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Seasonal Estimation in Primary Productivity of Akilpur Lake in Dighwara, Saran (Bihar)

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ABSTRACT

The phytoplankton primary productivity forms the basis of the ecosystem functioning as it makes the chemical energy and organic matter available to the entire biological community. The primary productivity and its regulating factors were studied in Rasalpura pod during April 2019 to March 2021. Primary productivity of the pond was analyzed by light and dark bottle method introduced by Gardner and Grant (1927).

The seasonal variation in primary productivity showed an increasing trend from 1.22±0.81 mg/l/hr then 1.99±0.65 mg/l/hr to 2.48±0.98 mg/l/hr in the monsoon, winter and summer season respectively. Investigation confirms the several variations do markedly affect pond productivity. The higher value of GPP and NPP during the summer season was due to penetration of more light intensity, suitable temperature, phytoplankton abundance which favors higher rate of photosynthesis and ultimately the pond productivity. The P/R ratio is an excellent functional index of the relative maturity of the system. The P/R ratio was highest during winter and lowest during summer season. The P/R≥1 value was observed during winter. During the monsoon, this ratio≤1 which could be on account less penetration of light into the water due to increased sediments resulting in lesser photosynthetic activity and thereby increase in productivity. Standing stock of phytoplankton is related to productivity which justifies its use as an index. Phytoplankton community and gross production showed significant relation at the sampling sites.

Keywords: Light intensity, Phytoplankton, Primary productivity, Rasalpura Pond.

INTRODUCTION

The flow of energy through any ecosystem starts with the fixation of sunlight by plants and other autotrophic organisms. In this way the plants accumulate which is called primary production. The rate at which this energy accumulates is called primary productivity. The total energy accumulated is gross primary production; however, since plants use some of this energy themselves, it is not available for the food web (Mitsch and Gosselink, 1993). Estimation of primary productivity is essential to understand food chain and food web (Chinnaiah and Madhu, 2010), water quality (Wetzel, 2000) and pollution study (Prabhakar et *al*, 2009).

The primary productivity of the aquatic ecosystem is adversely affected by anthropogenic activity. The overall productivity of a water body can easily be deduced from its primary productivity, which forms the backbone of the aquatic food chain (Ahmed and Singh, 1989). It gives information related to support bioactivities of the system. According to Odum and Barrett (Odum, 2008) the primary productivity of an ecosystem is the rate at which radiant energy is converted to organic substances by the photosynthetic and chemosynthetic activity of the producer organisms. The aquatic resources have been till date the potential source of organic production for the entire living organisms. Many ecologists of the world have laid

emphasis on the importance of the primary productivity as an important functional attribute of the biosphere because of its controlling effects on the rate of multiplication and growth of the living organisms of the ecosystem. Primary productivity of aquatic ecosystem has been measured by several workers (Chinnaiah and Madhu, 2010; Joseph and Shanthi, 2010; Vasanthkumar and Kumar, 2011). The present study has been undertaken to analyze the seasonal variations of Primary productivity in the Akilpur lake, Dighwara, Saran (Bihar).

METHODS AND MATERIALS

The primary productivity is determined by using standard "light and dark bottle" method (Gardner and Gran, 1927) at an interval of 15 days in every month for a period of two years from April 2019 to March 2021. The method of Gardner and Gran (1927) is slightly modified by Vollenweider (1974) and Wetzel (2000) to make it more suitable. The time of exposure (incubation period) in the present study was for the period of 2 hours. The dissolved oxygen is estimated by initial bottle and light and dark bottle method of Winkler (Wetzel, 2000). The observed Gross Primary Productivity (GPP), Net Primary Productivity (NPP) and Community Respiration (CR) in mg/l/hr were converted into gC/m**3**/hr by multiplying these values with a factor of 0.375 as suggested by Benton and Werner (1972).

The Gross Primary Productivity (GPP), Net Primary Productivity (NPE) and Community Respiration (CR) were estimated as Westlake (1963), while NPE and Respiration (% of GPP) were calculated as Chattopadhyay and Banerjee (2008) formulations with the help of GPP, NPP and CR. Net production efficiency (NPE): (%) = NPP × 100/ GPP

Respiration (% of GPP): % = CR × 100/ GPP

RESULTS AND OBSERVATIONS

The different productive parameters like GPP, NPP, CR, NPE and RESP of Akilpur Lake has been calculated during April 2019 to March 2021 is depicted in Table 1.

Table 1: Seasonal Primary Productivity of Akilpur lake during April 2019 to March 2021.

Seasonal parameters	Winter	Summer	Monsoon
GPP (gC/m^3/hr)	2.60±1.00	2.23±0.82	1.49±0.74
NPP (gC/m3/hr)	2.48±0.98	1.99±0.65	1.42±0.81
CR (gC/m3/hr)	0.24±0.13	0.43±0.18	0.27±0.13
NPE (%)	95.74±0.54	89.26±4.22	95.30±2.41
RESP (% of GPP)	3.15±0.90	3.39±1.42	1.83±0.74

Abbreviations: GPP= Gross Primary Productivity, NPP= Net Primary Productivity, CR= Community Respiration, NPE= Net Production Efficiency, RESP = Respiration.

The Gross Primary Productivity (GPP) OF Akilpur lake showed low in monsoon (1.29±0.74), moderate in summer (2.23±0.82) and high in winter season (2.60±1.00), while Net Primary Productivity corresponds also similar pattern as low in monsoon (1.22±0.81), moderate in summer (1.99±0.65) and high in winter season (2.48±0.98) during the study period.

The Community Respiration of Akilpur lake showed low in winter (0.14±0.13), moderate in monsoon (0.17±0.13) and high in summer (0.33±0.18), while Net Primary Efficiency was low in summer (89.26±5.22) and somewhat similar value in monsoon (95.30±2.41) and winter (95.74±0.54). The Net Primary Efficiency was given in percentage that may utilize in assimilation of different metabolites in this freshwater ecosystem. The RESP is percentage of GPP which showed low in monsoon (0.83±0.73) and somewhat similar in winter (2.15±1.95) and summer (2.39±2.42) during this research period.

DISCUSSION

The Gross primary productivity is the total rate of photosynthesis including the organic matter utilizes in respiration during the period of measurement. This is also known as total photosynthesis or total assimilation, while Net primary productivity is the rate of storage of organic matter in plant tissues in the excess of the respiratory use by the plants during the measurement period. This is also called as apparent photosynthesis or net assimilation.

Seasonal record of gross and net primary productivity is minimized in monsoon at this lake. Mitsch and Gosselink (1993) stated that the trend of fluctuations shows that the values of gross and net primary productivity increased gradually during winter and summer and decreased during monsoon. The highest rate of productivity during the summer may be due to bright sunshine with high temperature, high phytoplankton density and algal blooms. The low in monsoon could be attributed to the reduced photoperiod coupled with low light intensity, temperature and reduced phytoplankton. These authors also reported high primary productivity during summer season due to high light penetration while low productivity during monsoon season because of the influx of the turbid water to the reservoir. Prabhakar et *al* (2009) reported that the primary productivity higher in winter and lower in monsoon season from Khadakwasla reservoir of Pune. Clear water surface, which permitted more light to penetrate and water flow perhaps accounted for the higher values of primary productivity during winter. Addition of nutrients with runoff water during monsoon rain and later clarity of water during this season are responsible for high primary productivity during winter.

Lower values are observed during monsoon might be due to increased turbidity and suspended slit content of water resulting from soil erosion from surrounding hills. Radwan AM (2005) from Nainital and Bhimtal lakes of Kumaon Himalaya of Uttarakhand state reported that a lake having a dense population of plankton indicating higher productivity and less plankton concentration showed low productivity. Akilpur lake has rich population of planktons, high nutrient load dues to inflow of sewage, human activities, brick factories, excessive algal growth and macrophytes resulting in high productivity during winter and summer season. Hence, high productivity indicated pollution in this lake also as reported by Anjinappa (2002) and Das (2002) in a similar study.

The Community respiration means deducting the net primary productivity from gross primary productivity and converted into CO_2 release. Seasonal values of community respiration were minimum in monsoon, but maximum in winter. Shallow lake water leads to a rapid change in the productivity with the change in Physico-chemical conditions of water. The high respiration of all living organisms and non-living organic matter reduce the dissolved oxygen content (Prabhakar et *al* (2009). This observation supports the present study as values of dissolved oxygen content were found lower during the summer season in this lake.

According to Prabhakar et al (2009), the rate of respiration attain highest values in summer due to the effect of drainage water discharged from the different drains around the station. These effluents enhance the biological activities of bacteria, especially in summer due to the decomposition of organic matter. Similar findings are observed in present study for Akilpur lake lake because this lake receives domestic sewage from surrounding village and other human activities responsible for higher community respiration and also low count of phytoplanktons and high density of zooplanktons might be responsible for high values of community respiration. Radwan (2005) reported maximum primary productivity for Lake Burulus of Egypt in summer season and lower in winter and monsoon season.

The Net Production Efficiency is the ratios measure the efficiency with which an organism converts assimilated energy into primary or secondary production. Net production efficiency was minimum in summer and higher in winter season. Chattopadhyay and Banerjee (2008) reported seasonal records of Net Production Efficiency to be maximum in monsoon and minimum in winter season for Krishnasayar Lake at Burdwan. Chinnaiah and Madhu (2010) reported that Net Production Efficiency was higher in monsoon and summer and lower in winter season for Darmasagar Lake in Adilabad. Such findings showed inverse relationship to present study on Akilpur lake.

The respiration was minimum in monsoon, whereas somewhat similar in summer and winter season in this lake. Chinnaiah and Madhu (2010) reported that respiration was higher in winter and summer and lower in monsoon season for Darmasagar Lake in Adilabad supporting the present study.

High productivity has close relationships with the degree of pollution which is mainly caused by high amounts of nutrients from sewage, fertilizer, animal wastes, detergents and run-off nitrates from catchment areas which enter the lakes and result in excessive growth or bloom of microorganism and aquatic vegetation. Thus, the nutrients stimulate algal growth and lead to plankton blooms. The productivity of water which body greatly depends on the amount of available dissolved nutrients in water is directly controlled by nutrient cycling in the area. High nutrient content causes pollution.

CONCLUSION

It is observed from above results that most of the seasonal values of primary productivity of were higher than reference in this lake, and, hence it is concluded that the productivity is high and so food chain and food web is in good condition and it favors better growth of zooplanktons and fishes. It also indicates water body is polluted and leads towards pollution. Rich productivity of this lake may be due to shallowness of area which is more productive than deep lakes in part due to nutrients regulating from sediments and extent of attached macrophyte growth.

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