# ANALYSIS OF WATER QUALITY PARAMETERS OF GROUNDWATER IN SANGRUR DISTRICT OF PUNJAB (INDIA)

[1]Suman Sharma and [2]Manpreet Kaur Chahal*
[1] Professor, [2] Research Scholar
[1] Department of Zoology and Environmental Sciences, Punjabi University, Patiala (Pb)
[2] Department of Zoology and Environmental Sciences, Punjabi University, Patiala (Pb)

***Abstract***: In this study, ground water samples were collected from twenty tube-wells of different villages of the study area. The samples have been analyzed for physico-chemical parameters like pH, electrical conductivity (EC), total dissolved solids (TDS), total alkalinity (TA), total hardness (TH), chloride ($Cl^-$),sodium($Na^+$) and potassium($K^+$) ions. The results showed that pH, EC, TDS, $Cl^-$, TH,TA, sodium($Na^+$) and potassium($K^+$) ions ranged from 7.83 to 8.65, 0.50 to 2.04(mS), 320.64 to 1,307.2(mg/L), 5.89 to 264.90(mg/l),186 to 392(mg/l),98 to 272(mg/l), 39.5 to 220.3(mg/l) and 6.3 to 19.7(mg/l) respectively. All the measured parameters were within the standard limits of water quality values suggested by WHO and BIS. The concentration of the chemicals detected in groundwater of Sangrur is found good for irrigation and drinking purposes as it met the standards laid by WHO.

***Keywords*:** Physico-chemical parameters, Ground water quality, Water quality standards

## 1. Introduction

Water is the most indispensable natural resource on earth, without which life cannot exist. In developing countries like India, groundwater is the main source of drinking, irrigation and industrial purposes (Bhatti et al., 2015).Water is the most abundant compound (70%) found on earth surface. It is significant due to its unique chemical and physical properties(Onifade et al.,2008;Osci,2005; Obiad and Okocha,2007)Groundwater constitutes about two third of the freshwater resources of the world and if the polar ice caps and glaciers are not considered, groundwater accounts for nearly all usable freshwater (Chilton,1996).But due to widespread use of harmful chemicals in agriculture, pollution of rivers, industrial effluents, human population growth etc. have intensified pressure oneach and every natural resource to produce adequate food and raw materials to meet the proportional demand (Smil,1999). In the view of international perspective of ''<1,700 $m^3$/person per year'' as water stressed and ''<1,000 $m^3$/person per year'' as water scarce, India is water stressed today and is likely to be water scarce by 2050 (Gupta and Deshpande,2004). India supports more than 16% of the world's population with only 4% of the world's fresh water resources (Singh,2003). The total area cultivated in India using groundwater has increased from 6.5 million hectare in 1951 to35.38 million hectare in 1993 (GWREC,1997).The data of fertilizer consumption at the state level shows that consumption of plant nutrient per unit gross area is highest in Punjab at 158.9 kg/ ha and lowest in Assam 14.6 kg/ha (Census of India 2004,Punjab).About 94% of the total sown area in Punjab is irrigated, out of which 61.6% is irrigated by tube wells and 38.3% by canals. However, uncontrolled extraction without commensurate recharge and heavy leaching of pollutants from pesticides and fertilizers to the aquifers has resulted in pollution of groundwater (Rajmohan and Elango, 2005). Various workers in our country have carried out an extensive work on water quality for various purposes. Subramani *et al.,* (2005) studied groundwater quality and its suitability for drinking and agricultural use in Chithar River Basin. Raju (2007) has evaluated the groundwater quality in the upper Gunjanaeru Riverbasin, Cuddapah District, Andhra Pradesh, South India. Tank et al.,(2010) examined the major ion constituents in the groundwater of Jaipur City for water quality determination. Physicochemical parameters of water samples of Nujendla area in Guntur District, Andhra Pradesh(India) was determined by Rao et al.,(2012). Mushtaq et al.,(2015) analyzed the physico-

chemical parameters of ground water of Kapurthala District, Punjab. Kumar et al.,(2016)studied the physico-chemical analysis of drinking water in Hanumangarh District, Rajasthan (India).

The main aim of the present paper is to highlight the variations in physico-chemical parameters of groundwater of the most extensively cultivated district(Sangrur) in Punjab and to evaluate the suitability of groundwaterfor irrigation purposes for a sustainable agriculture.

## 2. Materials and Methods

### 2.1. Study Area

The present study has been conducted in twenty villages of Sangrur district of Punjab. It is located at 30.23°N and 75.83°E. It falls in the southern part of the Punjab State and covers 3685 sq.km (appox.) of area bounded by Ludhiana and Ferozpur districts on the north side, Bathinda district in the west side, Patiala district in the East side and by Jind district (Haryana State) in the south side and is 232 m (761 ft) above the sea level. According to official census 2011, District had population of 1,655,169 out of which male and female were 878,029 and 777,140 respectively The area from a part of Indo-gangetic plain is sandy, loam to clayey in nature. The rainfall in the area occurs mainly due to south west and north east monsoon. From the last 3 decades, District stands on the top in the productivity of wheat and paddy crops.

### 2.2. Sample collection and measurement

Water samples were collected in acid washed polypropylene bottles from electrically operated deep tube-wells in year 2015 from 20 villages of Sangrur district of Punjab. The water was left to run for 10- 15 minutes from tube-wells to stabilize the value of temperature, pH and electrical conductivity. The pH and electrical conductivity of water samples were examined on site. Other physico-chemical characteristics were analyzed in the laboratory as per APHA (American Public Health Association) 1989 protocol. Physical parameters like Total Hardness, Total alkalinity were determined titrimetrically. Sodium and potassium were quantified by using flame photometer. The physicochemical characteristics of the water samples are compared with Bureau of Indian Standards (BIS,2012) and World Health Organization (WHO,2011a) drinking water standards(Table1).

### 2.3. Determination of physico-chemical parameters of ground water as per APHA (American Public Health Association) 1989 protocol.

2.3.1. pH and EC Estimation:- The pH of each sample was measured with portable field pH and EC meter.

2.3.2.Total Dissolved Salts Estimation:- Total dissolved solids were calculated indirectly making use of electrical conductivity(EC).To calculate the TDS, United States Salinity Laboratory Staff(1954)- Diagnosis and improvement of saline and alkaline salts, US deptt. of Agriculture, Hand Book 60,160 formula was used as given below:

$$TDS\ (mg/l) = 640 \times EC\ (in\ mS) \qquad (1)$$

2.3.3. Chloride Estimation:-Chloride was determined by Argentometric titration method.

25 ml water sample was taken in a titration flask and 3-4 drops of $K_2CrO_4$ indicator were added. It was titrated with standard $AgNO_3$ solution till yellow color changed to light brick red. The titration was reported to get three concordant readings.

$$Cl^- (mg/l) = M_2 \times V_2 \times 35.5 \times 1000 / V_1 \qquad (2)$$

Where, $M_2$ = Molarity of standard $AgNO_3$ solution (0.141 M); $V_2$ = Volume of $AgNO_3$ solution used in ml; $V_1$ = Volume of sample taken (25 ml).

2.3.4. Total alkalinity Estimation:-To 25 mL of each of the water samples, 3 drops of phenolphthalein indicator was added, if pink color appeared, titrated it against standardized $H_2SO_4$ solution until sample became colorless. The volume of acid used was recorded as 'A' ml. To the same solution, added 2-3 drops of methyl orange indicator and titrated it further with standard $H_2SO_4$ until color changed from light yellow to pink. Again recorded the volume of acid consumed as 'B'(ml). The experiment was repeated to get three concordant reading.

$$\text{Total alkalinity (mg/L) as } CaCO_3 = N_2 \times V_2 \times EW \times 1000 / V_1 \quad (3)$$

Where $V_2$= volume (A + B) of acid used, $N_2$ = Normality of $H_2SO_4$, $V_1$ = volume of sample, EW = Equivalent weight of $CaCO_3$ = 50

2.3.5. Total Hardness Estimation (as $CaCO_3$):-25 ml water sample was taken in a titration flask. To this, 2 ml of ammonia buffer solution and 1-3 drops of EBT indicator were added. It was titrated with against EDTA solution till wine red color changed to blue. The experiment was repeated to get three concordant readings.

$$\text{Total Hardness (as } CaCO_3) = M_2 \times V_2 \times 1000 \times M.W / V_1 \text{ ( mg/l)} \quad (4)$$

Where, $M_2$ = Molarity of standardized EDTA solution; $V_2$ =Volume of EDTA used; $V_1$ = Volume of sample taken; M.W = Molecular weight of $CaCO_3$(100).

2.3.6. Sodium and Potassium Estimation: These cations were estimated by using ELICO CL- 220 Flame – Photometer. Using stock solution, standard solutions of 0, 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100 mg/l were prepared. Standard curve was prepared as per APHA standard methods (1989). The concentration of $Na^+$ and $K^+$ in samples were determined by comparing the instrumental with standard curve.

**3. Results and discussion**

3.1. Physico-chemical characteristics of ground water

Ground water samples were analyzed for various physico-chemical parameters like pH ,electrical conductivity, total dissolved solids, total hardness, total alkalinity, sodium, potassium and the results were compared with WHO and BIS permissible limits for drinking water(Table 1).Samples collected from all sampling sites were odorless, colorless and turbidity free.

3.1.1. pH

The pH is a measure of the hydrogen ion concentration in water. Drinking water with a pH between 6.5 to 8.5 is generally considered satisfactory (Rede, 2016). Range of pH of the ground water samples of the study area was between 7.83 to 8.65 with an average value of 8.23 (Fig. 1). The results show that the pH of all the collected samples was within the permissible limit except GW 1 (8.65) when compared with the specified BIS(1998) limits of pH value for irrigation water which is 6.5 to 8.5. The present study indicates the alkaline nature of water.

3.1.2. Electrical conductivity

The ability of a solution to conduct an electrical current is governed by the migration of solutions and is dependent on the nature and numbers of the ionic species in that solution. This property is called electrical conductivity(EC). In all studied samples, EC varied from 0.50 to 2.04 (mS)(Fig. 2.) with average value of 0.86 (mS). EC value for all the samples was found within acceptable limits when compared with the permissible limits of 3000(μ mho/cm.) for irrigation water which is specified by BIS(1998).

3.1.3 Total Dissolved solids

Total dissolved solids (TDS) can be taken as indicator for the general water quality because it directly affects the aesthetic value of the water by increasing turbidity. High concentration of TDS limit suitability of water as a drinking source and irrigation

quality. In the present study, (Fig. 3.) TDS varied from 320.64 to 1,307.52 mg/L with an average value of 555.68 mg/L. Total Dissolved Solids(TDS) concentration in all studied samples was observed to be within permissible limits except the few samples GW 3 (507.52 mg/l), GW 5 (528.64 mg/l),GW 7 (578.56 mg/l), GW 8 (538.24 mg/l) which have little higher TDS than the acceptable limits of 500 mg/l as suggested by WHO but the samples GW 9 (659.54 mg/l), GW 12 (550.4 mg/l), GW 14 (538.8 mg/l), GW 16 ( 688 mg/l), GW18 (1014.4 mg/l),GW 19 (680.96 mg/l) and GW 20 (1307.52 mg/l) had much higher TDS than acceptable limits.The higher value of total dissolved solids is attributed to application of agricultural fertilizer contributing the higher concentration of ions into the groundwater (Rao et al.,1986).

3.1.4. Chloride

Porosity and permeability of soil also play key role in building up the chloride concentration (Chanda,1999). The value of chloride content varied from 5.89 – 264.90 mg/L(Fig. 4) and an average of 46.52 mg/L was observed. All studied ground water samples were found to be within permissible limits as suggested by BIS (250-1000 mg/l) and WHO (200-1000 mg/l).

3.1.5.Total Hardness

In ground water, hardness is contributed by bi-carbonates, carbonates, sulphates and chloride of calcium and magnesium. So, the principal hardness causing ions are calcium and magnesium. In all analyzed samples, range of chloride content varied from 186 – 392 mg/L(Fig.5) with an average value of 273.05 (mg/L).Total hardness in all studied samples was observed within according to permissible limits suggested by BIS( 600 mg/L).

3.1.6. Total alkalinity

Alkalinity of water is its acid neutralizing capacity. The alkalinity of water is mainly due to carbonates and bi-carbonates. The acceptable limit of alkalinity of water is 200 mg/l and in the absence of alternate water source, alkalinity upto 600 mg/l is acceptable. In all studied samples, the range of alkalinity varied from 98 to 272 mg/L (Fig. 6)with an average value of 186.1 mg/L and the values were found to be within permissible limits in all the samples.

3.1.7. Sodium

Sodium is the sixth most abundant element in the earth's crust. Not only seas, but also rivers and lakes contain significant amounts of sodium. The range of sodium ions in analyzed samples varied from 39.5 – 220.3 mg/L(Fig. 7) with an average value of 115.35 mg/L.

3.1.8. Potassium

Potassium is an essential element for humans, plants and animals, and derived in food chain mainly from vegetation and soil. The main sources of potassium in ground water include rain water, weathering of potash silicate minerals, use of potash fertilizers and use of surface water for irrigation (Deshpande et al.,2012). In the present study, potassium ranged from 6.3 – 19.7 mg/L(Fig. 8) and an average value of 10.56 mg/L was observed.

**4. Conclusion**

Groundwater is the main source of irrigation in the entire study area. Quality of water is assuming great importance with the rising pressure of industries and agriculture. The adequate amount of water is very essential for proper growth of plants but the quality of water used for irrigation purpose should also be well within the permissible limit otherwise it could adversely affect the plant growth. In this study, the collected ground water samples of Sangrur district were analyzed for physicochemical parameters

of pH, EC, TDS, TA, TH, $Cl^-$, $Na^+$ and $K^+$. The results revealed that almost all the measured parameters were within the standard drinking water quality given by WHO and BIS.

Table 1. Physico-chemical parameters of ground water samples of Sangrur district

| Sample ID | pH | EC (mS) | TDS (mg/l) | Chloride (mg/l) | Total Hardness (mg/l) | Total Alkalinity (mg/l) | Sodium (mg/l) | Potassium (mg/l) |
|---|---|---|---|---|---|---|---|---|
| GW 1 | 8.5 | 0.61 | 389.76 | 10.99 | 196 | 150 | 79.9 | 9.5 |
| GW 2 | 8.43 | 0.7 | 448 | 17.29 | 236 | 176 | 100.8 | 11.3 |
| GW 3 | 7.92 | 0.79 | 507.52 | 38.43 | 296 | 184 | 107.1 | 11.4 |
| GW 4 | 8.65 | 0.5 | 320.64 | 18.99 | 252 | 98 | 39.5 | 10.1 |
| GW 5 | 8.2 | 0.83 | 528.64 | 15.93 | 280 | 202 | 124.7 | 11.7 |
| GW 6 | 8.36 | 0.54 | 343.04 | 9.6 | 192 | 150 | 86.9 | 6.8 |
| GW 7 | 7.94 | 0.9 | 578.56 | 38.79 | 320 | 192 | 114.5 | 9 |
| GW 8 | 8.22 | 0.84 | 538.24 | 37.61 | 252 | 194 | 125.6 | 9.6 |
| GW 9 | 8.43 | 1.03 | 659.54 | 41.65 | 300 | 272 | 153.4 | 11.8 |
| GW 10 | 8.14 | 0.62 | 396.8 | 19.83 | 276 | 178 | 66.9 | 10 |
| GW 11 | 7.83 | 0.61 | 387.84 | 5.89 | 316 | 186 | 84.4 | 11.5 |
| GW 12 | 8.04 | 0.86 | 550.4 | 17.25 | 240 | 242 | 136.3 | 9.8 |
| GW 13 | 8.05 | 0.68 | 435.2 | 16.16 | 186 | 188 | 64 | 14.9 |
| GW 14 | 8.17 | 0.84 | 538.88 | 31.17 | 215 | 202 | 117.1 | 19.7 |
| GW 15 | 8.39 | 0.57 | 366.72 | 8.52 | 204 | 146 | 105.7 | 6.3 |
| GW 16 | 8.32 | 1.08 | 688 | 112.3 | 320 | 182 | 145.2 | 10.1 |
| GW 17 | 8.27 | 0.68 | 432.64 | 7.37 | 316 | 180 | 72.1 | 8.5 |
| GW 18 | 8.28 | 1.59 | 1014.4 | 143 | 312 | 154 | 218.3 | 7.5 |
| GW 19 | 8.24 | 1.06 | 680.96 | 74.65 | 392 | 226 | 144.3 | 10 |
| GW 20 | 8.31 | 2.04 | 1307.52 | 264.9 | 360 | 220 | 220.3 | 11.7 |
| MIN | 7.83 | 0.50 | 320.64 | 5.89 | 186 | 98 | 39.5 | 6.3 |
| MAX | 8.65 | 2.04 | 1,307.2 | 264.90 | 392 | 272 | 220.3 | 19.7 |
| AVG | 8.24 | 0.87 | 555.68 | 46.52 | 273.05 | 186.1 | 115.35 | 10.56 |
| ±SD | 0.22 | 0.37 | 238.67 | 62.78 | 58.13 | 37.77 | 46.69 | 2.91 |
| BIS limits | 6.5-9.2 | 300 | 500-2000 | 250-1000 | 300-600 | 200-600 | – | – |
| WHO limits | 6.5-9.2 | – | 1500 | 200-1000 | 500 | 500 | – | – |

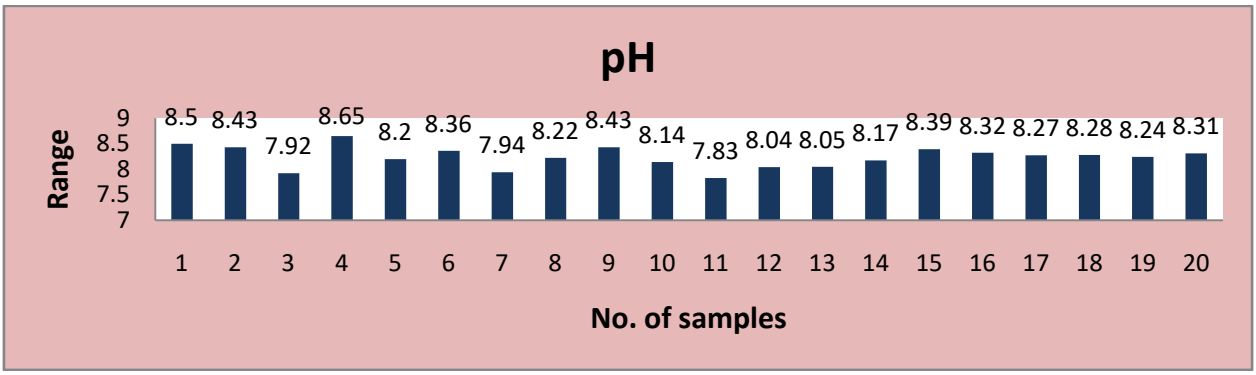


Fig.1 Range of pH of different samples of the study area

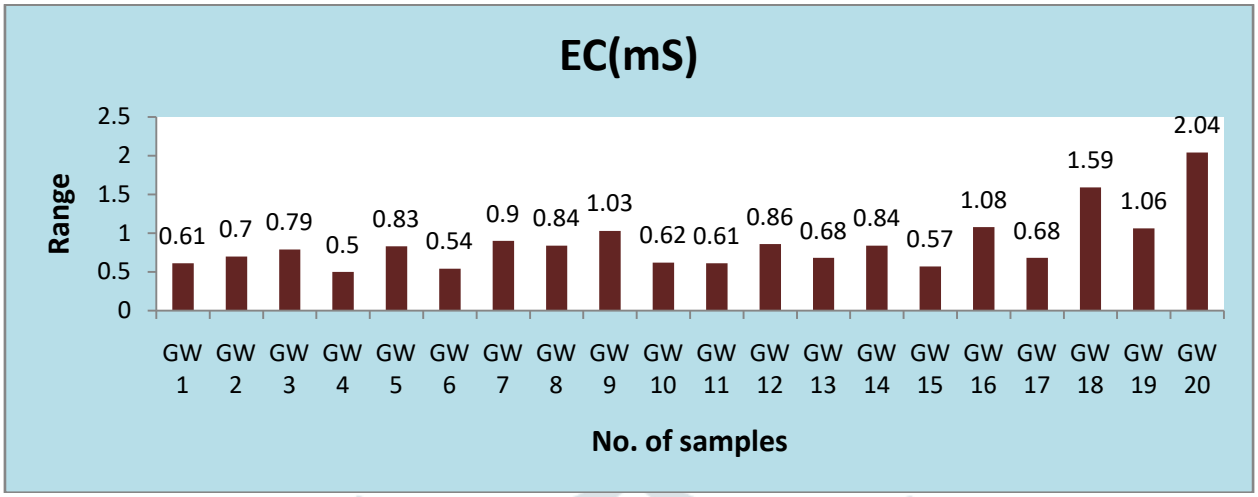


Fig.2 Range of electrical conductivity of different samples of the study area

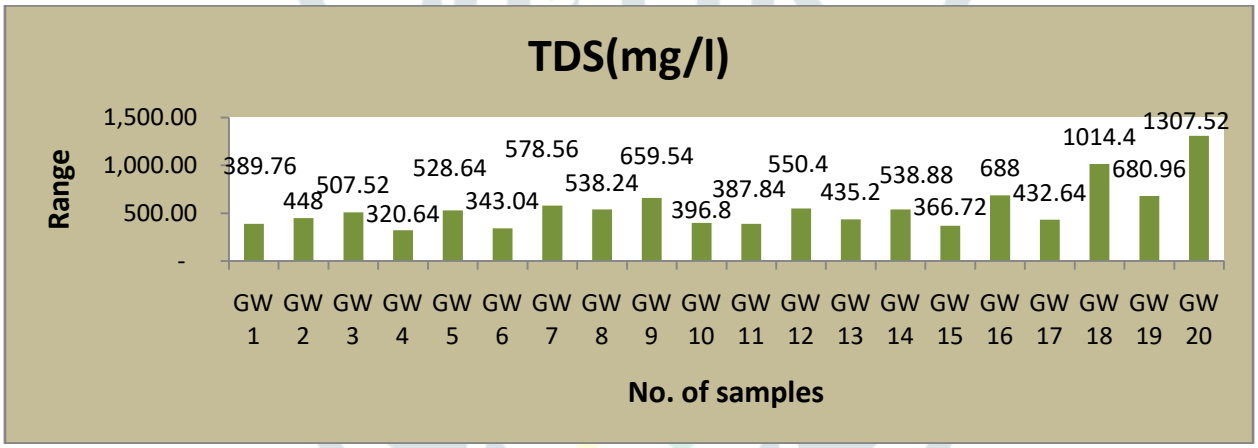


Fig. 3 Range of total dissolved solids of different samples of the study area

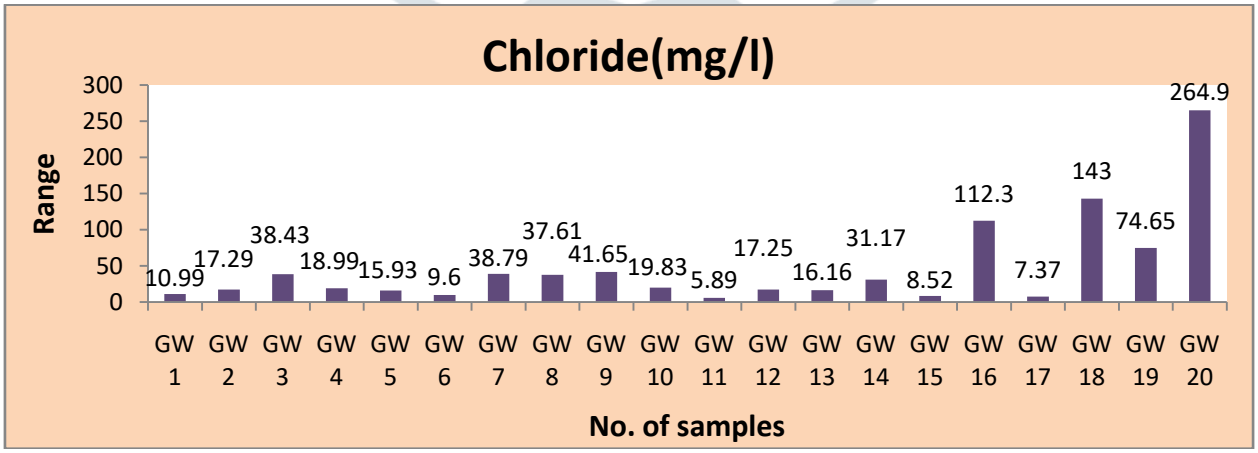


Fig.4 Range of chloride of different samples of the study area

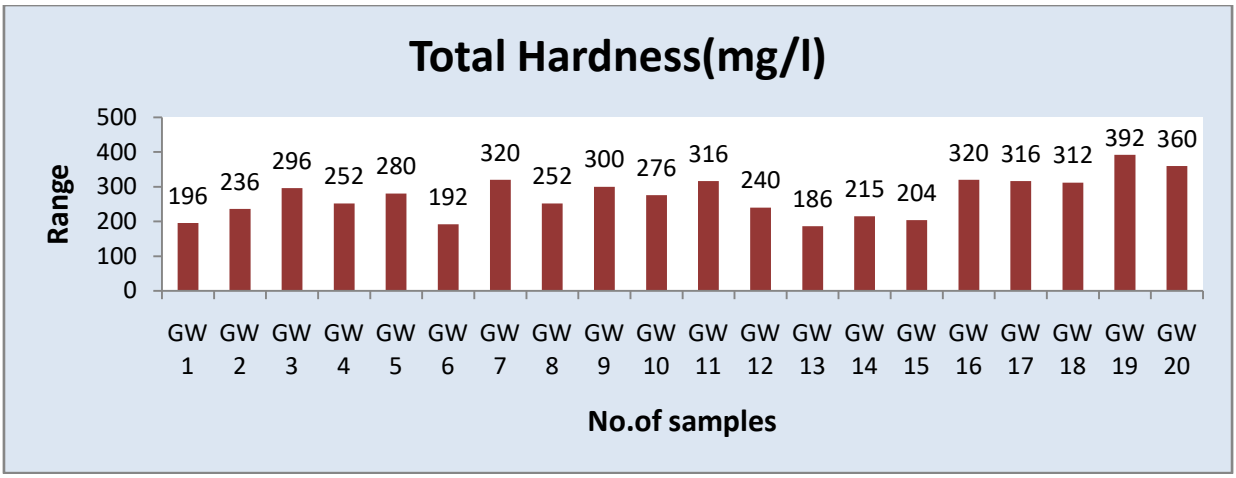


Fig.5 Range of total hardness of different samples of the study area

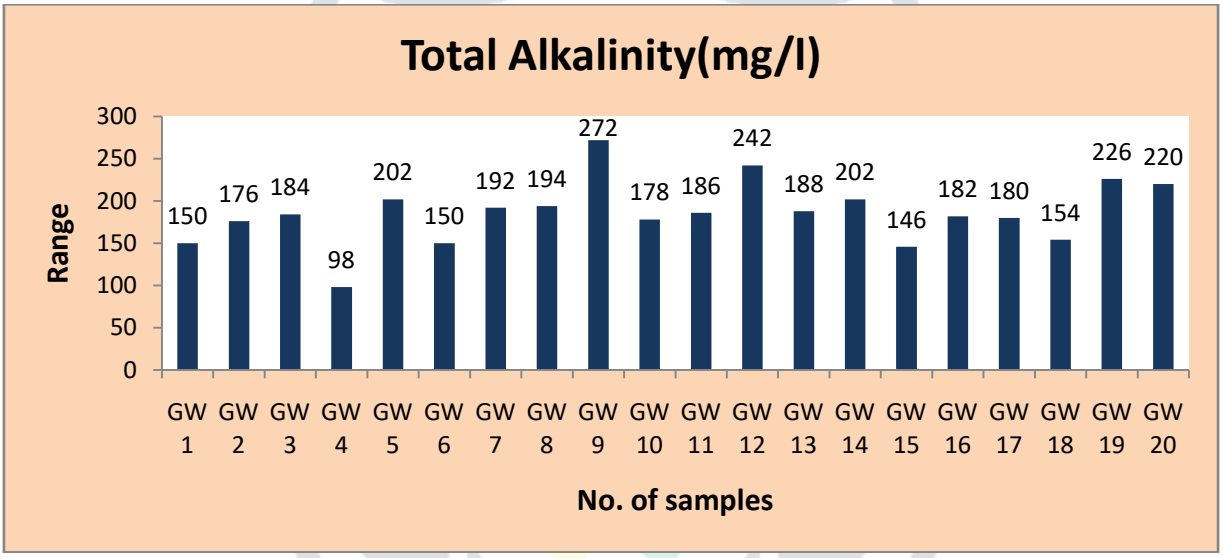


Fig.6 Range of total alkalinity of different samples of the study area

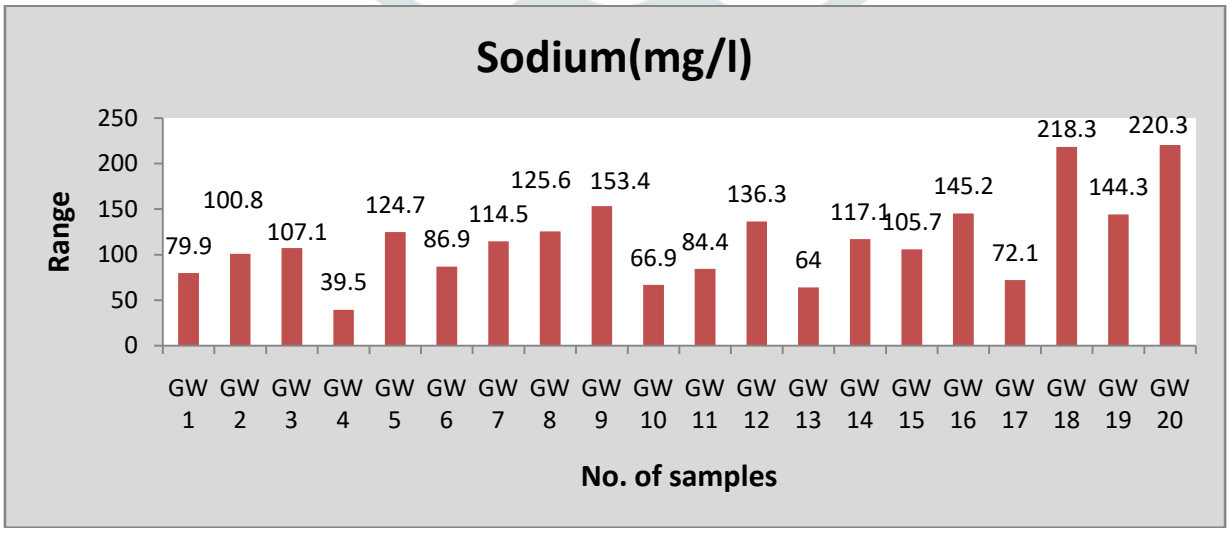


Fig.7 Range of sodium of different samples of the study area

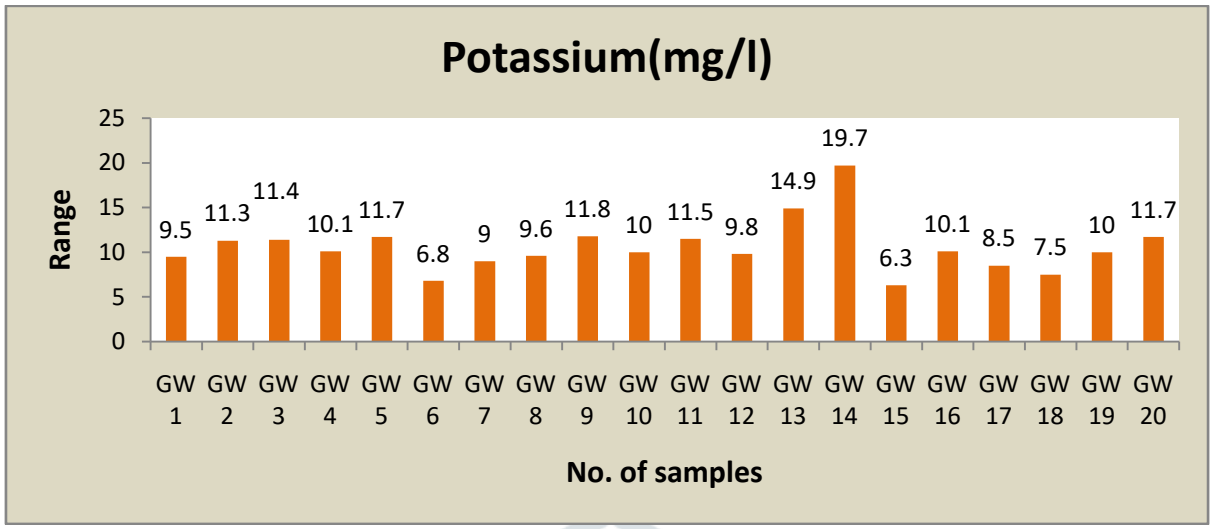


Fig. 8 Range of potassium of different samples of the study area

**Acknowledgment:-**

The authors gratefully acknowledge the facilities provided by Department of Zoology and Environmental Sciences, Punjabi University, Patiala and Department of Environment Sciences, Guru Jambheshwar University of Science and technology, Hisar (Haryana) to provide lab facilities for the research work.

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