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Classification of Tubewell Waters of Block Ellenabad of Sirsa District for Irrigation

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ABSTRACT

This study test the water quality of 120 samples collected during 2019 to 2021 from Block Ellenabad, district Sirsa Haryana, regarding electrical conductivity (EC), carbonate ion (CO_3^{2-}), bicarbonate ion (HCO_3^-), calcium and magnesium (Ca^{++} and Mg^{++}), and residual sodium carbonate (RSC). The analysis revealed that most samples (50% on average) fell within the 0-2 dS/m EC range, indicating generally good water quality for irrigation. However, higher EC levels (2-8 dSm^{-1}) were present, necessitating careful water management, including mixing with canal water to mitigate potential adverse effects on crops. The study also observed variability in CO_3^{2-} concentrations with a trend toward increasing levels over time particularly in 2021. Bicarbonate concentrations were predominantly in the 4-6 meL^{-1} range, but higher levels (>8 meL^{-1}) increased in 2021, raising concerns about rising alkalinity. The Ca^{++} and Mg^{++} concentrations were mostly within the lower range (0-8 meL^{-1}), but higher concentrations became more prevalent in 2021, indicating a potential increase in mineral content in the water. RSC values, crucial for determining water's suitability for irrigation, showed that 58.18% of samples had values between 2.5 and 4.5 meL^{-1}, suggesting moderate to severe restrictions on their use. The study underscored the importance of regular monitoring and management practices to ensure sustainable agricultural practices in regions where water quality may be compromised.

Key Words: Bicarbonate ion, Calcium, Carbonate ion, Electrical conductivity,Water quality,

INTRODUCTION

Water is one of the most important and abundant compounds of the ecosystem. All living organisms on the earth need water for their survival and growth (Jain *et al*, 2014). The qualities of these water bodies vary widely depending on the location and environmental factors (Pawari and Gavande, 2015). Jakhar *et al* (2024) 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. Ellenabad block in Sirsa district in Haryana, confronts significant challenges related to groundwater quality due to a blend of natural and anthropogenic factors. Located in a semi-arid region characterized by erratic rainfall, the District's reliance on groundwater for agricultural, industrial, and domestic purposes places considerable strain on this critical resource (Jain *et al*, 2021).

The quality of groundwater in Ellenabad is particularly affected by high levels of salinity and elevated total dissolved solids (TDS), primarily resulting from excessive groundwater extraction and the district's underlying geological conditions (Choudhary *et al,* 2020). Furthermore, nitrate

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contamination is a pressing issue, largely attributed to the intensive use of chemical fertilizers in agriculture, which poses severe health risks and impacts water usability (Singh and Singh, 2019). Fluoride concentrations also vary across the district, contributing to public health concerns and influencing water quality (Kumar *et al,* 2022). Industrial activities, combined with inadequate waste management, further exacerbate contamination problems by introducing additional pollutants into the groundwater system (Yadav *et al,* 2023). To address these challenges, a comprehensive approach is needed, involving the adoption of sustainable agricultural practices, improved waste management strategies, and robust monitoring and regulatory frameworks (Rani *et al,* 2021). Effective groundwater management is essential for safeguarding crop production and maintaining ecological balance in this resource-dependent region (Mehta and Kumar, 2021). Singh *et al* (2014) reported that the quality of irrigation water available to the farmers has a considerable impact on which crops can be successfully grown, the productivity of these crops, and water infiltration and other soil physical conditions. Based on EC and RSC values together, it was found that 40 per cent water samples were fit, 40 per cent were marginal and 20 per cent were unfit for irrigation purpose. A large proportion of samples falling in marginal and unfit category indicated the need of water testing for sustainable crop production without deteriorating the soil health. Thus, the present investigation was carried out to assess the quality parameters of underground water being used for irrigation in the block Ellenabad of Sirsa district of Haryana.

MATERIALS AND METHODS

Ellenabad is a region increasingly facing the challenges associated with groundwater quality and sustainability. As an area heavily reliant on agriculture, the groundwater resources of Ellenabad are vital for supporting the local economy, which is predominantly agrarian. However, this reliance on groundwater has brought to light several concerns regarding the quality and safety of water for agriculture purposes. The ground water quality of the district 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. A large number of farmers across the district use to bring water samples for testing to the soil and water testing laboratory at Krishi Vigyan Kendra, Sirsa. The present study is based on the analysis of water samples received at KrishiVigyan Kendra, Sirsa during the years 2019, 2020 and 2021. A total of 120 water samples were received representing 55, 28 and 37, during the years 2019, 2020 and 2021, respectively.

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

RESULTS AND DISCUSSION

The EC of water samples (120) was categorized between 0 and 12 dSm^{-1} irrespective of the years as majority of the water samples fell in these limits (Table 1). The data analysis revealed the distribution of water samples across different Electrical Conductivity (EC) classes from 2019 to 2021, highlighting significant trends in water quality. The 0-2 dSm^{-1} EC class consistently represents the largest proportion of samples in the present study recording 43.64% in 2019 to 64.86% in 2021, with an average of 50% over the three years, indicating that a substantial portion of the water samples fall into this lower EC range, often associated with better water quality. In contrast, the 2-4 dSm^{-1} categories recorded 32.73% in 2019 to 8.11% in 2021, averaging 21.94%, suggesting that samples falling in this particular group water quality cannot be used with freedom and there is restriction over choice of crops. The 4-8 dSm^{-1} range exhibits variability, with proportions fluctuating between 16.36% and 32.14%, and an average of 23.37%, reflecting some inconsistency in water quality in this middle range. In this range it was advised that the tubewell water should be mixed with canal water in cyclic mode so that it may not adversely affect the crops.

Table 1. Electrical conductivity of samples during the years 2019, 2020 and 2021.

EC Classes dSm^{-1}	No. of water samples			Average of three years (%)
	2019	2020	2021	
0-2	24 (43.64)	12(42.86)	24(64.86)	50
2-4	18(32.73)	7(25.00)	3(8.11)	21.94
4-8	9(16.36)	9(32.14)	8(21.62)	23.37
8-12	3(5.45)	0(0.00)	1(2.70)	2.71
> 12	1(1.82)	0(0.00)	1(2.70)	1.50

Table 2. CO_3^{2-} concentration of samples during the years 2019, 2020 and 2021.

CO_3^{2-} meL^{-1}	Number of water samples			Average of three years (Percent)
	2019	2020	2021	
0 to 0.2	23(41)	6(21)	16(43)	35
0.21 to 0.30	24(43)	17(60)	5(43)	38.66
0.31 to 0.40	8(14)	3(10)	4(10)	11.33
>0.40	0(0.0)	27(7)	12(32)	13
HCO_3^- meL^{-1}				
<2	8(14)	0(4.08)	3(8)	8.69
2 to 4	17(21)	2(34.69)	10(27)	27.56
4 to 6	19(56)	22(38.78)	15(40)	44.92
6 to 8	9(14)	3(18.37)	2(5)	12.45
>8	2(5)	1(4.08)	7(18)	9.09

EC is considered as good criterion to assess water quality (Jakhar *et al,* 1994) and level of salinity is marked accordingly. Based on the present study, only 50% water samples were found of good quality and the water can be used for irrigation in almost all the crops grown on all types of soil. The medium saline water (23.33%) can be utilized in conjunction with canal water for cultivation of semi-tolerant to tolerant crops. In some pockets of the district where water quality was of very high salinity observed in 1.66% water samples, the fields may be kept vacant during rainy season for reclamation and salinity tolerant *rabi* crops should be grown using the water as lifesaving irrigation. Rajput and Polara (2013), Chopra *et al* (2014), Kumar *et al* (2017) and Dhaker *et al* (2020) has also shown variation in electrical conductivity in different samples analysed.

The data analysis on CO_3^{2-} concentration in water samples from 2019 to 2021 revealed significant variations in the distribution across different concentration ranges. For the 0 to 0.2 meL^{-1} range, the proportion of samples fluctuated, starting at 41% in 2019, dropping to 21% in 2020, and rising to 43% in 2021, with a three-year average of 35%. This indicates variability in the concentration of CO_3^{2-}, with a notable prevalence of lower concentrations in the sample set. The 0.21 to 0.30 meL^{-1} range had a high proportion of samples in 2019 (43%) and 2020 (60%), but a sharp decline to 13% in 2021, averaging 38.66% over the three years. This suggests that while this concentration range was predominant in earlier years, it diminished significantly in the most recent year. The 0.31 to 0.40 meL^{-1} range showed relatively low proportions, with 14% in 2019, 10% in 2020, and 11% in 2021, averaging 11.33%, indicating it is a less common concentration range. The >0.40 meL^{-1} category had no samples in 2019 but saw an increase in 2020 (7%) and a significant rise to 32% in 2021, with an average of 13%. This suggests an emerging trend of higher CO_3^{2-} concentrations in more recent samples.

Table 3. Ca^{++}+Mg^{++} of samples during the years 2019, 2020 and 2021.

Ca^{++}+Mg^{++} meL^{-1}	No. of water samples			Average of three years (%)
	2019	2020	2021	
0 to 8	34(68.18)	14(53.85)	15(68.0)	63.34
8 to 16	9(18)	6(23.08)	2(9.09)	16.72
16 to 24	3(6)	3(11.54)	10(27)	14.84
24 to 28	8(14)	4(14)	8(21)	16.33
>28	1(2)	1(3)	2(9)	4.98

Table 4. RSC of samples during the years 2019, 2020 and 2021.

Residual Sodium Carbonate meL^{-1}	Percent of total samples			Percent of total samples
	2019	2020	2021	
2.5 to 3.5	18(56)	8(66)	6(54)	58.18
3.6 to 4.5	4(12)	1(8)	3(27)	14.54
4.6 to 5.5	4(12)	1(8)	0(0)	9.09
5.6 to 6.5	1(3)	0(0)	0(0)	1.81
6.6 to 7.5	2(6)	2(16)	1(9)	9.09
7.6 to 8.5	1(3)	0(0)	0(0)	1.81
8.6 to 9.5	2(6)	0(0)	1(9)	5.45

The distribution of bicarbonate ion (HCO_3-) concentrations in water samples from 2019 to 2021 revealed distinct patterns in concentration ranges. The <2 meL^{-1} range showed low prevalence, with 14% of samples in 2019, 4.08% in 2020, and 8% in 2021, averaging 8.69% over three years. The 2 to 4 meL^{-1} range had moderate representation, with 21% in 2019, increasing to 34.69% in 2020, and then decreasing to 27% in 2021, resulting in a three-year average of 27.56%. The 4 to 6 meL^{-1} range was the most dominant, with a high proportion of 56% in 2019, 38.78% in 2020, and 44% in 2021, averaging 44.92%, indicating it is the most common concentration range across the period. Conversely, the 6 to 8 meL^{-1} range recorded a decrease from 14% in 2019 to 5% in 2021, averaging 12.45%, reflecting a decline in this concentration range over time. The >8 meL^{-1} category had a minimal presence with 5% in 2019 and 4.08% in 2020, but increased notably to 18% in 2021, averaging 9.09%, suggesting a rising trend in higher bicarbonate concentrations. Overall, the data indicates that while the 4 to 6 meL^{-1} range remains prevalent, there is a noticeable increase in higher bicarbonate concentrations, particularly in the most recent year. Similar trend was also observed by Dhaker *et al* (2020).

The distribution of Ca^{++}+Mg^{++} concentrations in water samples from 2019 to 2021 reveals several key trends across different concentration ranges. The 0 to 8 meL^{-1}range consistently represented the largest proportion of samples, with 68.00% in 2019, 53.85% in 2020, and 68.18% in 2021, averaging 63.34% over the three years. This indicates that the majority of samples fall within this lower concentration range, reflecting a common baseline level of these minerals in the water. The 8 to 16 meL^{-1} range showed moderate representation, with 18.00% of samples in 2019, 23.08% in 2020, and a decrease to 9.09% in 2021, resulting in a three-year average of 16.72%. This category demonstrates some fluctuation but remains a notable concentration range. The 16 to 24 meL^{-1} range saw a significant increase in 2021, with 27% of samples compared to 6.00% in 2019 and 11.54% in 2020, averaging 14.84% over the three years. This indicates a rise in higher mineral concentrations in recent years. The 24 to 28 meL^{-1}range had relatively stable proportions, with 14% in 2019, 14% in 2020, and

21% in 2021, averaging 16.33%, suggesting a moderate presence of these higher levels. Finally, the >28 meL^{-1}range was the least common, with only 2.00% of samples in 2019, 3.85% in 2020, and an increase to 9.09% in 2021, averaging 4.98%, reflecting a rare occurrence of very high mineral concentrations. Overall, the data indicates a predominance of lower Ca^{++}+Mg^{++} levels with a noticeable increase in higher concentrations in recent years. Similar results are obtained by Serawat *et al* (2022) while characterising water samples of Balesar tehsil in Rajasthan.

Residual sodium carbonate of water is very important and deciding property for its use in cultivation and selection of specific crops. During three years of study, 56, 66 and 54% of total water samples received during the years 2019, 2020 and 2021, respectively, were found sodic in nature which required moderate to severe restrictions on their use for irrigation purpose. On average basis of three years, out of 32 samples 58.18% samples recorded the RSC in the range of 2.5-3.5 and 3.6-4.5 meL^{-1}each signifying better water quality than rest of the samples (Table 5). The RSC of 5 to 9% samples ranged between 4.6 and 8.5 meL^{-1}. However, exceptional samples (5.45% of total sodic water samples) recorded the RSC of 9.6-13.6 meL^{-1}also during the years 2019 and 2020, whereas samples of very high sodicity were not reported during the year 2021. The higher RSC values above 2.5 $meL^{-1}$are hazardous for the soils particularly that are fine textured while in light textured soils these hazards are comparatively less due to more leaching. Similar results have also been recorded by Kumar *et al* (2017) and Dhaker *et al* (2020).

CONCLUSION

The study highlights significant trends in water quality across 120 samples collected from 2019 to 2021 in Ellenabad block of Sirsa district in Haryana. A substantial proportion of the water samples exhibited low Electrical Conductivity (EC) and moderate CO_3^{2-} and HCO_3^- levels, indicating generally good water quality for irrigation. However, the presence of higher EC, Ca^{++}+Mg^{++}, and Residual Sodium Carbonate (RSC) levels in some samples suggest the need for careful management practices, such as blending with canal water and the application of soil amendments, to mitigate potential risks to crop health and soil quality. Regular monitoring is essential to ensure sustainable agricultural practices.

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