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Study of Primary Productivity of a Fresh Water Pond of Great Indian Desert "Thar"

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ABSTRACT
Water is a key feature in universe. Primary productivity gives information related the amount of energy available to support bioactivities of a system. The productivity of a small desert pond Sansolav was studied by the light-and-dark bottle method and by following the natural changes in carbon dioxide and oxygen.

Introduction

The flow of energy through any ecosystem starts with the fixation of sunlight from plants and other autotrophic organisms. Limnological investigations on water bodies were generally aimed to assess the water quality and its interaction with biotic and abiotic factors. The role of water in nature is unique not only from the point of human consideration; even the numerous organisms make aquatic medium their habitat. Rajasthan is the largest state of India. The North West part of the state is comes in the Thar Desert. In the adverse conditions of desert water is the most important factor for existence of life. The physical and chemical properties of freshwater bodies are characterized by the climatic, geochemical, geo-morphological, biological and pollution conditions. The quality of aquatic life depends on the water quality; all heterotrophic life, directly or indirectly depends for its requirements upon autotrophs that have unique capacity to trap the radiant energy of sun and transform it into high potential. Primary production is most important biological phenomenon in nature on which the entire diverse array of life depends, either directly or indirectly. During photosynthesis cells utilize solar radiation energy to combine water and carbon dioxide into organic compounds (e.g. as carbohydrates) with the release of oxygen to the atmosphere. The present study was carried out at a desert water pond "Sansolav" It is situated 5 km west to Bikaner city. This pond is partly natural and partly artificial. Primary production is the basis of the entire metabolic activity in natural aquatic habitat. Primary productivity can be defined as the weight of new organic matter created through carbon assimilation by plants. Primary productivity is the rate of which the sun`s radiant energy is stored by photosynthetic and chemosynthetic activities of the producers (phytoplankton, algae and macrophytes) in water in the form of organic substances[1]. Oxygen is vital to life. The concentration of oxygen in water can be affected by many physical chemical and biological factors; respiration by plants and animals reduces oxygen concentration, while the photosynthetic activity of plants increases it. The rate of assimilation of carbon in water depends on the type and quantity of plants within the water. Primary productivity is the measure of this rate of carbon assimilation. The production of organic matter is carried out in water, as elsewhere, by plants through the familiar process of photosynthesis. In photosynthesis carbondioxide is reduced to organic carbon with the e^- (electron) ion of free oxygen, the reaction utilizing the energy of solar radiation. Physiologists found early in their investigations of this process that the volume of oxygen liberated very nearly approximates the volume of CO_2 assimilated. These early workers reached the conclusion, still widely upheld, that the primary if not the sole product of photosynthesis is carbohydrate in nature.

Materials & methods

3 BOD bottles (300ml) out of which two are kept transparent and one is blackened from outside by covering carbon paper were used for the assessment of primary productivity of pond. Laboratory glassware like pipettes, burette, flasks, beakers, etc and reagents Winkler's-A, Winkler's-B, concentrated H_2SO_4, freshly prepared starch indicator, sodium thiosulphate solution and other equipment float, rope etc were used. Primary production of the water body determined by light and dark bottle method[2&3]. The sampling of water for primary productivity is same as for dissolved oxygen. To measure the primary productivity water samples were collected from Sansolav pond using BOD bottles. Three BOD bottles (2 light and 1 dark) were used for this process. One BOD bottle used for estimate initial DO one BOD bottle filled with pond water and the oxygen content was determined by using Winkler's method. Second bottle (light bottle) was filled with pond water and incubated into the pond. Third bottle (dark bottle) was covered by black carbon paper and it also filled with pond water and incubated into the pond. The incubation time was three hours. DO (dissolved oxygen) in 2^{nd} & 3^{rd} was calculated by following

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standard methods[3,4&5] and by applying values of DO and time the gross primary productivity (G.P.P.) and net primary productivity (N.P.P.) were calculated.

Results & discussion

In the present study primary productivity of Sansolav pond has been calculated. Total fifteen months study was carried out for the assessment of primary productivity (Gross primary productivity and Net primary productivity) from September 2012 to November 2013 is shown in Table 1. Net Primary Productivity ($gC/m^3/hr$) recorded at water body was maximum 0.3548 in the month of September 2013 and minimum 0.1014 in the months of November 2012, March 2013, April 2013, June 2013. The average value of net primary productivity of the fifteen months recorded was 0.2085. Gross primary productivity ($gC/m^3/hr$) recorded at water body was maximum 0.6081 in the month of October 2013 and minimum 0.2034 in the months of November 2012 and April 2013. The average value of gross primary productivity of fifteen months was 0.3657 recorded. 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. 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. Total recorded (gross and net) primary productivity were minimum in April month whereas these were maximum in October 2013. The highest rate of productivity in month October 2013 may be due to full of food supplement for phytoplankton, high phytoplankton density and algal blooms and the low values in April could be lack of water amount (little water present) high temperature, high evaporation rate and reduced number of phytoplankton. High primary productivity reported during post monsoon period may be the reason was high light penetration and good availability of water while low productivity were noted during pre monsoon period because of the scarcity of water and high temperature. During post monsoon period clarity and good availability of water were responsible for high primary productivity. The primary productivity higher in post monsoon due to large water amount in water body which permitted more light to penetrate and perhaps accounted for the higher values of primary productivity and Clear water surface and lower values were observed in pre monsoon might be due to increased temperature and loss of large amount of water from water source. Plankton density, nutrient status, high nutrient load due to inflow of sewage, human activities, and faunal activities are responsible for high value of primary productivity. Primary productivity of fifteen water bodies in desert region were assessed and reported that physiographic of the region influences primary productivity[6]. While studying primary productivity in upper Lake of Bhopal reported[7] that for the assessment of biological activity of a reservoir evaluation of its primary production is also necessary. Oligotrophic lakes have low primary productivity[8]. Gross primary productivity is a better indicator of trophic status rather than net primary prodectivity[9]. Net primary productivity fluctuated from 0.025 $gC/m^3/h$ (august) to 0.037 $gC/m^3/h$ (February 2013) also wide gap was noted between gross primary productivity and net primary productivity during winter showed lower metabolic rate of autotrophs Net primary productivity was lesser than the gross primary productivity. Gross primary productivity value (0.05$gC/m^3/h$) was almost same with an exception in august month (0.03 $gC/m^3/h$) throughout the study period[10]. Gross primary productivity & net primary productivity were varied in the range of 0.7 to1.4 $gC/m^3/h$ and 0.5 to 0.9 $gC/m^3/h$ respectively in two water bodies in same region[11]. Nutrient load have considerable influences on plant vegetation and consequently on eutrophication[12]. Most lakes of the world have experienced more or less problem of eutrophication during 20th century[13]. Values of net primary productivity and gross primary productivity were recorded from 0.189 $gC/m^3/h$ to 0.761 $gC/m^3/h$ and from 0.493 $gC/m^3/h$ 0.138 $gC/m^3/h$ respectively at Darbari village pond located in the same region[14].

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Table 1. Primary Productivity (gC/m^3/h) at Sansolav pond of Bikaner (from September 2012 to November 2013) (pond was dry in May month).

MONTHS→ / PRIMARY PRODUCTIVITY ↓	Monsoon		Winter				Summer				Monsoon				winter	Average
	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	
NET PRIMARY PRODUCRIVITY	0.3041	0.2338	0.1014	0.1520	0.2534	0.1520	0.1014	0.1014	-	0.1014	0.2534	0.3040	0.3548	0.3040	0.2027	0.2085
GROSS PRIMARY PRODUCTIVIY	0.4561	0.5068	0.2034	0.2534	0.4054	0.2534	0.2534	0.2034	-	0.2534	0.4054	0.4561	0.5068	0.6081	0.3548	0.3657

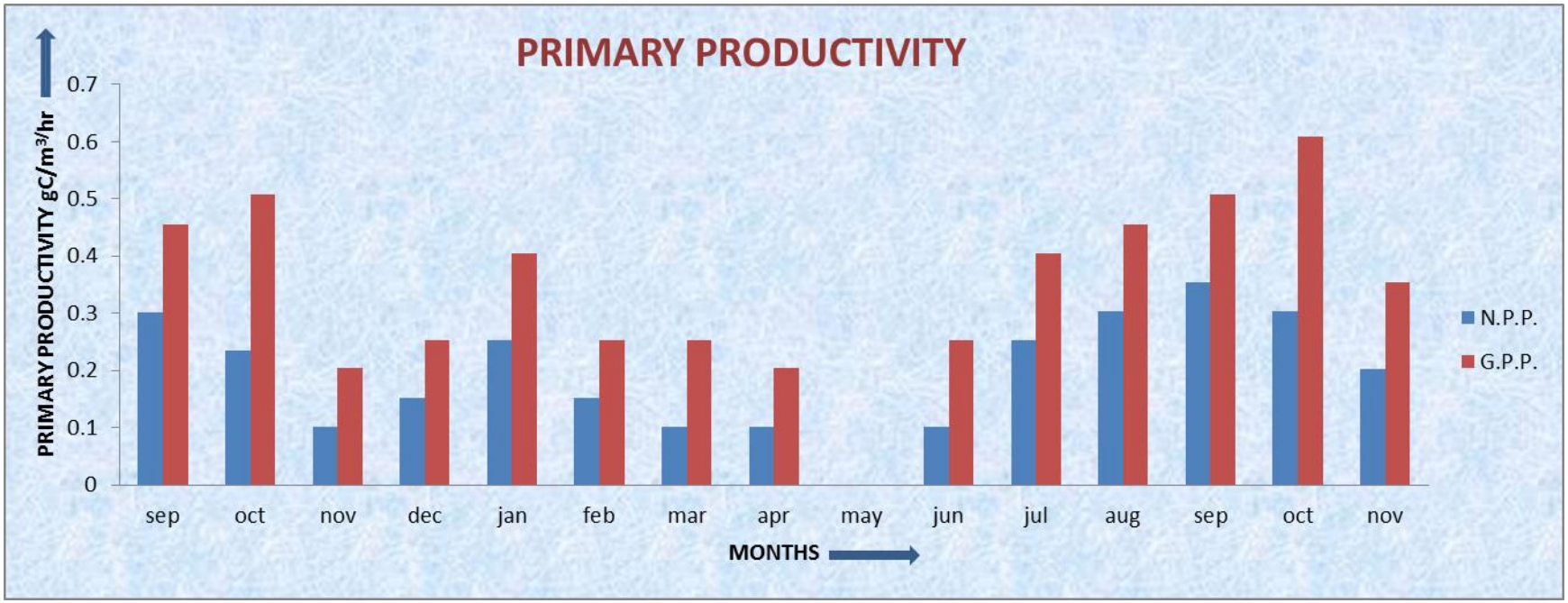

Fig 1. Net Primary Productivity and Gross Primary Productivity of Sansolav pond during September 2012 to November 2013.