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Classification of Tubewell Water for Sustainable Soil Health and Crop Growth

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ABSTRACT

The study was conducted at Krishi Vigyan Kendra, to evaluate the groundwater quality in Nathusari Chopta block, Sirsa district, Haryana, during the year 2019 to 2021. Due to an average rainfall of only 300 mm, farmers in the region heavily rely on canal and tubewell water for irrigation. A total of 150 water samples were analyzed for parameters such as pH, electrical conductivity (EC), carbonate (CO_3^{2-}), bicarbonate (HCO_3^-), chloride (Cl^-), calcium (Ca^{2+}), magnesium (Mg^{2+}), and residual sodium carbonate (RSC). The results indicated that 38% of the samples were suitable for all crops, with EC levels between 0-2 dS/m. However, 35% of samples exhibited medium to high salinity (4-8 dS/m), and 11% showed very high salinity (>12 dS/m), which limits crop choices and requires careful management. The study highlighted the importance of regular groundwater quality monitoring and management for sustaining soil health and crop production. Recommendations included blending saline groundwater with canal water, periodic water quality testing, and adjusting crop choices based on water quality to mitigate adverse effects, especially in areas with high salinity and low rainfall.

Key Words: Electrical conductivity, Salinity, Cation, Anions, Soil health, Water quality.

INTRODUCTION

Water is one of the most important resources needed for sustainable crop production. All living organisms on the earth need water for their survival and growth (Jain *et al,* 2007). The water qualities largely affect soil fertility and crop production, therefore, critical evaluation of subsurface water quality is necessary to figure out the important properties of ground water (Kaif *et al,* 2021).To increase production with limited water resources, sustainable management and judicious use of water are the only options available(Kumar *et al,* 2023).In canal command areas during lean period when there is less canal water supply at the tail end of canal, ground water is used by the farmers to supplement irrigation in different crops without considering its impact on soil physico-chemical properties as well as on crop production. The periodic monitoring of ground water becomes a need to minimize the risk of deteriorations soil health and its effects on crop production. Rainfall is also an important factor which plays a key role in changing the water quality of underground aquifers (Kaushik *et al,* 2002). As the average rainfall of Sirsa district is low (300 mm), yet the district, tubewells are the key source of irrigation. The irrigation sources in Nathusari Chopta block largely depend on canal water as well as underground water. In the areas where canal water is not sufficient to meet irrigation requirement, the underground water is used to fulfil the water needs of various crops grown in the district. Therefore, it becomes necessary to have an overall idea of ground water quality to sustain soil health and in turn the crop production in the district. Thus, the present investigation was carried out to assess the quality parameters of underground water being used for irrigation in the district Sirsa of Haryana.

MATERIALS AND METHODS

Sirsa is located in western parts of Haryana touching the boundaries of Rajasthan and Punjab.

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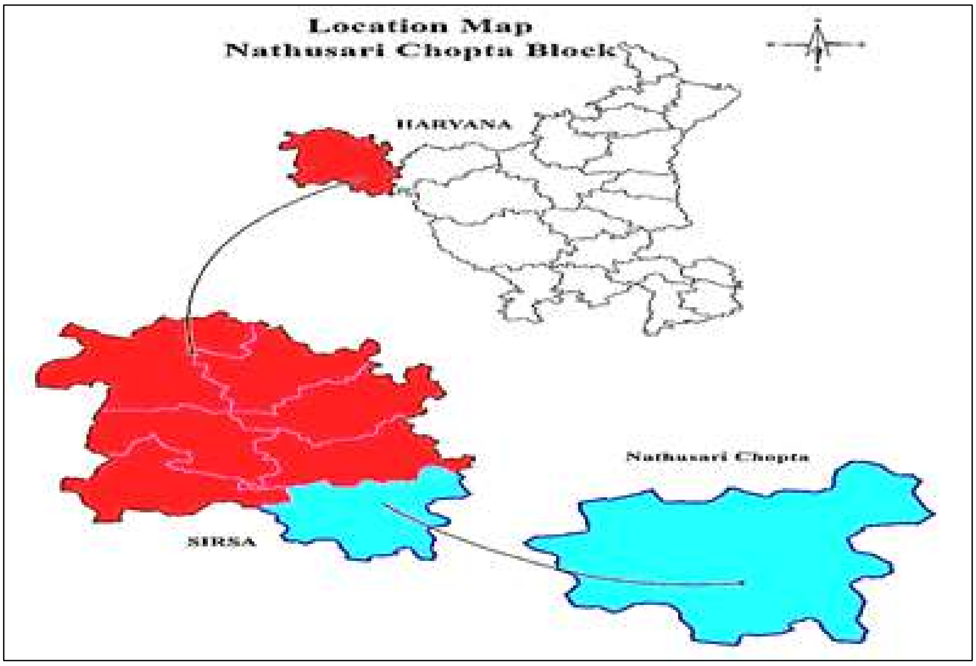

Figure: 1. Location map of study area

The soil of the district varies from sandy loam to loam with very low water holding capacity. Cotton-wheat and rice-wheat are the dominant cropping patterns prevalent in the district but the soil and climate are suitable for growing all the crops. It is the quality of water available which decides cropping pattern. Although canal water is available for irrigation yet the farmers have to rely upon alternate sources of irrigation primarily on ground water depending on the water needs of the crops. As the ground water quality of the wholedistrict is not good at all locations and the farmers are advised to get their tube-well water tested at regular intervals for safe use in agriculture. For getting their water samples tested, a large number of farmers visit KrishiVigyan Kendra, Sirsa so that crops may be grown according to the quality of water available with them. In the present study, water samples received from the villages of blockNathusariChopta during the years 2019, 2020 and 2021 in the soil testing laboratory of KrishiVigyan Kendra Sirsa were analysed for studying the suitable of tubewell water in the block for growing different crops. A total of 150 water samples were tested.

The chemical analysis of samples was done using standard procedures for electrical conductivity (EC), carbonate (CO_3^-), bicarbonate (HCO_3^-), calcium and magnesium (Ca^{2+}+Mg^{2+}), and residual sodium carbonate (RSC) by the procedure developed by Richards (1954). For the ease of understanding, the values of all the parameters have been expressed in per cent of total samples and average per cent of samples.

RESULTS AND DISCUSSION

pH level

The pH levels were divided into three categories: less than 6.5, between 6.5 and 7.5, and between 7.5 and 8.5 (Table 1). In pH range 6.5-**7.5**the number of samples in this slightly acidic to neutral range varied over the years, with 4 samples in 2019, 6 in 2020, and 3 in 2021. The percentage of total samples for each year in this category was 5.8% on average, with individual yearly percentages being 13% in 2019, 8.3% in 2020, and 9.03% in 2021. In 2019, 64 samples fell within this range, followed by 40 in 2020, and 33 in 2021. The average percentage of samples in this category over the three years is 94.2%, with yearly percentages of 87% in 2019, 81.7% in 2020, and 87.6% in 2021. The results suggested that the water quality in terms of pH has remained fairly consistent over the years, with most samples being good for crop growth and soil health. Similar

Table 1. Variation of pH and EC of water samples during the year 2019 to 2021.

Parameter	No of water samples			Average
pH	**2019**	**2020**	**2021**	
<6.5	0 (0)	0 (0)	0 (0)	0
6.5-7.5	4 (5.8)	6 (13)	3 (8.3)	9.03
7.5-8.5	64 (94.2)	40 (87)	33 (81.7)	87.6
EC (dSm^{-1})				
0.2-2	17 (25)	5 (10.8)	8 (22.2)	19.33
2-4	11 (16.2)	4 (8.6)	4 (11.1)	11.96
4-8	26 (38.2)	13 (28.2)	14 (38.8)	35.06
8-12	12 (17.6)	10 (21.7)	9 (25)	21.43
>12	2 (2.9)	14 (30.4)	1 (2.7)	12.0

Table 2.Variation of Carbonate and Bi-Carbonate of water samples during the year 2019 to 2021

CO_3^- concentration meL^{-1}	No of samples			Average
	2019	**2020**	**2021**	**Percentage**
0 to 0.2	36 (52.9)	27 (58.6)	16(44.4)	51.96
0.21 to 0.30	24 (35.2)	12(26.0)	13 (36.1)	32.46
0.31 to 0.40	5 (7.35)	5 (10.8)	4 (11.1)	9.75
>0.40	3 (4.4)	2 (4.3)	3 (8.3)	5.66
HCO_3^- concentration meL^{-1}				
<2	6 (8.8)	2 (4.3)	1 (2.8)	5.3
2to4	28 (41.1)	16(34.7)	12 (33.3)	36.36
6 to 8	6 (8.8)	0 (0)	3 (8.33)	5.71
>8	2 (2.9)	0 (0)	1(2.8)	1.9

results have also been obtained by Girdhar and yadav (1982).

Electrical conductivity (EC)

EC Range 0.2-2 dSm^{-1} represents low salinity water, which is generally considered safe for most agricultural purposes. The number of samples in this category decreased significantly from 17 in 2019 to 5 in 2020, with a slight increase to 8 in 2021. The percentage of total samples in this range was 25% in 2019, dropping to 10.8% in 2020, and increasing to 22.2% in 2021. The average percentage over the three years was 19.33%.The**EC Range of 2-4** dSm^{-1}**,** there were 11 samples in 2019, with a decrease to 4 samples in both 2020 and 2021. The percentage of total samples in this range was 16.2% in 2019, dropping to 8.6% in 2020 and slightly increasing to 11.1% in 2021. The three-year average percentage was 11.96%. This is a category where choice of crops is restricted to semi tolerant crops in the sandy to sandy loam soils and irrigation should be applied by mixing in canal water or in cyclic moded with canal water. A large area of soils in the block NathusariChopta came under the soil type sandy to sandy loam so this quality of water may be signified as medium level from quality perspective hence all the crops in the *Rabi* season and semi tolerant crops in the *kharif* season can be successfully grown. EC range **4-8** dSm^{-1} indicates moderately high salinity, which can pose risks for both drinking and irrigation. The number of samples in this category was 26 in 2019, decreasing to 13 in 2020 and 14 in 2021. The percentage of total samples in this range was 38.2% in 2019, 28.2% in 2020, and 38.8% in 2021, with an average of 35.06% over the three years. Across the years, particularly in the extreme values (>12 dSm^{-1}),

Table 3. Variation in $Ca^{++}+Mg^{++}$ and RSC Concentration of water samples.

Parameter	No of samples			Average
$Ca^{++}+Mg^{++}$	2019	2020	2021	
0 to 8	20 (29.4)	4 (8.6)	6 (16.6)	18.2
8 to 16	16 (23.5)	9 (19.5)	4 (11.1)	29.03
16 to 24	8 (11.7)	11 (23.9)	7 (19.4)	18.33
24 to 28	6 (8.8)	1 (2.2)	9 (25)	12
>28	18 (26.2)	21 (45.6)	10 (27.7)	33.16
RSC (meL^{-1})				
1.5 to 3.5	11 (91.6)	0 (0)	0 (0)	30.5
3.6 to 4.5	1 (83.3)	1 (100)	1 (100)	94.3

indicating potential anomalies or shifts in water quality conditions. In assessing the water quality, EC is considered as good criterion (Singh *et al* 2014) and level of salinity is marked accordingly.

Carbonate Concentration :

In 2019, 36 samples fell within range 0-0.2 meL^{-1}, the respective number was 27 in 2020 and 16 in 2021. The percentage of total samples in this category was 52.9%, 58.6% and 44.4% in the year 2019, 2020 and 2021respectively; three-year average of samples in therange 0-0.2 meL^{-1} was 51.96%. CO_3^{2-}concentration 0.21 to 0.3 meL^{-1} indicates a moderate level of carbonate concentration.

There were 24 samples in this category in 2019, which decreased to 12 in 2020 and slightly increased to 13 in 2021. The percentage of total samples was 35.2% in 2019, 35.2%, 26.08% and 36.1% in the year 2019,2020 and 2021 respectively with an average of 32.46%. This suggested some variability in the carbonate concentration, but overall, a substantial number of water sources had moderate carbonate levels.CO_3^{2-} levelsranging between 0.31 to 0.4 meL^{-1}may be considered as highercarbonates levels, which can be problematic for water use, particularly in agriculture. The number of samples in this category remained stable with 5 samples in both 2019 and 2020, and a slight decrease to 4 samples in 2021. The percentage of total samples in this range increased from 7.35% in 2019 to 10.8% in 2020 and 11.1% in 2021, averaging 9.75% over the three years. This trend indicated a minor but consistent presence of higher carbonate levels in the water. The percentage of total samples in the category **>0.4** $meL^{-1}$was 4.4% in 2019, 4.3% in 2020, and 8.3% in 2021, with an average of 5.66%. The reason for carbonate(CO_3^-) and bicarbonate (HCO_3^-) concentrationsin groundwater can be ascribed to carbonateweathering as well as from the dissolution ofcarbonic acid in the aquifers. (Serawat*et al,* 2022). These results were in line with Singh *et al* (2006) and Kumar *et al* (2017).

Biocarbonate concentration (HCO_3^-)

Bicarbonate is a crucial component in determining the alkalinity of water, influencing its suitability for irrigation. HCO_3^- Concentration under <2 meq/L typically indicating lower alkalinity in water. The percentage of total samples in this category was 8.8% in 2019, 4.3% in 2020, and 2.8% in 2021, The average percentage of 5.3% over the three years. The decreasing trend suggests that fewer water sources had low bicarbonate levels over time.In the range 2 to 4 meq/L the number of sampleswere highest in 2019 with 28 samples, decreasing to 16 samples in 2020 and 12 samples in 2021. The percentage of total samples in this range was 41.1% in 2019, 34.7% in 2020, and 33.3% in 2021, with an average of 36.36% across the three years. The number of samples in the range 4 to 6 increased from 26 in 2019 to 28 in 2020, before decreasing to 19 in 2021. The percentage of total samples in this range was 38.2% in 2019, rising significantly to 60.8% in 2020, and slightly decreasing to 52.7% in 2021. HCO_3^- concentration 6 to 8 meL^{-1} and higher this range reflects very high bicarbonate concentration. There were 6 samples in this range in 2019, none in 2020, and 3 in 2021. The percentage of total samples was 8.8% in 2019, 0% in 2020, and 8.33% in 2021, with an average of 5.71%. The absence of samples in this range in 2020 suggests a temporary reduction in very high bicarbonate concentrations, though this increased again in 2021. The results obtained were in line with those from Kumar *et al* (2017).

Ca^{2+}+Mg^{2+} concentrations in water samples are important indicators of water hardness, which affects water quality and usability for agriculture. In the range 0 to 8 meL^{-1} in 2019, 20 samples where as 4 samples in 2020 and 6 samples in 2021. The percentage of total samples in this range was 29.4% in 2019, dropping significantly to 8.6% in 2020, and rising to 16.6% in 2021. The three-year average percentage is 18.2%. The number of samples in the range 8 to 16 meL^{-1} was 16 in 2019, 9 in 2020, and decreased further to 4 in 2021. The percentage of these samples in this category was 23.5% in 2019, 19.5% in 2020, and 11.1% in 2021, with an average of 29.03%. In the range 16-24 meL^{-1} the number of samples were 8, 11 and 7 in the years 2019, 2020 and 2021. The percentage of 11.7%, 23.9% and 19.4% in 2019, 2020 and 2021 respectively with an average percentage over the three years was recorded 18.33%. like wise the number of samples in 24 to 28 and more than 28 was 34, 47 and 50 percent during the respective years with combined average percentage 45 per cent. The presence of Ca^{++} in ground water might be attributed to calcium-rich minerals suchas amphiboles, pyroxenes and feldspars and the Mg^{++} in groundwater might be due to olivine mineral and the ion exchange is with the ions in minerals (Serawat *et al* 2022).

Residual sodium carbonate (RSC)

Residual sodium carbonate of water is very good indicator for its use in crop cultivation. In the block Nathusari Chopta, majority of water samples received did not show considerable values of RSC which can be of concern to the crop and soil health. Only during the year 2019 some samples recorded RSC values ranging from 2.5 to 3.5 meL^{-1}. The soils of block Nathusari Chopta range from sandy to sandy loam hence the RSC values between 2.5 to 3.5 hardly affect soil sustainable health and choice of crops. Exceptionally during the same year some of water samples recorded higher values to the tune of 3-4meL^{-1}. It is suggested that soils irrigated with such waters should be tested and if any adverse effect of high RSC is noticed on the soil then proper management practices should be followed. It is advised that wasters of such tubewells should be checked after every cropping season to reach up to a clearcut conclusion and proper solution. Most of the samples RSC values were in the safe range. Similar results have been obtained by Singh *et al*(2006) and Kumar *et al* (2017).

CONCLUSION

In Nathusari Chopta block, only 38% of water samples were of good quality for irrigation. Medium saline water (12.6% samples) can be used in conjunction with canal water. High salinity water (20.6%) poses challenges for crop selection and requires careful management. Regular monitoring and appropriate management practices are essential to sustain soil health and crop productivity.

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