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PRODUCTIVITY STATUS OF POLLUTED AQUATIC SYSTEMS IN WARANGAL,ANDHRA PRADESH

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Four aquatic bodies in Warangal situated near the industries namely, Ajam Jahi Mills, Unicorn Organics Limited, Nirup Synchrome dye Industries and Leather industry were severely contaminated with industrial effluents. To assess the status of these polluted water bodies, the productivity and respiration were used as monitoring systems. The maximum GPP was recorded during winter months. The NPP levels were towards negative side. The respiration levels ranged between 0.30 to 1.20 g/m^3/day which indicates the heterotrophic nature. The data obtained is compared with unpolluted control pond situated in Kakatiya University and assessed the pollution loads in Warangal. .

Keywords : Gross Primary Productivity (GPP); Net Primary Productivity (NPP); Polluted systems; Respiratory Consumption (RC).

Introduction

Productivity is the characteristic feature of the fresh water communities that has become very important in modern ecological research. Primary productivity is the rate at which sun's radiant energy is stored by photosynthetic and chemosynthetic activity of producers in the form of organic substances. It is of two types : (i) Gross Primary Productivity (GPP) and (ii) Net Primary Productivity (NPP). A part of the GPP is used in respiration while the remaining portion accumulated and used in the growth and development and is called NPP.

The primary productivity is an important biological phenomenon in nature on which the entire diverse array depends directly or indirectly. It provides an assessment about the exact nature of ecosystems, its tropic level and availability of energy for secondary producers.

In Indian conditions, discharging of industrial effluents into the near by water bodies, is a very common practice. These effluents contain heavy metals, toxic substances and organic pollutants which are quite hazardous and can deplete the dissolved oxygen content of the water and effect aquatic biota and their community structure. Pollution load in any water body may be assessed by physico-chemical analysis and productivity studies[1-3].

Sudhira and Kumar[4] monitored the lake water quality by determining the densities of phytoplankton and their subsequent degradation with seasonal variations. Garg and Garg[5] developed many metal strategies of water quality by applying biological parameters with special reference to the gross and the primary production in aquatic systems. Saha[6], Samal and Mazumdar[7] estimated the GPP, NPP and community respiration in Gobindgarh lake and Rabindra Sarovar and related its pollution status. They further added the values of GPP, NPP and CR decreased drastically with increased pollutants. Influence of environmental factors on productivity status of polluted aquatic bodies clearly indicated the heterotrophic nature of the aquatic bodies and trends towards eutrophication[8] and Somanath and Saha[9] analyze the spatial variation in primary productivity of river Damodhar.

Material and Method

The productivity (GPP, NPP and RC) levels in different polluted aquatic bodies i.e., Ajam jahi Mills, Unicorn Organics Limited, Nirup Synchrome Dye Industry, Leather industry and in the pond situated in Kakatiya University (control pond) was estimated by Gaarder and Gran[10] Light and Dark method.

The water samples were collected with monthly intervals in a clean sterilized BOD bottles and immediately the dissolved oxygen was measured in Di bottle by using Winkler's method. In other two bottles i.e., Dl bottle was kept in diffused sunlight and Dd bottle was kept in dark for six hours of incubation. After the incubation period, the DO levels in these two bottles were determined for the analysis of GPP, NPP and RC, where

Gross Primary Productivity =

$$(g/cm^3/d) = \frac{Dl - Dd}{h} \times \frac{0.375}{PQ}$$

Net Primary Productivity =

$$(g/cm^3/d) = \frac{Dl - Di}{h} \times \frac{0.375}{PQ}$$

Community Respiration =

$$(g/cm^3/d) = \frac{Di - Dd}{h} \times \frac{0.375}{PQ} \times RQ$$

where

Di - Dissolved oxygen (DO) in initial bottle (mg/l)
Dl – DO in light bottle in mg/l
Dd – DO in dark bottle in mg/l
h - Duration exposure in hours
PQ – Photosynthetic quotient (1.0)
RQ – Respiratory quotient (1.0)
0.375 - Factor (ratio of molecular weight of carbon and oxygen) – used for conversion of production value to carbon value and expressed in g/cm^3/day.

The periodic observations on the productivity of ponds situated near Azam Jahi Mills, Unicorn Organics Limited, Nirup Synchrome Dye Industries, Leather Industry and Kakatiya University campus during 2004-2005 were under taken to establish pollution status and presented in Tables 1-5.

Results and Discussion

Primary productivity of polluted pond near Azam Jahi Textile Mills - The maximum GPP was recorded in the month of August and January (0.45g/m^3/day) but was absent in March (Table 1). It was observed that NPP was completely absent in this pond water except in the month of May (0.30 g/m^3/day). The annual mean average of GPP was 0.22 g/m^3/day. There is a 50% reduction in the mean average value of GPP, which indicates the remarkable increase in the pollution load in the pond waters. The annual mean average of community respiration was 0.59 g/m^3/day. The respiratory consumption was maximum 1.20 g/m^3/day in the month of September. Saha and Pandit[11] and Vargheese[12] also observed higher values of community respiration in eutrophic lakes. Agarwal *et al.*[13] investigated the impact of sewage containing domestic water and varied concentration of heavy metals on the productivity status of lentic waters. Shukla and Powar[14] studied the primary productivity of Gobindgarh lake. Roy *et al.*[15] in his findings reported an alarm for sustenance of aquatic body by cement embankment. Similarly, studies on primary productivity of sulphur pond of Coimbature was analysed[16].

Productivity in the pond near Unicorn Organic Limited- The GPP was maximum in the month of October (0.75 g/m^3/day) and minimum in May and June (0.03 g/m^3/day) (Table 2). There was no change in GPP values from July to September (0.60 g/m^3/day). Singh[2] while studying the primary production observed maximum GPP during summer and minimum during winter and the annual mean average GPP was 0.29 g/m^3/day. The NPP values were absent in majority of the months but could be detected in the months of April (0.15 g/m^3/day). In all the remaining months, the NPP values were on the negative side. Higher values of community respiration were observed during summer months. Maximum values of community respiration were noticed during rainy season (1.20 g/m^3/d) and minimum (0.04 g/m^3/d) during summer months. The respiratory consumption varied between 0.04 (January) to 1.20 g/m^3/d (August to October).

Productivity in the pond near Nirup synchrome Dye Industry-The gross primary productivity in the pond near Nirup synchrome dye industry ranged from 0.00 to 0.60 g/m^3/day with its maximum value in summer months (Table 3) and the mean value of GPP was 0.28 g/m^3/day. The NPP values were on the negative side and explained the extent of pollution load. The repiratory consumption varied between 0.15 g/m^3/day (September) to 1.20 g/m^3/day (July and December) with an annual mean average of 0.61 g/m^3/day. The higher average values of respiration as percentage of GPP and NPP in the pond may be due to comparatively higher microbial populations. Hickman[17], Saha and Pandit[11] noticed a similar trend in the ratios between the productivity and respiration. Windrop *et al.*[18] studied the temperature and wet land plant species effect on waste water treatment and root oxidation.

Productivity in the pond near leather industry- The annual mean average of GPP was 0.25 g/m^3/day (Table 4). The reduction in the mean average indicates the increase in degree of pollution which directly affect the productivity of the pond. Maximum GPP was 1.20 g/m^3/day (May) and minimum was 0.15 g/m^3/day (January and April). Total absence of GPP was recorded in the month of March, while the NPP values were absent in almost all the months except September (0.30 g/m^3/day).

The minimum and maximum community respiration was 0.10 g/m^3/d and 2.55 g/m^3/d in the months of March and May respectively. Similar to the present observations Verma *et al.*[19] and Mathew[20,21] showed smaller differences in the productivity values in winter and summer months while, rainy season exhibited low

Table 1. Primary productivity of polluted pond near Azam Jahi Textile mills (g/m³/day).

Month	GPP	NPP	RC
July – 2004	0.30	-0.45	0.75
August	0.45	-0.60	1.05
September	0.15	-1.05	1.20
October	0.15	-1.05	0.30
November	0.30	-0.45	0.75
December	0.15	-0.15	0.30
January – 2005	0.45	-0.60	1.05
February	0.15	-0.30	0.45
March	0.00	0.00	0.30
April	0.07	0.00	0.07
May	0.30	+0.30	0.60
June	0.16	-0.18	0.34
M.V.	0.22	-0.02	0.59
S.D.	0.13	0.08	0.34
S.E.	± 0.03	± 0.02	± 0.10

GPP = Gross primary productivity; NPP = Net primary productivity;
RC = Respiratory consumption

Table 2. Primary productivity of polluted pond near Unicorn organics limited (g/m³/day).

Month	GPP	NPP	RC
July – 2004	0.60	-0.45	1.05
August	0.60	-0.60	1.20
September	0.60	-0.60	1.20
October	0.75	-0.45	1.20
November	0.15	-0.15	0.30
December	0.15	-0.30	0.45
January – 2005	0.04	0.00	0.04
February	0.15	-0.30	0.45
March	0.07	0.00	0.07
April	0.37	+0.15	0.22
May	0.03	-0.12	0.15
June	0.03	-0.15	0.18
M.V.	0.29	0.01	0.54
S.D.	0.25	0.04	0.45
S.E.	± 0.07	± 0.01	± 0.13

GPP= Gross primary productivity; NPP = Net primary productivity;
RC = Respiratory consumption

Table 3. Primary productivity of polluted pond near Nirup synchrome dye industry (g/m³/day).

Month	GPP	NPP	RC
July – 2004	0.60	-0.60	1.20
August	0.00	0.00	0.30
September	0.00	0.00	0.15
October	0.15	-0.60	0.45
November	0.30	-0.15	0.45
December	0.45	-0.75	1.20
January – 2005	0.45	-0.30	0.75
February	0.15	-0.15	0.30
March	0.45	-0.15	0.30
April	0.30	-0.60	0.90
May	0.60	-0.45	1.05
June	0.00	0.00	0.30
M.V.	0.28	0.01	0.61
S.D.	0.21	0.04	0.36
S.E.	± 0.06	± 0.01	± 0.10

GPP= Gross primary productivity; NPP = Net primary productivity;
RC = Respiratory consumption

Table 4. Primary productivity of polluted pond near Leather Industry (g/m³/day).

Month	GPP	NPP	RC
July – 2004	0.15	-0.15	0.30
August	0.30	-0.15	0.45
September	0.15	+0.30	0.45
October	0.15	-0.30	0.45
November	0.45	-0.75	1.20
December	0.00	0.00	0.60
January – 2005	0.15	-1.05	1.20
February	0.30	-1.20	1.50
March	0.00	0.00	0.10
April	0.15	-0.15	0.30
May	1.20	-1.35	2.55
June	0.00	0.00	0.30
M.V.	0.25	0.02	0.70
S.D.	1.32	0.08	0.67
S.E.	± 0.38	± 0.02	± 0.19

GPP= Gross primary productivity; NPP = Net primary productivity;
RC = Respiratory consumption

Table 5. Primary productivity of pond near Kakatiya University (g/m³/day) (Control).

Month	GPP	NPP	RC
July – 2004	0.45	0.00	0.45
August	0.30	-0.30	0.60
September	0.45	-0.60	4.05
October	0.30	-0.30	0.60
November	0.00	-0.15	0.15
December	0.30	-0.60	0.90
January – 2005	0.00	0.00	0.15
February	0.30	-1.20	0.15
March	0.15	-0.15	0.30
April	0.75	+0.45	0.30
May	0.02	-0.15	0.22
June	0.22	-0.15	0.37
M.V.	0.27	0.03	0.68
S.D.	0.20	0.12	1.03
S.E.	± 0.05	± 0.03	± 0.29

GPP= Gross primary productivity; NPP = Net primary productivity;
RC = Respiratory consumption

value.

Productivity of a pond in Kakatiya University campus- The GPP varied between 0.02 g/m³/day (May) to 0.75 g/m³/day (April) while in January no productivity values were observed (Table 5). Siddiqui[22] recorded high gross primary production values from March to May. The NPP values were negative or nil-during the study period with the exception of 0.45 g/m³/day in April. Yadava *et al.*[23], Valecha and Bhatnagar[24] also recorded the nil NPP values and indicated the physiological state of phytoplankton arising due to nutrient deficiency. The variation in community respiration was in between 0.15 g/m³/day (January and February) to 4.05 g/m³/day (September) with a mean value of 0.68 g/m/d. Enujiugha and Nwanma[25] used the concepts of primary productivity as an indicator for aquatic oil pollution. Nutrient overloading of fresh water lake was studied[26].

Thus, the data presented in the paper explains the pollution status of the aquatic bodies in Warangal and to develop the reclamation, protection and conservation strategies.

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