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EFFECT OF MONSOON ON GROUNDWATER QUALITY OF JAIPUR DISTRICT, RAJASTHAN

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ABSTRACT

Deterioration of ground water resources has long been a major concern to human society, the aim is to preserve and maintain balanced biological communities and sustainable stream ecosystem health. The sustainable use of ground water resources in India and other countries requires the development of more powerful tools to assess the water quality and health of ground water. The present study area enjoys arid and semi-arid climate with mild winter and long summer days. The area receives rainfall from the southwest monsoon lasting from June to September with a mean annual rainfall of 61.36 cm, 90 to 93 per cent of which is received during June to September and potential evapo-transpiration is about more than annual rain fall. The temperature of the area varies from 4 °C to 45 °C. The physico-chemical analysis of water samples in the study area indicates pH ranged from 7.1 to 8.4 suggesting neutral to alkaline nature of groundwater. The water samples have been collected from different blocks and villages of Jaipur district before and after rainfall season, thirteen parameters have been considered for determining water quality namely pH, EC, total dissolved solids, total hardness, calcium, magnesium, carbonate, bicarbonate, chloride, nitrate, sodium, potassium, phosphorus. The study show the presence of nitrate in the ground water in different water sample varies between 0.45 and 3.77 ppmL^{-1}, but it does not exceeds BIS standard except in one case.

KEY WORDS : Ground water quality, Chemical parameters, Monsoon.

INTRODUCTION

Groundwater makes up about 98 per cent of all the usable fresh water on the planet and it is about 60 times as plentiful as fresh water found in lakes and streams, has a strong influence on river and wetland habitats for plants and animals. As a matter of fact as groundwater is not visible, it is often overlooked when considering all of the water on earth and yet, water beneath the land surface is a valuable resource. Protecting it from contamination and carefully managing its use will ensure its future as an important part of ecosystems and human activity (Mullen, 2017). Rajasthan is the largest state in the country in terms of geographic spread. It has an area of 342,239 Sq km's being largest state of the country having 10.41 per cent of the country's area and 5.5 per cent of nation's population but has low water resources *i.e.*, 1 per cent of the country's resources. It is situated between north latitudes 23º 03′ and 30º 12′ and east longitudes 69º 30′ and 78º 17′. The groundwater monitoring is being carried out through a network of observation wells the National Hydrograph Network Stations (NHS) (Groundwater year book 2014 - 2015, Rajasthan state). Rajasthan mostly clouts industry groundwater are in use and most available source of drinking water in Rajasthan is from groundwater. Groundwater is the sole resource of drinking water in arid areas, which is also used in domestic consumption and irrigation (Switzman *et al*., 2015). Information about groundwater occurrence and

recovery is critical in the arid and semiarid areas because of the poor yearly precipitations rate and over use of groundwater resources in these areas (Hussain *et al*., 2013).

There are few studies which highlighted that ground water quality improved due to monsoon and heavy pour. The assessment of pre and post-rainfall scenario on ground water quality was conducted to monitor the variability in pollutants behaviour during different seasons. The samples were collected from representative site locations before and after rainfall. Those samples were promptly brought into the laboratory for physical, chemical and biological parameters. The obtained results indicated that the overall ground water quality was decreased because of excessive concentration of total dissolved solids (TDS), chlorides and Magnesium, respectively.

On the other hand, the quality in deeper aquifers also varies from place to place and is generally found suitable for common uses (Mishra and Mishra, 2006; Choudhury and Rakshit, 2012). In recent times, the issues related to the optimal design of water quality monitoring network and efficiency improvements have been the subject of research science 1970s (Ning and Chang, 2002). On basis of the above discussion the experiment was designed to appraise the ground water quality affected by monsoon. It was, thought to study groundwater quality of Jaipur district, Rajasthan, India. Various sample of groundwater were collected from the villages of Jaipur district and were analysed for various hydro-chemical parameters to understand impact of monsoon on concentration of pollutant. Statistical methods were employed to establish the relationship between these parameters with monsoon variation. So, some discrete hydro chemical data are available for the region, seasonal variation of groundwater quality has never been studied so far. In this paper an attempt has been made to study the effect of pre and post monsoon effects on groundwater quality for irrigation.

MATERIALS AND METHODS

The present investigation involved a water sampling in Jaipur district Rajasthan followed by laboratory analysis of water sample in the Department of Soil Science and Agricultural Chemistry, Institute of Agriculture Sciences, Banaras Hindu University, Varanasi.

STUDY AREA

Jaipur district, covering geographical area of 11,061.44 sq. km and extending between north latitudes 26° 25′ and 27° 51′ and east longitudes 74° 55′ and 76° 15′ forms east-central part of the Rajasthan State. The climate of the area under study is hot semi-arid with extremes of temperature (15-45 °C) having average rainfall around 650 mm (26 inch.). The location of study area is shown in the Map given below (Fig. 1).

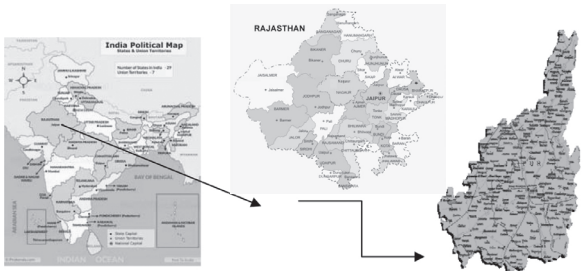

Fig. 1. Map of the sampling site in Jaipur District, Rajasthan.

Sample Collection

A total number of 40 groundwater samples were collected (20 samples were collected before and 20 samples were collected after rainfall) from different blocks in Jaipur district namely Jaipur city, Chomu, Kalwar, Jobner, Kishangarh renwal, Govindgarh including city and villages. The samples were collected from hand pump, well, borwell and deep tube well it's collected before rainfall (May-June, 2017) and after rainfall (September-October, 2017) from various locations and various depth. The ssampling location of study area is shown in the GIS Map given below (Fig. 2).

Physico-chemical Analysis: The physico-chemical analysis was performed following standard methods (Gupta, 2009). pH and electrical

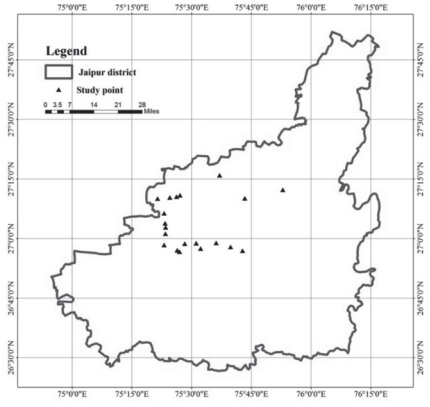

Fig. 2. GIS map of locations in study areas

conductivity were measured by using digital pH meter and EC by digital conductivity meter. Calcium, magnesium and total hardness in water sample will be analysed by EDTA titration method, determination of potassium and sodium were carried out directly with the use of flame photometer, Carbonate and bicarbonate were determine by titration method, Total dissolved solid was estimated by ionic calculation. Chloride was measured by Mohr method by using silver nitrate. Nitrate content in ground water was determined electro chemically, using the EBT direct ion selective electrode method. Phosphate- phosphorus is determined by the using ascorbic acid procedure (Table. 1).

RESULTS AND DISCUSSION

The physico-chemical quality of irrigation and domestic water totally depends on the geological condition of the soil and ground water pollution of the study area. A major objective of water quality assessment is to determine whether or not the water quality meets previously defined objectives for designated uses, to describe water quality at regional, national or international scales, and also to investigate trends in time, etc. The following are the important characteristic properties of ground water of determine its suitability for irrigation and domestic proposes.

General Hydrochemistry of Groundwater

pH: The observed overall pH values, ranged between 7.0 to 8.5 Maximum pH (8.5) was observed in Manpura Mazeri village of Chomu Block. All water samples were found to be within limits but were alkaline in nature.

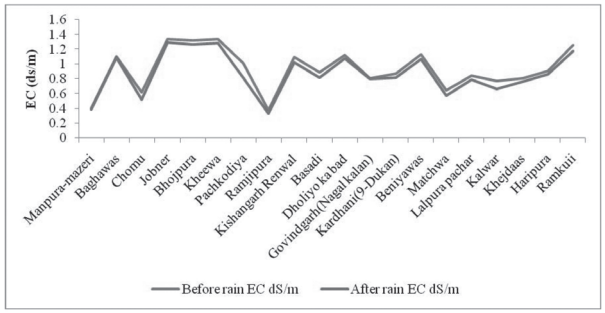

Fig. 3. Electrical Conductivity (EC dS/m) of different sampling sites

Electrical Conductivity: Electrical conductivity in general varies from 0.32 to 1.29dSm^{-1}. Maximum observed (1.34) in kheewa, Jaipur block. High value of EC is due to the presence of high amounts of dissolved salts and can be verified by the TDS values. The Electrical conductivity of different

Table 1. Physico-chemical methods and equipment used in the study

S. No.	Parameters	Unit	Methods
1	pH	-	Digital pH-meter
2	EC	ds/m	Digital Conductivity-meter
3	Calcium	mg/L	EDTA
4	Magnesium	mg/L	Versenate titration method
5	Potassium	Ppm	Calibration
6	Sodium	mg/L	Calibration
7	Carbonate & Bicarbonate	mg/L	Titration with standard H_2SO_4
8	Chlorine	mg/L	Titration with standard $AgNO_3$
9	Phosphorus	mg/L	Ascorbic acid
10	Nitrate	mg/L	EDT direct ion selective electrode method
11	TDS	mg/L	Electrometric
12	TH	mg/L	Titrimetrically by standard EDTA

Table 2. Salinity hazard table (Salinity hazard classification table after Richard 1954)

Salinity class	EC in µs/cm	Water class	Number of samples		% of sample	
			Before rainfall	After rainfall	Before rainfall	After rainfall
C1	<250	Low	0	0	0	0
C2	250-750	Medium	4	5	20	25
C3	750-2250	High	16	15	80	75
C3	>2250	Very high	0	0	0	0

sampling points in the study area was shown in Fig. 3. The Salinity hazard has been classified by their EC values, was given in Table 3.

TDS (Total Dissolved Solids): The TDS in water samples of the present study ranged between 209.92 to 857.6 ppmL^{-1}. Based on Freeze and Cherry (1979) classification, 99 per cent of the groundwater samples of the study area are categorized as fresh water (TDS<1,000 ppmL^{-1}).The highest value of TDS are recorded in Haripura Jaipur block and lowest value of TDS is recorded in Ramjeepura Jaipur. The TDS content of different sampling points in the study area was shown in Fig. 4.

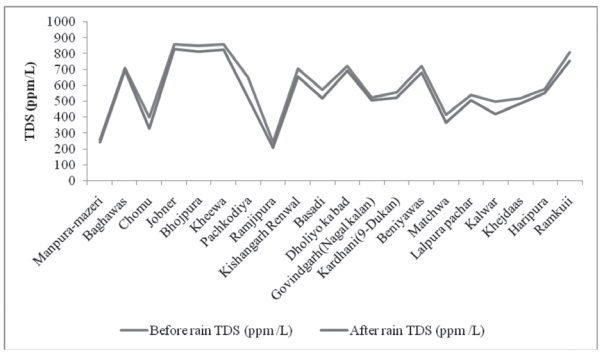

Fig. 4. TDS (ppm/L) content present in different sampling sites

Recharge of ground water after monsoon brought about some improvement in water quality with respect to EC, Na^+ , K^+ , Cl^- , HCO_3 , P, Mg^{2+} and TDS. There was almost no change in pH and NO^{3-} was increased between the study periods. Another possibility may be that the source of the ground water may be lying somewhere outside the region of study and contribution of rain water to ground water recharging may not be very significant.

Chloride (Cl^-): High content of chloride gives salty taste to the water. The minimum (1.37 and 12.7meq/l) was reported from Ramjipura and Kishangarhrenwal village and maximum (42.8 and 90.2 meq/L) was observed from Pachkodiya village during before and after rainfall. It shows negative correlation with electrical conductivity (Table 5 and 6). The Chloride (Cl^-) content of different sampling points in the study area was shown in Fig. 5.

Nitrate (NO_3): In the study area the observed overall nitrates values ranged between 0.45 to 3.77 ppm/L in different water sampling condition, in which they are taken, the highest value of nitrates are recorded in Renwal block and lowest value of nitrate is recorded in Chomu block. Approximately all water samples taken before the rainfall did not exceed the maximum limit of 45mg/L given as per BIS drinking water standards. The high NO_3 content in Renwal block and surrounded area of Jaipur block can be due to excessive Nitrous fertilizer application in the intensive cropping system (>250%) and higher net irrigated area. The Nitrate (NO_3) of different sampling points in the study area was shown in Fig. 6.

Sodium (Na^+) and Potassium (K^+): Minimum (4.78 mg/L) and maximum (40.43 mg/L) Sodium (Na^+) content was observed from Bagawas and Kishangarhrenwal villages respectively (Table 2, before rainfall), minimum (1.07 mg/L) and maximum (19.65) sodium content was observed from Chomu and Matchwa village respectively (Table 3, after rainfall). All observed water limit are acceptable. The acceptable limit for Na^+ is 50 mg/L and K^+ is 20 mg/L according to WHO guidelines (1984). Potassium (K^+) content of water samples varied from 2 to 17 mg/L in different sampling points. The Sodium and Potassium content in different sampling sites was shown in Fig. 7 and 8.

Bicarbonate (HCO_3^-): CO_3^{-2} and HCO_3^- taken together make total alkalinity. Higher values of

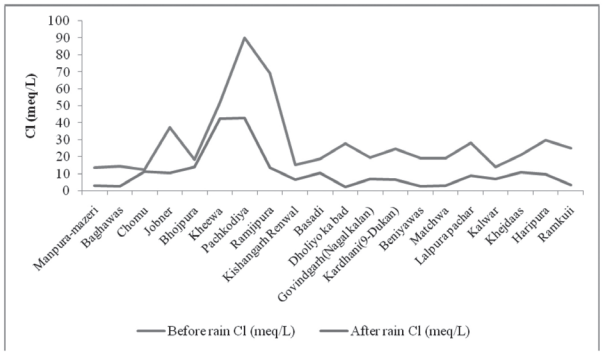

Fig. 5. Chloride (meq/L) content present in different sampling sites

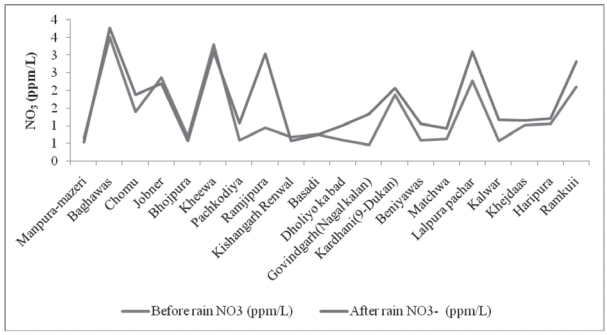

Fig. 6. Nitrate (ppm/L) content present in different sampling sites

Table 3. Physico-chemical analysis of the Groundwater Samples (before rainfall)

Sampling Sites	pH	EC	TDS	CO_3 meq/L	HCO_3 meq/L	Ca+Mg meq/L	RSC	PO_4	NO_3	Na meq/L	K	SAR	SSP	Cl
Manpura-mazeri	8.5	0.40	259.2	1.2	2.74	29.6	-1.46	20.87	2.7	26.52	401.34	4.87	89.6	13.9
Baghawas	7.6	1.11	710.4	2	9.2	22	-1.62	8.04	3	36.06	74.48	7.69	164.03	14.5
Chomu	8.1	0.625	400	1.2	2	5.2	-3.52	6.09	3	40.43	89.51	17.73	777.59	12.7
Jobner	7.3	1.34	857.6	1.6	2.2	34.8	-34	21.3	9	13.48	56.66	2.28	38.73	37.6
Bhojpura	8	1.325	848	1.2	7.4	13.2	3.26	8.87	6	4.78	158.39	1.32	36.23	18.5
Kheewa	7.8	1.34	857.6	1.2	2	12.8	-7.4	25.22	3.3	16.52	252.17	4.62	129.08	52
Pachkodiya	7.8	1.02	652.8	3.6	2.8	11	-4.48	21.74	5.7	33.04	231.27	9.96	300.4	90.2
Ramjipura	8.3	0.38	243.2	2	4.4	6.8	1.72	21.3	5.7	32.61	463.14	12.5	479.54	69.5
Kishangarh Renwal	8.2	1.1	704	2.4	3.2	25.4	-18.76	5.22	5	24.78	22.11	4.92	97.57	15.6
Basadi	8.4	0.895	572.8	3.6	3	28.4	-3.56	5	3	25.22	58.14	4.73	88.79	19.6
Dholiyo ka bad	7.9	1.125	720	1.6	4.4	28	-1.2	8.39	4.7	14.35	131.11	2.71	51.24	28
Govindgarh(Nagal kalan)	8.1	0.815	521.6	2.8	1	7	1.74	6.17	2.6	16.52	140.32	6.24	236.02	19.7
Kardhani(9-Dukan)	8	0.87	556.8	0.8	2.4	5.8	-0.84	24.35	5.7	15.22	640.73	6.32	262.37	24.9
Beniyawas	8	1.13	723.2	0.8	1.8	14.4	-8.78	38.26	5.8	21.7	318.84	5.72	150.66	19.5
Matchwa	8.1	0.65	416	1.2	2	24.4	-1.24	43.04	2.4	23.04	896.74	4.67	94.44	19.4
Lalpura pachar	8.1	0.845	540.8	1.2	2.2	10.2	-2.68	34.35	3.2	26.52	554	8.3	260.02	28.6
Kalwar	8.1	0.777	497.28	1.6	4.4	20.4	2.18	5.3	2.6	37.83	147.34	8.37	185.42	14.2
Khejdaas	8.2	0.81	518.4	1.2	3.2	4.8	-3.12	5.87	2.8	24.78	83.85	11.31	516.3	21.4
Haripura	8.1	0.905	579.2	1.2	5	9.2	-0.48	5	3.1	25.65	80.65	8.46	278.83	30.2
Ramkuii	7.9	1.26	806.4	1.2	4	17.6	-11.42	8.43	5.1	14.3	52.07	3.41	81.27	25.4
ICMR Std.	6.5-9.2	–	500-3000	–	–	–	–	–	–	–	–	–	–	200-1000
Mean	8.02	0.93	599.26	1.68	3.467	16.55	-4.78	16.14	4.22	23.66	242.64	6.80	215.90	28.77
STD	0.26	0.28	183.44	0.82	1.98	9.41	8.59	12.20	1.73	9.29	236.08	3.91	188.62	20.062
Variance	0.07	0.08	33651	0.68	3.92	88.64	73.93	148.9547	3.0105	86.36	55734	15.35617	35580.97	402.5148
Skewness	-0.87	-0.33	-0.33	1.410	1.65	0.40	-2.42	0.89	1.12	0.02	1.49	1.17	1.71	2.11
Kurtosis	1.86	-0.49	-0.49	1.20	2.99	-1.14819	6.77	-0.31	1.22	-0.43	1.80	1.86	3.11	4.29

Table 4. Physico-chemical analysis of the Groundwater Samples (after rainfall)

Sampling Sites	pH	EC	TDS	CO_3 meq/L	HCO_3 meq/L	Ca+Mg meq/L	RSC	PO_4	NO_3	Na meq/L	K	SAR	SSP	Cl
Manpura-mazeri	8.1	0.378	241.92	0.8	2.54	5.2	-26.06	0.17	0.64	9.15	15	0.28	0.54	2.8
Baghawas	7.2	1.089	696.96	0.4	7.18	10.8	-12.4	0.34	3.51	2.45	8	0.78	3.77	2.5
Chomu	7.9	0.516	330.24	1.6	2.08	6.8	-1.6	0.57	1.38	2.33	2.5	0.88	1.89	11.4
Jobner	7	1.295	828.8	1.2	2	37.6	-31.4	0.45	2.36	3.47	4	1.09	2.21	10.5
Bhojpura	7.7	1.27	812.8	1.6	7.66	5.6	-4.2	0.21	0.68	3.75	4	0.28	0.58	13.9
Kheewa	7.5	1.29	825.6	0.8	1.4	10	-10	0.8	3.31	7.97	3	0.97	3.09	42.5
Pachkodiya	7.5	0.818	523.52	0.8	1.32	9.4	-7.4	0.12	0.58	7.09	4	0.25	1.09	42.8
Ramjipura	7.9	0.328	209.92	1.6	4.32	4.6	-0.8	0.44	0.94	9.93	4	0.68	3.04	1.37
Kishangarh Renwal	7.8	1.024	655.36	1.2	2.44	23.6	-21	0.22	0.68	1.07	9	0.3	0.58	6.4
Basadi	8.1	0.814	520.96	0.4	1.44	8.6	-25	0.96	0.75	1.7	17	0.98	0.74	10.6
Dholiyo ka bad	7.6	1.08	691.2	0.4	3.6	6.4	-23.2	0.64	0.59	3.32	6	0.87	1.02	2.2
Govindgarh(Nagal kalan)	7.8	0.795	508.8	7.6	3.34	4.4	1.6	0.56	0.45	2.94	7.2	0.91	1.34	6.8
Kardhani(9-Dukan)	7.9	0.82	524.8	0.4	2.16	3.8	-3	0.33	1.87	12.49	3	0.74	2.08	6.4
Beniyawas	7.8	1.065	681.6	2	2.42	12	-10.6	0.67	0.59	11.04	12	0.85	1.06	2.4
Matchwa	7.7	0.57	364.8	2	2.36	4.8	-20.4	0.62	0.61	19.65	15	0.83	0.94	3.1
Lalpura pachar	7.6	0.79	505.6	1.2	2.32	6.2	-6.8	0.45	2.28	13.79	7	0.98	3.1	8.8
Kalwar	7.6	0.66	422.4	1.2	4.18	3.6	-14.8	0.11	0.57	2.8	2	0.21	1.18	7
Khejdaas	7.8	0.76	486.4	0.4	2.68	7	-1.2	0.37	1.02	2.22	2	0.49	1.16	10.7
Haripura	7.7	0.86	550.4	0.4	4.52	6.2	-3.8	0.34	1.06	2.01	6	0.42	1.21	9.5
Ramkuii	7.6	1.18	755.2	0.4	3.58	16.2	-13.2	0.48	2.1	2.1	4	2.81	3.2	3.2
ICMR Std.	6.5-9.2	–	500-3000	–	–	–	–	–	–	–	–	–	–	200-1000
Mean	7.69	0.87	556.86	1.32	3.17	9.64	-11.763	0.44	1.29	6.06	6.735	0.78	1.691	10.24
STD	0.26	0.28	185.4	1.57	1.732	8.14	9.805	0.227	0.94	5.11	4.62	0.558	1.030	11.67
Variance	0.070	0.08	34379.1	2.49	3.00	66.31	96.14	0.05	0.89	26.17	21.36	0.31	1.062	136.370
Skewness	-0.91	-0.20	-0.20	3.59	1.52	2.57	-0.497	0.47	1.26	1.24	1.11	2.56	0.739	2.37
Kurtosis	1.56	-0.71	-0.71	14.58	2.10	7.24	-0.92	-0.06	0.55	0.96	0.13	9.32	-0.87	5.13

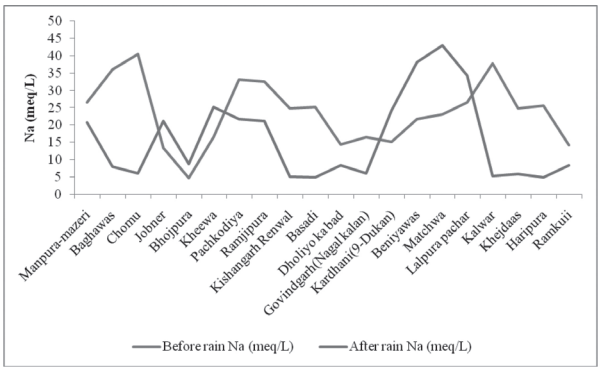

Fig. 7. Sodium (meq/L) content present in different sampling sites

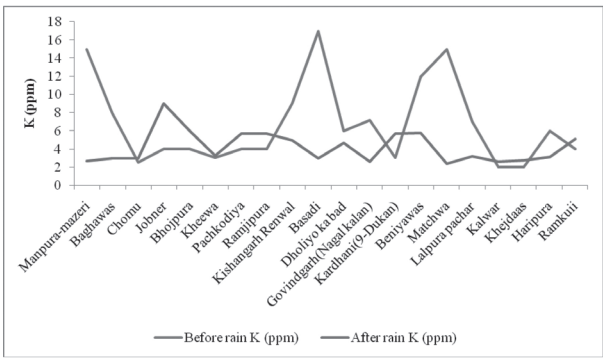

Fig. 8. Potassium (ppm) content present in different sampling sites

alkalinity give undesirable taste to water and also make it not potable. Minimum bicarbonate (HCO_3-) (1.0 meq/L) was observed in Nagalkalan, govindgarh village while maximum (9.2 meq/L) was found in Jobner village before rainfall. And after rainfall, maximum bicarbonate (HCO_3) (7.66 meq/L) was observed in bagawas village. While minimum (1.4 meq/L) was observed in Kheewa village. The Bicarbonate content in different sampling points was shown in Fig. 9.

Correlation analysis

It is evident that before rainfall, NO_3 content was significantly positively correlated with EC (r=0.41) and TDS (r=0.41). However, NO_3 content was significantly negatively correlated with pH (r=-0.55) and was found statistically at par with other parameters. Further, after rainfall, NO_3 content was significantly positively correlated with PO_4 (r=0.54) and NO_3 content was found non-significant effect on any of the determined parameters. The correlation table on before and after rainfall with compare to other chemical parameters was given in Table 5 and Table 6.

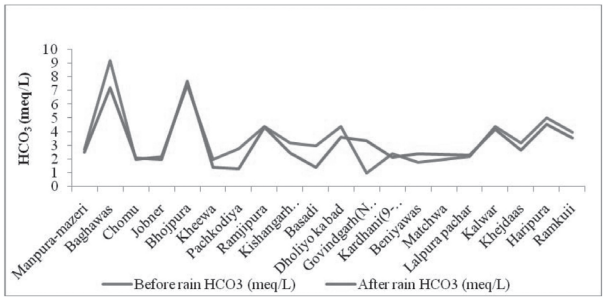

Fig. 9. Bicarbonate (meq/L) content present in different sampling sites

CONCLUSION

The present study has been conducted on the ground water quality of Jaipur district, Rajasthan. From the cross sectional analysis of different water quality parameters it is evident that the water quality index of Jaipur district of Rajasthan is ranged from average to good; the water is partially safe for drinking purpose. Now one need to take adequate policy decisions as well as effective conservation practice for improving the water quality in the water shed. Places where water quality index was rated low warrants adequate management and treatment provisions for its effective utilisation. Suitable water treatment process such as water softening, ion exchange, and demineralization should be applied to reduce the concentration of contamination.

Recharge of ground water after monsoon brought about some improvement in water quality with respect to EC, Na^+, K^+, Cl^-, HCO_3, P, Mg^{2+} and TDS. There was almost no change in pH and NO_3^- was increased between the study periods. Another possibility may be that the source of the ground water may be lying somewhere outside the region of study and contribution of rain water to ground water recharging may not be very significant.

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Table 5. Correlation matrix of parameters of water samples of villages of Jaipur district (before rainfall)

	Sample Number	pH	EC	TDS meq/L	CO_3 meq/L	HCO_3 meq/L	Ca+Mg	RSC	PO_4	NO_3 meq/L	Na	K	SAR	SSP	Cl
Sample number	1.000														
pH	0.197	1.000					.								
EC	-0.011	-0.711**	1.000												
TDS	-0.011	-0.711**	1.000	1.000											
CO_3 meq/L	-0.215	0.066	-0.018	-0.018	1.000										
HCO_3 meq/L	-0.180	-0.190	0.225	0.225	-0.010	1.000									
Ca+Mgmeq/L	-0.285	-0.184	0.222	0.222	0.173	0.102	1.000								
RSC	0.164	0.547*	-0.496*	-0.496*	-0.018	0.267	-0.488*	1.000							
PO_4	0.029	-0.100	-0.099	-0.099	-0.324	-0.422	0.011	-0.093	1.000						
NO_3	-0.212	-0.550	0.484*	0.484*	-0.022	0.012	0.178	-0.628**	0.172	1.000					
Na meq/L	-0.111	0.243	-0.578**	-0.578**	0.241	0.069	-0.145	0.231	-0.100	-0.440	1.000				
K	0.125	0.223	-0.451*	-0.451*	-0.324	-0.311	-0.132	0.302	0.821**	-0.106	-0.019	1.000			
SAR	-0.015	0.254	-0.589**	-0.589**	0.040	-0.104	-0.624**	0.302	-0.127	-0.322	0.788**	0.000	1.000		
SSP	0.004	0.239	-0.530*	-0.530*	-0.062	-0.170	-0.715**	0.273	-0.150	-0.237	0.591**	-0.010	0.959**	1.000	
Cl	-0.126	-0.241	0.039	0.039	0.377	-0.112	-0.240	-0.067	0.255	0.386	0.087	0.115	0.183	0.150	1.000

** Correlation significant at the 0.01 level (2-tailed); * Correlation significant at the 0.05 level (2-tailed)

Table 6. Correlation matrix of parameters of water samples of villages of Jaipur district (after rainfall)

	Sample number	pH	EC	TDS	CO_3 meq/L	HCO_3 meq/L	Ca+Mg meq/L	RSC	PO4	NO3	Na meq/L	K	SAR	SSP	Cl
Sample number	1.000														
pH	0.127	1.000													
EC	-0.019	-0.613**	1.000												
TDS	-0.019	-0.613**	1.000	1.000											
CO_3 meq/L	0.007	0.114	-0.129	-0.129	1.000										
HCO_3 meq/L	-0.094	-0.215	0.192	0.192	0.019	1.000									
Ca+Mg meq/L	-0.215	-0.576**	0.550*	0.550*	-0.130	-0.197	1.000								
RSC	0.239	0.212	-0.196	-0.196	0.319	0.235	-0.540*	1.000							
PO_4	0.068	0.134	0.161	0.161	0.123	-0.365	0.009	-0.137	1.000						
NO_3	-0.213	-0.589**	0.443	0.443	-0.303	0.082	0.307	0.004	0.161	1.000					
Na meq/L	0.097	0.130	-0.332	-0.332	0.029	-0.281	-0.290	0.024	0.107	-0.003	1.000				
K	-0.097	0.385	-0.217	-0.217	0.073	-0.180	-0.050	-0.527*	0.348	-0.291	0.307	1.000			
SAR	0.297	-0.181	0.324	0.324	-0.014	-0.115	0.274	-0.087	0.458*	0.407	-0.047	-0.047	1.000		
SSP	-0.049	-0.472*	0.175	0.175	-0.133	0.140	0.128	0.235	0.149	0.851**	0.090	-0.384	0.536*	1.000	
Cl	-0.230	-0.236	0.266	0.266	-0.106	-0.342	0.039	0.163	0.009	0.214	-0.026	-0.318	-0.167	0.047	1.000

** Correlation significant at the 0.01 level (2-tailed); * Correlation significant at the 0.05 level (2-tailed)

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