SO_4^{--}) (mgL^{-1})	(Ca^{++} + Mg^{++}) (mgL-1)	(Ca^{++}) (mgL-1)	(Mg^{++}) (mgL-1)	Mg^{++}/Ca^{++} (mgL^{-1})	(K^+) (mgL^{-1})	(Na^+) (meq/l)	S.A.R.	R.S.C.
1	7.8	0.69	120	366	Absent	119.1	36	83.1	2.3	9	2.00	1.36	1.36
2	8.2	0.87	180	183	"	161	24	137	5.7	11	3.00	1.70	-3.48
3	7.5	0.7	0	366	"	135.2	32	103.2	3.22	7	1.00	0.63	-4.09
4	7.8	0.75	180	244	"	193.1	48	145.1	3.02	8	2.00	1.06	-4.34
5	8	0.77	120	305	"	187	40	147	3.67	10	3.00	1.60	-5.10
6	7.5	0.47	0	732	"	109.4	60	49.4	0.82	6	2.00	1.50	4.93
7	7.5	0.97	120	366	"	135.2	40	95.2	2.38	8	4.00	2.55	0.16
8	7.5	0.87	120	549	"	261	80	181	2.26	7	4.00	1.84	-5.90
9	7.5	0.60	0	427	"	164	40	124	3.1	7	1.00	0.57	-5.21
10	7.8	0.80	60	366	"	206	44	162	3.68	8	3.00	1.52	-7.53
11	7.5	1.60	120	549	"	431.4	54	377.4	6.98	6	4.00	1.38	-20.76
12	7.5	0.73	60	427	"	128.7	36	92.7	2.57	5	2.00	1.30	-0.43
13	7.3	1.27	0	305	"	251	80	171	2.13	6	0.50	0.24	-13.07
14	7.5	0.83	0	549	"	193.1	44	149.1	3.38	5	1.00	0.53	-5.47
15	8.0	0.85	120	366	"	202.8	28	174.8	6.24	9	4.00	2.01	-5.79
16	7.5	0.88	0	549	"	225.3	44	181.3	4.12	8	2.00	0.97	-8.12
17	7.8	0.86	60	488	"	154.5	30	124.5	4.15	8	2.00	1.17	-1.75
18	7.5	1.06	60	427	"	270.4	40	230.4	5.76	7	4.00	1.75	-11.96
19	7.5	0.93	0	610	"	218.9	36	182.9	5.08	5	0.75	0.37	-6.85
20	8.0	0.69	120	183	"	170.6	32	138.6	4.33	5	4.00	2.22	-6.01
21	7.5	1.60	120	427	"	376.6	32	344.6	10.76	8	3.00	1.10	-18.96
22	7.2	0.52	0	305	"	109.4	56	53.4	0.95	5	1.00	0.75	-2.20
23	7.2	0.63	0	427	"	148.1	60	88.1	1.46	5	1.50	0.94	-3.25
24	8.2	1.00	120	244	"	170.1	36	134.1	3.72	11	5.00	2.79	-4.84
25	7.5	1.24	0	610	"	273.6	50	223.6	4.47	7	3.00	1.31	-10.90
26	7.8	0.84	120	183	"	177	56	121	2.16	9	2.00	1.12	-5.76
27	8.0	1.11	60	427	"	183.5	44	137.5	3.13	10	4.00	2.18	-4.52
28	8.0	1.00	120	305	"	154.5	20	134.5	6.72	9	4.00	2.30	-3.07
29	7.7	1.35	60	610	"	212.4	30	182.4	6.08	7	2.00	0.98	-4.51
30	7.6	0.65	60	427	"	164.2	50	114.8	2.28	5	2.00	1.16	-2.95
31	7.5	0.84	0	549	"	177	40	137	3.42	7	1.00	0.55	-4.28
32	7.5	0.65	60	305	"	144.9	60	84.9	1.41	6	1.20	0.76	-2.99
33	7.5	0.80	0	427	"	167.4	52	115.4	2.22	6	1.00	0.58	-5.10
34	7.5	0.82	60	366	"	177	56	121	2.16	4	3.00	1.68	-4.76
35	7.5	0.66	60	305	"	125.6	34	91.6	2.69	3	3.00	1.97	-2.24
36	7.5	0.75	60	305	"	135.2	36	99.2	2.76	3	1.00	0.63	-2.96
37	7.8	1.12	60	366	"	177	36	141	3.92	8	2.00	1.09	-5.40
38	7.5	0.80	60	366	"	151.3	40	111.3	2.78	5	2.00	1.20	-3.16
39	8.0	0.81	120	366	"	177	36	141	3.92	9	3.00	1.64	-3.40
40	7.5	0.89	60	427	"	167.4	30	137.4	4.58	7	2.00	1.12	-3.81
41	7.8	1.09	60	305	"	167.4	36	131.4	3.65	4	3.00	1.69	-5.61
42	7.8	0.88	60	488	"	177	28	149	5.32	4	2.00	1.08	-3.66
43	7.8	1.00	120	366	"	183.5	30	153.5	5.12	6	2.00	1.06	-4.13
44	7.5	0.88	120	366	"	193.2	44	149.2	3.39	7	1.26	0.66	-4.48
45	7.5	0.95	60	427	"	193.2	40	153.2	3.83	9	2.00	1.05	-5.61
46	7.5	0.76	60	488	"	173.9	40	133.9	3.34	9	1.00	0.55	-3.02
47	7.5	0.87	0	671	"	186.7	38	148.7	3.91	6	2.00	1.06	-3.14
48	7.5	0.89	120	549	"	209.3	50	159.3	3.19	3	1.00	0.51	-2.61
49	7.2	0.81	60	427	"	183.5	38	145.5	3.83	4	1.50	0.81	-4.88
50	7.2	1.22	120	549	"	193.2	36	157.2	4.37	8	2.00	1.04	-1.74
Mean	7.61	0.89	68.4	415.8	-	187	42.2	146.1	3.72	6.7	2.27	1.23	-4.95
S.D.	0.25	0.24	51.4	125.4	-	58.3	12.6	57.2	1.75	2.04	1.11	0.59	4.25

Potassium (K): Potassium is one of the important building blocks of plants and animals. Potassium content of irrigation water samples are presented in Table-1. The perusal of data indicates

that K^+ content of irrigation water samples ranged from 3.0mgL^{-1} to 11.0 mgL^{-1} with mean value 6.70 mgL^{-1}. Water containing a high concentration K^+ is considered good because K^+ alleviates to some extent the harmful effect of sodium. (19 and 20). The European Economic Community (21 and 22) (EEC) has prescribed the guideline level of potassium at 10 mg/l in drinking water. As per European Economic Community (21) criteria, 26.66% samples exceeding maximum permissible limit while 73.34% samples of the study area fall within the guideline level of 10 mg/l.

Sodium (Na): Sodium content of irrigation water samples are given Table-1. Na^+ content of irrigation water samples ranged from 0.5 meq/l to 5.0 meq/l with mean value 2.27 meq/l Most of irrigation water samples are low sodium hazard in nature. It means that all the irrigation water samples are suitable for the irrigation. The Sodium content in study area has shown variation from 82 to 1093 meq/l prescribed by *Bureau of Indian Standards.*, (13).

Sodium Absorption Ratio (SAR): The sodium adsorption ration (SAR) indicates the effect of relative cation concentration on sodium accumulation in the soil. Sodium adsorptions ratio of irrigation water samples are given in Table-1. Any increase in the S.A.R. of irrigation water increases the SAR of the soil solution. SAR of irrigation water samples ranged from 0.24 to 2.79 with mean value 1.23. Most of irrigation water samples are low sodium hazard in nature. It means that all the irrigation water samples are suitable for the irrigation. It can be used for irrigation on all soils and on most crops but leaching is required in case of extremely low permeability. The SAR is calculated by the formula given by Richards L.A., et al., (23) expressed as the sodium adsorption ration (SAR) content shown variation from 1.3 to 16.3 with an average value 7.6.

Residual sodium carbonate (RSC): Residual sodium carbonates of irrigation water samples were given Table-1. It is observed that R.S.C. of irrigation water samples ranged from -20.76 to 4.93 with mean value -4.95. The R.S.C. is used to evaluate the quality of irrigation water. The residual sodium carbonate (RSC) were also calculated by Glover., (24) and Adamu. G.K., (25) were ranged from 8.00 to 30.69)**.** The finding of Monika C., et at., (26) indicated that the values of Residual sodium carbonate (RSC) ranges from -8.3 to 13.with an average value -10.8.

CONCLUSION

Groundwater is the main source of irrigation in almost study area. The adequate amount of healthy water is one of the essential needs for the crop irrigation for the proper growth and development. The continuous decrease in the quality of ground irrigation water may create serious problem in crop production. In the present investigation the ground water samples from different part of Buksha block of Jaunpur district of eastern Uttar Pradesh showed lowest concentration of EC were ranged 0.47 to 1.6 dSm^{-1} where as SAR calculated as a maximal of 2.79. The range of salinity hazard were low to medium while sodium hazard were calculated as low indicated that the ground irrigation water is suitable for the irrigation.

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