UTTAR PRADESH JOURNAL OF ZOOLOGY

41(9): 55-64, 2020
ISSN: 0256-971X (P)

WATER QUALITY AND PHYTOPLANKTON ASSESSMENT OF SURYAPOKHRA POND; GAYA, INDIA

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AUTHOR'S CONTRIBUTIONS

This work was carried out in collaboration between both authors. Author PK designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author RK managed the analyses of the study and literature searches. Both authors read and approved the final manuscript.

Article Information

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Reviewers:
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Received: 07 May 2020
Accepted: 11 July 2020
Published: 25 July 2020

Original Research Article

ABSTRACT

Introduction: In pond ecosystem, the basis of life and the resulting food web is photosynthesis. Without the primary production, there would be no new biomass produced within the ecosystem to support other life forms. The greater the primary production within pond the more living biomass that can be supported within the food web. Ponds are good candidates of intensive fishery. Each pond has to be characterized thoroughly and its deficiencies should be corrected before it can be used for fish culture. Local conditions and economic considerations should eventually be required for aquaculture practices. The economics of input and output can be studied only after measuring the productivity and limnological characteristics of each pond. The total carrying capacity of the pond has to be estimated and the application of inputs stopped at the determined level. Any sustained input beyond the harvest period would be a loss and cut down the profit of fish farmer.
Suryapokhra is a healthy pond in Gaya district (Bihar). Based on data of seasonal variations, it has been observed to cultivate various types of bony fishes like *Labeo rohita*, *Catla catla* etc.
Methodology: Pond water and Phytoplanktons diversity of the pond have been analysed on regular basis at a particular time. Various physic-chemical parameters are recoded in terms of pH, DO etc.
Results and Conclusion: The condition of fish productivity in general is good; particularly during the winter and pre- monsoon months. The reason is that the food environment is favourable during the pre-monsoon period. The adult fishes are sexually matured. There are deposition of fats in the body. Various ecological conditions also play an important role for increase in the weight of fishes. Pond water is also observed as clear, transparent and less polluted. Abundance of phytoplanktons also provide the improved feeding conditions, as a number of phytoplanktons are observed.

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Keywords: Limnological; phytoplanktons; pond ecosystem; primary production; Suryapokhra.

1. INTRODUCTION

The importance of fisheries and aquaculture sector cannot be overemphasized in the economy of India. A greater percentage of the annual fish production comes from aquaculture practiced in closed-and fresh-water bodies, and the production is increasing day by day. Fish production from closed water bodies is 2 million annually ton. Pond is an important components of closed water aquaculture. Indian major carps, catfish, prawn etc. are mainly cultured in the ponds [1]. Approximately 0.37 Million ha area is under closed water bodies generates fish production in ponds. On the other hand, production from open water capture fisheries does not show such improvement [2].

By definition, the plankton includes all those organisms suspended in the free water. Biological tissues are denser than the water and hence only particles with large surface areas in relation to their volumes and with slow sinking speeds are likely to remain suspended [3]. Most organisms belonging to the planktonic community are small, although their size is variable. Primary producers, primary and secondary consumers and decomposer organisms, are all represented in the plankton, although it is the photosynthetic primary producers which are especially significant in the ecology of many aquatic habitats [4].

Phytoplanktons have been used as a biological parameters for water bodies like ponds and lakes since the late 19th century [5]. It is elaborated and explained by Apstein (1896) and Kolkwitz and Marsson (1902,1908) from Germany. Phytoplanktons contribute good role in forming the food web. So these offer important role in primary production [6]. When water leaves the soil for rivers, ponds lakes and wetlands its new composition has a major effect on the abundance of the biota, its community structure and productivity [7]. The evaporative loss of water not only returns water to the atmosphere but also affects concentration and composition of the remaining water and thus its suitability to the biota, in turn, the water affects the condensation and evaporation of the temperature in the aquatic system and the surrounding land [8].

2. MATERIALS AND METHODS

2.1 Study Area

The experiment was conducted in Suryapokhra pond, Manpur (Gaya) for a period of 12 months from June, 2018 to May, 2019.

2.2 Sample Collection

All of the samplings were done in the morning between 9.00 and 10.00 AM for the estimation of Phytoplankton [9]. Samples were collected from the four different points of the pond. A 500 ml glass jar was used for the collection of 1000 ml water. After collection of water from the surface of ponds. It was concentrated to 90 ml passing through a bolting silk plankton net and then kept in a vial. Then the collected samples were preserved in 10% formalin and transferred to the laboratory as soon as possible for further analyses.

2.3 Phytoplankton Study

Two types of study were done in the laboratory using the collected samples: Qualitatively and quantitatively. A qualitative study gives an idea on the types of phytoplankton present in the experimental ponds; on the other hand, quantitative study estimates the number of various phytoplankton in water of the experimental pond. Finally, primary productivity of the experimental ponds was determined by quantitative study [10]. The formula used for calculation of phytoplankton units, L^{-1} is presented below.

n- (ax1000) C (Welch, 1948)

Where n =No of Plankton per litre of water
A = Average number of Plankton in me of sample
C = No of Plankton concentrate (20 ml)

Identification of the phytoplankton was done up to genera level with the help of standard keys and books (Palmer, 1980), Prescott (1938, 1981a, b), Smith (1950), APHA (1989)

2.4 Quantitative Study

Estimation of Phytoplankton was done with a plankton counting cell named Sedgwick-Rafter cell (SR cell) Phytoplankton was counted by placing the cell under a high power microscope with the projection of 10x15 and the number of Phytoplankton was expressed as Units/L. Identification of phytoplanktons was done using microphotography at Patna University.

The sedgewick Rafter (S-R) counting cell is 55 mm long, 20 mm wide and 1 mm deep, and volume of the chamber is 1 ml, the counting chamber is equally divided into 1000 fields, each of the fields having a capacity of 1 micro liter. One ml from the concentrated volume of the phytoplankton samples

was taken on the S-R cell with a dropper. Then the counting chamber was covered with a cover slip so as to eliminate the air bubbles and left to stand for a few minutes to allow the Phytoplankton settle down. Further analyses were done placing the cell under the microscope.

2.5 Studies on Water Quality Parameters

The water quality parameters namely temperature (°C) – was determined with a celsius thermometer; pH and dissolved oxygen (mg/L) were determined using winklers method fortnightly during the study period.

3. RESULTS AND DISCUSSION

Primary productivity of a pond was mainly indicated by phytoplankton. They are the basic and direct food of fishes [11].

3.1 Quantitative Production of Phytoplankton

The highest abundance of phytoplankton was found in the Suryapokhra although there was no significant differences ($p>0.05$) among the treatments during the study period spatially. The average phytoplankton production during the study period was 1122 units/l.

Maximum production of phytoplankton was 2400 units/1 in March, 2019 while minimum number was 432 units/l recorded in November, 2018 (Table 2 /Graph 1).

Chlorophyceae: It is the most dominant group in all phytoplankton. Maximum 1265 units/l was found in March and minimum 232 units/l was found in Nov.

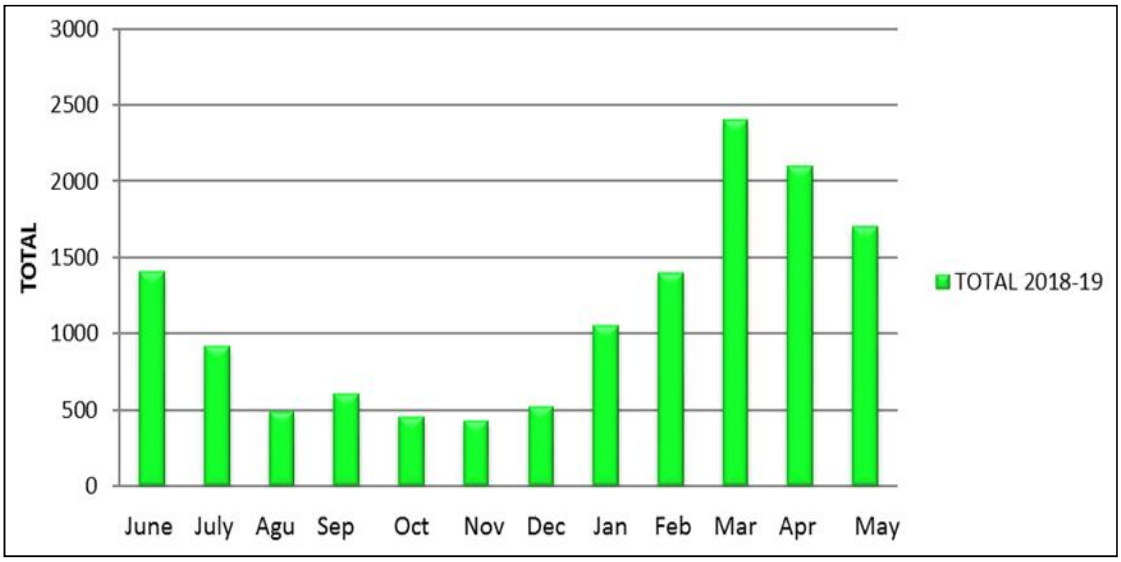
Bacillariophyceae: It is the second dominant group. Under this group, 12 genera were found in the study. Maximum 980 units/l was found in March and minimum 85 units/l was found in November.

Cyanophyceae: It is the third dominant group. Highest production of Cynophyceae was 117 units /l in March whilethe lowest was recorded (21 units/l) in August. (Table 2). Under this group, 10 genera found in the treatments (phytoplanktons analysis at four sampling points) were Anabaenopsis, Chroococcus, Gleocapsa, Gomphopharia, Merismopedia, Nostoc, Oscillatoria, Pleurococcus and Spirulina.

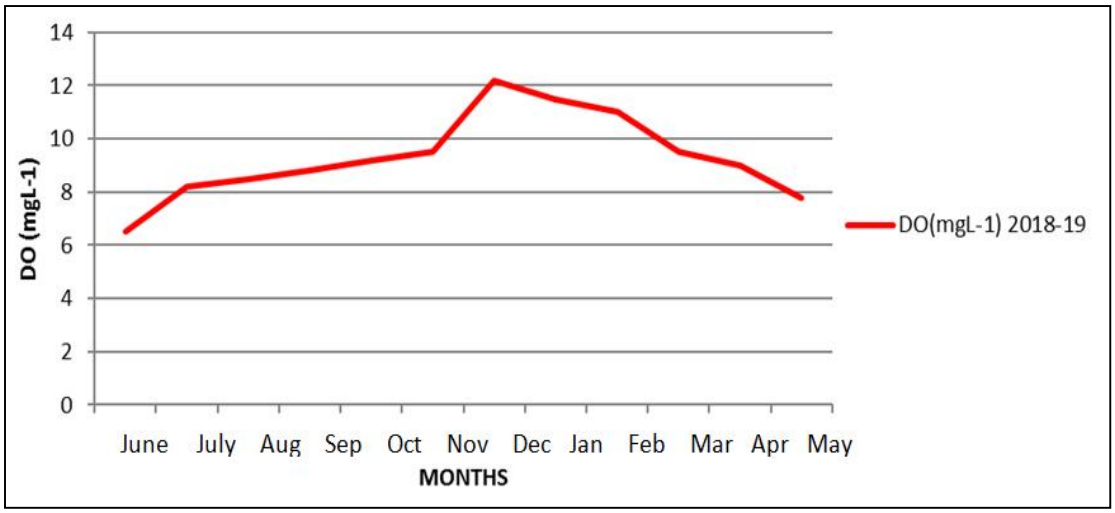
Charophyceae: It is the fourth dominant group.

3.2 Water Quality Parameters

Dissolved oxygen is the most important chemical factor for all aquatic organisms (APHA, 1992). D.O. Varied from 6.5to 12.2 mg/pl and the mean value is 9.3 mg/l and is considered another important chemical factor in fish culture (Graph 2). pH indicates the acidity-alkalinity condition of water body [12]. It is also called the productivity index of a water body. The acidic pH of water reduces the growth rate, metabolic rate and other Physiological activities of fishes [13]. pH values ranging from 7.2 to 8.2 is suitable for pond aquaculture and values more than 9.5 is unsuitable because of unavailability of free CO_2. On the other hand, pH less than 6.5 reduces fish growth, Physiological activities and tolerance to toxic substances [14].



Graph 1. Monthly variations in total phytoplanktons (Unit/L) of Suryapokhra Pond



Graph 2. Monthly variations in the physico-chemical characteristics of suryapokhra pond water (DO)

pH: It is already maintained for a healthy pond condition. The pond water of Suryapokhra was showing an average pH of 8 during the investigation period.

Dissolved Oxygen: DO also shows similar patern of wide fluctuations in different season.

Water Temperature: Water and air temperature are found to be closely interrelated. The water temperature was generally found to be 3-4°C colder than air temperature.

Transparency: There was wide variation in turbidity and transparency in the pond water during different months.

Carbonate & Bicarbonate: Carbonate alkalinity was present during the period of complete absence of free CO_2 only for the reason that CO_2 facilitated the formation of stable bicarbonates and there by checked theformation of carbonate.

3.3 Phytoplankton Production

Phytoplankton populations in Suryapokara pond were found to be consisted of 4 phytoplanktonic groups namely Chlorophyceae, Bacilliariophyceae, Cyano-phyceae and Charophyceae [15]. The most dominant group was Chlorophyceae followed by Cyanophyceae, Bacilliariophyceae and Charophyceae. There were 31 genera identified from the study which belonged to the four groups. The phytoplankton found in the ponds indicate that it can support the production of wide range of biologically important thing. In this study it is clear that there is no statistical difference ($P>0.05$) among the treatments for Phytoplankton groups. Exception is that a significant difference ($P< 0.05$) was found in case of Charophyceae (Table 1).

Chlorophyceae was the most dominant group in all the treatments during the study period. The highest production of Chlorophyceae was 1265 units/1 at final sampling. The lowest was 232 units/l. Various important species under Chlorophyceae were Chlamydomonus, Chlorella and Chlorogonium (Table 2) etc. [16].

Second dominant group was Bacilliariophyceae (Table 3). The highest production of Bacilliariophyceae was 980/1 in March. Cynaophyceae was the 3rd dominant group. 10 genera were found under this group in all the treatments. Anabaenopsis, and Nostoc are two harmful phtoplanktons under Cyanophyceae. However, the most important phytoplankton Spirullina was also available in the pond.as it is rich source of protein. Diurnal variations of phytoplanktons indicate a particular trend which are beneficial for primary production of the pond.

Count of total individual also vary comparing various phytoplanktons (Table 2). Interestingly there are good correlation between various physico-chemical factors. Air and water temperature are closely interrelated [17]. pH and DO is also suitable for fishery as these are observed in better proportion in compare to a polluted pond of Gaya district. DO is correlated in water temperature [18]. In winter season it rises to 12.2 (Table 3).

Graph 1 exhibits monthly variations of phytoplankton. In March '2019 the total phytoplanktons is observed which indicted sutable month for primary productivity. Graph 2 shows seasonal variation of DO.

Table 1. Phytoplanktonic abundance in Suryapokhra Pond during 2018-19

a. Chlorophyceae													
		1 June	**2 July**	**3 Aug.**	**4 Sept.**	**5 Oct.**	**6 Nov.**	**7 Dec.**	**8 Jan.**	**9 Feb.**	**10 Mar.**	**11 Apr.**	**12 May**	**Occur-ance in a year**
1.	Chlamydomonas	+	+	+	+	+	+	+	+	+	+	+	+	12
2.	Botriococcus	+	-	+	+	+	+	+	+	+	+	+	+	11
3.	Tetraspora	+	-	+	+	+	+	+	+	+	+	+	+	11
4.	Lepocinclis	-	+	+	+	+	+	+	+	+	+	+	+	11
5.	Oedogonium	+	+	+	+	+	+	+	+	+	+	+	+	12
6.	Spirogyra	-	+	+	+	+	+	+	+	+	+	+	+	11
7.	Ulothrix	+	+	+	+	+	+	+	+	+	+	+	+	12
8.	Hydrodictyon	-	+	+	+	+	+	+	+	+	+	+	+	11
9.	Palmella	-	+	+	+	+	+	+	+	+	+	+	-	10
10.	Zygnema	-	+	+	+	+	+	+	+	+	+	+	-	10
11.	Cladophora	-	+	-	+	-	-	+	+	+	+	-	-	06
12.	Pediastrum	-	+	+	-	-	-	+	+	+	+	-	-	06
Total Genera in month.		05	10	11	11	10	10	12	12	12	12	10	08	123
b. Cyanophyceae														
		June	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Occur-ance in a year**
1. Agmenellum		-	-	-	-	+	+	+	+	+	+	+	+	08
2. Arthrospira		-	-	-	+	+	+	+	+	+	+	+	+	09
3. Oscillatoria		-	-	-	+	+	+	+	+	+	+	+	+	09
4. Nostoc		-	-	+	+	+	+	+	+	+	+	+	+	10
5. Rivularia		-	+	+	+	+	+	+	+	+	+	+	+	11
6. Microystis		+	+	+	+	+	+	+	+	+	+	+	+	12
7. Anabaena		+	+	+	+	+	+	+	+	+	+	+	+	12
8. Nadularia		+	+	+	+	+	+	+	+	+	-	+	+	11
9. Aphanocapsa		+	+	+	+	+	-	+	+	+	-	+	+	10
Total Genera in month.		04	05	06	08	09	08	09	09	09	07	09	09	92

c. Bacillariophyceae	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Occur-ance in a year
1. Dialoma	+	+	+	+	+	+	+	+	+	+	+	+	12
2. Synedra	+	+	+	+	+	+	+	+	+	+	+	+	12
3. Cymbella	+	+	+	+	+	+	+	+	+	+	+	+	12
4. Nizschia	+	+	+	+	+	+	+	+	+	+	+	+	12
5. Navicula	-	-	+	+	+	+	+	+	+	+	+	+	10
6. Gyrosigma	-	-	-	-	+	+	+	-	+	+	+	-	6
Total Genera in month.	04	04	05	05	06	05	06	06	06	06	06	05	64

d.Charophyceae	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Occur-ance in a year
1. Chara vulgaris	+	+	+	+	+	+	+	+	+	+	+	+	12
2. Zygnema	+	+	+	+	-	-	+	+	+	+	+	+	10
3. Nitella	+	+	+	+	-	-	+	+	+	+	+	+	10
Total Generain month.	03	03	03	03	01	01	03	03	03	03	03	03	32

Table 2. Phytoplanktonic populations in Suryapokhra Pond during 2018-19

	Chlorophyceae		Bacillariophyceae		Cyanophyceae		Charophyceae	
	Total Genera L'	Total 'Individuals L '	Total Genera L'	Total 'Individuals L '	Total Genera L'	Total 'Individuals L '	Total Genera L'	Total 'Individuals L '
June	5	830	4	488	4	67	2	18
July	10	615	4	215	5	70	2	15
Aug.	11	304	5	135	6	21	3	25
Sep.	11	290	5	210	8	93	2	10
Oct.	11	255	5	103	7	86	3	8
Nov.	11	232	5	85	8	103	3	12
Dec.	12	410	5	50	10	44	3	16
Jan.	12	630	5	315	10	77	2	28
Feb.	12	890	5	390	10	68	3	52
Mar.	12	1265	6	980	8	117	3	38
Apr.	11	1220	6	730	9	108	3	42
May	11	1185	5	415	10	67	2	33

Table 3. Monthly variations in the physico-chemical characteristics of Suryapokhra pond water

	2018							2019				
	JUNE	**JULY**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**
Water Depth	4.3	5.5	6.3	6	5.8	5.5	5.3	5	4.7	4.5	4.3	4
Air Temp [°C]	40	35	33	32	28	26	20	18	22	25	36	39
Water Temp [°C]	35	31	29	28	24	22	17	15	18	21	32	35
Transparency [cm]	46	45	43	42	53	48	46	45	43	50	52	53
pH	7.8	7.6	8.3	8.2	8	7.9	8.1	7.8	7.7	8.2	8.1	7.2
DO (mgL^{-1})	6.5	8.2	8.5	8.8	9.2	9.5	12.2	11.5	11	9.5	9	7.8
Carbonate (mgL^{-1})	40.12	25.3	25.6	32	28.5	35.3	28.9	32.6	33	32	40.5	42.5
Bicarbonate (mgL^{-1})	120	125	123	105	109	115	133	120	130	139	145	122

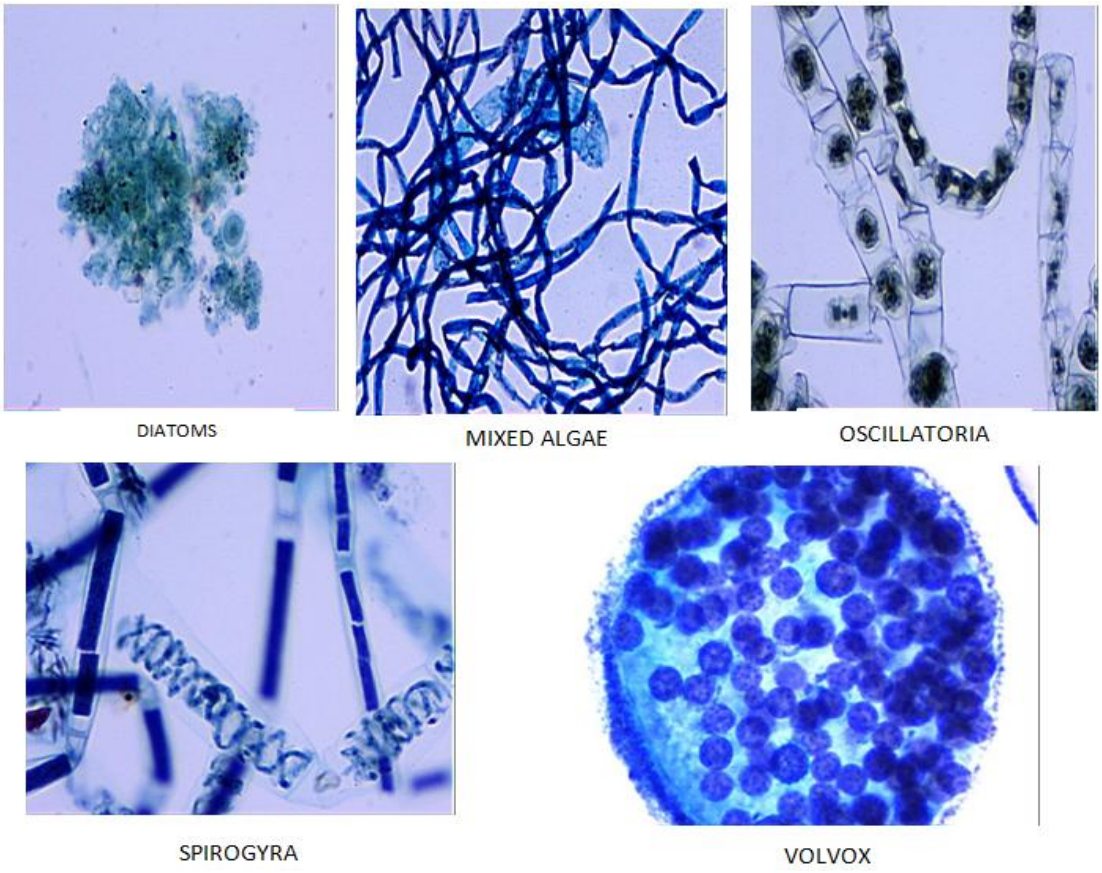


Plate 1. Picture of some phytoplanktons in Suryapokhra Pond (Microphologragh)

Plate 2. Aerial view of suryapokhra pond water

Source: All data including microphotography, tables and graphs are collected and analysed by self at A.N. College Patna and Patna University

4. CONCLUSIONS

Four groups of algal classes of the pond Suryapokhra (Manpur, Gaya) namely Chlorophyceae, Cyanophyceae, Bacillariophyceae and Charophyceae were identified. Phytoplanktons are important parameters to get the primary production of the pond [19]. It is essential to study the primary productivity to predict fish yield and also determining the total carrying capacity of the pond [20]. By studying the primary productivity we can also estimate the quantum and spacing of supplementary feeding, measures for correcting the physico-chemical characteristics of water, fixing the species composition to be stocked [21]. The study to Primary productivity will also determine to save the wastage of biomass and to cut down the wastage and enhance the profit of fish farmer. Fish yield of a water body can be increased by the introduction of fish with a particular food [22]. Fish yield can be raised by the primary production through introducing preferred plankton of the fish species. The measurement of primary productivity of pond is done to prescribe stocking of fingerlings of economic species by taking consideration of hydrobiological characteristics of the pond.

Suryapokhra pond shows the suitable environment to cultivate various types of bony fishes. Based on data and seasonal variation, the pond offers good aquaculture practices.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Dixit AK, Pandey SK, Mehta R, Niyaz A, Gunjan, Pandey J. Study of physico-chemical parameters of different pond water of Bilaspur District, Chhattishgarh, India. Environ. Skeptics Crit. 2015;4(3):89-95.
2. Barrington K, Chopin T, Robinson S. Integrated multi trophic aquaculture (IMTA) in marine temperature water in: Soto D (Editor), integrated Mariculture. A Global Review. FAO fisheries and Aquaculture Technical paper. No. 529. Rome, FAO. 2009;7-46.
3. Gaarder T, Gran HH. Investigations of the production of planktons in Oslo Fjord J. Cons. Perm. Int. Exploc. Mer. 1927;42:1-48.
4. Monirizzaman Khondker, Md Ahsan Kabir. Phytoplankton primary production in a mesotrophic pond in subtropical Bangladesh, Hydrobilogia. 1995;304(1):39-47.
5. Kensa MV. Interrelationship between physic-chemical parameters and phytoplankton diversity of two perennial ponds of Kulasekharam area, Kanyakumari district, Tamil Nadu. Plant Science Feed. 2011;1(8):147-154.
6. Ahmad SH, Singh AK. Energy flow through primary production to fish yield in a tank at Patna (Bihar), India. J. Hydrobiol. 1989;IPP:55-57.
7. Chandrakiran. Impact of sediment characteristics on the benthic communities of Lake Mansar. Ph.D Thesis, University of Jammu, Jammu; 2011.
8. Khare SL, Paul SR, Dubey A. A study of water quality of Khomph – Niwau Lake at Chhatarpur, M.P. Nat. Env. and Poll. Tech. 2007;6(3):539-540.
9. APHA, AWWA and WPCF. Standard methods for the examination of water on waste water. American Public Health Association. American Water Works Association and Water Control Federation 22nd Edition. American Public Health Association. Washington, D.C; 2012.
10. Marra J. In : Williams PJ. leb, Thomas, D.N, Reynolds, C.S (Eds.), Phytoplankton Productivity : Carbon Assimilation in Marine and Freshwater Ecosystems, Blackwell, Oxford, UK. 2002;78–108.
11. Sarvesh Kumar BK, Sharma B. Upadhyay. Primary productivity. International Journal of Fauna and Biological studies, ISSN No.2347-2677 UFBS. 2015;2(5):09.12.
12. Anhwange BA, Agbaji EB, Gimba EC. Impact assessment of human activities and seasonal variation on River Benue, within Makurdi Meropolis. International Journal of Science and Technology: Standard methods for Examination of Water and Waste Water, 16th Ed. American Public Health Association, Washington D.C. 2012;2(5).
13. Azmi N, Rauf AM, Mahalaxmi K. Water quality analysis of fish pond of Araria district, Bihar. Ind. J. Appl Res. 2015;5(1): 587–589.
14. Sinha B. Kumar, Singh T. Water quality assessment of two ponds of Samastipur district (India). Int. J. Environ. Sci. 2014;4:567–574.
15. Natrajan AV, Palchak. Bio energetic approach to the productivity of the man made lakes. J. India Fish Soc. India. 1980;12(i):1-13.
16. Rahman MA. Comparative study on plankton community between gonia monoculture and carp polyculture in pond. MS thesis, Department of Agriculture, Bangladesh Agri-culture University, Mymensingh, Bangladesh; 2004.

17. Saroj M, Dilip B. Assessment of physico-chemical characteristics of the soil of Nagchoon pond Khandwa,MP India; 2014.
18. Nag AK, Singh B, Ghosh K. Studies related to physicochemical characteristics of water of Surya kund-a religious pond located in Gaya town of Bihar, India. Ultra Chem. 2014;10(2): 109–116.
19. Dogipatri A, Chakravarty MS. Study on distribution and diversity of phytoplankton in relation to physic-chemical parameters in Bhavanapadu creek, Andhrapradesh, India. International Journal of Basics and Applied Sciences; 2013.
20. Soni V, Khwaja S, Visavadia M. Pre-impoundmental studies on water quality of Narmada river of India. Int. Res J. Environ. Sci. 2013;6(2):31–38.
21. Jemi JR, Bala Singh GSR. Studies on physic-chemical characteristics of Freshwater temple ponds in Kanyakumari district (South Tamil Nadu). International Journal of Geology, Earth and Environmental Sciences. 2011;1(1):59-62.
22. Bangotra K. Diversity of macrobenthic invertebrates assosicated with Macrophytes in lotic and lentic water bodies of Jammu. M. Phil Dissertation, University of Jammu, Jammu; 2012.