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STUDIES ON SEASONAL VARIATIONS IN SOME PHYSIOCHEMICAL PARAMETERS OF THE VILLAGE PONDS OF JHAJJAR DISTRICT (HARYANA), INDIA

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Abstract

Fresh water is very important to sustain life and this supply must be available to all. The increasing population and water scarcity is affecting the quality of life significantly. Availability of clean and potable water has emerged as a key issue in developing countries. Fresh water resources are declining day by day due to anthropogenic impacts, unawareness among people about their importance, lack of legal and institutional framework in conservation of village ponds. Village ponds are one of the major sources of fresh water in rural areas. From ancient time, the rainwater is being stored in village ponds. In rural areas, the people depend upon pond water for domestic, irrigation, fisheries etc. The aim of the present study was to evaluate physico-chemical properties (TDS, conductivity, sodium and potassium) of water in village ponds of district Jhajjar (Haryana) India, using standard procedures. The analysis was carried out in three seasons *viz*. pre-monsoon, monsoon and post-monsoon for the period of two years during 2014-15. The observed values of studied parameters of water samples were compared with WHO and Indian standards (IS-10500, 2012). It was observed that 90% samples for TDS, 90.6 for conductivity, 46.6 for sodium, and 91.4 for potassium were not in acceptable limit. Therefore, from the study it is concluded that the water quality of these ponds are degrading. Consequently, necessary step should be taken to conserve and manage these small but ecologically important water bodies.

Key words : Fresh water, village ponds, physico-chemical characteristics, water quality, WHO.

Introduction

Aquatic ecosystems are the most diverse ecosystems in the world. In terms of salinity aquatic ecosystems fall under two broad categories i.e. saline ecosystem and freshwater ecosystem. Freshwater ecosystems are inland water that have low concentration of salt (<5ppt) (Roy *et al*., 2014). Only 3.5% of water is fresh water as majority of the water available on earth cannot be used directly due to their saline nature (Gupta and Shukle, 2006). About 2.5% of water is trapped in polar icecaps and glaciers and less than 1% is present in ponds, lakes, dams and rivers, which is being used by human for domestic, agriculture, industrial and various other purposes (Dara *et al*., 2010).

Ponds are one of the most important freshwater aquatic ecosystems in the entire rural landscape as they can store and purify water, provide various resources to the local communities for their survival and substience. They provide habitat to several rare and threatened aquatic plants, amphibians and macro-invertebrates (Bella *et al*., 2010). Pond ecosystems also contribute significantly to regional freshwater biodiversity (Nicolet *et al*., 2004; Oertli *et al*., 2004; Williams *et al*., 2004; Angelibert *et al*., 2006). Alongwith the rich reservoir of biodiversity freshwater ecosystem provides numerous other environmental benefits. They provide many ecological services *viz*. regulating, provisioning, cultural and conservative. They are good site ground water recharge, flood control, storage and recycling of nutrients and carbon sink. The carbon sequestering by pond is greater than forest, grassland and oceans (Downing, 2010). Therefore, they play very important role in CO_2 concentration balance in the environment.

In rural India, village ponds play very important role in socio-cultural, economic and environmental development. They support the livelihoods of marginalized community in rural, urban, coastal and tribal areas of the country. Most of the population of Haryana resides in villages and their main occupations are agriculture and

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animal husbandry. Ponds are the source of fresh water for villagers and they mainly depend upon pond water for drinking and bathing of their livestock's, production of fisheries, irrigation etc. At present the water quality of village ponds is declining at alarming pace due to encroachment by villagers, dumping of domestic waste, loading of the periphery by cow dung cakes, consequences of infilling, land drainage, changes in their many traditional uses and dumping of industrial waste in urban areas. There is also a lack of legal and institutional framework for small water bodies, therefore, they are ignored in comparison to large water bodies (*i.e.* lakes, rivers). All these factors are responsible for degradation of village ponds. The temporary ponds are most affected as they are inconspicuous and poorly known due to their temporary nature and small size and have been frequently destroyed by anthropogenic activities (Williams *et al*., 2001; Grillas *et al*., 2004; William, 2006; Zacharias *et al*., 2007). Due to use of contaminated water the human and livestock's population are continuously exposed to variety of water borne diseases. Need of the hour is to give particular emphasis on conservation and management of village ponds as an important national/international issue which should be given equal or higher importance as national development or economic development of any country. Therefore, the present study was planned to assess the status and quality of pond water of southern Haryana.

Materials and Methods

Study area

Haryana is one of the states of northern India. Haryana surrounds the capital of the country from three sides and form the northern, southern and western borders of Delhi. A large area of south Haryana is included in the national capital region. Jhajjar is one of the 21 districts of Haryana state which lies in south east of the state and located between 28° 22' to 28° 49' north latitudes and 76° 18' to 76° 59' east longitudes. The geographical area of the district is 1834 Km^2 which is 3.77% of total area of the state. The district headquarter is situated in Jhajjar town at a distance of about 65 km from Delhi. Administratively, Jhajjar district is divided into three sub-divisions and five community development blocks *viz*. Beri, Bahadurgarh, Jhajjar, Matanhail and Salhawas. In this district there are total 263 revenue villages and 250 Gram panchayats. Each village has many village ponds under the jurisdiction of local panchayats. These sites are locally called as Johar, talab, talav, taal, pokher etc.

Sample collection

Water samples were collected from 25 sampling sites/ponds situated in different villages of district Jhajjar. The samples were collected from all the five communities blocks of district Jhajjar, selecting five ponds from each block (table 1). Each sampling site was divided randomly into three sampling points. The samples were collected in three seasons *viz.* pre-monsoon, monsoon and post-monsoon for a period of two years during 2014 to 2015. To analyze the water quality, samples were collected in one liter bottle from each sampling point. Before sampling again, the bottles were cleaned and washed with detergent and dilute nitric acid. The bottles were finally rinsed with deionised water and then dried in sunlight. After sampling the bottles were screwed carefully and marked with the sampling number *i.e.* S_1, S_2, S_3, …, S_{25}.

Sample analysis

The collected samples were taken to the Ecology Laboratory of Department of Botany (Maharshi Dayanand University, Rohtak) in ice box for the analysis. Before analysis, all the samples were filtered with Whatman filter paper to remove unwanted solid and suspended material. Water samples were analyzed for sodium and potassium concentration by using Flame Photometer (ESICO, Model No- 381) against the standard solutions of NaCl and KCl, respectively (Amrutkar, 2013). The turbidity was measured by portable turbidity-meter and conductivity by portable conductivity-meter on the spot. Each analysis was carried out in triplicate for a particular sample.

Preparation of standard solutions for sodium and potassium measurement (Gupta, 2000)

For sodium, dissolve 5.845 g of NaCl in water and make to one litre. It gives 100 me/L of Na. From this, solutions having 10, 20, 30 and 40 me Na/L were prepared. For potassium, dissolve 1.908 g of KCl per litre in distilled water to prepare a stock solution of 1000 ppm K. Working standard having 10, 20, 30 and 40 ppm are obtained from above solution in 100 ml volumetric flask.

Statistical analysis

The results are expressed as mean±SD. One way ANOVA was used to analyze level of statistical significance among the pond water samples. Further the difference in the mean values of samples between 2014 and 2015 were analyzed by t-test. PAST (Version 2.17) software was employed for statistical analysis.

Results

Total dissolved solids (TDS)

Total dissolved solids (TDS) recorded in the pond water sample during pre-monsoon, monsoon and post-

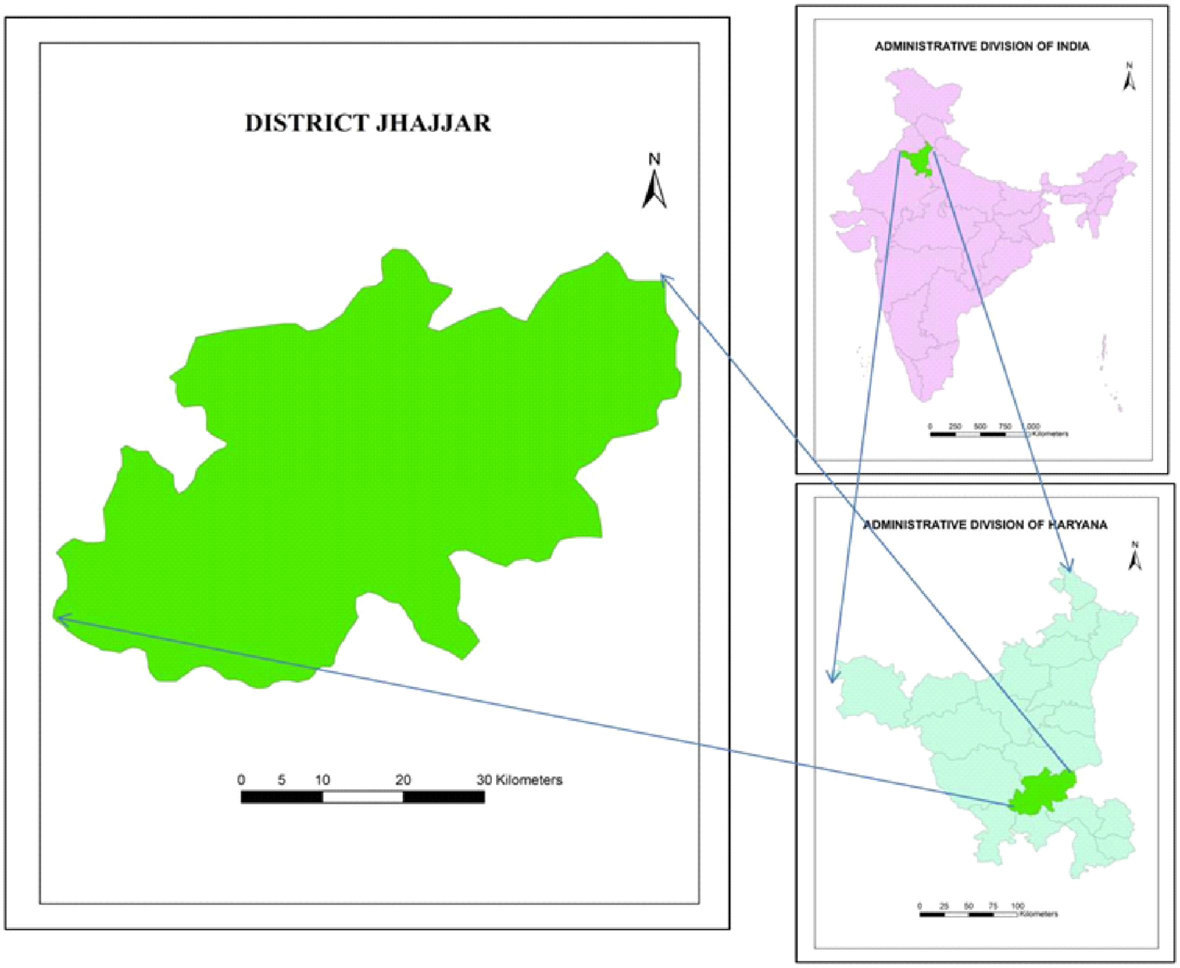

Fig. A : Map of the study site.

monsoon were ranged from 274-5250, 168-4870, 220-4950 and 271-5991, 216-5980, 253-5510 mg/L in 2014 and 2015, respectively. The maximum value of TDS was recorded in pre-monsoon season in S_{23} (5991 mg/L) in 2015 and minimum was recorded in S_{14} (168.0 mg/L) during monsoon (2014) (table 2).

According to Indian standard (IS-10500, 2012) the acceptable limit of TDS for drinking water is specified as 500 mg/L. When TDS of the samples were compared with Indian standard, it was found that during 2014, samples S_1, S_{14} and S_{25} were found within the acceptable limits in all the three seasons, all other samples were found out of acceptable limit (fig. 1). Similarly in 2015, only S_1 and S_{14} were found within the acceptable limit in all the three seasons. It was interesting to note that sample S_{13} was within the acceptable limit only during monsoon. All other samples were found beyond the acceptable limit (fig. 2).

Conductivity

Conductivity recorded in the pond water sample ranged from 410-7510, 260-7280, 338-7396 in 2014 and 420-8950, 325-8945, 386-9240 µ-mho/cm in 2015 during pre-monsoon, monsoon and post-monsoon seasons, respectively (table 3). The maximum conductivity was recorded in S_{23} (9240 µ-mho/cm) during post-monsoon (2015) and minimum (260 µ-mho/cm) in S_{14} during monsoon (2014). The acceptable limit for conductivity is 600 µ-mho/cm (WHO, 1993). When compared to WHO standard the sample S_{20} was only the sample found within the acceptable limit in all three seasons. All other samples were not in acceptable limit. The samples S_1 and S_{14} were within the acceptable limit in 2014 but above the acceptable limit in 2015. It was interesting to note that the sample S_{25} was found beyond the acceptable limits during 2015 in all the three seasons but during 2014 only in pre-monsoon season (figs. 3, 4).

Sodium

Sodium level recorded in the ponds ranged from 47-320, 32-310, 40-290 (2014) and 43-348, 32-320, 41-300 mg/L (2015) during pre-monsoon, monsoon and post-monsoon seasons, respectively. The maximum sodium concentration was recorded in S_5 (348 mg/L) and

Table 1 : Location of village ponds.

Sample No.	Block	Name of the village	Pond name	Coordinates
S_1	Bahadurgarh	Badli	Rabsar Johar	N28º34'27.85" E76º48'05.74" Elev-214m
S_2		Bamnoli	Gaonwala Johar	N28º43'48.42" E76º56'32.00" Elev-219m
S_3		Rodh	Germawala Johar	N28º44'27.33" E76º48'32.20" Elev-220m
S_4		Parnala	Shivemandir Johar	N28º41'54.77" E76º57'15.00" Elev-213m
S_5		Balore	Mandirwala Johar	N28º40'08.65" E76º55'16.98" Elev-217m
S_6	Beri	Dighal	Bhorsa Johar	N28º46'08.7" E76º37'39.1" Elev-211m
S_7		Gochhi	Mokhri Johar	N28º44'04.4" E76º36'03.3" Elev-260m
S_8		Beri	Tulyan Johar	N28º41'53.8" E76º34'54.1" Elev-205m
S_9		Jhajgarh	Tala Johar	N28º38'16.3" E76º33'45.2" Elev-202m
S_{10}		M.P.Majra	Pilsan Johar	N28º38'25.1" E76º34'13.5" Elev-201m
S_{11}	Jhajjar	Dujana	Nya Johar	N28º41'14.3" E76º37'18.7" Elev-192m
S_{12}		Shikanderpur	Gaonwala Johar	N28º35'06.4" E76º41'33.3" Elev-210m
S_{13}		Raipur	Dadawala Johar	N28º31'43.5" E76º39'45.0" Elev-211m
S_{14}		Bhadani	Bda Johar	N28º37'53.1" E76º43'24.6" Elev-203m
S_{15}		Kablana	Mandirwala Johar	N28º37'20.6" E 76º43'24.6" Elev-203m

Table 1 continued...

minimum in S_{20} (32 mg/L) (table 4). According to WHO standards (2006) acceptable limit for sodium is 200 mg/L. During 2014, the samples (S_1, S_7, S_{13}, S_{14}, S_{15}, S_{16}, S_{17}, S_{19}, S_{20}, S_{21}, S_{22}, S_{24} and S_{25}) were within the acceptable limit and sample S_9 was within acceptable limit during monsoon and post monsoon. Similarly, during 2015 the samples (S_1, S_7, S_9, S_{13}, S_{14}, S_{15}, S_{16}, S_{17}, S_{19}, S_{20}, S_{21}, S_{22}, S_{24} and S_{25}) were within acceptable limit. All other samples were not in acceptable limit (figs. 5, 6).

Potassium

Potassium occurs widely in the environment including all natural freshwater bodies. Potassium concentration recorded in the ponds ranged from 24-310, 13-280, 20-292 mg/L (2014) and 20-332, 23-314, 23-327 mg/L (2015) during pre-monsoon, monsoon and post-monsoon seasons, respectively. Maximum concentration of potassium was recorded in S_{12} (332 mg/L) during pre-monsoon and minimum in S_{15} (13 mg/L) during monsoon (table 5).

The acceptable limit of K^+ for drinking water is specified at 25 mg/L (WHO, 1993). When the results were compared with the standard it was reported that during 2014, water samples including S_{15} and S_{20} in all the three seasons, S_{13} and S_{19} in monsoon and S_{14} in monsoon and post monsoon were found within the acceptable limit. During 2015, water samples including S_{20} in all the season, S_{15} in monsoon season were within the acceptable limit (figs. 7, 8). All other samples were not in acceptable limit.

Discussion

TDS analysis

Total dissolved solids (TDS) gives indication of the salinity behavior of water and it describes all solids particularly mineral salts that are dissolved in water. In the present study maximum value of TDS was recorded in S_{23}, it was mainly because of ongoing construction work around this pond. Most of the ponds showed maximum TDS in pre-monsoon, moderate during post-monsoon and minimum in monsoon season. High value of TDS during pre-monsoon season may be due to high evaporation rate. Some previous reports by Sahni and Yadav (2012), Yadav *et al.* (2013) also obtained the similar results.

In some pond samples including S_{22} and S_{24}

Table 1 continued...

S_{16}	Matanhail	Matanhail	Peelkhudana Johar	N28º34’49.2" E76º28’33.7" Elev-202m
S_{17}		Amadal-Sahpur	Johri	N28º32’15" E76º28’18.4" Elev-209m
S_{18}		Mundsa	Tala Johar	N28º32’32.4" E76º28’40.3" Elev-206m
S_{19}		Akeri-Madanpur	Schoolwala Johar	N26º30’44.8" E76º38’ 11.8" Elev-201m
S_{20}		Rudiawas	Medhawala/ Nyajo-har	N28º33’44.36" E76º26’41.93" Elev-220m
S_{21}	Salhawas	Surehti	Bda Johar	N28º31’34.1" E76º37’07.5" Elev-209m
S_{22}		Samaspur-Majra	Ghamdi Johar	N28º29’02.6" E76º35’48.8" Elev-209m
S_{23}		Subana	Tala Johar	N28º27’50.9" E76º34’007" Elev-210m
S_{24}		Girdharpur	Sirjawala Johar	N28º27’7.17" E76º33’39.90" Elev-219m
S_{25}		Dhakla	Puranmal Johar	N28º29’02.6" E76º35’48.8" Elev-209m

in 2014 and S_1, S_6, S_7, S_9, S_{16} and S_{18} in 2015 the high value of TDS was reported during monsoon in comparison to pre-monsoon (table 1). It may be due to addition of domestic waste water, garbage and sewage etc. during monsoon. Our results are in agreement with Dhanalakshmi *et al*. (2013) and Chaurasia and Pandey (2007). Increased concentration of TDS increases the nutrient level of water body which results into eutrophication of aquatic bodies (Swarnlata and Narsigharao, 1998; Singh and Mathur, 2005; Verma *et al*., 2012).

Conductivity analysis

Conductivity is the capacity of water to carry electric current. It mainly depends on the presence of relative concentration of ions their mobility, valence and on the temperature of the liquid. In present study, most of the ponds had high value of EC during pre-monsoon season. During pre-monsoon period, the amount of salt accumulates because of comparatively high temperature and therefore high rate of evaporation (Talling and Talling, 1965). During pre-monsoon, high temperature compel the livestock’s to frequently visit these ponds, their urination and other excretes inside the pond water is also responsible for increasing total ions concentration. The results are in concordance with the similar studies conducted in different part of India (Chaurasia and Pandey, 2007; Baruah and Kakati, 2012; Mishra *et al*., 2013; Qureshimatva *et al*., 2015).

It was interesting to note that some pond samples (S_1, S_6, S_7, S_9, S_{16}, S_{18}, S_{22} and S_{24}) showed high conductivity during monsoon than pre-monsoon. The results are in agreement with Hulyal and Kaliwal (2011), Dhanalakshami *et al*. (2013), Ramulu and Benarjee, (2013), Choudhary *et al*. (2014) and Luharia *et al*. (2016). The fluctuations in EC in different seasons are due to fluctuation in total dissolved solids (TDS) and salinity (Pandey and Pandey, 2003)

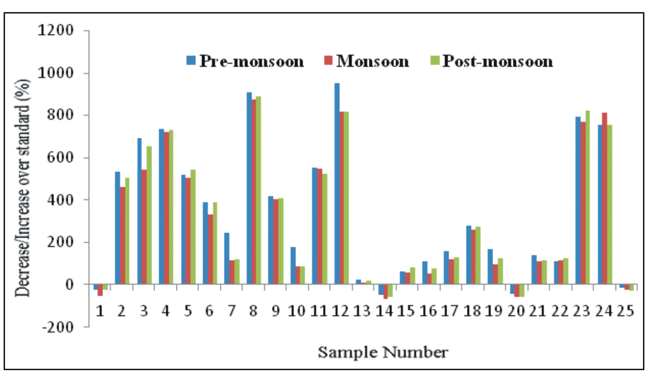

Fig. 1 : Percentage increase or decrease in TDS over standard value in 2014 during pre-monsoon, monsoon and post-monsoon seasons.

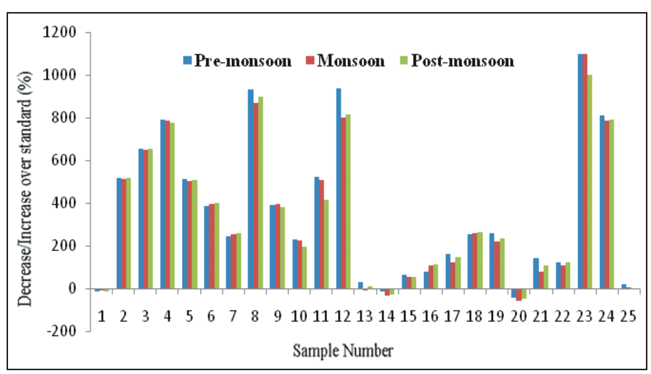

Fig. 2 : Percentage increase or decrease in TDS over standard value in 2015 during pre-monsoon, monsoon and post-monsoon seasons.

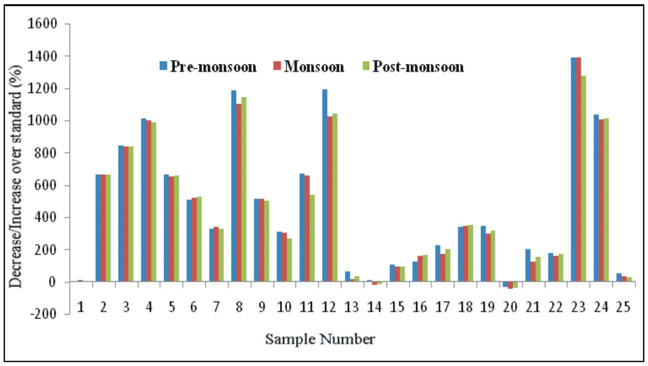

Fig. 3 : Percentage increase or decrease in conductivity over standard value in 2014 during pre-monsoon, monsoon and post-monsoon seasons.

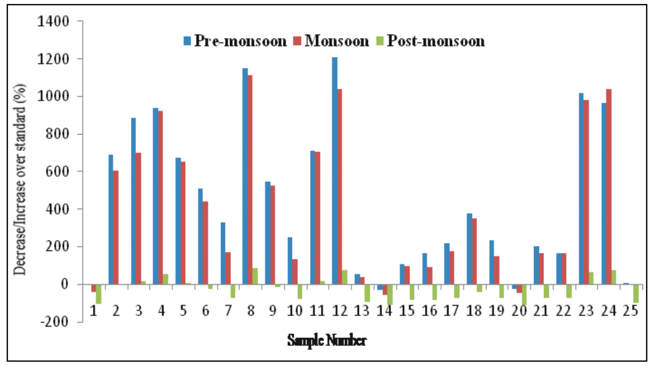

Fig. 4 : Percentage increase or decrease in conductivity over standard value in 2015 during pre-monsoon, monsoon and post-monsoon seasons.

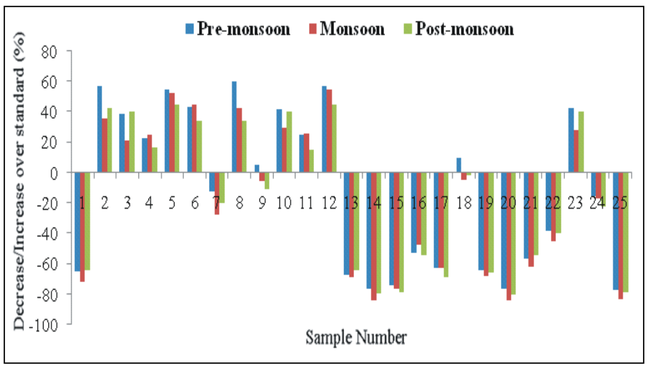

Fig. 5 : Percentage increase or decrease in sodium over standard value in 2014 during pre-monsoon, monsoon and post-monsoon seasons.

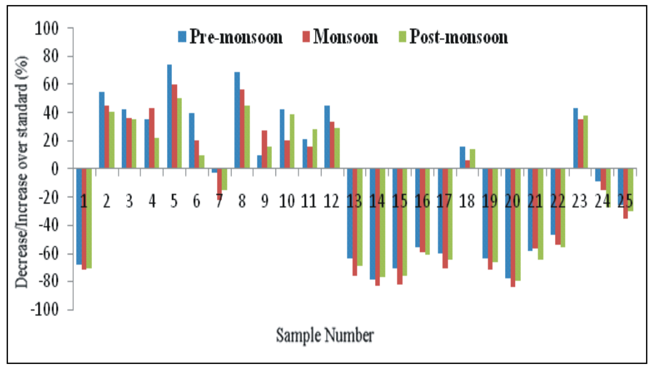

Fig. 6 : Percentage increase or decrease in sodium over standard value in 2015 during pre-monsoon, monsoon and post-monsoon seasons.

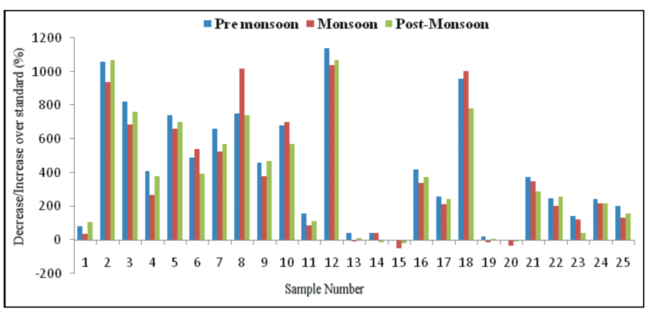

Fig. 7 : Percentage increase or decrease in potassium over standard value in 2014 during pre-monsoon, monsoon and post-monsoon seasons.

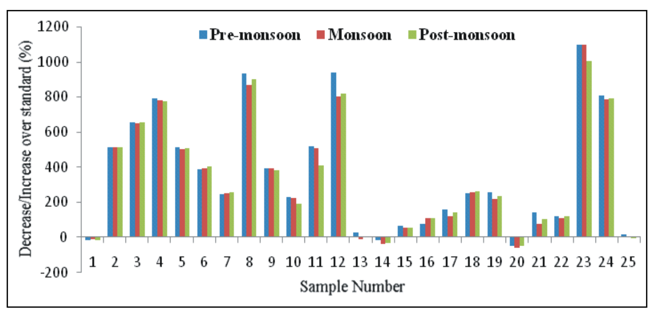

Fig. 8 : Percentage increase or decrease in potassium over standard value in 2015 during pre-monsoon, monsoon and post-monsoon seasons.

Sodium analysis

Sodium is a natural component of fresh water. The high concentration of sodium in natural freshwater ecosystem is mainly due to pollution such as soapy solution, detergent, human and animal waste disposal, precipitation runoff, sewage disposal, mineral deposits and water treatment chemicals such as sodium fluoride, sodium bicarbonate and sodium hypochlorite etc. In most of the ponds the values of sodium were higher in pre-monsoon season when compared with monsoon and post-monsoon seasons. High sodium content during pre-monsoon season may be due to increased rate of water evaporation and high atmospheric temperature during this period (Sahai and Sinha, 1969). The results were supported by Bordoloi and Baruah (2014) in one of the study conducted on historical pond of Upper Assam.

In some ponds, including S_4, S_6, S_{11} (2014) and S_4, S_9, S_{21} (2015) the value of sodium was found high in monsoon in comparison to pre-monsoon season. The high level of sodium during monsoon season may be due to the rainwater as it carries the salt dissolved from the surrounding area (Sahai and Sinha, 1969). The similar

Table 2 : Seasonal variations in TDS (mg/L) during pre-monsoon, monsoon and post-monsoon seasons.

Sample No.	Pre-monsoon		Monsoon		Post-monsoon	
	2014	2015	2014	2015	2014	2015
S_1	395±2.4	422±2.1	240±2.4	445±2.0	390±2.3	428±2.5
S_2	3170±5.3	3080±3.2	2820±3.1	3067±3.1	3025±3.0	3075±3.5
S_3	3960±6.2	3780±4.3	3216±3.5	3750±3.5	3774±3.2	3772±2.0
S_4	4180±6.1	4460±4.8	4107±4.7	4415±5.7	4142±2.5	4375±4.3
S_5	3105±3.8	3062±3.4	3032±2.9	3012±3.4	3224±3.0	3035±3.0
S_6	2440±4.7	2432±4.3	2168±3.0	2476±2.1	2448±2.3	2512±2.0
S_7	1720±3.9	1730±2.3	1080±2.9	1761±3.2	1104±1.5	1781±1.8
S_8	5030±7.5	5170±6.4	4870±3.0	4837±7.4	4950±3.5	4990±4.5
S_9	2592±6.2	2460±5.3	2516±2.9	2480±5.9	2535±2.1	2412±2.3
S_{10}	1390±4.3	1644±1.4	930±5.9	1615±3.1	945±1.7	1470±1.9
S_{11}	3265±3.2	3108±4.3	3230±4.0	3042±1.9	3112±2.4	2564±2.4
S_{12}	5250±5.3	5180±5.2	4580±3.2	4510±3.4	4580±3.2	4585±3.0
S_{13}	620±2.3	644±3.4	562±2.1	455±2.3	610±1.5	543±2.3
S_{14}	274±3.1	430±2.5	168±2.5	324±2.7	230±1.2	345±3.2
S_{15}	821±2.1	827±2.3	790±3.0	772±2.9	912±2.4	778±1.4
S_{16}	1070±2.4	890±3.9	760±3.4	1043±3.2	882±2.3	1065±2.0
S_{17}	1286±3.5	1293±3.3	1110±2.8	1102±2.5	1160±2.6	1228±1.8
S_{18}	1905±3.7	1770±3.6	1810±3.1	1800±2.7	1867±2.5	1817±4.2
S_{19}	1340±4.3	1790±3.9	997±2.0	1592±3.2	1130±2.1	1681±2.2
S_{20}	290±1.4	271±1.9	209±2.2	216±2.1	220±1.5	253±2.1
S_{21}	1205±3.2	1206±2.3	1051±3.2	892±2.4	1090±3.0	1025±2.9
S_{22}	1065±5.1	1120±1.8	1075±3.1	1042±2.2	1130±2.1	1105±2.0
S_{23}	4470±6.3	5991±5.4	4338±3.6	5980±5.7	4600±3.5	5510±3.6
S_{24}	4282±5.4	4552±3.9	4570±3.0	4425±1.3	4278±2.8	4460±4.0
S_{25}	435±2.4	590±2.4	391±2.8	529±2.1	370±2.3	509±2.1

Since $p > 0.05$ (0.9066 (2014); 0.9711 (2015), therefore, mean among pre-monsoon, monsoon and post-monsoon samples do not differ significantly. Further, there is significant difference in the TDS between 2014 and 2015, in monsoon ($p < 0.05$) and non-significant difference in pre-monsoon and post-monsoon seasons ($p > 0.05$).

Table 3 : Seasonal variation in conductivity (µ-mho/cm) during pre-monsoon, monsoon and post-monsoon seasons (mg/L).

Sample No.	Pre-monsoon		Monsoon		Post-monsoon	
	2014	2015	2014	2015	2014	2015
S_1	590±2.5	640±3.0	356±2.5	660±2.0	584±1.5	640±3.0
S_2	4740±4.6	4603±4.3	4220±4.0	4580±3.5	4525±4.5	4595±3.5
S_3	5920±4.5	5649±5.4	4800±3.8	5610±2.0	5635±5.0	5640±2.0
S_4	6240±6.4	6660±6.5	6130±3.5	6600±6.0	6190±4.5	6545±5.5
S_5	4640±3.4	4568±3.5	4530±2.0	4500±4.5	4820±3.0	4530±4.5
S_6	3650±3.9	3650±3.6	3240±2.5	3710±4.2	3662±3.2	3748±3.0
S_7	2580±3.0	2585±2.6	1612±1.5	2630±2.5	1657±1.5	2566±3.5
S_8	7510±5.0	7720±5.0	7280±6.5	7230±3.0	7396±2.0	7450±3.2
S_9	3870±3.8	3686±3.5	3752±3.5	3700±2.5	3792±3.5	3615±4.0
S_{10}	2090±2.8	2470±3.4	1200±2.0	2420±2.4	1411±3.0	2198±2.0
S_{11}	4880±4.5	4630±4.0	4830±4.5	4550±3.8	4650±3.5	3835±2.4
S_{12}	7850±7.0	7735±5.9	6840±6.5	6740±6.9	6844±6.0	6850±4.0

Table 3 continued...

Table 3 continued...

S_{13}	930±3.5	980±2.5	843±3.2	690±3.0	920±2.5	820±2.1
S_{14}	410±2.0	945±2.0	260±2.0	685±2.5	352±3.0	920±2.0
S_{15}	1230±2.5	1250±2.5	1190±2.0	1160±3.2	1370±2.4	1165±2.5
S_{16}	1600±3.0	1330±4.3	1140±2.5	1565±1.5	1323±2.1	1590±2.0
S_{17}	1920±3.4	1950±3.5	1670±3.0	1645±1.0	1733±3.2	1830±1.8
S_{18}	2850±3.6	2645±4.0	2710±2.5	2688±2.4	2790±2.5	2727±2.6
S_{19}	2000±2.0	2673±4.2	1510±2.0	2377±2.4	1700±2.4	2510±3.8
S_{20}	440±1.5	420±2.0	313±2.5	325±3.1	338±1.4	386±2.0
S_{21}	1810±3.2	1800±2.5	1585±3.0	1330±2.4	1630±1.5	1530±3.2
S_{22}	1600±3.0	1660±3.4	1606±1.8	1560±1.5	1696±1.0	1650±3.0
S_{23}	6700±6.0	8950±6.5	6490±5.5	8945±5.0	6900±4.0	9240±5.5
S_{24}	6400±5.2	6800±6.0	6840±5.0	6620±4.5	6390±3.5	6672±6.0
S_{25}	650±2.8	920±4.2	593±2.0	790±3.2	553±2.0	760±2.0

Since $p > 0.05$ (0.9071 (2014); 0.9695 (2015), therefore, mean among pre-monsoon, monsoon and post-monsoon samples do not differ significantly. Further, there is significant difference in the conductivity between 2014 and 2015, in monsoon ($p < 0.05$) and non-significant difference in pre- monsoon and post- monsoon seasons ($p > 0.05$).

Table 4 : Seasonal variations in sodium (mg/L) during pre-monsoon, monsoon and post-monsoon seasons.

Sample No.	**Pre-monsoon**		**Monsoon**		**Post-monsoon**	
	2014	**2015**	**2014**	**2015**	**2014**	**2015**
S_1	70±1.0	63±1.5	57±1.0	56±0.4	71±1.0	59±0.7
S_2	315±2.64	310±2.0	272±2.6	290±2.0	286±5.2	282±2.0
S_3	277±4.0	285±2.3	242±2.6	272±3.2	280±1.0	270±2.7
S_4	245±5.2	270±2.5	250±2.0	286±3.9	234±5.2	245±4.2
S_5	310±4.3	348±1.0	305±1.0	320±1.0	290±2.0	300±1.0
S_6	287±5.2	280±1.0	290±3.0	240±3.2	268±1.0	220±1.4
S_7	176±3.0	194±1.6	145±3.4	156±1.3	160±1.7	170±1.0
S_8	320±3.2	338±3.0	286±2.0	313±2.6	268±4.3	290±3.4
S_9	210±4.3	220±2.3	189±1.0	254±0.5	178±2.6	232±1.9
S_{10}	284±2.0	285±0.6	260±1.0	240±1.0	280±2.0	278±1.0
S_{11}	250±4.3	242±1.4	252±3.6	232±1.7	230±3.4	257±1.3
S_{12}	315±2.0	290±3.0	310±5.2	267±4.0	290±2.0	259±2.4
S_{13}	65±1.0	72±0.5	62±1.0	47±1.0	72±1.0	62±1.3
S_{14}	47±1.0	43±0.8	32±2.6	34±1.0	41±1.0	46±1.0
S_{15}	52±1.73	58±1.0	47±1.0	35±1.8	43±3.4	47±1.2
S_{16}	95±1.0	88±2.1	105±4.3	82±2.1	92±1.0	78±2.4
S_{17}	75±2.6	80±3.2	74±3.6	58±3.1	63±3.0	70±1.0
S_{18}	220±2.5	231±2.4	190±2.0	213±2.8	197±1.7	229±1.5
S_{19}	72±4.1	72±2.6	64±3.0	56±2.3	68±3.4	67±2.3
S_{20}	47±3.0	44±1.0	32±1.0	32±0.8	40±1.0	41±0.7
S_{21}	87±1.7	84±2.2	76±3.6	86±1.0	92±3.6	70±1.0
S_{22}	124±2.6	107±2.7	110±2.6	92±1.5	120±2.6	89±1.1
S_{23}	286±1.0	287±3.5	256±1.0	270±2.6	280±2.0	276±3.2
S_{24}	170±2.0	182±3.1	167±2.0	170±2.1	156±4.3	145±2.5
S_{25}	70±1.0	148±1.0	34±2.6	130±1.2	43±1.0	139±1.0

Since $p > 0.05$ (0.8745 (2014); 0.8184 (2015), therefore, mean among pre-monsoon, monsoon and post-monsoon samples do not differ significantly. Further, there is no significant difference in the sodium concentration between 2014 and 2015, in all the three seasons ($p > 0.05$).

Table 5 : Seasonal variations in potassium (mg/L) during pre-monsoon, monsoon and post-monsoon seasons.

Sample No.	Pre-monsoon		Monsoon		Post-monsoon	
	2014	2015	2014	2015	2014	2015
S_1	45±1.7	57±1.0	34±2.0	39±1.6	52±1.0	47±1.0
S_2	290±1.0	288±2.1	260±3.0	267±2.1	292±1.7	282±1.4
S_3	230±3.4	280±1.5	196±1.0	225±1.0	215±3.4	240±1.9
S_4	127±4.3	132±3.1	92±2.6	110±2.4	120±1.0	125±2.7
S_5	210±1.0	220±0.8	190±1.0	213±0.5	200±2.0	229±2.0
S_6	147±2.6	132±3.1	160±4.3	112±1.3	123±2.0	123±3.5
S_7	190±1.7	183±2.0	156±1.0	172±1.2	168±1.0	162±1.6
S_8	213±3.4	295±3.8	280±2.0	298±1.0	210±1.7	256±3.0
S_9	140±1.0	142±0.9	120±1.7	119±0.8	142±4.0	132±4.2
S_{10}	195±1.0	183±0.5	200±2.0	172±1.2	168±1.7	170±1.0
S_{11}	65±4.0	68±2.3	47±1.8	52±1.0	53±1.0	62±1.0
S_{12}	310±2.0	332±2.7	285±1.7	314±2.1	292±3.1	327±2.1
S_{13}	35±1.0	42±0.4	23±1.0	28±1.0	28±2.6	41±1.0
S_{14}	35±1.0	47±1.0	36±1.0	42±2.1	22±1.0	51±1.7
S_{15}	25±1.7	32±1.2	13±2.0	23±1.0	20±2.0	27±1.5
S_{16}	130±2.0	123±1.5	110±1.0	126±2.1	119±1.0	104±1.8
S_{17}	90±3.4	86±1.9	78±2.6	78±2.5	86±2.2	67±1.3
S_{18}	265±1.7	256±1.5	276±1.0	232±1.3	220±1.0	223±1.6
S_{19}	30±1.0	42±1.9	22±1.7	36±1.0	27±1.7	39±1.4
S_{20}	24±2.0	20±1.5	17±1.0	17±1.0	23±1.0	23±1.9
S_{21}	118±1.7	128±2.1	112±2.0	107±1.2	97±1.9	119±1.0
S_{22}	87±2.0	95±1.0	76±1.9	78±1.7	90±1.0	74±2.1
S_{23}	60±1.0	68±1.0	56±2.0	74±1.4	36±2.5	60±1.3
S_{24}	86±1.7	70±1.4	79±1.7	62±1.2	79±1.7	67±1.0
S_{25}	76±1.0	73±1.2	58±1.0	58±1.4	64±1.0	71±1.7

Since $p > 0.05$ (0.8529 (2014); 0.8846 (2015), therefore, mean among pre-monsoon, monsoon and post-monsoon samples do not differ significantly. Further, there is significant difference in the potassium concentration between 2014 and 2015 in post-monsoon ($p < 0.05$) and non-significant difference in pre-monsoon and monsoon seasons ($p > 0.05$).

results were also obtained by Kumar *et al*. (2014) in one of the study conducted on Lahru pond located in Himachal Pradesh.

Potassium analysis

In most of the pond the value of potassium were found higher in pre-monsoon season. The higher value of potassium may also be due to high rate of evaporation during pre-monsoon. The results were supported by Bordoloi and Baruah (2014) in one of the study conducted on historical pond of Assam.

In samples S_6, S_8, S_{10}, S_{14}, S_{18} in 2014 and S_8, S_{16}, S_{23} in 2015, the value of potassium was high during monsoon in comparison to pre-monsoon. The probable cause of high potassium during monsoon may be due to dumping of surface runoff water, containing soaps, detergents, cow dung cakes etc. Our results are in concordance with the reports of Mohamed (2005) from pond water samples of Abu za'baal ponds, Egypt.

Conclusion

From the present study, it is concluded that 90% samples of TDS, 90.6 for conductivity, 46.6 for sodium, and 91.4 for potassium were not in acceptable limit. It was found that there is no significant difference in sodium concentration between 2014 and 2015 in all the three seasons. There is significant difference in TDS and conductivity between 2014 and 2015 in monsoon and no significant difference in pre-monsoon and post-monsoon seasons. Potassium has significant difference between 2014 and 2015 in post-monsoon and no significant difference in pre-monsoon and monsoon seasons. There is also no significant difference in TDS, conductivity, sodium and potassium in all the three seasons. Present study only provides baseline information on the water quality of some village ponds of district Jhajjar. Therefore, broader scale study is required to obtain needed information. The higher level of TDS, conductivity, sodium and potassium in these ponds need some attention for their management efforts like separate disposal of village waste water, reduction in leaching of excessive nutrient from catchment area through plantation and water treatment would definitely be helpful in the regulation of the water quality of these village ponds.

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