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Evaluation of Physico-chemical Parameters of Water and Soil in Relation to Fish Production of Guthia Taal of Dstrict Bahraich, U.P.

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Abstract:
The physico-chemical condition of water and soil plays a vital role in the wetland ecosystem. Three sampling stations were selected for the study of physico-chemical parameters of water and soil of Guthia taal in relation to fish production. Various physico-chemical parameters of water like temperature, transparency, pH, dissolved oxygen, free carbon dioxide, biochemical oxygen demand, chemical oxygen demand, total alkalinity, total hardness, nitrate and phosphate were measured. The soil samples were analysed with respect to soil texture, pH, organic carbon, available phosphorus and nitrogen. The present finding established that, in spite of fevourable physico-chemical condition of water and soil, 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) and Exotic carps @ 1000-1500 fingerlings/ha to utilize all the available fish food resources.

Keywords: Physico-chemical parameters, soil condition, Wetland, Guthia Taal.

INTRODUCTION

Wetlands are areas where water is primary factor controlling the environment and the associated plants and animal life. They occur where the water table is at or near the surface of the land, or where the land is covered by water. Wetlands are among the world's most productive environments. They are cradles of biological diversity, providing the water and primary productivity upon which countless species of plants and animals including fish, amphibians, reptiles, birds, mammals, and invertebrate species depend for survival (Prakash, 2000)[1]. Wetlands like lake, jheel, taal etc. are of utmost importance for several reasons. They represent only a part of our land bases but they provide shelter to a great number of animal and plant species. Many species only use the wetland for a very small but in the important part of their life cycle such as for breeding (Yadav, 2011)[2]. Wetlands are important components of watersheds and provide many valuable functions to the environment and to 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.

The fish productivity mostly depends upon the characteristics of water and soil of waterbodies. Good water quality and soil condition plays an important role in the growth, development, survival and in order to increase its production. The physico-chemical condition of water and soil of a waterbody depend on the geographical and climatic conditions of that area. The biotic factors such as

phytoplankton and zooplankton that are used as food by different type of fishes are directly or indirectly influenced by water quality and soil condition of waterbody.

The presence of many natural lentic waterbodies including lakes and wetlands in tarai region of eastern Uttar Pradesh offers immense scope for fish production. For fish production in these waterbodies, it is of utmost important to have the knowledge of water and soil quality as it determines not only the existence of the fish fauna but also governs the production of fish food (plankton) organisms and primary productivity. Paucity of such knowledge is a serious constraint in exploitation of these waterbodies.

The result of the intended study may suggest suitable measures to utilize such fresh waterbody which is uncarefully managed for increase of the fish production so essentially needed and to eradicate the factors and conductions which adversely affect the increase in fish production. Though numerous works on physico-chemical parameters and plankton diversity are being reported from different parts of India but there is scarcity of report from freshwater lentic waterbody of eastern Uttar Pradesh except some work (Singh, 1983; Goel *et al*, 1986; Abbasi *et al*, 1996; Ansari and Prakash, 1999 & 2000; Kumar *et al*, 2015)[3-8] but till now there is no sufficient baseline data about Physico-chemical parameters of water and soil of wetlands of U.P. therefore, the present work has been undertaken for studying the Physico-chemical parameters characteristics of Guthia Taal, a wetland of Bahraich district of U.P in relation to fish production.

STUDY AREA

Guthia Taal is a large shallow perennial horse shoe shaped lentic waterbody. The total catchment area of wetland is about 75.9ha. Out of 75.9ha, 25.3ha is situated in Guthia, 25.3ha in Rucknapur, 22.77ha in Dihawa Sher Bahadur Singh and 2.53ha in Nawgeya villages, of Kaiserganj Tahseel of district Bahraich. But in summer season its water spread area becomes reduced up to 37.95ha. It is situated between the latitude 27.2537^{0}N- 81.54313^{0}E. The Taal is enriched with several type of vegetation such as *Nymphaea, Nelumbo* and Nymphya as well as aquatic birds like Duck, Saras and Bagula. The water of Taal is used for agriculture and fish culture. The abundant food attracts hundreds of resident and migratory birds including Siberian crane during winter season.

Image 1: Satellite view of Guthia Taal, a wetland of Bahraich district.

Image 2. Guthia Taal

MATERIAL AND METHODS

The water samples were collected monthly from three fixed sites in a plastic stoppered bottels, both from the surface and bottom layers between 8 to 10 A.M. The transparency, temperature, dissolved oxygen; free carbondioxide and pH were recorded on spot by using Secchi disc and water quality analyser kit. The total alkalinity, total hardness, nitrates, and phosphates analysis were made at field as well as in laboratory as per standard methods (APHA, 1998).[9]

The soil samples were collected monthly and dried to constant weight in an oven at 105[0]-110[0]C. The sand, silt and clay was determined by pipette method (Piper, 1966).[10] Trivedy *et al* (1987).[11]was used for the determination of organic carbon, available phosphorus. The available nitrogen was determined by alkaline permanganate method (Subbiah, and Asija, 1956).[12] The pH was determined in 1:5 soil water suspension by pH meter.

RESULTS AND DISCUSSION

Physico-chemical Properties of water (Table1): Results of the physico-chemical attributes of the taal waters have been presented in Table1. The parameter wise results obtained are elaborated and discussed below-

Table 1: Seasonal variations in Physico-chemical properties of water of Guthia Taal

Parameters	July, 2019 to June, 2020			Optimum range (Bhatnagar and Devi, 2013)
	Rainy Season (July-October)	Winter Season (Nov. – Feb.)	Summer Season (March-June)	
Temp. (^{0}C)	27.55±1.14	19.43±1.54	29.81±1.33	15-35
Trans. (cm)	69.5±1.15	112.3±1.54	95.4±1.28	-
pH	8.3±0.46	8.6±0.52	8.1±0.39	7.0-9.5
DO. (mg/l)	8.08±0.74	9.55±0.56	8.73±0.54	3.0-5.0
FCO_2 (mg/l)	8.5 ±0.57	5.4±0.43	7.9 ±0.64	-
BOD (mg/l)	5.16 ±0.14	3.89±1.16	6.28±1.11	3.0-6.0
COD (mg/l)	15.12±2.15	19.45±1.74	17.58±1.89	-
Total Alk.(mg/l)	93.68±4.54	100.15±3.25	121.25±3.89	50.0-200.0
T H (mg/l)	82.50±2.35	95.40±1.78	108.25±2.04	>20
Nitrate (mg/l)	0.82±0.25	0.54±0.26	0.36±0.28	0.0-100.0
Phosphate (mg/l)	0.13±0.31	0.11±0.14	0.15±0.19	0.03-2.0

Water Temperature: Water temperature is responsible for not only high biological productivity but also influences the physiological activities of aquatic organisms. The change in temperature affects the metabolism and physiology of fishes as well as its productivity. In the present study water temperature ranged between 19.43ºC -29.81ºC. The range of water temperature was within the optimum range and suitable for Indian major carps and exotic carps (Jhingran, 1988).[13] In the present study maximum temperature was recorded during summer followed by rainy and winter season. Seasonal variations noted in water temperature is a consequence of fluctuations in ambient temperature as the wetland represent smaller shallow waterbody in comparison to lakes and river and was due to quick changes in atmospheric temperature (Dhamija and Jain, 1996; Joshi and Singh, 2001). [14-15] In the present water body no thermal stratification was observed and water at different layers was noted almost isothermal. The taal water is liable to fast wind action thus providing an opportunity for frequent stirring of the water enabling aeration at different columns and continuous replenishment of the upper water layer with nutrients thereby increasing productivity of the wetland.

Transparency: The Secchi disc transparency is essentially determines the depth of the water body where light penetrates which influences the primary productivity of a pond. Water transparency controls the energy relationship at different trophic levels in food chain (Kumari and Jha, 2015).[16] In the present apparent changes (69.5-112.3 cm) were recorded in the transparency of the taal water during different seasons. Maximum transparency was noted during winter, low in summer and lowest in the rainy months. Maximum transparency recorded during winter months may be attributed to sedimentation of suspended matter as opined earlier (Chaurasia, and Adoni, 1985).[17] Boyd (1998)[18] reported the optimum level of transparency between 30 cm to 40 cm for fresh water aquaculture.

pH: The pH is an indicator of overall environmental condition of the aquatic system and is defined as negative logarithm of hydrogen ion concentration and indicates the acid base balance of the water. In the present study, the pH of water ranged between 8.1-8.6 which show the favorable conditions of productivity of fishes (Singh, 1990).[19] The decline in pH values during summer is associated with the dissociation of carbonic acid (formed by surplus free carbondioxide) into H^+ and HCO_3^- ions. These H^+ ions declined the pH of water in summer. Alkaline range of taal water are indicative of the fact that photosynthetic activity has dominance over the respiratory activity of the biota.

Dissolved Oxygen: Dissolved oxygen is the most important environmental factor for fish productivity. It plays a vital role in growth, survival, behavior and physiology of aquatic organisms. The dissolved oxygen level in a water body depends on water temperature as well as the photosynthesis and community respiration. The DO_2 range 8.08-8.73 mg/ l shows that taal water was saturated with oxygen throughout the year. The highest dissolved oxygen was recorded during winter season may be attributed to low temperature which enables to hold more oxygen and high photosynthetic activity during this season (Hazelwood and Parker).[20] Oxygen depletion in summer months may be due to high temperature and rapid oxidation of organic matter. The dissolved oxygen concentration above 5.0 ppm throughout the year shows that the wetland is very much productive (Ansari and Prakash, 2000).[6] Thus regarding concentration of dissolved oxygen, Guthia taal falls in a productive group.

Free Carbon dioxide: Free carbondioxide in a waterbody is generally derived from the atmospheric sources, biotic respiration and decomposition of organic matter by saprophytes. In the present study the FCO_2 range was ranged between 5.4-8.5 mg/l. The FCO_2 concentration was maximum during rainy season and minimum during winter season. The appearance of high concentration of free carbondioxide during rainy season could probably be associated with rapid decomposition of organic matter in the sediments owing to low depth, greater intensity and longer duration of sun light and ultimately more heat budget in the ecosystem. The present finding is similar to that of Kumar *et al* (2015).[8]

Biological Oxygen Demand: BOD is the amount of oxygen taken up by micro-organism for the decomposition of organic waste matter in water.[21] The BOD level between 3.0 to 6.0 mg/l has been reported as optimal for normal activities for fishes (Bhatnagar and Devi, 2013).[21] Boyd (1998)[18]

reported the optimum level of BOD 10mg/l for fresh water aquaculture. In the present study the level of BOD was ranged between 3.89 to 6.28 mg/l and is suitable for fish culture.

Chemical Oxygen Demand: COD represents the amount of oxygen required for oxidizing the all organic matters. The optimum level of COD was < 50 mg/l for fresh water aquaculture as recommended by Boyd (1998)[18]**.** In the present study the level of COD was ranged between 15.12 to 19.45 mg/l and was within the tolerable level of fish culture.

Total Alkalinity: Alkalinity is directly related to the productivity of water bodies because it equilibrates the pH changes that occur naturally as a result of photosynthetic activity of phytoplankton. In natural waters, alkalinity is generally caused by carbonates and bicarbonates of calcium and magnesium. In the present study maximum alkalinity was found in summer, low in winter and lowest in winter months. The optimum alkalinity for fish production is between 50 to 200 mg/l (Bhatnagar and Devi, 2013).[21] The range (93.68-121.25 mg/l) of total alkalinity indicates that the water is hard type and is an indicative of high fish production (Alikulini, 1957; Singh, 1990; Singh, 1983; Ansari and Prakash, 2000).[22, 19, 3, 7]

Total Hardness: The hardness of water primarily depends upon salts of calcium and magnesium ions in water, mainly the carbonates and sulphates (Wadia, 1966).[23] It is an index of fertility of the aquatic ecosystem. The total hardness ranged between 82.50 to 108.25mg/l indicates that water of the taal is suitable for fish culture.[13] The highest hardness was noticed in summer season and lowest in winter season. The increase of hardness in summer season was due to the decrease in water level and increase in the rate of evaporation. On the basis of hardness (Kiran, 2010),[24] classified the water into soft (< 75 mg/l), moderate hard (75-150 mg/l), hard (150-300 mg/l) and above that very. Thus the present finding suggests that the taal water is moderately hard.

Nitrate: It is essential nutrient for photosynthetic autotrophs and its presence in any aquatic ecosystem depends on the activity of nitrifying bacteria. Surface runoff, decayed vegetations and animal matter are the main sources of nitrates in water body. It is non toxic to fish except its level exceeded above 90mg/l (Stone and Thormforde, 2003).[25] The nitrate content of the water ranged between 0.36 to 0.82 mg/l. Its maximum concentration was observed in the rainy season. The result is supported by the findings of Khan *et al.* (1986).[26]

Phosphate: Phosphate is an essential nutrient for the growth of algae and limits the primary productivity of the water body. In the present study the phosphate content was ranged between 0.11 to 0.15 mg/l. It was minimum during winter months and maximum during the summer months. These values also agree within the acceptable range of 0.03 to 2.00 mg/l obtained by Bhatnagar and Devi.[21] Low phosphate contents during winter and high during summer season may be due to low decomposition of organic matters during summer seasons (Prakash, 2001).[27]

Natural waterbodies *viz.*, lakes and wetlands receive nutrients (nitrates and phosphate) from agricultural runoff, sewage and decomposed organic matters. When algae and other micro organisms die and settle to the bottom of any water body, they carry their cellular nitrogen and phosphorus with them. During decomposition, these nutrients are released and become available for subsequent growth of aquatic flora. Presence of more nitrates and phosphates in summer season might be due to released of more nutrients in water after decomposition of organic matter plus entering of new nutrients in taal from vast agricultural run-off. In relation to nutrients status, the lake falls into medium to high productive group (Banerjea, 1967).[28]

Physico-chemical Properties of Soil (Table2): Results of the physico-chemical characteristics of soil of Guthia Taal have been presented in Table 2. The parameter wise results obtained are elaborated and discussed below-

Table 2: Seasonal variation in Physico-chemical characteristics of Soil of Guthia Taal

Parameters	July,2019 to June,2020		
	Rainy Season (July-October.)	Winter Season (Nov.-Feb.)	Summer Season (March-June.)
Sand%	18.29	16.41	15.47
Silt%	26.69	25.95	30.69
Clay%	57.42	57.72	53.72
pH	7.83	7.78	7.90
Organic carbon %	1.39	1.65	1.28
Available Phosphorus (ppm)	9.53	12.05	8.63
Available Nitrogen (ppm)	210.75	239.25	209.00

Texture of Soil: The soil of taal under study is clay in texture (53.72-57.72%) suitable to support microphytic and macrophytic vegetation, and also good for fish culture because neither it is very sandy to allow leaching nor too clayey for the absorption of nutrients (Prakash, 2000).[29]

pH of Soil: The soil was alkaline in all three seasons, with a narrow range of pH 7.78-7.90. It is ideal for fish production and associated for high rate of soil respiration. An almost similar range of pH has also been reported by Prakash (Prakash, 2000)[29] Soil pH, near neutral to slightly alkaline is considered favourable for fish culture (Banerjea, 1967).[28] Thus the soil pH of this taal is conducive to high production.

Organic content: The organic carbon contents will affect the fish production and nitrogen fixation. In the present study organic carbon of the soil was varied between 1.28-1.65%. Banerjea (1967)[28] reported that organic carbon ranged between 1.5 to 2.5% to be optimal for fish production.

Phosphorus: The availability of phosphorus is the most important to aquatic productivity owing to the fact that phosphorus ion in soil from insoluble compound with iron and alumina under acidic condition and with calcium under alkaline condition. Available phosphorus of the soil was in the range of 8.63 to 12.05 ppm which is in almost similar range of available phosphorus observed by Prakash (2000)[29]. Sreenivasan (1967)[30] observed that soil with available phosphorus less than 0.5ppm are in low productive group, those with available phosphorus between 0.5 to 1.00 ppm are in moderate productive group (500-1000 kg of fish/ha) and soil with available phosphorus over 1.00 ppm are highly productive group (over 1000 kg of fish/ha). According to this observation, Guthia Taal falls into a high productive group.

Nitrogen: Nitrogen is present mostly in organic forms which are broken down through bacterial action into simpler inorganic molecules. Available nitrogen fluctuated in a narrow range of 209.00 to 239.25 ppm. Banerjea (1967)[28] observed that available nitrogen in the range of 25-50ppm and 50-75ppm, the fish production is average and above 75 ppm, there is no marked difference in fish production. In view of the above, the soil of the taal is indicative of high productivity with regard to its available nitrogen. It was observed that the values of organic carbon, available phosphorus, available nitrogen and clay content increased in winter season because of surface soil of cultivated brought by the rain water. The result is supported by the findings of Singh (1980).[31]

The widespread use of pesticides not only brought adverse influence on agro ecosystems but also caused alteration in physiological processes of non-target organisms (Verma and Prakash, 2018)[32]. These pesticides through surface runoff reach into the water bodies like ponds, taals and rivers which alter the physicochemical properties of water and soil (Prakash, 2020)[33] than enter the food chain and their subsequent bioaccumulation and biotransformation at different trophic levels have catastrophic effect to the ecosystem (Prakash and Verma, 2014)[34]. Application of pesticides in crop field has a great impact on aquatic system especially on fish population (Kaur and Mishra, 2019)[35].

CONCLUSION

It is evident from the present findings that physico-chemical properties of soil and water play a key role in fish food as well as (Sugumaran et al., 2020; Verma, 2018; Verma, 2019) [36,37,38] fish production alone or in combination with other factors (Prakash et al., 2015; Verma and Prakash, 2020)[39,40]. In spite of favourable physico-chemical condition of water and soil, 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) and Exotic carps @ 1000-1500 fingerlings / ha to utilize the plankton resources.

On the basis of data it can be concluded that the taal is slightly below the level of eutrophication as such proper management efforts need to be taken. Efforts like awareness programme among general mass to remove casual attitude of people about water quality deterioration and eutrophication; checking sewage entry, leaching of nutrients and plankton etc. may improve the situation.

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