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Studies on Primary Productivity of Khaire Reservoir, Raigad District, Maharashtra

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Primary productivity study is important for the assessment of productivity of any aquatic systems. The present investigation is carried out to understand the status of primary productivity of Khaire reservoir of Raigad district. Analysis of primary productivity was done by using standard 'Light and Dark bottle' method of Boyd (1981) in every last week of the month for a period of two years (February 2014 – January 2016). In reservoir the values of GPP, NPP and CR were ranged from 0.38 to 2.81, 0.19 to 1.90 and 0.18 to 1.44 mg C L^{-1} hr^{-1} respectively. The results of the present study revealed that, the primary peak of productivity was observed during pre-monsoon season and the secondary peak was noticed during post-monsoon season. However, during the monsoon season low productivity values were recorded from the reservoir. From this it can be concluded that, Khaire reservoir is productive in nature.

Keywords: Reservoir; gross primary productivity; net primary productivity; community respiration.

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1. INTRODUCTION

The word 'production' is synonymously used for standing crop as well as primary production, which is basically a measure of the photosynthetic activity of the micro algae. Primary productivity helps in measuring the ability of an area to support a biological population and sustain a level of growth and respiration [1]. High and low productivity values of water bodies due to the low nutrient content in the water [2]. Factors such as water level, meteorological factors like light intensity, photoperiod, rainfall, wind velocity, etc., and hydrological cycle (inflow and outflow) have great influence on the rate of primary production in lacustrine and flowing waters [3].

Raigad is a coastal district in the state of Maharashtra while falls under the division of Konkan region. Being a coastal area with the presence of indigenous communities, the district of Raigad has traditionally both marine and fresh water fishing dependent communities. The Katkari, Bhoi, Aagri and Koli are the traditional fishing communities residing in the district. In Maharashtra, the inland fishery is one of the major sources of livelihood for the poor and economically backward communities, however it has vast potential of providing nutritious food to society in a reasonable cost and also creating large employment opportunities for people and youth. For the up-liftment of these traditional fishing communities through better management strategies, biophysical dynamics and ecology of any reservoirs is a prerequisite. Therefore, the present study was carried out to measure the changes of primary productivity of Khaire reservoir for enhancing aquaculture practices, for possible utilization and sustainable management.

2. MATERIALS AND METHODS

2.1 The Study Area

The Khaire reservoir, is located (18°02'26.34" N and 73°20'20.19" E) in Mahad, Raigad district, Maharashtra and it covers a total area of 14.5 ha. The reservoir is extensively used for irrigation, drinking and for fish production purpose. The primary productivity was determined by Light and dark bottle method [4]. This method employs changes in DO concentrations of water samples incubated in clear (light) and opaque (dark) bottles to estimate phytoplankton productivity. A third bottle (initial bottle), is filled at the same time as the light and dark bottles and it is analyzed for DO. The values for gross and net photosynthesis and community respiration in mg L^{-1} of DO was converted to mg L^{-1} of carbon by multiplying by the factor 0.375, the ratio of the weights of carbon to oxygen. The primary productivity was estimated during 10 A.M to 1 P.M and the time of exposure (incubation period) in the present study was three hours. In order to account all the major seasonal fluctuations in primary productivity, the monthly analysis was done and grouped into averages of three seasons such as the summer season (February, March, April and May), monsoon season (June, July, August and September) and winter season (October, November, December and January). The analysis of data was carried out by taking averages of five sampling stations for each reservoir.

Calculation:

Gross photosynthesis in mg L^{-1} of DO = Light bottle – Dark bottle ….**A**

Net Photosynthesis mg L^{-1} of DO = Light bottle – Initial bottle …..**B**

Community respiration mg L^{-1} of DO = Initial bottle – Dark bottle …….**C**

Gross primary production (mg C L^{-1} hr^{-1}) = A (mg) X 0.375/ PQ X h

Net primary production (mg C L^{-1} hr^{-1}) = B (mg) X 0.375/ PQ X h

Community respiration (mg C L^{-1} hr^{-1}) = C (mg) X 0.375/ PQ X h

Where, PQ = Photosynthetic Quotient (Normally a PQ value of 1.2 is considered for field oriented primary production experiments.)

h = period of incubation in hrs.

The statistical analysis was done using SPSS (version 16.0 SPSS Inc.) The differences of each particular parameter within the seasons were calculated by using one way ANOVA. The variations are significant if ($P<0.05$) and non significant if ($P>0.05$). Calculations were performed using SPSS software package (version 16.0 SPSS Inc.).

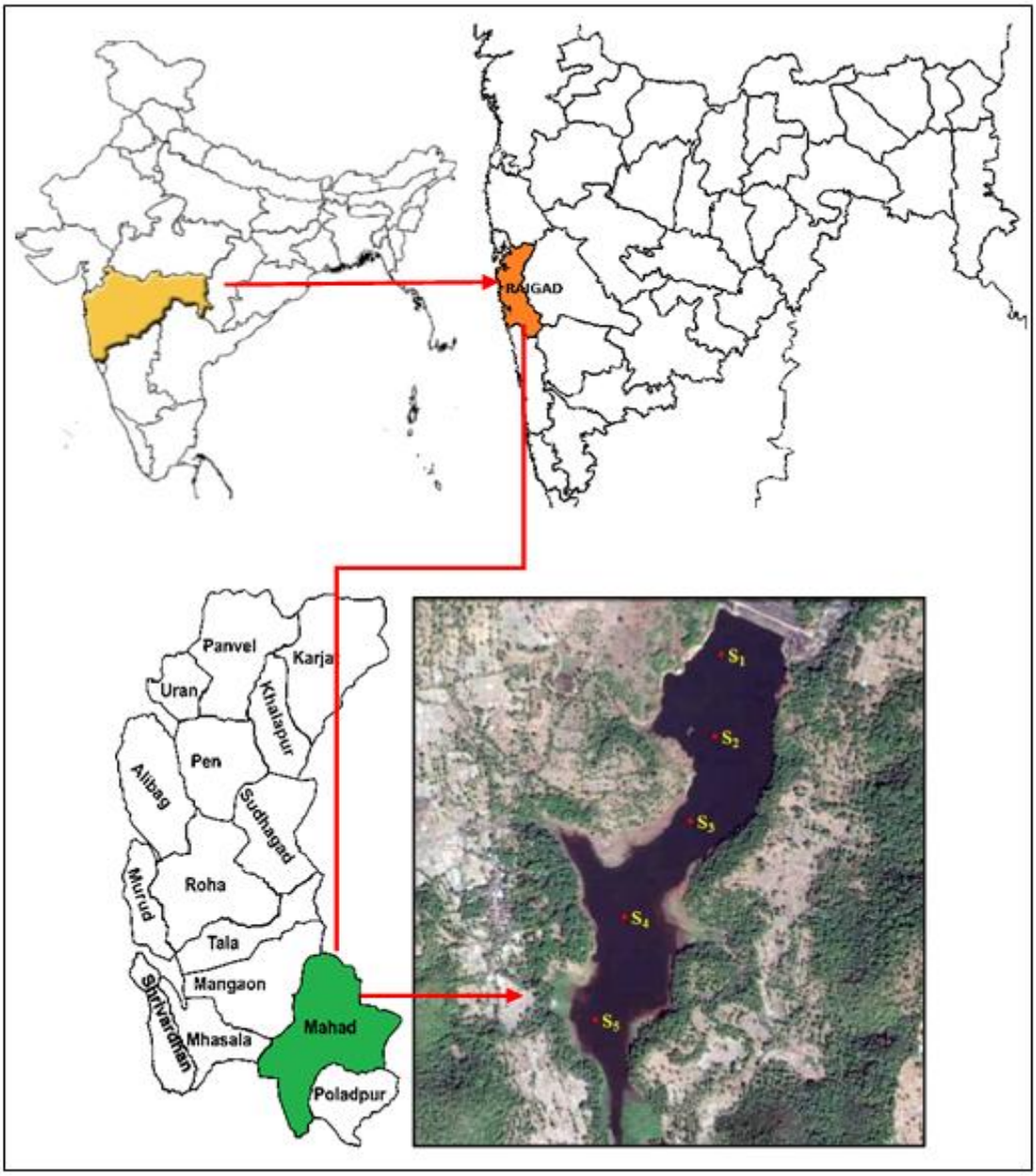

Fig. 1. Khaire reservoir sampling location

3. RESULTS

3.1 Gross Primary Productivity (mg C L^{-1} hr^{-1})

The GPP values in reservoir ranged from 0.38 (June-2015) to 2.81 (May-2014) with an average of 1.44 ± 0.61 mg C L^{-1} hr^{-1}. Seasonal variation in GPP showed lowest (0.82 ± 0.42) value during monsoon of 2015-16 and highest (2.09 ± 0.73) value during the pre-monsoon season of 2014-15. Analysis of variance for the comparison of GPP within the season showed significant difference ($P < 0.05$).

3.2 Net Primary Productivity (mg C L^{-1} hr^{-1})

The NPP ranged from 0.19 (June-2015) to 1.90 (May-2014) with an average of 0.90 ± 0.5 mg C

L^{-1} hr^{-1}. Seasonally, the minimum (0.45 ± 0.18) and maximum (1.39 ± 0.61) values of NPP were recorded during monsoon and pre-monsoon of 2014-15 respectively. Within the season, analysis of variance showed significant difference ($P < 0.05$) in NPP.

3.3 Community Respiration (mg C L^{-1} hr^{-1})

The monthly observation in CR ranged from 0.18 (July-2014) to 1.44 (November-2015) with an average of 0.55 ± 0.31 mg C L^{-1} hr^{-1}. According to seasons, the minimum (0.33 ± 0.18) and maximum (0.89 ± 0.44) values of CR were recorded during monsoon of 2014-15 and post-monsoon of 2015-16 respectively. Seasonally, analysis of variance showed no significant difference ($P > 0.05$) in values of CR.

Table 1. Monthly observations in primary productivity (mg C L^{-1} hr^{-1}) of Khaire reservoir

	Month	GPP	NPP	CR
Feb. 2014 - Jan. 2015	Feb	1.50	1.13	0.38
	Mar	1.41	0.66	0.75
	Apr	2.63	1.88	0.75
	May	2.81	1.90	0.94
	Jun	2.06	1.50	0.56
	Jul	0.94	0.75	0.18
	Aug	0.75	0.38	0.38
	Sep	0.56	0.38	0.19
	Oct	1.03	0.38	0.66
	Nov	1.13	0.75	0.38
	Dec	1.22	0.84	0.38
	Jan	1.50	0.84	0.66
Feb. 2015 - Jan. 2016	Feb	1.69	1.50	0.19
	Mar	1.31	0.80	0.60
	Apr	2.06	1.88	0.19
	May	2.25	1.31	0.94
	Jun	0.38	0.19	0.19
	Jul	0.94	0.56	0.37
	Aug	0.94	0.56	0.37
	Sep	1.03	0.47	0.56
	Oct	1.31	0.80	0.60
	Nov	1.80	0.36	1.44
	Dec	1.78	0.75	1.03
	Jan	1.59	1.13	0.47
	Avg	1.44±0.61	0.90±0.51	0.55±0.31
	Min	0.38	0.19	0.18
	Max	2.81	1.90	1.44

Table 2. Season-wise variations in primary productivity (mg C L^{-1} hr^{-1}) of Khaire reservoir

Primary productivity	Feb. 14 - Jan. 15			Feb. 15 - Jan. 16		
	Pre-monsoon	Monsoon	Post-monsoon	Pre-monsoon	Monsoon	Post-monsoon
	Feb - May	Jun - Sept	Oct - Jan	Feb - May	Jun - Sept	Oct - Jan
GPP	2.09±0.73	1.08±0.67	1.22±0.20	1.83±0.42	0.82±0.30	1.62±0.23
NPP	1.39±0.61	0.75±0.53	0.70±0.22	1.37±0.45	0.45±0.18	0.76±0.32
CR	0.71±0.23	0.33±0.18	0.52±0.16	0.48±0.36	0.37±0.15	0.89±0.44

Table 3. Analysis of variance for the comparison of GPP, NPP and CR within the seasons

Seasons	GPP	df	Mean square	F	Sig
Pre-monsoon	1.96±0.18[b]				
Monsoon	0.95±0.18[a]	2	0.511	10.383	0.045
Post-monsoon	1.42±0.28[ab]				

Seasons	NPP	df	Mean square	F	Sig
Pre-monsoon	1.38±0.01[b]				
Monsoon	0.60±0.21[a]	2	0.349	22.294	0.016
Post-monsoon	0.73±0.04[a]				

Seasons	CR	df	Mean square	F	Sig
Pre-monsoon	0.59±0.16				
Monsoon	0.35±0.028	2	0.066	2.071	0.272
Post-monsoon	0.70±0.261				

**abcd: The values in column with different superscript differ significantly (P < 0.05)*

4. DISCUSSION AND CONCLUSION

4.1 GPP and NPP

Gross primary productivity is the total rate of photosynthesis including the organic matter utilizes in respiration during the period of measurement. Net primary productivity is the rate of storage of organic matter in plant tissues in the excess of the respiratory use by plants during the measurement period. In the present investigation, the monthly and seasonal variations in GPP and NPP showed lowest values during monsoon season and highest values during the pre-monsoon season. The higher values of GPP and NPP during the pre-monsoon season may be due to higher temperature, availability and utilization of solar radiation leads to the high biomass of phytoplankton. However, the lower values of GPP and NPP during monsoon season may be due to the minimum photoperiod of the seasons with low solar radiation, and reduction in phytoplankton population. In Pykara dam, Tamilnadu the observed GPP and NPP values were ranged from 2.24 to 4.50 mg C L^{-1} hr^{-1}, NPP from 0.16 to 1.93 mg C L^{-1} hr^{-1}, with highest productivity during summer, while lower productivity during monsoon [5]. From Morawane dam of Ratnagiri, a gradual increase in GPP and NPP were noticed from January to May, while decline in GPP was recorded from June to December. However, it further showed gradual increase from February to June [6]. From all the reservoirs of Kolhapur district the GPP and NPP values were recorded as in Gavase reservoir from (0.19 to 1.07 gC m^{-3} hr^{-1} and 0.11 to 0.91 gC m^{-3} hr^{-1}), Dhangarmola reservoir from (0.15 to 0.91 gC m^{-3} hr^{-1} and 0.08 to 0.76 gC m^{-3} hr^{-1}), Yarandol reservoir from (0.23 to 1.36 gC m^{-3} hr^{-1} and 0.15 to 1.06 gC m^{-3} hr^{-1}), Khanapur reservoir from (0.23 to 1.06 gC m^{-3} hr^{-1} and 0.15 to 0.76 gC m^{-3} hr^{-1}) and Ningudage reservoir from (0.26 to 1.67 gC m^{-3} hr^{-1} and 0.19 to 1.36 gC m^{-3} hr^{-1}). However, reported study showed that, the GPP and NPP values were lower during monsoon season, while higher during pre-monsoon season [7]. From Mailapur reservoir of Karnataka lower value of GPP were during southwest monsoon (0.69±0.12 gC m^{-3} hr^{-1}) and higher GPP during pre-monsoon season (2.35±0.95 gC m^{-3} hr^{-1}), while NPP value was recorded minimum (0.64±0.10 gC m^{-3} hr^{-1}) during southwest monsoon season and maximum (1.88±0.91 gC m^{-3} hr^{-1}) during northeast monsoon season [8].

4.2 CR

Community respiration is defined as reduction of NPP from GPP and later converted into releasing of CO_2. The study results showed that, CR was low during monsoon season, while during pre-monsoon and post-monsoon season higher values of CR were recorded. CR was high during pre-monsoon season may be attributed due to the raised temperature, which released nutrient from soil through the decomposition. However, this higher temperature and nutrient concentration favored growth of plankton in the reservoir. The CR recorded in Sidhewadi reservoir ranged from 0.51 to 2.47 O_2 mg L^{-1} hr^{-1} and in Borgaon reservoir it ranged from 0.20 to 1.55 O_2 mg L^{-1} hr^{-1} with higher values during pre-monsoon followed by post-monsoon and monsoon [9]. From Pykara dam, reported CR values ranged from 1.03 to 1.08 mg C L^{-1} hr^{-1},

with highest CR values during summer [5]. From Morawane dam, the lowest (0.026 mg C L^{-1} hr^{-1}) value of CR was observed during post-monsoon and highest (0.042 mg C L^{-1} hr^{-1}) during pre-monsoon [6]. From the reservoirs of Yadigir District, lower values of CR were noticed during the monsoon (0.06±0.02) and higher values during winter season (0.30±0.11) [8].

4.3 Conclusion

The results revealed that, Khaire reservoir is productive in nature. The primary peak of productivity was observed during pre-monsoon season and the secondary peak was noticed during post-monsoon season. Moreover, the cloudy weather during monsoon might have resulted in low productivity. The primary production might have been influence by nutrient availability during pre-monsoon due to evaporation of water and bright sunlight, while the organic runoff from agriculture and nutrient coming along with the rainfall during monsoon played the major role in the development of primary productivity latter during the post-monsoon season. From the above result it can be concluded that, the present reservoir is suitable for higher stocking of fish seed for development of culture based capture fishery.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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