Research Article

Irrigation Water Characteristics, Their Correlations and Suitability for Agriculture in District Gujranwala (A Survey Study)

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Abstract | A survey study was conducted in Gujranwala district to evaluate the quality of groundwater for agriculture purpose. A total of 565 groundwater samples were collected from farmers' tube wells during random survey of four tehsils of Gujranwala district, i.e., Gujranwala, Kamoke, Wazirabad and Noshera Virkan. The water samples were analyzed in Soil and Water Testing Laboratory Gujranwala for electrical conductivity (EC), sodium adsorption ratio (SAR), residual sodium carbonate (RSC), chloride (Cl) and sodium (Na) of the groundwater. The results revealed that out of 565 samples, 231 (41%) were fit; 149 (26%) were marginally fit, and; 185 (33%) were unfit regarding their quality. The maximum samples were found unfit for high RSC followed by EC and combined effect of EC and RSC, implying that use of such groundwater for irrigation may be a cause of salinity as well as sodicity for soils of the district. The 'maximum values' of Cl ion and 'mean values' of Na ion were observed higher than their permissible values (4 me L^{-1} and 3 me L^{-1} respectively) in all the four tehsils, indicating that groundwater is toxic to crop growth at certain locations of the district. The data manifested that the quality deciding parameters i.e., EC, SAR and RSC of irrigation water were statistically positively correlated ($p < 0.01$) with each other having coefficient of correlation r = 0.685, 0.540, 0.597 for EC; SAR, EC; RSC and SAR; RSC respectively. From these results, it was concluded that RSC is the major factor for unfitness of water quality in Gujranwala district followed by EC and SAR, whereas, toxicity of groundwater to crop growth due to Cl and Na ions is also worth-considering.

Received | January 15, 2021; **Accepted** | May 18, 2022; **Published** | June 28, 2022
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Citation | Ali, A., S.N. Malik, M. Akmal, H.U. Rafa and A. Subhani. 2022. Irrigation water characteristics, their correlations and suitability for agriculture in district Gujranwala (A survey study). *Pakistan Journal of Agricultural Research,* 35(2): 303-310.
DOI | https://dx.doi.org/10.17582/journal.pjar/2022/35.2.303.310
Keywords | Groundwater quality, Gujranwala district, Electrical conductivity (EC), Sodium adsorption ratio (SAR), Residual sodium carbonate (RSC)

Introduction

Population of Pakistan was estimated as 211.17 million in 2019. In 2019-20, agriculture sector contributed as 19.31% alone, and 38.60% combined with industrial sector to the GDP of the country, because most of the industry in the country is also agro-based (GOP, 2020). It was estimated that agriculture sector employed country's work-force as 38.5% alone, and 62.2% combined with industrial sector in 2017-18 (GOP, 2018).

Water is the basic need for agricultural activities. It was estimated that the agriculture sector (crops + livestock) consumed around 94 percent of the total water annually available in 2008 (183.421 km^3), followed by municipalities and industry which consumed 5 and 1 percent respectively (Frenken, 2012). Hence, agriculture is the largest consumer of water available in the country. In 2018-19, out of total 22.15 million ha cultivated area 19.32 million ha (87.22%) was sown with different irrigation sources whereas the remaining area (12.78%) was cultivated with rain-water. Out of 19.32 million ha, 6.63 million ha (34.32%) was commanded by canals, 3.57 million ha (18.48%) by tube wells and 8.19 million ha (42.4%) by canals plus tubewells (GOP, 2020). It was estimated that water-managed area contributed more than 90% to the total crop production of the country (Mahmood *et al*., 2015; UNDP, 2017; Qureshi *et al*., 2010).

Since, the surface water (canals) cannot alone cater for the irrigational needs, therefore, the role of tube well water is very crucial in the country. That is why, 52 MAF (million-acre feet) groundwater had to be abstracted by 1391277 tube wells for cultivation of different crops in 2017-18 (GOP, 2019). This large number grew to this extent from 163208 tube wells within only 17 years in 2000-01 in the country (GOP, 2019). Hence, tendency of dependence on tube well water has tremendously been increased over the time. However, simultaneous with enormous benefits of tube well water, there had been many reservations in its use for irrigational purpose as well, among which, poor quality of 70 % groundwater is of paramount importance (Latif and Ahmed, 2008; Hanan, 2012), which may negatively impact crop production through direct osmotic stress, and indirect soil salinization (Kahlown *et al*., 2003; Riaz *et al*., 2018).

Ali *et al.* (2009) analyzed groundwater samples of 20 villages of Lahore district and found unfitness of 28 samples (46.6%), 19 samples (31.6%), 44 samples (73.3%) and 10 samples (16.6%) on the basis of EC, SAR, RSC and Cl ion respectively. Khattak *et al.* (2012) analyzed 33 groundwater samples adjacent to Hadiara industrial drain Lahore out of which 79% samples were found as unfit for irrigation of agricultural crops. They found that high SAR and RSC caused unfitness of 24.3% and 82% samples respectively. However, the chloride level of only 3% samples exceeded to the permissible limit. Maqsood *et al.* (2016) analyzed 71 groundwater samples from different locations of Hafizabad district and found 08 (11.27%) samples as unfit for irrigation purpose. The unfitness of these samples was caused by high EC and RSC. Awais *et al*. (2017) collected groundwater samples from 289 points of 8042.83 km^2 area of Lower Chenab Canal at times pre-monsoon and post-monsoon. They analyzed the samples and found as unfit of 846 km^2 (10.53%) for pre-monsoon time whereas 798.33 km^2 (9.93%) for post-monsoon time. They further found that maximal contribution to unfitness was imparted by RSC. Riaz *et al.* (2018) analyzed 3326 groundwater samples in Bahawalpur tehsil out of which 52.78% came out to be unfit. Electrical conductivity, SAR and RSC contributed to unfitness as 34%, 21% and 7% respectively. The researchers have reported that the waters with high value of EC and RSC can be used under regular monitoring and by adopting special irrigation and management techniques (Ayers and Westcot, 1985; Nishanthiny *et al*., 2010) to avoid salinization of agricultural lands. In 2001-2004, out of total 41721884 acres (16.89 million ha) of agricultural land surveyed 11803544 (4.78 million ha) (27%) land was found as salt-affected of different categories (GOP, 2019).

In the light of available information, this study was undertaken to know the quality characteristics of groundwater water in different tehsils of Gujranwala. The objective of the study was to find out relationship among different irrigation water quality parameters so that groundwater could safely be applied to soil and agricultural crop by adopting different management techniques.

Materials and Methods

A survey study to monitor the groundwater quality for irrigation use was conducted in Gujranwala district which is located in 32.1877°N, 74.1945°E. From four tehsils of Gujranwala district, 565 water samples were collected in following numbers: 204 samples from tehsil Gujranwala, 156 samples from tehsil Kamoke, 127 samples from tehsil Wazirabad, and 78 samples from tehsil Noshera Virkan respectively, by pumping out water after operating tube wells for 20-30 minutes prior to collecting water samples. These samples were randomly collected from farmers' tube wells in the four tehsils of district Gujranwala. The collected water samples were stored in sterile plastic/glass bottles tightly fitted with bottle cap. Each bottle was properly labeled showing the name, location and sampling date. These samples were analyzed for EC, Ca, Mg, Na, CO_3, HCO_3, and Cl following the standard analytical procedures, as given in Table 1, at Soil and Water Testing Laboratory, Gujranwala. Electric Conductivity (EC) was determined by EC meter. While CO_3, HCO_3 was determined by titration with H_2SO_4. Whereas, Cl was determined by titration with $AgNO_3$ and Ca, Mg was determined by titration with EDTA.

Table 1: *Analysis techniques with references.*

Parameters	Technique	Reference
pH	pH meter	Richards (1954)
Electrical conductivity	Conductivity meter	Richards (1954)
Na and K	Flame photometer	Richards (1954)
Ca, Mg, CO_3, HCO_3 and Cl,	Titrimetric method	APHA (2000)

The data regarding sodium adsorption ration (SAR) and residual sodium carbonate (RSC) was derived using the following formulae (Richards, 1954).

$$SAR = \frac{Na}{[(Ca + Mg) / 2]^{1/2}} (mmol\ L - 1)^{1/2}$$

$$RSC\ (meq\ L^{-1}) = [CO_3 + HCO_3\ (meq\ L^{-1})] - [Ca + Mg\ (meq\ L^{-1})]$$

The results obtained for EC, SAR and RSC of analyzed water-samples were categorized for their quality fitness/unfitness following the criteria as being adopted in agriculture department of the Punjab (Malik *et al*., 1984), which is given in Table 2. The toxicity criteria for Cl and Na elements concentration in irrigation water is presented in Table 3.

Table 2: *Criteria for quality of irrigation water.*

Parameters	Fit	Marginally fit	Unfit
EC (μScm^{-1})	<1000	1000 - 1250	>1250
RSC (me L^{-1})	<1.25	1.25 - 2.25	>2.25
SAR (mmol L^{-1})	<6	6 - 10	>10
Cl (me L^{-1})	<3.9	-	>3.9
Na (me L^{-1})	<3	-	>3

(Malik et al., 1984).

Table 3: *Criteria for specific ion toxicity of irrigation water.*

Parameters	Non toxic	Toxic
Cl (meL^{-1})	<4	>4
Na (meL^{-1})	<3	>3

(Ayers and Westcot. 1985).

The data obtained was analyzed statistically for percent, mean, and standard deviation following the methods of Steel and Torrie (1980).

Results and Discussion

As is obvious from Figure 1, in total 565 water samples were analyzed for EC, SAR and RSC parameters. It was found that out of 565 water samples, 231 (40.88%) were fit; 149 (26.37%) marginally fit, and; 185 (32.74%) unfit for irrigation of cultivated land. These results are in line with those of Latif and Ahmad (2008), Hannan (2012) and Khattak *et al*. (2012) who reported unfitness of groundwater up to 79% in their studies.

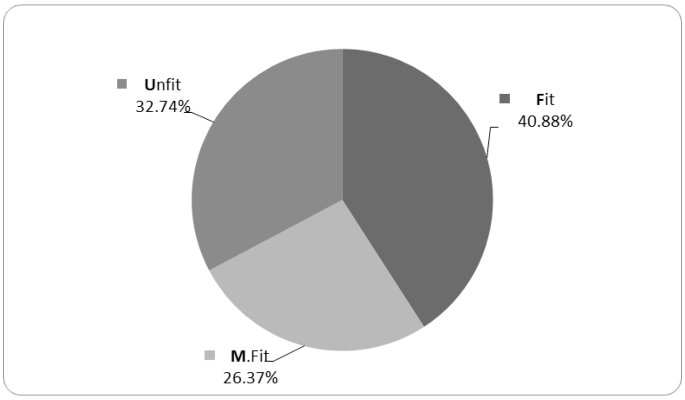

Figure 1: *Irrigation Water Quality in District Gujranwala.*

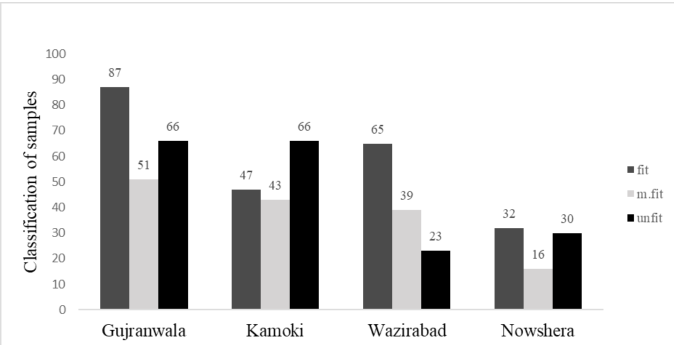

Figure 2: *Classification of water samples in four tehsils of Gujranwala district.*

The tehsil-wise classification of water quality of Gujranwala district has been presented in Figure 2. It was observed that in total 204, 156, 127 and 78 water samples were collected from tehsil Gujranwala, Kamoki, Waziabad, Nowshera Virkan respectively the analysis of which showed the order for fitness as follows: Wazirabad (51.18%) > Gujranwala (42.65%) > Nowshera Virkan (41.03%) > Kamoki (30.13%). The order for marginal fitness remained as follows: Wazirabad (30.71%) > Kamoki (27.56%) > Gujranwala (25%) > Nowshera Virkan (20.51%).

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The order for unfitness of samples was revealed as follows: Wazirabad (18.11%) < Gujranwala (32.35%) < Nowshera Virkan (38.46%) < Kamoki (42.31%).

The detail of unfitness of water samples on the basis of EC, SAR and RSC in different tehsils of Gujranwala district are presented in Table 4. As has been manifested in Figure 1, 32.43% of the total analyzed samples were unfit out of which 95.68% had become unfit due to high EC, RSC and EC+RSC in four tehsils of Gujranwala district. For example, EC, RSC and EC+RSC caused unfitness of samples in Gujranwala, Kamoke, Wazirabad and Noshehra Virkan as 20.55, 42.70 and 32.43 percent. Hence, RSC is the biggest contributor to unfitness of groundwater in Gujranwala district followed by EC+RSC and EC. When analyzed data of unfit samples was reviewed separately for each tehsil it came out that 16.67, 30.30, 13.04 and 13.33 percent of total unfit samples of Gujranwala, Kamoke, Wazirabad and Noshehra Virkan tehsils became unfit by EC, respectively. Hence, groundwater of Kamoke tehsil was found most saline followed by Gujranwala tehsil. The other two Tehsil of Wazirabad and Noshehra Virkan were found almost at par for salinity hazard of groundwater. Similarly, 42.42, 34.85, 56.52 and 50.00 percent of total unfit samples of Gujranwala, Kamoke, Wazirabad and Noshehra Virkan tehsils were turned unfit by RSC, respectively. It implies that RSC problem is most severe in Wazirabad followed by Noshehra Virkan, Gujranwala and Kamoke tehsils. The holistic picture of this detail depicts the fact that 32.74% of total groundwater of Gujranwala district is unfit mainly due to EC and RSC, whereas, SAR is not a significant contributor to the unfitness. These results have similarity with those of Maqsood *et al.* (2016) and Awais *et al.* (2017) who found high EC and RSC values as major unfitness causing agents of groundwater in their scientific studies.

Table 4: *Unfit water-samples (%) in different tehsils of district Gujranwala on the basis of EC, SAR and RSC values.*

Tehsil	EC	SAR	RSC	EC+ SAR	EC+ RSC	SAR+ RSC	EC+ SAR+ RSC
Gujranwala	16.67	0	42.42	0	33.33	3.03	4.55
Kamoke	30.30	0	34.85	0	34.85	0	0
Wazirabad	13.04	0	56.52	8.70	17.39	0	4.35
Noshera	13.33	0	50.00	0	36.67	0	0
Total	20.55	0	42.70	1.08	32.43	1.08	2.16

Table 5 explains the details of minimum and maximum limits/concentrations of quality and toxicity parameters of groundwater in different tehsils of district Gujranwala. For example, EC ranged as 0.0065-2.98 (Mean 0.91), 0.47-2.08 (Mean 1.05), 0.42-12.16 (Mean 0.99) and 0.12-2.5 (Mean 1.00) for Gujranwala, Kamoke, Wazirabad and Noshehra Virkan, respectively; SAR ranged as 1.1-20.23 (Mean 4.99), 1.11-9.96 (Mean 3.51), 0.42-12.16 (Mean 0.99) and 0.12-2.5 (Mean 1.00) for Gujranwala, Kamoke, Wazirabad and Noshehra Virkan respectively, and; RSC ranged as 0.05-9.2 (Mean 2.43), 0.02-11.7 (Mean 2.1), 0.02-10.9 (Mean 1.8) and 0.09-11.68 (Mean 2.47) for Gujranwala, Kamoke, Wazirabad and Noshehra Virkan respectively. The values for Cl ion concentration ranged as 0.1-10.5 (Mean 1.17), 0.1-6.9 (Mean 1.31), 0.1-68.6 (Mean 1.8) and 0.2-6.0 (Mean 1.29) for Gujranwala, Kamoke, Wazirabad and Noshehra Virkan, respectively, whereas, the values for Na concentration ranged from o.16-23.15 (Mean 4.34), 0.17-15.15 (Mean 5.47), 0.25-93.1 (Mean 5.1) and 0.29-16.92 (Mean 4.84) for Gujranwala, Kamoke, Wazirabad and Noshehra Virkan, respectively. The aforementioned maximum values of EC, SAR, RSC, Cl and Na show that the groundwater at certain locations of Gujranwala district is not only of poor quality but also toxic to many agricultural crops. Such water, if applied in un-monitored and un-managed manner, may not only deteriorate agricultural lands turning them salt-affected but also markedly reduce crop production due to osmotic stress in all the four tehsils of Gujranwala district. These results are similar to those of Maqsood *et al.* (2016) and Awais *et al.* (2017) who found high EC and RSC values as major unfitness causing agents of groundwater in their scientific studies. The results also resemble to those of Ali *et al.* (2009) and Khattak *et al.* (2012) who found Cl in excess concentration in groundwater (17% and 3%, respectively) than its permissible limit.

Since, maximum percentage of samples got unfit on the basis of RSC, therefore, there is a need to take view of analysis data of Ca+Mg and CO_3+HCO_3 in the four tehsils. It was observed that CO_3 was not a big contributor to RSC, whereas, HCO_3 had been the remarkable contributor to RSC in all the tehsils of Gujranwala district. It was further observed that in Gujranwala and Noshehra Virkan tehsils the minimum and maximum values of CO_3+HCO_3 exceeded to Ca+Mg values. However, in Kamoke tehsil only maximum value, whereas, in Wazirabad tehsil only minimum values of CO_3+HCO_3 exceeded to Ca+Mg values. But the most important point in this regard is that mean values of CO_3+HCO_3 exceeded to Ca+Mg values in all the four tehsils of Gujranwala district. This detail has been presented in Table 5.

Table 5a: *Minimum and maximum limits/concentrations of quality and toxicity parameters of groundwater in different tehsils of district Gujranwala.*

Parameters	Gujran-wala	Kamoke	Wazirabad	Noshera Virkan
EC (dS m^{-1})				
Minimum	0.001	0.47	0.42	0.12
Maximum	2.98	2.08	12.16	2.50
SD	0.38	0.38	1.07	0.38
Mean	0.91	1.05	0.99	1.00
Median	0.84	1.01	0.83	0.96
SAR (mmol L^{-1})$^{1/2}$				
Minimum	1.1	1.11	0.14	0.17
Maximum	20.23	9.96	24.66	9.39
SD	2.58	2.22	3.0	1.92
Mean	4.99	3.51	3.2	3.06
Median	2.56	3.29	2.74	3.20
RSC (me L^{-1})				
Minimum	0.05	0.02	0.02	0.09
Maximum	9.2	11.7	10.9	11.68
SD	1.86	1.98	1.7	0.34
Mean	2.43	2.1	1.8	2.47
Median	2.1	1.6	1.4	1.8
Cl (me L^{-1})				
Minimum	0.1	0.1	0.1	0.2
Maximum	10.5	6.9	68.6	6.0
SD	1.25	1.13	6.2	0.98
Mean	1.17	1.31	1.8	1.29
Median	0.7	1.0	0.7	1.1
Na (me L^{-1})				
Minimum	0.16	0.17	0.25	0.29
Maximum	23.15	15.15	93.1	16.92
SD	3.28	3.40	8.6	3.16
Mean	4.34	5.47	5.1	4.84
Median	3.91	4.9	3.8	4.9

There are three kind of hazards associated with irrigation water quality. They are: (1) salinity hazard; (2) sodicity hazard, and; (3) toxicity hazard. They are commonly interpreted through five criteria of water quality fitness, i.e. EC, SAR, RSC, C and Na. The groundwater with standard quality parameter should be used for irrigation under regular monitoring and adoption of special management techniques (Ayers and Westcot, 1985; Nishanthiny *et al*., 2010).

Table 5b: *Minimum, maximum, and mean value of different quality parameters of water samples in district Gujranwala.*

Tehsil name		Ca+Mg (me L^{-1})	CO_3 (me L^{-1})	HCO_3 (me L^{-1})	CO_3+HCO_3 (me L^{-1})
Gujran-wala	Min	0.4	0.04	1.22	1.26
	Max	9.9	1.6	13.76	15.36
	SD	1.80	0.65	2.59	
	Mean	4.73	0.59	6.56	
Kamoke	Min	1.9	0.19	0.3	0.49
	Max	11.5	0.2	14.8	15.00
	SD	1.47	0.01	2.22	
	Mean	4.98	0.20	6.55	
Wazira-bad	Min	01.5	2	0.3	2.30
	Max	97	2	14	16.00
	SD	08.6	-	2.2	
	Mean	0 5.6	2.0	5.9	
Noshera Virkan	Min	2.2	0	2.4	2.40
	Max	8.94	0	19.8	19.80
	SD	1.48	0	3.06	
	Mean	5.28	0	7.27	

The first kind of problem, i.e. the salinity problem, appears when the high quantity of salts is dissolved in irrigation water leading to accumulation of salts in the root zone and causing osmotic stress to the crop. The salinity level of an irrigation water can be determined directly by evaporation of a known quantity of water and measuring the residue of dissolved salts that remain behind. An indirect and a more common method of determining the salt content of an irrigation water is to measure its electrical conductivity (EC). The greater the conductivity, the greater is its salt content.

Second kind of problem, i.e. the sodicity problem, is often confronted in the form of poor infiltration and inadequate permeability of water in soil. The problem develops through long-term and unschematic application of irrigation water bearing high concentration of sodium relative to calcium and magnesium. Sodicity causes swelling and dispersion of soil clays, surface crusting and pore plugging. This degraded soil structure condition in turn obstructs infiltration, enhances water runoff and restricts root growth. The most common measure for assessment of sodicity in water and soil is done by calculating sodium adsorption ratio (SAR). The SAR defines sodicity in terms of the relative concentration of sodium (Na) compared to the sum of calcium (Ca) and magnesium (Mg) ions in a sample. The SAR assesses the potential for infiltration problems due to a sodium imbalance in irrigation water. Residual Sodium Carbonate (RSC) is another index of the sodicity hazard of irrigation water. High carbonate (CO_3^{-2}) and bicarbonate (HCO_3^{-1}) in irrigation water increase SAR index in the soil. Bicarbonate and carbonate ions combined with calcium and magnesium leading to their precipitation and raising the proportion of sodium ions than calcium and magnesium. When dissolved sodium in comparison with dissolved calcium and magnesium is higher in water, clay soil succumbs to dispersion and in turn swelling which drastically reduces infiltration and permeability of soil. The plant roots become unable to spread vertically as well as horizontally in the soil due to its hardness in addition to sufferance from severe moisture stress.

Third kind of problem, i.e., toxicity problem related to water quality, occurs when Cl and Na are found in irrigation water in excessive concentration. Though these are essential elements for plant growth but they are required in very small amounts to the plants. When their concentration in irrigation water increases the crop yield inversely decreases due their toxic effect on the crop growth. The decrease in yield is more drastic in crops which are sensitive to these elements.

Pearson correlation coefficient for irrigation water parameters is presented in Table 6. It is evident from the data that the quality deciding parameters i.e. EC, SAR and RSC of irrigation water were positively correlated ($p < 0.01$) with each other expressing coefficient of correlation r = 0.685, 0.540, 0.597 for EC; SAR, EC; RSC and SAR; RSC respectively. Data suggested that EC, SAR and RSC in irrigation water are positively correlated with each other in irrigation samples. Similar results were reported by (Pervaiz et al., 2002) where a highly significant correlation existed among EC, SAR and RSC. Carbonates (CO_3) in irrigation water were non-significantly correlated with EC. A significantly positive correlation also existed between SAR, Na, HCO_3 and Cl having coefficient of correlations at $p < 0.01$, with r = 0.825, 0.341 and 0.479. Sodium adsorption ratio (SAR) of irrigation water is non-significantly correlated with CO_3 and negatively correlated with Ca + Mg. Residual sodium carbonate (RSC) in irrigation water was statistically positively correlated with coefficient of correlation values r = 0.638, 0.739 and 0.246 at $p < 0.01$ for Na, HCO_3 and Cl. Negative coefficient of correlation exists between RSC and Ca + Mg in irrigation water.

Table 6: *Pearson correlation analysis of irrigation water characteristics.*

Parameters		**EC (dS m^{-1})**	**Ca + Mg (me L^{-1})**	**Na (me L^{-1})**	**CO_3 (me L^{-1})**	**HCO_3 (me L^{-1})**	**Cl (me L^{-1})**	**SAR (mmol L^{-1})$^{1/2}$**	**RSC (me L^{-1})**
EC	CC	1							
	Sig. (P-value)	-							
Ca + Mg (me/l)	CC	.418**	1						
	Sig. (P-value)	.000	-						
Na (me/l)	CC	.951**	.305**	1					
	Sig. (P-value)	.000	.000	-					
CO_3 (me/l)	CC	.498	-.506	.851**	1				
	Sig. (P-value)	.143	.135	.002	-				
HCO_3 (me/l)	CC	.401**	.215**	.338**	.528	1			
	Sig. (P-value)	.000	.000	.000	.117	-			
Cl (me/l)	CC	.833**	.240**	.809**	.358	.078	1		
	Sig. (P-value)	.000	.000	.000	.309	.064	-		
SAR	CC	.685**	.105*	.825**	.845**	.341**	.479**	1	
	Sig. (P-value)	.000	.012	.000	.002	.000	.000	-	
RSC	CC	.540**	-.038	.638**	.660	.739**	.246**	.597**	1
	Sig. (P-value)	.000	.404	.000	.154	.000	.000	.000	-

*CC: Pearson correlation coefficient (r); **: Correlation is significant at the 0.01 level (2-tailed); *: Correlation is significant at the 0.05 level (2-tailed).*

Conclusions and Recommendations

The irrigation with poor quality water of high salt concentration can cause salt accumulation in agricultural lands and salt stress in root zone leading to degradation of soil quality and low crop yield. Therefore, it is imperative to test the water quality before its selection for irrigation. Regular monitoring of quality characteristics of groundwater/ tube well water should be made for safety of the soils' productivity and harvest of high crop yield. High carbonates and bicarbonates in water (RSC) is the major factor for unfitness/ quality of irrigation water in the study area followed by EC. The quality parameters of irrigation water i.e., EC, SAR and RSC have some positive correlation in the surveyed area depicting dependency on each other. It is recommended that after qualifying the type of problem in the water samples, appropriate site-specific management should be adopted. It includes application of gypsum and organic amendments or their integrated use for treatment of RSC. The total salt content in irrigation waters can be managed through dilution with good quality ground or canal water. Over all such studies will provide the baseline data to the farmers for safe use of irrigation water / to value their input cost and identify future water research areas for water quality research in Pakistan.

Novelty Statement

Quality of water used for irrigation purpose is very much important for agriculture sector.

Author's Contribution

Abid Ali: Supervised the research work and wrote initial draft.
Safia Naureen Malik: Assisted in write up of the draft, compiled the data and submitted the manuscripg.
Muhammad Akmal: Gave technical input and analysed the data.
Hafeez Ullah Rafa: Assisted in data analysis and results and discussion.
Abid Subhani: Reviewed and edited the final draft.

Conflict of interest

The authors have declared no conflict of interest.

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