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RESEARCH PAPER

To Study the Suitability of Water for Irrigation Purposes in different Blocks of Kishanganj District, Bihar

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ABSTRACT

The surface and ground water sample were collected from Kishanganj and Bahadurganj blocks of Kishanganj, district, Bihar. The purpose this study to analyse the water suitability for the irrigation use. On the basis of Irrigation water quality classification (EC, SAR and RSC) in Bahadurgnj block 54.5 % sample were found suitable for the irrigation purpose 36.36 % water samples use after the treatment and 9.09% of samples were found unsuitable for the irrigation purpose. Kishanganj block 64.70 % water sample were found suitable for the irrigation use and 35.29 % water sample use after the proper management. The pH of the ground water Bahadurganj block were varies from 4.60-5.80 in surface water pH 4.98-5.84.

HIGHLIGHTS

- Water samples were found slightly acidic to acidic nature in both blocks of Kishanganj district.
- Bahadurgnj block 54.5 percentage (%) sample were found under C1S1-C2S1 this range its suitable for the irrigation purpose 36.36 percentage (%) water samples C3S1 use after the treatment and 9.09 percentage (%) of samples were found C4S1 category its unsuitable for the irrigation purpose.
- Kishanganj block 64.70 percentage (%) water sample were found under C1S1-C2S1 category its suitable for the irrigation use and under C3S1 category 35.29 percentage (%) water sample use after the proper management.
- A surface water sample was more suitable for irrigation use compare to the ground water.

Keywords: Surface, ground water, irrigation, treatment, pH

Water is an important source of life which is extremely essential for survival of all living organisms. Water is one of the abundantly available substances in the nature which men have exploiting more than any other resources for the sustenance of life. Life is impossible on this planet without water, our most important resource apart from air and land. Surface water, especially rivers is part of the source of water available to the people in general. The visible bodies of water are referred to as surface water. These are essential water for achieving good agricultural produce and to attain standard food security in developing countries in the world. Bihar state is agriculture base state and its aback bone of the economy. Kishanganj is a district of the koshi region eastern part of the Bihar. In Koshi region is major problem water in both case quantity as well as quality. This region is highly flood prone and ground water is badly contaminated by the iron. In Kishanganj district many blocks are highly affected by the iron contamination and this water is not suitable for the drinking purposes. Use of

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ground and surface water for irrigation has played a vibrant role in meeting the demand of crops but its blind use has caused bad effects on soils as reported by various workers. Kumar *et al.* (2014). In case of the irrigation purpose water are classify base on the salts and sodium concentration. Water for irrigation varies greatly in quality relating to the total quantity of dissolved salts and its ionic composition in relation to the source of the water its location and time of sampling. The quality of water is generally affected by diffuse contamination originating from intensive irrigated agriculture. The types of irrigation water that define its quality vary with the source of the water. The Water quality of any specific area or specific source can be assessed using physical, chemical and biological constraints. The values of these parameters are harmful to crop growth if they exceed certain threshold values. Therefore, the objective of the present study was to assess the suitability of surface and groundwater quality in the Bahadurgnj and Kishanganj block area with respect to pH, Electrical Conductivity (EC), Sodium Adsorption Ratio (SAR) and specific ions such as Sodium (Na^+), Magnesium (Mg^{2+}), Calcium (Ca^{2+}), Bicarbonate (HCO_3^-), Chloride (Cl^-) and hence to ascertain their suitability for irrigation purpose.

MATERIALS AND METHODS

GPS based 39 (Thirty nine) surface (Pond) and ground water (Deep tube well, Shallow tube well, Hand pump) samples were collected from the Kishanganj and Bahadurganj block. The study area situated on N 26.12159 latitude and E 87.72919 longitude. These blocks are situated between two to three rivers so, soil of these areas are normally sandy and sandy loam. Leaching rate is also very high.

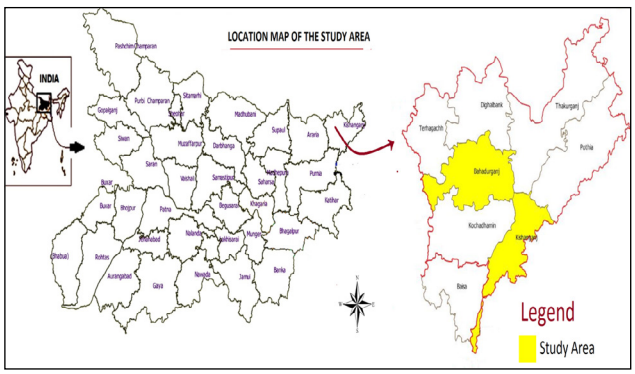

Fig. 1: Location map of the study area (Bahadurganj and Kishanganj blocks) Kishanganj District

Sample collection and analysis

Sampling was collected from both blocks in month of March to May 2022. Collected sample store in plastic bottle in 4°C temperature for the laboratory analysis of physiochemical properties.. After sampling, the bottles were marked, sealed and taken to the laboratory in ice-packed container for further analyses. The water quality indicators that were analyzed are: pH, EC, Ca^{2+}, Mg^{2+}, Na^+, CO_3, HCO_3, and Cl^-, (All analyses was done according to standard method. The concentrations of Na^+, Ca^{2+}, Mg^{2+}, CO_3^- and HCO_3^- were used to quantify the sodium adsorption ratio (SAR) and Residual Sodium carbonate (RSC) according to the equation. Irrigation water quality quantity based on the EC and SAR values.

$$SAR = Na^+ / \sqrt{(Ca^{++} + Mg^{++})/2}$$ (Richards 1954).

RESULTS AND DISCUSSION

Physico-chemical property of the Bahadurgnj block water samples

The analysed water sample of the Bahdurganj block were found slightly acid in nature the pH all of the groundwater samples were within the desirable limits 4.60 -5.80 and surface water 4.98-5.84 (Table 1) Salt concentration (EC) of the Ground water were found 0.23 -1.37 dsm^{-1} and 0.13-0.46 dsm^{-1} A lower EC value signifies less concentration of the dissolved ions and organic matters while salinity of water is an indication of high EC and TDS. It is thus extensively used to determine the appropriateness of groundwater for irrigation purposes Kumari & Rai (2020). Excessive salinity reduces plant osmotic activity and interferes with groundwater and soil nutrient absorption Lanjwani *et al.* (2020). The calcium and magnesium in waters are generally used to classify the suitability of water. Calcium and magnesium are directly related to hardness of the water and these ions are the most abundant elements in the surface and groundwater and exist mainly as bicarbonates and to a lesser degree in the form of sulphate and chloride. The calcium (Ca^{++}) concentration observed in ground water ranges 21.6-80.20 (mg/l) (Verma *et al.* 2018) and 2.4-40.9 (mg/l) in surface water (Table 1). Magnesium (Mg^{2+}) the spatial distribution map for Mg^{2+} ion revealed that the values of Mg^{2+} obtained in some

part of study are higher than the of 30 mg/l set by BIS (2012) 10.10-60.0 (mg/l) and pond water samples ranges were found 1.64-11.79 (mg/l) (Table 1). Magnesium is a leading element found in the both of water sample its responsible factors for the irrigation water quality. Sodium (Na^+) concentration in ground water were found ranges between 1.10-1.60 (mg/l) and 0.30-1.40 in surface water samples (Table 1) The concentrations of Na+ ion obtained in this study are within the prescribed limit of 200 mg/L as set by BIS (2012). sodium is a leading elements its play important role in irrigation water quality classification excess sodium concentration in soil reduce the uptake of water and nutrient in plant system. Sodium content was found the under the permissible limit both of water sources WHO (2012). Sodium adsorption ratio (SAR) is an important chemical parameter for refereeing the degree of suitability of water for irrigation is sodium content or alkali hazard. Its determine in groundwater samples ranges 0.29-0.65 and 0.10-0.64 in surface water (Table 1). Sodium absorption ratio (SAR) is used to know water quality for irrigation use because a higher value of SAR causes sodium hazard. According to Richards (1954), high sodium concentration in water can reduce soil permeability by cataion-exchange processes between water and soil (Alam *et al.* 2021; Chaudhary & Sateeshkumar, 2018). Based on SAR values (Richards, 1954) classified irrigation suitability as excellent (0–10), good (10–18), doubtful (18–26), and unsuitable (>26). Residual sodium carbonate (RSC) value were found (-68.67) - (-16.17) in ground water sample and surface water sample its varies ranges between (-47.38) - (-9.57) respectively (Table 1).

Physico-chemical property of the Kishanganj block water samples

Kishanganj block is head quarter of the Kishananj district, population density of this block is higher compare to the other blocks. The determine water sample pH ranges were found 4.76-6.05 in ground water samples and 4.80-5.86 of surface water samples (Table 2). The calcium (Ca^{++}) concentration observed in ground water ranges 29.7-182.8 (mg/l) and 6.4-32.9 9 (mg/l) in surface water (Table 2). It's great solubility and availability in most rocks, the presence of calcium ion is a common phenomenon in groundwater Ali & Ali (2018) Sharma *et al.* (2017). Higher Ca^{2+} ion concentration in the ground water might be related to weathering of limestone and sedimentary rocks and minerals Gaikwad *et al.* (2020) Ibrahim & Lyons, (2017). Magnesium (Mg^{++}) content in ground water varies in 27.9-112.1 (mg/l) and pond water samples ranges were found 22.4-232.0 (mg/l) (Table 2). Magnesium is a leading element found in the both of water sample its responsible factors for the irrigation water quality. Sodium (Na^+) concentration in ground water were found ranges between 1.2-8.3 (mg/l) and 1.2-1.8 in surface water samples (Table 2) sodium is a leading elements its play important role in irrigation water quality classification excess sodium concentration in soil reduce the uptake of water and nutrient in plant system. Sodium content was found under the permissible limit both of water sources WHO (2017). Sodium adsorption ratio (SAR) is an important chemical parameter for refereeing the degree of suitability of water for irrigation is sodium content or alkali hazard. Its determine in groundwater

Table 1: Water quality status of the Bhdurganj Block Kishanganj District

	Bahadurganj					
	Ground water			Surface Water		
Parameters	**Max.**	**Min.**	**SD**	**Max.**	**Min.**	**SD.**
pH	5.80	4.60	0.312	5.84	4.98	0.29
EC (dsm^{-1})	2.33	0.24	0.561	0.31	0.09	0.08
Hardness(mg/L)	318.00	64.00	76.338	82.00	18.00	21.88
Ca^{++} (mg/L)	80.20	21.60	16.796	40.90	2.40	14.48
Mg^{++} (mg/L)	60.00	10.10	15.180	11.79	1.64	3.30
CO^-_3 (mg/L)	0.06	0.00	0.015	0.00	0.00	0.00
HCO^-_3 (mg/L)	0.43	0.06	0.097	0.18	0.06	0.04
Na^{++} (mg/L)	1.60	1.10	0.135	1.40	0.30	0.34
SAR	0.65	0.29	0.106	0.64	0.10	0.19
RSC	-16.17	-68.67	15.391	-9.57	-47.38	15.54

Table 2: Water Quality status of the Kishanganj block, Kishnganj District

	Kishanganj					
	Ground water			Surface Water		
Parameters	**Max.**	**Min.**	**SD**	**Max.**	**Min.**	**SD.**
pH	6.05	4.76	0.3037	5.86	4.80	0.388
EC (dsm^{-1})	1.37	0.23	0.3241	0.46	0.13	0.119
Hardness(mg/L)	642	144	140.1348	240	24	80.721
Ca^{++} (mg/L)	182.8	29.7	42.4928	32.9	6.4	9.162
Mg^{++} (mg/L)	112.1	27.9	25.0273	232.0	22.4	78.672
CO^{-}_{3} (mg/L)	0.06	0.00	0.0171	0.0	0.0	0.0
HCO^{-}_{3}(mg/L)	0.305	0.061	0.0710	0.122	0.061	0.030
Na^{++}(mg/L)	8.3	1.2	2.0711	1.8	1.2	0.206
SAR	0.62	0.09	0.1787	0.29	0.15	0.057
RSC	-57.35	-294.76	64.9276	-28.79	-264.72	87.109

Table 3: Criteria of irrigation water quality of Bahadurganj block

Sl. No.	Latitude	Longitude	Class	Remark
1	26.2102316	87.86002638	C2S1	Suitable for Irrigation
2	26.32762768	87.83937114	C2S1	Suitable for Irrigation
3	26.26518044	87.84501601	C2S1	Suitable for Irrigation
4	26.20974445	87.75855804	C4S1	Not suitable for irrigation
5	26.20797578	87.78215631	C1S1	Suitable for Irrigation
6	26.32392202	87.87710607	C4S1	Not suitable for irrigation
7	26.2085286	87.87050467	C3S1	Required management
8	26.210255	87086003254	C3S1	Required management
9	26.22869538	87.86107761	C2S1	Suitable for Irrigation
10	26.21020323	87.86002934	C2S1	Suitable for Irrigation
11	26.22868939	87.86107487	C2S1	Suitable for Irrigation
12	26.2556272	87.85962456	C2S1	Suitable for Irrigation
13	26.3276402	87.86452838	C2S1	Suitable for Irrigation
14	26.33590753	87.86346006	C3S1	Required management
15	26.33848409	87.84671554	C3S1	Required management
16	26.3660712	87.84573497	C3S1	Required management
17	26.36606293	87.84621403	C3S1	Required management
18	26.28406632	87.8268709	C2S1	Suitable for irrigation
19	26.27599058	87.89521136	C3S1	Required management
20	26.23273192	87.9041791	C2S1	Suitable for irrigation
21	26.31390494	87.83515048	C3S1	Required management
22	26.32418399	87.87717444	C2S1	Suitable for irrigation

samples ranges 1.2-8.3 and 1.2-1.8 in surface water (Table 2). Residual sodium carbonate (RSC) value were found (-294.76)- (-57.35) in ground water sample and surface water sample its varies ranges between (-264.72)- (-28.79) (Table 2) (Kumari, P. 2017).

Classification of irrigation water quality

The irrigation water quality classify based on the electrical conductivity (EC) and sodium adsorption ratio (SAR) on this basis water sample classify in four classes C1S1,C2S2,C3S3,C4S4. The value of Electrical conductivity (EC) and Sodium adsorption ratio (SAR) values were plotted on US salinity diagram that in the zone of C1-S1. C2-S1, C3-S1 and C4-S1, salinity and sodicity of water were indicated by C and S respectively. Salinity of water indicate very high- salinity hazards (C4), high -salinity hazards (C3) Medium – salinity hazards (C2), and low sodium hazards (S1), Medium – sodium hazards (S2), High -sodium hazards (S3), and very –high sodium hazards through (S4). In Bahadurgnj block 54.5 percentage (%) sample were found under C1S1-C2S1 class sample no. 1,2,3,5,9,10,11,12,18,20,22 (Table 3) this range its suitable for the irrigation

Table 4: Classification of irrigation water quality of Kishanganj block

Sl. No.	Latitude	Longitude	Class	Remark
1	26.12159	87.72919	C2S1	Suitable for irrigation
2	26.11723	87.77011	C3S1	Required management
3	26.11508	87.79092	C2S1	Suitable for irrigation
4	26.11294	87.79585	C3S1	Required management
5	26.11291	87.81818	C2S1	Suitable for irrigation
6	26.11291	87.82655	C3S1	Required management
7	26.11503	87.83472	C2S1	Suitable for irrigation
8	26.1204	87.83421	C2S1	Suitable for irrigation
9	26.128	87.8335	C1S1	Suitable for irrigation
10	26.20061	87.9807	C2S1	Suitable for irrigation
11	26.19576	87.9806	C2S1	Suitable for irrigation
12	26.19094	87.98051	C2S1	Suitable for irrigation
13	26.18258	87.98035	C3S1	Required management
14	26.16041	87.97607	C2S1	Suitable for irrigation
15	26.15698	87.97506	C3S1	Required management
16	26.15016	87.97017	C3S1	Required management
17	26.14566	87.96725	C2S1	Suitable for irrigation

purpose 36.36 percentage (%) water samples C3S1 sample no. 7,8,14,15,16,17,19,21 (Table 3) use after the treatment and 9.09 percentage (%) of samples were found C4S1 sample no. 4 (Table 3) category its unsuitable for the irrigation purpose.

The majority of water sample In Kishanganj block was found safe condition on the basis of EC and SAR. Irrigation water quality Kishanganj block 64.70 percentage (%) water sample were found under C1S1-C2S1 category sample no. 1,3,5,7,9.10,11,12,14,17 (Table 4) its suitable for the irrigation use and under C3S1 category sample no. 2,4,6,13,15,16 (Table 4) about 35.29 percentage (%) water sample use after the proper management.

CONCLUSION

The study was undertaken to evaluate the current groundwater status for physico-chemical characteristics for the irrigation purposes at Kishanganj district. The analytical findings conclude that groundwater is slightly acidic in nature. Maximum samples of the both blocks (Bahadurganj and Kishanganj) in Kishangnj district were found suitable for the irrigation purpose. On the basis of irrigation water quality classification surface water is more suitable for the irrigation purpose some samples of the ground water use after the proper treatment.

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