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DIURNAL VARIATION IN PHYSICO-CHEMICAL FACTORS OF A FLOODPLAIN WETLAND IN VAISHALI DISTRICT OF BIHAR, INDIA

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ABSTRACT
Diurnal variations in physicochemical factors such as temperature, pH, dissolved oxygen, free CO_2, total alkalinity, conductivity and total hardness were observed between 9:00 hrs to 5:00 hrs of next day. Average water temperature ranged from 18.6 to 33.2°C. The pH of water remained alkaline and fluctuated from 7.2 to 8.2. The dissolved oxygen fluctuated between 2.4- 10.2 mg/l and free CO_2 between 0-24 ppm. Temperature, dissolved oxygen and pH were maximum in day hrs and minimum in night hrs. Alkalinity ranged from 70-332 ppm, conductivity from 160-342 uS/cm and total hardness from 62-90 ppm. Maximum values were obtained at 1:00 hrs, 17:00 hrs and 9:00 hrs respectively for alkalinity, conductivity and total hardness. Well marked diurnal variations have been recorded in the physico-chemical parameters. A positive relationship was observed between temperature, pH and dissolved oxygen. Free CO_2 showed a negative relationship with temperature, pH and dissolved oxygen. All the parameters were found to be fluctuating within the permissible limits indicating the scope of aquaculture in the *Chaur*.

KEY WORDS: Diurnal variation**,** physico-chemical, water, wetland, Bihar.

INTRODUCTION

Wetlands are areas where water is the key factor influencing and regulating the environment and the associated flora and fauna. Wetland ecosystems sustain diverse taxonomic groups and are rated highly productive often equally or more productive than the adjacent terrestrial and aquatic ecosystems (Hassan and Patial, 2015). The floodplain wetland, locally called *Chaur* - a distinct fresh water ecosystem of Bihar, is characterized by shallow depth, dense growth of macrophytes and seasonal flooding. Ecologically, *Chaurs* get inundated with floodwater during monsoon and retain perennially. These *Chaurs* constitute an ideal habitat for fishes and are highly significant from fish production point of view. The *Chaurs* are also the major source of livelihood for fishermen and poor villagers and affect the socio-economic conditions of the area (Patial and Hassan, 2014). *Chaurs* are very complex and unique biotype due to several geomorphic factors. The quality of *Chaur* water is of vital concern for mankind since it is clearly linked with fish production and other human uses. The scientific management of fisheries in a *Chaur* requires a thorough understanding of physico-chemical properties of water.

Water quality management is a key for successful aquaculture and play significant role in development of aquatic resource. Most period of poor growth, disease and parasite outbreak and fish kill can be traced to water quality problems. For effective maintenance of water quality through appropriate control measures, continuous monitoring of large number of quality parameters is essential (Bhandari and Nayal, 2008). Water quality is directly proportional to human population and its various activities. It is, t therefore, very important to know something about the water quality parameters and their management. Environmental conditions may change dramatically within aquatic ecosystem during a period of 24 hrs (Salahuddin *et al*., 2014). The term diurnal refers to events that reoccur after an interval of 24 hour. Diurnal fluctuations in physicochemical parameters affect the population of an aquatic ecosystem. The *Chaurs* of north Bihar has almost a unique identity with respect to their characteristics as compared to other regions of country. Such transitional habitats between the aquatic and terrestrial ecosystems were found to have a number of novelties in their physico-chemical profile. There are some studies related to physico-chemical properties of floodplain wetlands of Bihar (Singh and Roy, 1990; Pandey *et al*., 1994; Mandal *et al*., 2004; Murugan and Prabaharan, 2012). But, there is paucity of information on diurnal variation in physico-chemical factors (Munshi *et al*., 1993; Sidhartha *et al*., 2012). So in the present study diurnal variations in physico-chemical properties of Sakari *Chaur* were investigated.

MATERIALS & METHODS

Sakari *Chaur*, measuring water area of 22.3 ha, is located at eastern side of River Ganges in Jandaha block, Vaishali district of Bihar, adjacent to National Bird Sanctuary, Baraila *Chaur*. The *Chaur* is flanked by two tributaries of river Ganga *viz.* Vaya and Noon River. Water abstraction for irrigation, agriculture in marginal area, cattle bathing and traditional fishing are the anthropogenic activity in the *Chaur*. Both the soil and water of the *Chaur* is being utilized for soil fertility improvement and irrigation of crops, respectively, in the adjacent areas. Profuse growth of higher aquatic plants like *Nelumbo, Nymphoides,*

Hydrilla, Vallisneria, Ipomea, Bacopa etc. occupies both column and surface of the water spread.

For the study of diurnal variations, water samples were collected monthly from December 2012 to November 2014. Water samples were collected at internal of 4 hrs and diurnal changes were recorded from 9:00 hrs of one particular day to 5:00 hrs of the next day. For the study of diurnal variations, annual cycle was divided into four seasons as PRM (Pre-monsoon *i.e.* March-May), MON (Monsoon *i.e.* June-August), RMON (Retrieving monsoon *i.e*. September-November) and WIN (winter *i.e.* December-February). Analysis of various physico-chemical parameters such as water temperature, pH, dissolve oxygen (DO), free CO_2, conductivity, total alkalinity (TA) and total hardness (TH) was made following standard methods (APHA, 1998).

RESULTS & DISCUSSION

It is an established fact that maintenance of healthy aquatic ecosystem is dependent on the physico-chemical properties of water and biological diversity (Moundiotiya *et al.*, 2004). Physico-chemical characteristics not only reflect the quality of an aquatic ecosystem but also its biological diversity (Ghavzan *et al*., 2006). In *Chaur* ecosystem, any quality of water that influence the growth, reproduction, survival or management of aquatic organism including fish in any way is a water quality variable. The quality of *Chaur* water is of vital concern for mankind since it is clearly linked with fish production and other human uses. The functions of *Chaur* are very extensive and range from nutrient recycling, groundwater recharge, prevention of erosion, salinity control to anthropocentric functions such as providing livelihood and life support such as food, water, fish, fuel, recreation, *etc.* Since the impact of human intervention is growing on the *Chaurs*, so the present limnological investigations were carried out in Sakari *Chaur*. Well marked diurnal variations have been recorded in most of the physico-chemical parameters.

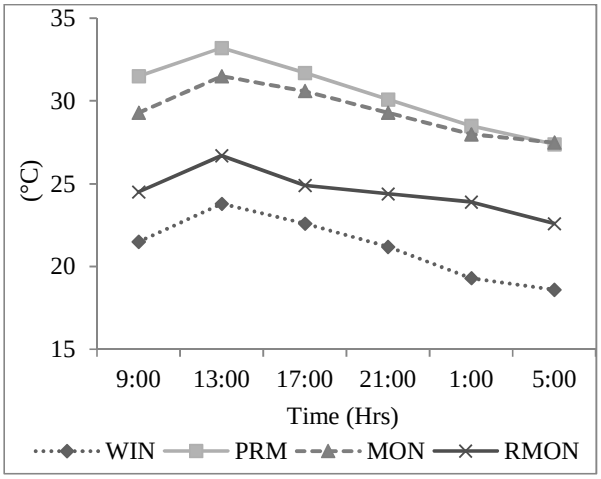

FIGURE 1: Diurnal variations in temperature

Average water temperature ranged from 18.6 to 33.2°C. The present study revealed that water temperature showed an increasing pattern from 9:00 hrs to 13:00 hrs and then showed a decreasing pattern from 13:00 hrs to 5:00 hrs of the next day. Diurnal variations of temperature in different season are given in Figure 1. Generally lower temperature was observed in the early morning hour and higher in noon hour. Similar trends were observed by Siddhartha *et al.* (2012). Maximum temperature was recorded at 13:00 hrs of PRM and minimum at 5:00 hrs of WIN season. The fluctuation of water temperature largely depends on the changes in the solar radiation (Hazarika, 2010). Temperature is a physical factor that alters the quality of the water and considered as an important factor in controlling the functioning of the aquatic ecosystem (Wetzel, 2001).

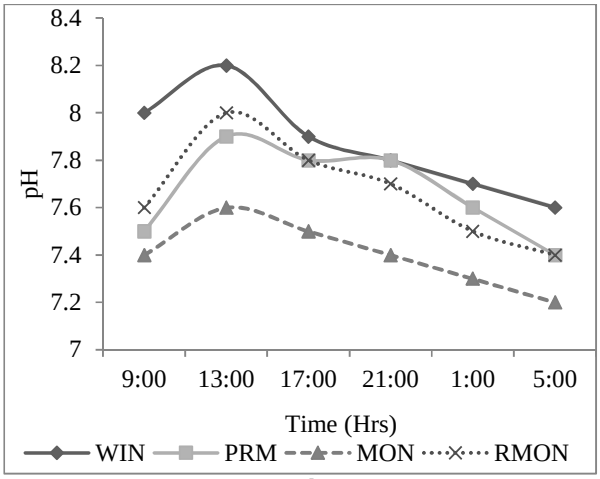

FIGURE 2: Diurnal variations in pH

The pH is a measure of acidity or alkalinity and is the concentrations of hydrogen ions present in water. In the present study pH of water remained alkaline and fluctuated from 7.2 to 8.2 (Figure 2). This alkalinity could be due to low rates of putrefaction and considerable quantity of carbonates, calcium and magnesium (Manna and Sarkar, 2008). Diurnal variations of pH in different season are given in Figure 2. The pH of water increased from 9:00 hrs to 13:00 hrs, thereafter a decrease was recorded. Similar fluctuations in pH were noticed by Jindal and Thakur (2013). The greater utilization of CO_2 due to increased photosynthetic activity was responsible for the increased pH in noon hours. The pH showed a positive relation with temperature as both were fluctuating in same direction. Minimum value of pH was recorded in MON and maximum in WIN season. These findings are also in accordance with Pandey *et al.* (1994) and Moundiotiya *et al.* (2004).

DO is the most important factor that supports aquatic life and self purification capacity of water body (Kumar, 2014). DO regulate the metabolic processes and is the major demand for survival of aquatic plants and animals (Manna and Sarkar, 2008). The dissolved oxygen fluctuated between 2.4-10.2 mg/l. Diurnal variation of DO in different season is shown in Figure 3. A maximum value of dissolved oxygen was recorded at 13:00hrs followed by decrease in value up to 5:00 hrs of next day and then again a increase upto 13:00 hrs. Salahuddin *et al.* (2014) and Kumar (2014) also reported similar diurnal variations in DO concentration**.** Increase in dissolved oxygen during the day hours may be due to photosynthetic activity of the autotrophs in the presence of high

illumination and decrease during night hours due to the respiratory activity of the heterotrophs (Singh *et al*., 1982; Murugan and Prabaharan, 2012; Jindal and Thakur, 2013). Minimum oxygen was recorded during morning hours of PRM and maximum in noon hours of WIN season. The high water temperature during PRM accelerated the decomposition of aquatic vegetation causing decreased amount of DO (Pandey *et al.*, 1989). DO showed a positive relationship with pH and temperature.

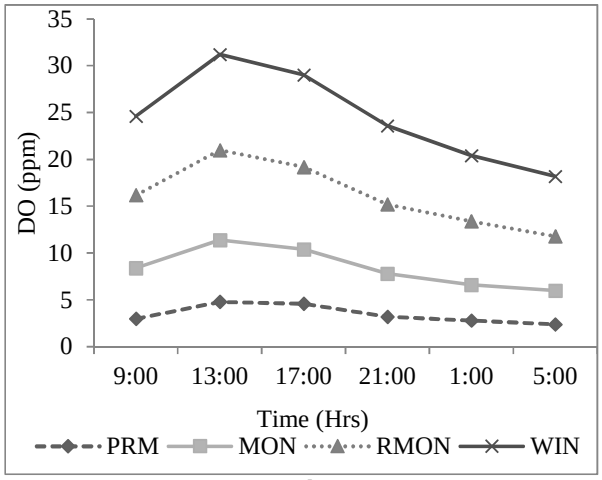

FIGURE 3: Diurnal variations in DO

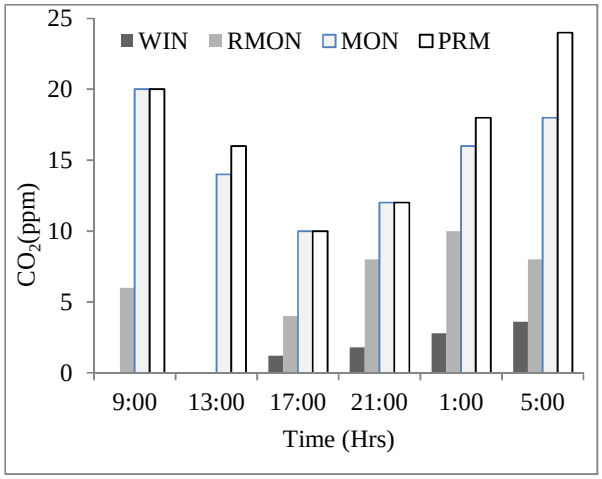

FIGURE 4: Diurnal variations in Free CO_2

Free CO_2 is derived from various sources *viz*. atmosphere, respiration of aquatic plants, bacterial decomposition and finally from within the water itself in combination with other substances chiefly calcium and magnesium (Hazarika, 2010 and Abir, 2014). Free CO_2 was in the range of 0-24 ppm. There was no clear pattern in variation of free CO_2 (Fig. 4). Total absence of free carbon dioxide in some samples could be attributed to relatively less number of organisms and low decomposition of oxidizable organic matter at low temperature (Jindal and Thakur, 2013). On average maximum free CO_2 was found in PRM and minimum in WIN season. The high water temperature during PRM accelerated the decomposition of aquatic vegetation causing increased value of free CO_2 (Pandey *et al.*, 1989). As earlier reported by Siddhartha *et al.* (2014) CO_2 showed a negative relationship with temperature, pH and DO.

Total alkalinity of water depends upon the occurrence of mineral salts present in water. It is also used as a productivity measure of aquatic water body. Alkalinity ranged from 70-332 ppm in *Chaur* water. Alkalinity was minimum at 13:00 hrs, showed an increase up to 1:00 hrs and then followed by a decrease up to 5:00 hrs (Fig. 5). Thus minimum value of total alkalinity was recorded during day hours and maximum during night hrs in all the seasons. Contrary to Kumar (2014), total alkalinity showed a negative relation with temperature, pH and DO. Average alkalinity was minimum in MON and maximum in PRM season. Moundiotiya *et al.* (2004) also reported highest alkalinity value in summer followed by steep fall in the MON season.

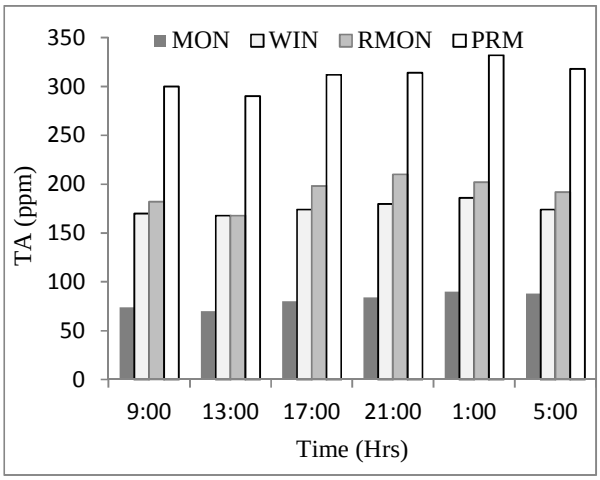

FIGURE 5: Diurnal variations in Total Alkalinity

The conductivity of water ranged from 160-342 uS/cm. Conductivity of water depends upon the concentration of dissolved ions and its nutrient status. It also specifies the degree of mineralization in a water body. Dial variations revealed that the conductivity increased from 9:00 to 17:00 hrs and then decreased upto 5:00 hrs (Fig. 6). Conductivity was maximum at 17:00 hrs and minimum at 5:00 hrs. Similar dial variations were noted by Jindal and Thakur (2013) in a wetland of Himachal Pradesh. The fluctuations in the values of conductivity observed during present study could be due to variations in the rate of decomposition of organic matter and variations in the water level (Ganesh, 2006). Conductivity value was lowest in MON and highest in PRM. Moundiotiya *et al.* (2004), Kedar *et al.* (2007) and Abir (2014) also reported the high value of conductivity during summer season. The accumulation of dissolved salts due to high rate of evaporation in summer increases the electrical conductivity of water (Hulyal & Kaliwal, 2011). Dilution of water during the rains causes a decrease in electrical conductance (Moundiotiya *et al*., 2004)

Hardness of water is due to the compounds of Calcium and Magnesium which exists in the form of carbonate, sulphates, chlorides *etc*. High value of total hardness indicated the greater productivity of water body (Barot and Patel, 2014). Total hardness in *Chaur* water was found to be fluctuated between 62-90 ppm. Hardness of water

showed a decrease in values from 9:00 hrs to 17:00 hrs followed by an increase up to 5:00 hrs of next day. Diurnal variation of total hardness in different season is shown in Figure 7. The total hardness was found to be higher during PRM and lower in WIN season. This result is supported by the findings of Hulyal and Kaliwal (2011) and Barot and Patel (2014). Higher value in PRM could be attributed to decreases in water volume and increases in rate of evaporation at high temperature (Hulyal and Kaliwal, 2011).

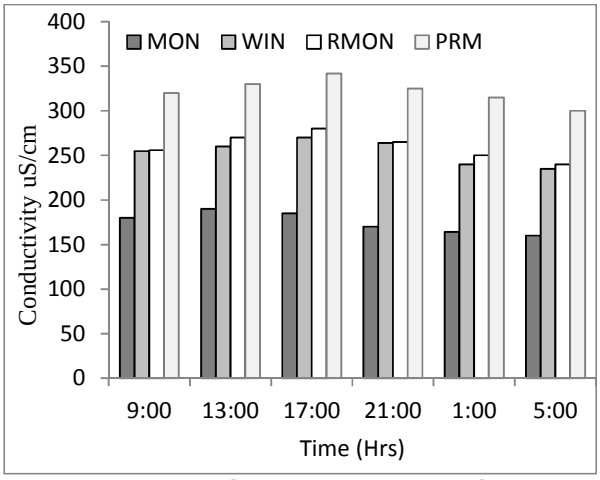

FIGURE 6: Diurnal variations in water conductivity

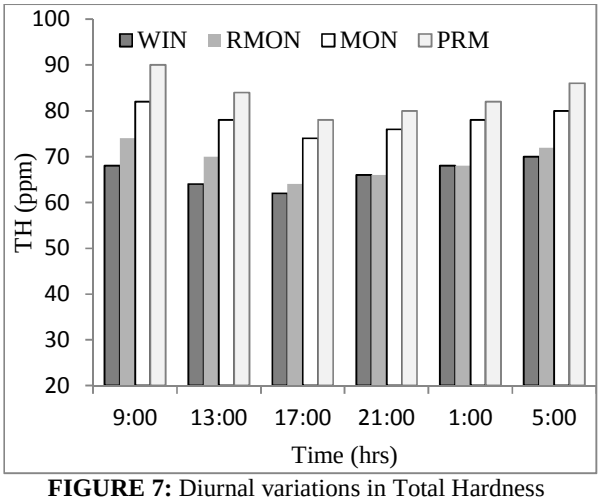

FIGURE 7: Diurnal variations in Total Hardness

CONCLUSION

All the parameters were found to be fluctuating within the permissible limits indicating the scope of aquaculture in the *Chaur*. Well marked diurnal variations have been recorded in most of the physico-chemical parameters. Each factor contributes in making of the specific ecosystem and thus determines the trophic dynamics of the aquatic body. Any change in one factor directly or indirectly alters the other factors. Diurnal variations in physico-chemical factors must be taken into consideration in understanding the eco-composition of the natural water bodies. The present study will be helpful in ecological assessment and development of fisheries management programs in the *Chaur* areas of Bihar.

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