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Research Article

Limnological studies of Semara Taal, a wetland of district Siddharthnagar, Uttar Pradesh, India

Ashok Kumar Verma[1] and Sadguru Prakash[2]

[1]*Department of Zoology, Govt. PG College Saidabad, Prayagraj (U.P.)*
[2]*Department of Zoology, M.L.K. (P.G.) College, Balrampur (U.P.)*

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***CORRESPONDENCE**
sadguruprakash@gmail.com

ABSTRACT

The physico-chemical condition of water plays a vital role in the wetland ecosystem. The various physico-chemical parameters of water of Semara Taal have been studied during Jan, 2018 to Dec., 2018 to find out its impact on planktonic population, fish culture and agriculture. The authors recorded that water temperature ranges from 12.8-35.4°C, transparency ranges from 28.6-38.8 cm, dissolved oxygen ranges from 6.1-9.4 ppm, free carbon dioxide ranges from 15.0-28.0 ppm, pH ranges from 7.1-9.8, total alkalinity ranges between 137.0 and 296.0 ppm, total solids ranges between 34 and 116 ppm, nitrate ranges between 1.08 and 1.41 ppm and phosphate ranges from 1.02-1.08 ppm. Total 25 species of phytoplankton and 24 species of zooplankton were also recorded. Bimodal pattern of seasonal variation of plankton was observed with a primary peak in the month of July and secondary peak in January. The physico-chemical and biological conditions were found suitable for fish culture and agriculture.

INTRODUCTION

Wetlands are defined as lands transitional between terrestrial and aquatic ecosystem, where the water label is usually at or near the surface or the land is covered by shallow water. Wetlands are very productive ecosystems, which help in the regulation of biological cycles, maintenance of water quality, nutrient movement and support for food chains. Wetlands are areas where water is the primary factor controlling the environment and the associated plants and animal life (Kumar *et al*., 2015). Wetlands are important components of watersheds and provide many valuable functions to the environment and society. The water resource is being used for various purposes such as domestic use, agriculture and fish culture etc. by local community. Now wetlands are shrinking rapidly because of urbanization and industrialization. Due to urbanization and anthropogenic pressure most of the wetlands are succumbed to greater degree of biologically active nutrient accumulation (Verma and Prakash, 2018). Review of literature revealed that several workers did researches on limnology and plankton diversity of different water bodies including Prakash *et al*., (2015a, 2015b and 2015c), Verma *et. al*, (2016a, 2016b) and Verma (2016 and 2019) and so on. In future, there will be a threat of contamination of water from the surface runoff of used fertilizers and pesticides. The physico-chemical characters of the wetland water can be used to assess the ecological nature of the wetlands. Although extensive works on the physico–chemical parameters of wetlands have already been carried out (Goel, *et. al*, 1986) but till now there is no sufficient baseline data about limnological parameters of Semara Taal water, hence the authors have undertaken for studying the limnological characteristics in relation to agriculture and fish culture.

MATERIALS AND METHODS

Study area

The wetland under exploration is situated in Shohratgarh tahsil of district Siddharthnagar of Uttar Pradesh (image shown below). The Taal is more than 3 km away from Shohratgarh, 28 km from Naugarh (headquarter of district Siddharthnagar) and about 370 km from Lucknow. Its nearest railway station is Shohratgarh. It is situated between the latitude 27.4025^0N- 82.9597^0E (Fig.1a&b). The total area of this Taal is 466.66 acre. The maximum depth of water in the pond is 15 feet during monsoon (July-August) and minimum 5 feet in summer (May-June). The sources of water supply to the pond are drainage water from Banganga River. The Taal is enriched with several type of vegetation. The water of Taal is used for Agriculture and fish culture .The margin of the Taal is

heavily infested by *Eichornia crassipes* and the organic deposition causes sedimentation of the Taal.

Fig.1a Map of Siddhrathnagar district

Fig.1b Satellite view of Semara Taal, a wetland

Water sampling

Water samples were collected fortnightly from three different sites in plastic stoppered bottles, the temperature, dissolved oxygen, free carbon dioxide and pH recorded on spot by using water quality analyzer kit. The total alkalinity, total hardness, nitrates and phosphates analysis were made at field as well as in laboratory as per standard methods (APHA, 2005). In biological parameters, plankton productivity was measured by using Sedgewick Rafter plankton counting cell and quantities are expressed here as units per liter of the pond water. Plankton were identified with the help of a book entitled "A guide to the study of fresh water biology" written by Needham and Needham (1962) and other standard literature.

RESULTS AND DISCUSSION

Physico-chemical Properties of Taal water

Results of the physico-chemical attributes of the pond water is presented in Table 1. The parameter wise results obtained are elaborated and discussed below-

Water Temperature

Water temperature influences the physiological activities of aquatic organisms. It was observed that water temperature is influenced by the air temperature. The water temperature of Taal ranged from 12.8-35.4°C during January to December, 2018. The range of water temperature is suitable for culture of Indian major carps and exotic carps (Jhingran, 1988). In the present study, maximum temperature was recorded during summer followed by rainy season whereas the minimum temperature during winter. Monthly variations noted in water temperature is a consequence of fluctuations in ambient temperature as the Taal represent smaller body of water in comparison to lakes and river and more quickly react to changes in atmospheric temperature (Dhamija and Jain,1994; Joshi and Singh, 2001).

Transparency

The average depth at which Sachhi disc disappears and reappears from open surface of water is called transparency of water. It is inversely proportional to the turbidity of water (Kumar *et al*., 2015). Water transparency controls the energy relationship at different trophic levels in food chain (Kumari and Jha, 2015). The water transparency of Taal was ranged from 28.6-38.8cm. The highest transparency was noted during winter, moderate in rainy and minimum in summer. Lower transparency observed during summer may be due to high planktonic population (Kumari and Jha 2015). Similarly maximum transparency recorded during winter may be attributed to sedimentation of suspended matter as opined earlier (Chaurasia and Adoni, 1985).

pH

pH is one of the most important parameters in water chemistry and is defined as negative logarithm of hydrogen ion concentration and measured as intensity of acidity or alkalinity on a scale ranging from 0-14. The pH is an indicator of overall environmental condition of the aquatic system. The pH of Taal water ranged from 7.1-9.8. pH value during summer and lowest during rainy season and may be attributed to productive capacity of the Taal. The alkaline nature of water is suitable for aquatic life (Singh, 1990).

Dissolved Oxygen

Analysis of dissolved oxygen of any water body is an important parameter because it serves as indicator of the physical, chemical and biological activities of that water body. The DO of Taal ranged between 6.1and 9.4 ppm. The highest dissolved oxygen was recorded during winter months may be attributed to high photosynthetic activity

during these months. Oxygen is more soluble in cold water. Hazelwood and Parker (1961) stated that the highest dissolved oxygen in winter may be due to low atmospheric temperature and minimum dissolved oxygen in summer may be due to high metabolic rate of organisms. Oxygen depletion in rainy season may be due to the low photosynthetic or respiratory activity of heterotrophic organisms and also probably due to the biological oxidation of organic matter and the combined effects of temperature and photosynthetic activity. The dissolved oxygen concentration above 5.0 ppm throughout the year shows that the wetland is very much productive (Ansari and Prakash, 2000).

Free Carbon dioxide

Free carbon dioxide in a water body is generally derived from the atmospheric sources, biotic respiration and decomposition of organic matter by saprophytes. In the present study, the FCO_2 was ranged between 15.0 and 28.0 ppm. The FCO_2 concentration in the Taal was maximum during rainy months and minimum during winter months. The appearance of high concentration of free carbon dioxide during monsoon months could probably be associated with active decomposition of organic matter. The present finding is similar to that of Kumar *et al*., (2015).

Total Alkalinity

Alkalinity is directly related to the productivity of water bodies because it regulates the pH and free carbon dioxide of the water bodies. Bicarbonates and carbonates in most of natural water are responsible for alkalinity. The total alkalinity ranged between 137.0 and 296.0 ppm indicates that the water of the Taal is nutrient rich as well as high productive (Alikunhi, 1957; Singh, 1990; Ansari and Prakash, 2000). The maximum alkalinity was in rainy season and minimum during winter season.

Total Hardness

The total hardness is defined as the sum of calcium and magnesium carbonate concentrations in water. It is an index of fertility of the aquatic ecosystem. Moyle (1946) suggested 40 ppm of hardness as a natural separation point between soft and hard waters. The total hardness ranged between 76-123 ppm indicates that water of the Taal is suitable for fish culture (Jhingran, 1988). The highest hardness was noticed in in winter months and lowest in rainy months. The result is supported by the findings of Kumar *et al*., (2015).

Nitrate

The most chemically stable available form of nitrogen is nitrate. High nitrate concentration is responsible for algal blooms in water body. Surface runoff, decayed vegetations and animal matter are the main sources of nitrates in water body. The nitrate content of the water ranged between 1.08-1.41ppm. Its maximum concentration was observed in the post monsoon season. The result is supported by the findings of Khan *et al*., (1986).

Phosphate

Phosphate is considered as the most critical nutrient substance in the maintenance of pond productivity. They are essential for the growth of organisms and a nutrient that limits the primary productivity of the water body. In the present study the phosphate content was ranged between 1.02-1.08 ppm. It was minimum during winter months and maximum during the summer months. Low phosphate contents during winter months and high during summer or post monsoon months may be due to low decomposition of organic matters during summer season (Prakash, 2001b).

Biological Properties of Taal water

In the present study, twenty five species of phytoplankton were found (Table 2). Of these 8 belong to Chlorophyceae (*Pediastrum, Ankistrodesmus, Coelastrum, Scenedesmus, Botryococus, Colosterum, Crucigenia* and *Chlorella*); 8 to Bacillariophyceae (*Synedra, Navicula, Cymbella, Fragillaria, Melosira, Cyclotella, Pinnularia* and *Nitzschia*); 7 to Cyanophyceae (*Anabaena, Spirulina, Microcystis, Raphidiopsis, Merismopedia, Cloecapsa,* and *Oscillatoria*) and 2 to Euglenophyceae (*Euglena* and *Phacus*). Apart from this 24 species, species of zooplankton were also seen. Of these 8 species belong to Rotifers (*Brachinous, Keratella, Notomate, Notholca, Rotaria, Asplanchna, Polyarthra* and *Lecane*); 9 to Cladocerans (*Diaphnosoma, Ceriodaphnia, Daphnia, Simocephalus, Chydorus, Bosmina, Bosminopsis, Sida* and *Macrothrix*), 5 to Copepods (*Cyclops, Mesocyclops, Diaptomus, Heleodiaptomus* and *Nauplius* larva) and 2 Ciliates (*Paramecium* and *Vorticella*). Presence of these species was reported in fresh water bodies of eastern Uttar Pradesh (Prakash, 2001a, Prakash *et al*., 2002 and Sinha *et al*., 2002). Presence of 25 species of phytoplankton and 24 species of zooplankton shows that the Taal is rich in planktonic diversity.

The annual periodicity of phytoplankton shows that Cyanophyceae dominated and constituted 38.64% of the total phytoplankton followed by Chlorophyceae (31.0%), Bacillariophyceae (24.21%) and Euglenophyceae (6.15%). In the present study the maximum density of phytoplankton was recorded in July (1187 unit / litre) and minimum in the month of April (255 unit / Litre). The annual productivity of zooplankton shows that Rotifers dominated and constituted 32.70% of the total zooplankton followed by Copepods (24.50%), Cladocerans (22.27%) and Ciliates (19.54%). In the present study the maximum density of zooplankton was recorded in July (5859 unit / litre) and minimum in December (1372 unit / litre). Similar observation was made by Ansari and Prakash (2000), Prakash (2001a) and Sinha *et al* (2002). The plankton density in the Semara Taal shows is highly productive.

In the present study bimodal pattern of seasonal variation of plankton was observed, with a primary peak in the month of July and secondary peak in January (Table 2). Similar pattern of plankton distribution were reported in the fresh water bodies of U.P. by Khan and Siddiqui (1974), Ansari and Prakash (2000) and Prakash (2001a).

Table1. Monthly variations in Physico-chemical properties of water of Semara Taal

Months	Temp. (^{0}C)	Trans. (cm)	pH	DO. (ppm)	FCO_2 (ppm)	Total Alk.(ppm)	T H (ppm)	Nitrate (ppm)	Phosphate (ppm)
Jan.	12.8	38.8	7.8	9.3	15.1	209.0	113.0	1.18	1.03
Feb.	15.9	35.6	7.6	8.7	15.3	218.0	123.0	1.21	1.05
Mar.	20.9	30.4	8.2	8.5	15.4	226.0	112.0	1.31	1.06
Apr.	27.6	30.5	8.5	7.2	15.6	201.0	108.0	1.41	1.06
May.	30.8	29.3	9.6	6.1	16.4	213.0	99.0	1.31	1.08
Jun.	32.5	28.6	9.8	6.3	16.5	234.0	92.0	1.27	1.05
Jul.	35.4	33.6	7.1	7.9	16.7	269.0	86.0	1.22	1.04
Aug.	31.6	32.8	7.2	8.1	18.0	296.0	76.0	1.18	1.03
Sep.	27.3	32.6	7.2	8.6	22.1	141.5	88.0	1.09	1.04
Oct.	24.5	33.8	7.3	9.1	25.0	167.0	99.0	1.08	1.03
Nov.	18.7	34.3	7.5	9.2	28.0	137.0	103.0	1.10	1.04
Dec.	14.4	36.8	7.7	9.4	15.0	201.0	108.0	1.12	1.02
Ranges	12.8-35.4	28.6-38.8	7.1-9.8	6.1-9.4	15.0-28.0	137.0-296.0	76-123	1.08-1.41	1.02-1.08
Average ±.S.D.	24.36 ±0.41	33.09 ±0.47	7.95 ±0.23	8.2 ±0.23	18.25 ±0.35	209.37 ±1.20	98.12 ±0.70	1.20 ±0.09	1.04 ±0.08

Table2. Monthly fluctuations in Plankton Population in Semara Taal

Month	Phytoplankton Group density (Units / Litre)					Zooplankton Group density (Units / Litre)					Total
	Chloro-phyceae	Caono-phyceae	Bacillari ophyceae	Eugleno phyceae	Total	Rotifera	Cladocera	Copepods	Ciliate s	Total	
Jan.	887	1176	923	129	3115	1054	1167	854	898	3973	7088
Feb.	503	423	321	34	1281	878	819	876	276	2849	4130
Mar.	374	354	223	24	975	746	702	754	389	2591	3566
Apr.	255	654	276	75	1260	543	467	409	276	1695	2955
May.	299	659	276	71	1305	507	487	412	301	1707	3012
Jun.	843	1043	834	205	2925	923	998	1032	796	3749	6674
Jul.	1187	1465	1023	353	4028	1737	1554	1514	1054	5859	9887
Aug.	765	743	387	139	2034	805	487	328	218	1838	3872
Sep.	543	511	423	173	1650	702	402	294	123	1521	3171
Oct.	487	477	342	102	1408	654	379	254	101	1388	2796
Nov.	295	386	243	47	971	354	487	254	287	1382	2353
Dec.	323	543	284	59	1209	435	395	267	275	1372	2681
Total / Av.	6761/ 563	8425 / 702	5279 / 440	1340 / 112	21805 /1817	9338 / 778	6358 / 530	6994 / 583	4994 / 416	28552 /2379	50357 /4196
%age	31.00	38.64	24.21	6.15	-	32.70	22,27	24.50	19.54	-	-

CONCLUSION

Thus, it can be concluded that in spite of favorable physico- chemical and biological condition of water, potential fish yield is not being realized. Fish production can be augmented to a great extent if we managed scientifically. It can be realized optimally by stocking of fast growing Indian major carps, Catla, Rohu, Mrigal and Calbasu in ratio 4:3:3 or by stocking of Indian major carp and exotic carp in ratio 3:3:2:2 for Catla, Rohu, Mrigal and Common carp, respectively @ 1000-1500 fingerlings/ha to utilize the rich plankton resources.

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