AN AJSS An Asian Journal of Soil Science
Volume 12 | Issue 2 | December, 2017 | 257-264 | e ISSN–0976–7231 ■ Visit us : www.researchjournal.co.in

Research Article

DOI : 10.15740/HAS/AJSS/12.2/257-264

Assessment of the quality of canal water used for irrigation purpose in Muzaffarnagar district of Uttar Pradesh

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Received : 22.07.2017; **Revised :** 05.11.2017; **Accepted :** 15.11.2017

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Summary

Water is the most important natural resource which needs to be properly and scientifically utilized for improving the productivity, environment and economic condition of the rural area. The present study was conducted to canal water quality status in district of Muzaffarnagar, Uttar Pradesh, for irrigation purpose. The canal water samples were analyzed for their chemical properties total salt (electrical conductivity), pH, anions (Cl, HCO_3, SO_4, NO_3, F, B), cations ($Ca^{2+} + Mg^{2+}$, Na^+, K^+). In water samples total salt (EC) ranged from 0.20 to 0.64 dSm^{-1}, pH7.2 to 8.1, potassium 1.95 to 12.12 mg L^{-1}, sodium 2.80 to 65.55 mg L^{-1}, Ca +Mg 22.80 to 96.40 mg L^{-1}, bicarbonate 82.96 to 269.01 mg L^{-1}, chloride 12.60 to 44.38 mg L^{-1}, sulphate 12.81 to 105.71 mg L^{-1}, nitrate 2.50 to 25.42 mg L^{-1}, fluoride 0.21 to 0.86 mg L^{-1} and boron 0.10 to 3.51 mg L^{-1}. Correlation was also works out between different parameters. The correlation co-efficient (r) among nine canal water quality parameter namely total salt (electrical conductivity), pH, anions (Cl, HCO_3, SO_4, NO_3, F, B), cations ($Ca^{2+} + Mg^{2+}$, Na^+, K^+) were calculated for correlation analysis which showed chemical facies of canal irrigation water samples. The EC showed good positive correlation with chloride, sulphate, Ca + Mg, nitrate, bicarbonate, potassium, sodium and negative correlation with pH. The Muzaffarnagar district is safe for irrigation purpose.

Key words : Canal water analysis, Cations and anions, Correlation, Irrigation purpose

How to cite this article : Kumar, Sushil, Singh, G.R., Yadav, H.K. and Kumar, Pramod (2017). Assessment of the quality of canal water used for irrigation purpose in Muzaffarnagar district of Uttar Pradesh. *Asian J. Soil Sci.*, **12** (2) : 257-264 : **DOI : 10.15740/HAS/AJSS/12.2/257-264.**

Introduction

Water is a precious, finite, and in view of growing demand, ultimately scarce natural endowment. India which has 2.45 per cent of the world's land resources, has roughly, 4 per cent of the world's fresh water resources, whereas the country's population is 16 per cent of the world's population. Most of the rainfall, 76 per cent as per India Meteorological Department, in India occurs as a result of the southwest monsoon between June and September, except in the state of Tamil Nadu which falls under the influence of northeast monsoon during October and November. More than 50 per cent of precipitation takes place in about 15 days and less than 100 hours altogether in a year.

Water is essential requirement of human and industrial development and also it is one of the most

delicate part of the environment (Das and Acharya, 2003). Ground water is the main source of drinking, irrigation and industrial purpose. During last two decades the indiscriminate disposal of industrial wastes on mother earth slowly makes the ground water susceptible to pollution (Tank and Chandel, 2010).

Various workers in our country have carried out extensive work on water quality for various purposes. Subramani *et al*. (2005) have studied ground water quality and its suitability for drinking and agriculture use in Chithar river basin. Parashar *et al.* (2008) have studied the drinking water quality status in Bhopal and conclued that the water quality is good and within the range of standard value prescribed by various agencies. Raju (2007) has also evaluated the ground water quality in the upper Gunanaeru river basin, Andhra Pradesh.

Water is frequently referred to as universal solvent, because it has the ability to dissolve some amount of all substance that comes in contact. Rainfall and snow melt percolating the soil zone and unsaturated material chemically reacts with the gases, minerals and organic compounds that occur naturally within the subsurface. These reactions continue to act below the water table as the water flows through the aquifer. The result is that the characteristics and composition of the water evolve as it flows through the ground in response to the types of solids and gas phases that the solution encounters and the geochemical reactions that occur between these phases (Deutsch, 1977). Therefore, each groundwater system has its own characteristic chemical signature produced as a result of chemical alteration of the meteoric water recharging the system (Drever, 1982).

Resource and Research Methods

Outline of study area :

Muzaffarnagar is an important district in western Uttar Pradesh and the town Muzaffarnagar is the district Headquarter. It lies between latitude $29^0$11'N and $29^0$43'N and longitude $77^0$04'E and $78^0$07'E. It forms a part of the Saharanpur division and is situated in the interfluves of Ganga and Yamuna rivers between the districts of Saharanpur on the north and Meerut on the south. On the west, the Yamuna separates it from district Karnal of Haryana and on the east; the Ganga forms the boundary between this district and the district of Bijnor. Almost all the villages of the area are approachable by motarable roads.

Collection of water and soil samples :

Fifty canal irrigation water samples were collected from different locations of district Muzaffarnagar during 2007-2009 . The samples were collected in plastic bottles, which were thoroughly rinsed with sample water. The bottles were carefully corked, properly labeled and brought to the laboratory for chemical analysis. Canal water samples were collected from the irrigation Rajwahe and Khatauli Ganga river at different locations across the district, analyzed for their chemical properties *i.e.* pH, total salt (electrical conductivity), anions (Cl^-, CO_3^-, HCO_3^-, SO_4^- and NO_3^-, F and B), cations (Ca^{++}, Mg^{++}, Na^+, K^+), (APHA, 2002; Jackson, 1973 and Tondon, 1993).

Magnesium content:

Magnesium content of water is considered as one of the most important qualitative criteria in determining quality of water for irrigation. Magnesium content was calculated by the following formula. Mg content = $[Mg^{2+} / (Mg^{2+} + Ca^{2+})] 100$.

Sodium percentage :

Doneen method was used to calculate the sodium percentage.

$$Na\% = [Na^+ K^+)/ (Ca^{2+}+ Mg^{2+}+ Na^+ K^+)] 100.$$

All the analysis of canal water was carried out in the laboratory of Department of Soil Science and Ag. Chemistry, CCRD College, Muzaffarnagar (U.P), India by adopting the standard methods.

Research Findings and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Electrical conductivity:

The electrical conductivity of study area ranged from 0.20 to 0.64 dSm^{-1} (Table 1). Maximum value (0.64 dSm^{-1}) was from Kaidi (Kairana) location, while minimum (0.20 dSm^{-1}) from Allem (Budhana) location. The most influential water quality guide line on crop productivity is the water salinity hazards measured by electrical conductivity (EC). By comparing EC value with standard as proposed by WHO, it was found that all samples were in permissible limit and found suitable for irrigation purpose indicting the presence of high amount of dissolve inorganic substances in ionized form, similar finding was

Table 1 : Physico-chemical characteristics of canal water samples collected from different locations of Muzaffarnagar district

Sr. No.	Location	Tehsil	EC (ds/m)	pH	K (mg/l)	Na (mg/l)	Ca+ Mg (mg/l)	HCO_3 (mg/l)	NO_3 (mg/l)	Cl (mg/l)	SO_4 (mg/l)	F (mg/l)	B (mg/l)
1.	Ghamat	Muzaffarnagar	0.23	8.1	2.03	9.43	34.77	99.0	9.92	17.23	18.74	0.29	1.51
2.	Buraheri	Muzaffarnagar	0.25	7.6	2.61	20.47	30.65	101.87	5.58	18.23	30.11	0.25	0.97
3.	Tejalhera	Muzaffarnagar	0.24	8.0	2.13	2.8	39.43	119.99	2.5	15.02	21.62	0.23	1.19
4.	Baseda	Muzaffarnagar	0.22	8.0	2.53	9.43	38.15	107.39	16.74	12.78	20.81	0.31	1.10
5.	Jutmujhera	Muzaffarnagar	0.41	7.5	6.93	19.61	50.47	215.94	21.7	12.6	18.79	0.38	0.25
6.	Shikhreda	Muzaffarnagar	0.26	7.6	2.71	4.9	38.45	106.75	6.82	14.82	27.21	0.58	-
7.	Bahadurpur	Muzaffarnagar	0.34	7.9	4.81	12.91	44.32	144.57	10.54	17.83	29.31	0.39	-
8.	Johra	Jansath	0.24	7.4	2.02	5.06	35.52	90.78	9.3	18.33	24.51	0.31	-
9.	Nawla	Jansath	0.25	8.1	3.11	4.9	40.88	115.28	8.06	19.33	26.43	0.28	-
10.	Bhainsi	Jansath	0.22	8.1	1.95	8.28	37.26	96.15	11.78	16.82	24.07	0.27	1.84
11.	Antwada	Jansath	0.24	7.5	2.55	24.38	22.8	88.86	5.58	16.42	28.13	0.23	2.27
12.	Tajpur	Jansath	0.22	8.0	2.58	6.9	35.75	100.65	6.82	15.82	30.13	0.25	-
13.	Ladpur	Jansath	0.21	8.0	2.74	9.43	39.76	88.82	15.5	18.82	19.39	0.29	-
14.	Palda	Jansath	0.24	7.6	2.67	4.9	40.73	83.04	6.2	18.33	30.26	0.39	-
15.	Khatauli	Jansath	0.35	7.9	6.44	8.9	56.49	155.32	8.68	14.52	41.8	0.42	0.67
16.	Mansurpur	Jansath	0.33	7.6	4.90	13.41	46.63	143.84	11.16	17.93	31.23	0.41	0.10
17.	Satedhi	Jansath	0.23	7.9	2.42	4.5	45.45	97.6	8.06	14.46	32.67	0.59	0.37
18.	Sarai	Jansath	0.35	7.7	4.93	13.31	53.44	153.11	11.16	24.85	26.43	0.38	0.97
19.	Belda	Jansath	0.27	8.1	3.91	4.6	45.84	120.07	14.26	16.69	31.54	0.32	1.51
20.	Dheraheri	Jansath	0.38	8.1	7.52	8.05	52.8	89.46	5.58	16.32	105.71	0.45	1.19
21.	Bhopa	Jansath	0.40	7.8	7.67	18.4	53.59	173.85	19.84	24.85	36.04	0.39	0.76
22.	Jouli	Jansath	0.43	7.4	6.84	36.8	46.15	179.95	17.98	28.4	39.4	0.58	1.4
23.	Shikhera	Jansath	0.46	7.9	6.80	65.55	31.73	183.61	7.44	24.85	49.01	0.48	1.08
24.	Nagla	Jansath	0.39	8.1	5.87	13.8	54.22	152.5	5.09	28.4	33.64	0.53	0.25
25.	Chitoda	Jansath	0.45	7.9	7.23	11.5	62.09	198.25	6.20	21.3	40.84	0.78	0.41
26.	Sotta	Kairana	0.42	8.0	7.64	16.21	59.24	192.15	5.58	28.4	33.64	0.42	-
27.	Kurmali	Kairana	0.44	8.1	6.97	20.41	55.81	198.25	3.10	21.3	40.84	0.37	-
28.	Khanpur	Kairana	0.34	8.0	2.53	4.30	45.67	128.1	7.44	20.43	24.03	0.29	-
29.	Silawar	Kairana	0.40	7.7	7.84	21.41	45.09	170.8	9.30	21.3	31.23	0.5	-
30.	Tanna	Kairana	0.37	7.8	5.87	18.40	51.47	189.1	13.64	15.82	12.81	0.52	2.38
31.	Mansura	Kairana	0.41	7.6	7.94	20.81	55.69	176.9	25.42	21.3	26.43	0.59	1.41
32.	Kairana	Kairana	0.38	8.1	5.47	13.80	56.69	145.79	22.32	26.63	28.35	0.48	3.51
33.	Usmanpur	Kairana	0.46	7.9	7.33	17.25	64.94	203.13	6.20	26.63	33.64	0.86	2.06
34.	Manak	Kairana	0.43	7.8	7.63	20.31	60.99	186.05	9.30	31.95	28.83	0.37	1.43
35.	Kaidi	Kairana	0.64	7.4	6.81	20.73	96.4	269.01	13.12	44.38	43.25	0.55	2.27
36.	Monnnet	Kairana	0.45	7.9	6.83	54.05	42.19	180.04	5.58	36.21	45.65	0.49	1.94
37.	Kajipura	Kairana	0.40	8.1	7.82	18.40	49.58	170.8	9.92	17.75	31.23	0.37	1.51
38.	Madalpur	Kairana	0.38	7.2	6.92	8.30	65.92	164.09	9.30	33.73	52.33	0.35	1.19
39.	Bhaiswal	Kairana	0.48	7.5	12.12	61.64	37.4	192.15	8.06	21.3	57.66	0.29	2.05
40.	Kiroadi	Kairana	0.43	7.6	7.64	48.99	35.51	176.9	8.06	24.85	26.43	0.52	0.86
41.	Gohrana	Kairana	0.53	7.6	6.91	37.49	70.76	241.22	16.12	40.83	26.31	0.51	1.55
42.	Nala	Budhana	0.45	7.9	7.36	21.85	54.26	217.16	6.2	33.73	19.39	0.71	0.65
43.	Malakpur	Budhana	0.42	7.6	7.18	51.06	34.74	201.3	13.02	23.08	17.24	0.79	0.67
44.	Fatehpur	Budhana	0.33	7.8	7.77	26.22	39.71	153.11	8.68	30.53	26.91	0.80	-
45.	Kandawadi	Budhana	0.23	8.0	5.88	26.45	27.45	116.51	4.96	14.2	21.62	0.29	-
46.	Allem	Budhana	0.20	8.0	2.53	17.48	31.57	82.96	7.44	17.4	18	0.28	-
47.	Sunna	Budhana	0.23	7.8	4.82	14.26	37.98	112.85	19.22	15.98	17.3	0.32	-
48.	Hasanpur	Budhana	0.33	7.6	4.95	18.17	49.84	148.67	11.78	23.08	20.81	0.21	0.67
49.	Shahpur	Budhana	0.38	7.5	5.30	44.85	28.02	150.44	6.82	32.66	28.71	0.29	2.39
50.	Atali	Budhana	0.37	7.6	5.51	13.8	53.9	147	6.2	25.92	29.14	0.39	0.21

reported by Gill (2005).

pH:

Values of pH were measured in canal water which ranged between 7.2 to 8.1 (Table 1). The canal water was normal to slightly alkaline in nature. From the point of view irrigation consumption, all the samples considered fit, as they were neither acidic nor strongly alkaline. pH has no direct effect on human health, but lower value below 5.0 produce sour test and higher value above 8.5 produce alkaline test. A similar finding was reported by Patil and Patil (2011).

Potassium :

In the present study, all the canal water samples ranged from. 1.95 to 12.12 mg L^{-1} (Table 1). The minimum potassium content 1.95 mg L^{-1} was in the samples of Bhainsi (Jansath) location, while maximum 12.12 mg L^{-1} in the Bhainswal (Kairana) location. By comparing observed value with the standard value it was found that potassium content of all canal water samples was within permissible limit (7.9- 19.5 mg L^{-1} or 0.5 MeL^{-1}) as per standard set by BIS (2009). The high concentration of potassium may be due to the influence of more application fertilizers through farmer suggested by Umadevi *et al.* (2010) and Patil and Patil (2011).

Sodium :

The sodium contents in the study area varied from 2.80 to 65.55 mg L^{-1} (Table 1). The sodium content 65.55 mg L^{-1} was maximum in the samples of Sikhera (Jansath) location, while minimum 2.80 mg L^{-1} in the samples of Tejalhera (Muzaffarnagar) location. Umar and Alam (2011) also reported the similar results of Pre-monsoon samples show marginally higher concentration of Na. This inferred by the fact that compared to 23 samples with Na values of > 200 mg/l (highest value being 382 mg/l) in post-monsoon, there are 26 such samples in pre-monsoon with the highest value being 398 mg/l.

Calcium and magnesium:

Ca^{+2} and Mg^{2+} cause by for greatest portion of the hardness occurring in natural water. Hardness of the water is objectionable from the view point of water use. (Achrya *et al.*, 2008). The Ca^{+2} and Mg^{2+} values of the water samples varied from 22.80 to 96.40 mgL^{-1} (Table 1). The lowest value of 22.80 mgL^{-1} was from Antwada (Jansath) whereas the highest value of 96.40 mgL^{-1} was recorded canal water samples from Kaidi (Kairana) location. On the other hand Ca^{2++} mg^{2++} was higher in bottom than in the surface layer during the summer. Similar finding was also reported by Umadevi *et al.* (2010). The high concentration of calcium may be due to the discharge of industrial wastes and passage through deposit of lime stone, dolomite and gypsum.

Bicarbonate :

The values of bicarbonate in the water samples varied from 82.96 to 269.01 mgL^{-1} (Table 1) of fifty different locations. The lowest value of 82.96 mgL^{-1} was observed in the canal water sample obtained from Allem (Budhana) location, whereas the highest value of 269.01 mgL^{-1} was observed in Kaidi (Kairana) location. Similar results were reported by WHO (1993).

Chloride :

Chloride in canal water varied from 12.60 to 44.38 mgL^{-1} (Table 1). The lowest chloride content 12.60 mg L^{-1} was found in the Jat Mujhera (Muzaffarnagar) location, while highest 44.38 mgL^{-1} from Kaidi (Kairana) location. The range of permissible limit as per BIS and WHO of potable water is 250 mgL^{-1}. In the 20 per cent, most of the cases chloride concentration was within permissible limit. It is observed that around 80 per cent of the water samples had highest than the permissible limit of 250 mgL^{-1} which was observed in the water samples obtained from different locations.

Sulphate :

The sulphate of canal water samples of the study area ranged from 12.81 to 105.71 mgL^{-1} (Table 1) in fifty canal water of different locations. The value of all the canal water samples was within the permissible limit (500 mgL^{-1}) as per the standard of WHO (1993). The presence of high concentration of sulphate in the study area can be attributed the discharge of domestic sewage and littering of organic waste in the regions. Similar results were reported by WHO (1993) standard.

Nitrate :

The nitrate content of canal water samples in the study area varied from 2.50 to 25.42 mgL^{-1} (Table 1). The maximum nitrate content 25.42 mgL^{-1} was found in water samples of Mansura (Kairana), while minimum 2.50 mgL^{-1} in Tejalhera (Muzaffarnagar) location. It was found that most of the water samples are below the

Table 2 : Evaluation of irrigation water on the basis of magnesium content and sodium per cent

Sr. No.	Location	Tehsil	Mg content (MeL^{-1})	Sodium percentage (MeL^{-1})
1.	Ghamat	Muzaffarnagar	47.51	238.49
2.	Buraheri	Muzaffarnagar	31.32	311.66
3.	Tejalhera	Muzaffarnagar	35.43	232.65
4.	Baseda	Muzaffarnagar	47.92	290.27
5.	Jutmujhera	Muzaffarnagar	49.02	757.23
6.	Shikhreda	Muzaffarnagar	48.09	299.43
7.	Bahadurpur	Muzaffarnagar	49.39	528.92
8.	Johra	Jansath	46.59	228.78
9.	Nawla	Jansath	49.24	341.08
10.	Bhainsi	Jansath	26.84	221.63
11.	Antwada	Jansath	48.99	315.15
12.	Tajpur	Jansath	48.95	289.44
13.	Ladpur	Jansath	24.14	302.55
14.	Palda	Jansath	25.36	287.22
15.	Khatauli	Jansath	30.11	678.97
16.	Mansurpur	Jansath	28.35	530.19
17.	Satedhi	Jansath	29.42	264.45
18.	Sarai	Jansath	26.61	533.97
19.	Belda	Jansath	27.84	413.08
20.	Dheraheri	Jansath	50.63	795.12
21.	Bhopa	Jansath	47.62	829.59
22.	Jouli	Jansath	50.03	780.99
23.	Shikhera	Jansath	15.32	816.21
24.	Nagla	Jansath	31.59	631.89
25.	Chitoda	Jansath	54.79	780.28
26.	Sotta	Kairana	49.32	825.89
27.	Kurmali	Kairana	50.35	766.17
28.	Khanpur	Kairana	39.96	279.94
29.	Silawar	Kairana	61.59	855.04
30.	Tanna	Kairana	25.98	637.32
31.	Mansura	Kairana	24.01	849.18
32.	Kairana	Kairana	25.72	589.31
33.	Usmanpur	Kairana	27.13	785.27
34.	Manak	Kairana	27.50	820.56
35.	Kaidi	Kairana	32.95	754.33
36.	Monnnet	Kairana	31.10	804.45
37.	Kajipura	Kairana	51.47	844.65
38.	Madalpur	Kairana	54.37	744.67
39.	Bhaiswal	Kairana	27.62	1346.06
40.	Kiroadi	Kairana	29.43	872.73
41.	Gohrana	Kairana	20.94	780.92
42.	Nala	Budhana	59.34	812.23
43.	Malakpur	Budhana	29.74	830.74
44.	Fatehpur	Budhana	55.07	851.75
45.	Kandawadi	Budhana	24.77	647.98
46.	Allem	Budhana	26.96	296.58
47.	Sunna	Budhana	20.80	518.58
48.	Hasanpur	Budhana	25.92	544.39
49.	Shahpur	Budhana	54.21	635.30
50.	Atali	Budhana	29.31	594.54

permissible limit of Indian Standard (45 mgL^{-1}) and WHO (50 mgL^{-1}) in nitrate content.

Floride:

The floride content of canal water samples in the study area varied from 0.21 to 0.86 mgL^{-1} (Table 1). The maximum nitrate content 0.86 mgL^{-1} was found in canal water samples of Usmanpur (Kairana), while minimum 0.21 mgL^{-1} in Hasanpura (Budhana) location.

Boron :

The boron content of canal water samples in the study area varied from 0.10 to 3.51 mgL^{-1} (Table 1). The maximum boron content 3.51 mgL^{-1} was found in canal water samples of Kairana, while minimum 0.10 mgL^{-1} in Mansurpur (Jansath) location.

Suitability of ground water for irrigation purpose:

The chemical quality of canal water is an important factor in evaluating its suitability for irrigation purpose. Suitability of canal water for irrigation depends upon its mineral constituents, besides affecting the growth of plants; presence of salt in water also directly affects full soil structure, permeability and aeration, which affect the plant growth. It is an imperative to have knowledge of canal water quality before utilization and recommend for irrigation.

The chemical characteristics of fifty canal water samples at different locations are presented in Table 2. The canal water quality of the study area has been evaluated on the basis of, magnesium content, sodium percentage and salinity hazards for irrigation purpose.

Magnesium content :

Magnesium content of canal water is considered as one of the most important qualitative criteria in determining quality of water for irrigation. Generally, calcium and magnesium maintain a state of equilibrium in most water. In the present study, the magnesium content of the water of canal water varies from 15.32 to 61.59 MeL^{-1}. So, water is suitable for irrigation purpose in term of magnesium content. Similar findings were reported by Joshi *et al*. (2009).

Sodium per cent (SP) :

Sodium per cent is another important factor to study sodium hazard. It is calculated as the percentage of sodium and potassium against all cationic concentration. It is used for adjusting the quality of canal water for the use of agriculture purpose. The use of high percentage sodium water for irrigation purpose stunts the plant growth. Sodium reacts with soil to reduce its permeability. Sodium per cent in water is a parameter computed to evaluate the suitability for irrigation. Usually little or only minor problems occur when SP values are less than 15 per cent. When SP> 15 per cent, reduce permeability

Table 3 : Assessment of ground water quality based on salinity measurement for irrigation purpose

EC(dS/m) at 25^0C	Water class	No. of samples	%	Remarks
<0.25	C1- Low salinity	15	30	Safe with no likelihood of any salinity problem developing
0.25-0.75	C2 - Medium salinity	35	70	Need moderately leaching
0.75-2.25	C3 - High salinity	-	-	-
2.25-5.0	C4 - Very high salinity	-	-	-

Table 4 : Correlation matrix among various parameters of canal water quality

	EC	pH	K	Na	Ca + Mg	HCO_3	NO_3	Cl	SO_4
EC	1								
pH	-0.33	1							
K	0.82	-0.22	1						
Na	0.51	-0.3	0.58	1					
Ca + Mg	0.98	-0.31	0.82	0.53	1				
HCO_3	0.92	-0.28	0.77	0.50	0.93	1			
NO_3	0.07	-0.14	0.09	-0.03	0.10	0.16	1		
Cl	0.76	-0.32	0.47	0.42	0.77	0.66	-0.01	1	
SO_4	0.39	-0.01	0.41	0.14	0.37	0.08	-0.25	0.16	1

will occur. The finer the soil texture and the greater the organic matter content, the greater the impact of sodium on water infiltration and aeration. The sodium values of canal water ranged from 221.63 to 1346.06. These values are high in rainy seasons. Gypsum can be added to the soil to reduce the effect of high percentage of sodium in irrigation water. Similar findings were reported by Chaudhary and Ghuman (2008).

Salinity hazards :

Data are presented in Table 3. Based on the salinity hazards only 30 per cent of the canal water samples were useful for irrigation purpose without any hazards and about 70 per cent samples were used for irrigation which need moderately leaching suitable for irrigation purpose (Table 3).

Correlation :

The correlation co-efficient (r) among nine canal water quality parameter namely total salt (electrical conductivity), pH, anions (Cl, HCO_3, SO_4, NO_3, F, B), cations (Ca^{2+} + Mg^{2+}, Na^+, K^+) were calculated for

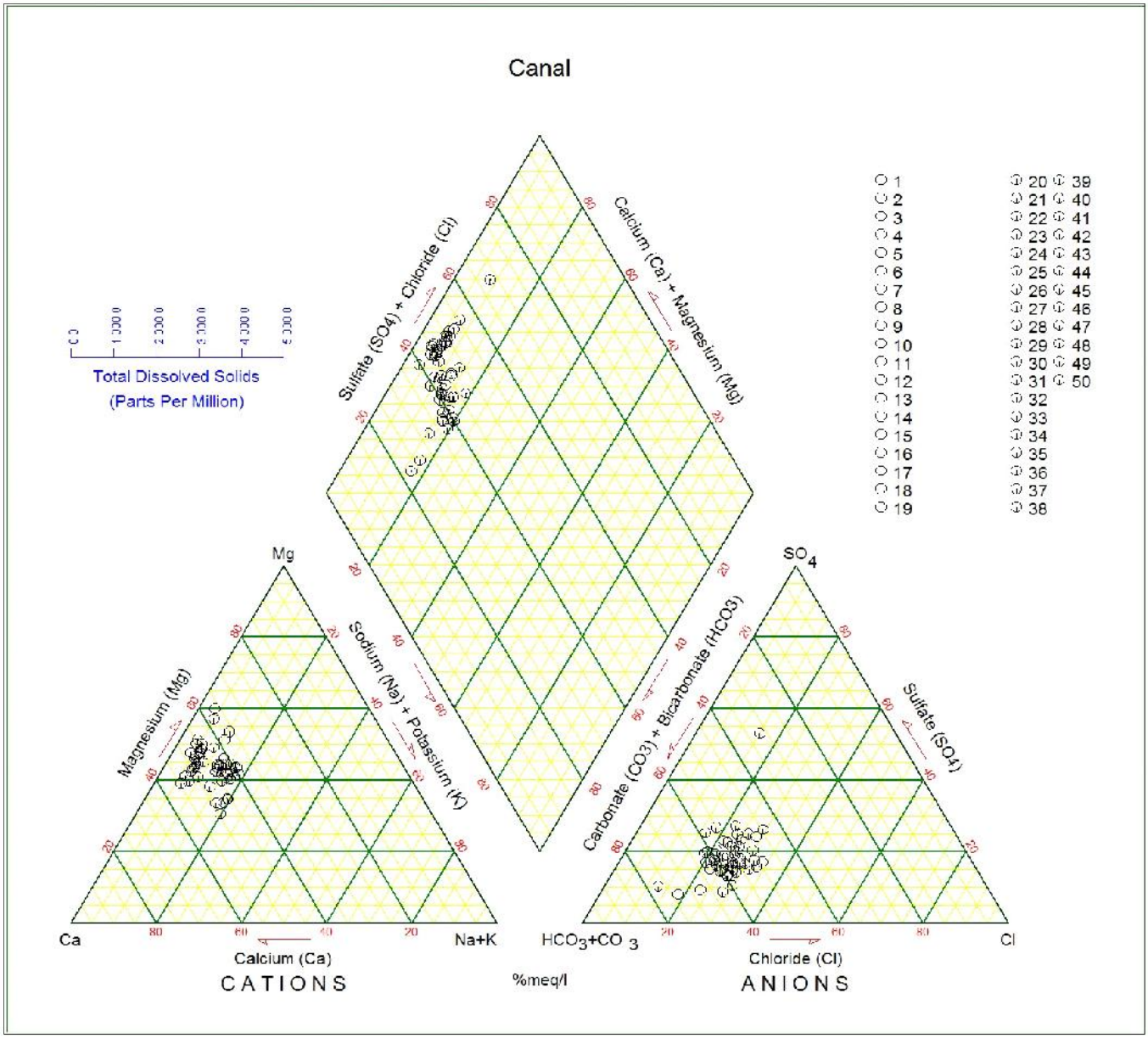

Fig. 1 : Chemical facies of canal irrigation water samples

correlation analysis. Interpretation of correlation gives a idea of quick water quality monitoring method. According to Table 4, the EC showed good positive correlation with chloride, sulphate, Ca + Mg, nitrate, bicarbonate, potassium, sodium and negative correlation with pH.

Conclusion :

From the study, it can be concluded that the canal water of fifty different locations (villages) of four Tehsil of Muzaffarnagar district is safe for irrigation purposes on the basis of most parameters, however, its suitability is questionable on the basis of few parameters for irrigation purposes.

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