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Composition of phytoplankton and zooplankton for better production of Indian major carps in fish farming of Marathwada region, (M.S.) India.

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Abstract

The present study deals with seasonal variations of Phytoplankton as well as Zooplankton, Gross Primary Productivity (GPP) of Indian Major Corps (IMC). The research work was performed during the period of Nov 2021 to Oct 2022.

The species composition and distribution pattern of Plankton community in both ponds. A total 18 genera of Phytoplankton were recorded including 8 genera of Chlorophyceae, 4 genera of bacillariophyceae, 3 genera of Cynophyceae, 2 genera of Euglenaphyceae and one genera of dinophyceae.

The total Plankton volume varied from 0.6-4.2 ml/50*l* and 0.4-3.6 ml/50*l* in experimental and control pond respectively. Mean values in experimental (2.16± 1.07 ml/ 50 litre) and control pond (1.97±0.95 ml/50 litre) are non-significantly different. Maximum value was observed during March-April in both ponds.

A total 7 species of Zooplankton were collected during the course of the present study including 2 species of Rotifera 3 species of Cladocerma and 2 Species of Copepada. The maximum number of Zooplankton was observed during winter season followed by summer.

The density varied from 160-636 nos/*l* and 168-620 nos/*l* in experimental and control pond respectively. The total density of Zooplankton was comparatively higher in experimental pond. Mean values in experimental (366.17±164.8 nos/*l*) and control pond (332.83±154.45 nos/*l*) are non significantly different.

GPP showed wide seasonal fluctuations ranging between 0.208-1.240 (0.58±0.30) g^C/m^3/ hr in experimental pond and 10.210-1.050 (0.52±0.26g^C/m^3/hr) in control pond.

The average net weight of *Catla catla* was 844.2g and 726.9g experimental and control pond respectively. *Labeo rohita* showed lower average weight as 692.9g and 576.6 gm in experimental and control pond, respectively. Individual fish of highest weight was recorded as *Catla catla* (1350g) in experimental, *labeo rohita*(1200 g) in experimental.

The total fish production during 12 months was recorded as 637.8 kg in experimental and 531.2 kg in control pond. The gross fish production was calculated to be 5315 kg/ha/yr in experimental pond and 4427/kg/ha/yr in control pond.Inexperimentalpond,thetotalproductionwascontributedas40.43 percent by *Catla catla*, 26.54 percent by *Labeo rohita,* In control pond it was 42.62 percent by *Catlacatla*, 25.83 percent by *Labeo rohita.*
At the end of experiment, 20.06 percent increase was recorded in fish production over the control pond in which 4 percent increased due to better survival and 16.06 percent increase was due to better productivity of pond. Maximum species wise increment was recorded in *Labeo rohita*(26%) While it was lowest for *Catla catla* (14.2 percent).

Keywords: Seasonal variations, Phytoplankton, Zooplankton, Gross Primary Productivity, *Catla catla, Labeo rohita,*

Introduction

The most precious natural resource on the surface of the earth is water which is 97% as Salt water in Oceans and 2% of the freshwater in glaciers and ice. Less than 1% is found in dams, streams, lakes and ponds in the atmosphere. Water is the habitat for a large number of aquatic organisms ranging from microscopic plankton to large number of aquatic animals and Macrophytes. Now a days due to unplanned urbanization, rapid industrialization, use of chemical fertilizer leading to the deterioration of water quality both qualitatively and quantitatively depleting aquatic fauna (Sati and Paliwal, 2008). Moreover, there is a very close relationship between metabolism of aquatic organism and hydrobiological parameters in the freshwater body. (Deshmukh and Ambhore, 2006).

Fisheries is destined to play an important role in human nutrition. Recycling of organic wastes for fish culture serves as the dual purpose of cleaning the environment and providing economic benefits. In India about 40% of cultivated area is under irrigation and 60% of cultivated area is under rainfed condition. Food security and the environment are two major global concerns particularly in India, where the increasing population and a corresponding economic pressure on the natural resources and the environment are most prominent. To meet the demand of protein rich food for an ever growing population, it has become essential to exploit the water resources.The developing countries like India where about 60% of the population is suffering from protein deficiency. Fish contains about 22% of protein and a high potential for digestion. It is the cheapest source of animal protein housing high nutritional value (89%) as compared to mutton (80%) and chicken (78%) World aquaculture with 110.2 million tonnes of production (FAO, 2018) is growing at a rapid pace caused by modernization and intensification of culture systems. In intensive culture, quite a high amount of inputs in the forms of fertilizars and feeds are used to obtain high production in a short period results in the deterioration of the culture environment (Avnimelech and Ritvo, 2003)The indiscriminate use of these manures in fishponds, instead of improving the pond productivity, may also lead to pollution. Therefore, it is necessary to know the standard doses of these wastes which would keep the physico-chemical and biological parameters of pond water in a favorable range required for the survival and growth of fish. The present study was conducted to work out effect of poultry droppings and cow dung as pond manure on biological parameters of the water and on the growth of Indian major carps.

In freshwater ecosystem zooplanktonic organisms are important food sources for many aquatic animals specially fishes. The main major carps like Catla and their hybrids were found to be plankton in origin (Mozumder, P.K. and Naser, M.N. 2009) Studies have been made on Ichthyofaunal diversity of various fresh water bodies in India during last few decades (Pawar et al, 2006) Study of fish fauna of Pethwadaj dam Nanded, (Kulkarni et al, 2008). Biological diversity provided the basis for life on earth. The fundamental, social, ethical, cultural and

economic values of the resources have been recognized in the region and literature from the earliest days of recorded history. (Mora, C, et al, 2011) Fishes have formed an important item of human diet from time immemorial and are primarily caught, for this purpose. Fish diet provides proteins, fat and vitamin A and D. As there is economic importance and scope of fish and fisheries especially in Maharashtra it is essential to study distribution and availability of fish from freshwater reservoirs and tanks. (Shindeet, al., 2009)

World aquaculture with 110.2 million tonnes of production (FAO, 2016) is growing at a rapid pace caused by modernization and intensification of culture systems. In intensive culture, quite a high amount of inputs in the forms of fertilizers and feeds are used to obtain high production in a short period results in the deterioration of the culture environment (Avnimelech, Y. and Lucher, 1979). The indiscriminate use of these manures in fish ponds, instead of Improving the pond productivity, may also lead to pollution. Therefore, it is necessary to know the standard doses of these wastes which would keep the physico-chemical and biological parameters of pond water in a favorable range required for the survival and growth of fish.

The present study was conducted to work out effect of poultry droppings and cow dung as pond manure on biological parameters of the water and on the growth of Indian major carps.

Materials and Methods

The present study was conducted at the fish farm of Jayakwadi Paithan, Aurangabad district for 12 months i.e. November 2021 - October 2022. Experiment was conducted in two earthen ponds of same size (0.12 ha) experimental unit fish pond was provided with chicken manure as feed and control unit was designed fish pond with cow manure. Fish ponds were stocked with advanced sized fingerlings of *Catla catla* and *Labeo rohita* at the rate 8000 fingerlings /ha in the ratio 6:4.During present study Plankton (Phytoplankton and Zooplankton) sampling carried out on month basis for the period of one year from both the ponds, experimental as well as control (Area is 0.12 ha) control pond (artificial feed 25% crude protein) Experimental (feeding chicken manure)

A standard methodology adopted for collection of phytoplankton and zooplankton, i.e. collection, fixation and preservation, storage, centrifugation and dilution, qualitative analysis and quantitative estimation. Plankton net (mesh size 25 um) was kept on water surface (Secchi's disc transparency zone) An iron tube was firmly tide to the tapering end of net having bottle was covered by a piece of blotting silk tide with cotton thread so that Plankton collected through the net could be easily transferred into separate bottle/container. These were fixed and preserved in 5% formalin. The formalin fixed plankton sample were centrifuged at 1500-2000 rpm for 10-12 min. The Phytoplankton and Zooplankton were settled at bottom diluted to a desirable concentration in such a way that they could be easily counted individually under compound microscope. Phytoplankton and Zooplankton were measured and multiplied with dilution factor.

Plankton i.e. Phytoplankton and Zooplankton species identification was done by Hamilton (1822), IAAB (1998), Trivedy and Goel, (1987), Edmonson, (1963), Battish (1992). The quantitative analysis of Plankton were carried out using Sedgwick-Rafter Plankton counting cell in accordance to Welch, (1948) and APHA, (2005).Observation on survival growth and production of fish in experimental pond (E) with Poultry manure and control pond (C) with cow dung. were taken for 12 months (November 2021 – October 2022.) Growth performance of fish in experimental pond and in control pond was studied for the period of rearing 12 months and area of pond 0.12 ha. Composition of Phytoplankton and Zooplankton in control pond and experimental pond recorded and Tabulated. Comparative study of *Catla catla* and *Labeo rohita* as grown during the period of 12 months carried out in both the ponds.

Results and Discussion

In the present study Phytoplankton and Zooplankton species composition and pattern of Plankton in Experimental pond and control pond. The average value of Phytoplankton and Zooplankton were presented in Table (1-3) depict the species composition and distribution pattern of Plankton community in both ponds. A total 18 genera of Phytoplankton were recorded including 8 genera of *Chlorophyceae*, 4 genera of *Bacillariophyceae*, 3 genera of *Cynophyceae*, 2 genera of *Euglenophyceae* and 1 genera of *Dinophyceae.*

Table 01 : Species composition and Distribution pattern of Plankton in Experimental pond.

Species	Months											
	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.	Sep	Oct.
Phytoplankton												
(A) Chlorophyceae												
Pediastrum spp.					+	+		+	+			
Chlamyclononas spp.	+	+	+	+		+	+	+	+	+	+	+
Volvox spp.			+				+		+	+		
Scenedesmus spp.	+				+	+	+	+		+	+	
Chlorella spp.	+			+	+	+	+		+	+	+	+
Spirogyra spp.		+	+	+					+			
Oedogenium spp.		+	+	+					+			
Cosmarium spp.		+				+	+		+			
(B) Bacillarophyceae												
Naviculaspp.	+			+		+	+	+	+	+	+	
Nitzschia spp.					+	+			+		+	
Fragilaria spp.			+				+	+	+	+		+
Pinnularia spp.		+							+	+	+	
(C) Cynophyceae												
Microsis spp.		+		+	+			+		+	+	
Anabaena spp.	+	+	+	+		+		+		+		+
Nostoc spp.		+	+	+				+				
(D) Euglenophyceae												
Euglena spp.	+	+	+	+	+	+					+	+
Phacus spp.		+	+			+		+				
(E)Dinophyceae												
Peridinium spp.				+	+			+	+	+	+	

Species	Months											
	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.	Sep	Oct.
Zooplankton												
(A) Rotifera												
Branchionus spp.	+	+	+		+	+		+	+		+	+
Keratella spp.		+	+			+	+					
(B) Cladocera												
Daphnia spp.	+	+	+	+	+	+	+		+	+	+	
Monia spp.	+	+	+	+	+	+	+		+	+	+	
Bosmina spp.		+	+			+						
(C) Copepoda												
Cyclops spp.		+	+	+		+	+	+				
Diaptomus spp.		+	+			+			+			

Table No. 2 : Species Composition and Distribution of Plankton in control pond.

Species	Months											
	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.	Sep	Oct.
Phytoplankton												
(A) Chlorophyceae												
Pediastrum spp.					+	+		+	+			
Chlamyclononas spp.	+	+		+	+			+	+	+	+	+
Volvox spp.		+	+		+	+	+		+	+	+	
Scenedesmus spp.	+				+	+	+	+		+	+	
Chlorella spp.	+			+	+	+	+		+	+	+	+
Spirogyra spp.		+	+	+	+	+	+		+			
Odogenium spp.		+	+	+			+					
Cosmarium spp.		+	+	+		+						
(B) Bacillarophyceae												
Navicula spp.	+		+		+	+	+	+	+	+	+	
Nitzschia spp.				+							+	
Fragilaria spp.								+	+	+		+
Pinnularia spp.		+				+		+	+		+	
(C) Cynophyceae												
Microsis spp.		+	+	+	+			+			+	
Anabaena spp.	+	+				+		+		+		+
Nostoc spp.		+	+		+							
(D) Euglenophyceae												
Euglena spp.	+	+	+		+	+	+	+		+	+	+
Phacus spp.		+	+			+	+	+				
(E) Dinophyceae												
Peridinium spp.			+	+	+		+	+	+	+	+	

Species	Months											
	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.	Sep	Oct.
Zooplankton												
(A) Rotifera												
Branchionus spp.	+	+	+	+	+	+	+	+	+	+	+	+
Keratella spp.	+	+	+			+	+					
(B) Cladocera												
Daphnia spp.	+	+	+		+	+	+		+		+	
Monia spp.	+	+		+	+		+		+	+	+	
Bosmina spp.		+	+			+						
(C) Copepoda												
Cyclops spp.		+		+		+	+	+				
Diaptomus spp.		+	+		+	+			+			

Table No. 3 : Composition (%) of Plankton in Experimental and Control pond

Plankton Group	Experimental Pond	Control Pond
Phytoplankton		
Chlorophyceae	60.3	52.9
Bacillarophyceae	20.2	14.8
Euglanophyceae	7.3	9.9
Cynophyceae	10.2	18.8
Dipnophyceae	2.0	3.6
Zooplankton		
Rotifera	41.5	61.0
Cladocera	40.1	20.3
Copepoda	18.4	18.7

In experimental pond, maximum number was observed for green algae (60.3%) followed by diatoms. While in control pond maximum number was observed for green algae (52.9%) followed by blue-green algae. The commonly occurring green algae included. *Pediastrum* spp. *Chlamydomonas* spp, *Volvox* spp, *Scenedemus* spp. and *Chlorella* spp. All these species were observed thriving well in the ponds throughout experimental period with their dominance in rainy and summer months. Diatoms were represented mainly by *Navicula* spp. *Nitzschina* spp, *Fragilaria* spp, and *Pinnularia* spp. Diatoms contributed 20.2% in Experimental and 14.8% in control pond of total composition of phytoplankton *Fragilaria* spp, was more prominent in experimental pond, while *Pinnularia* spp. was prominent in control pond. Among the blue green algae *Microcystis* spp, *Anabaena* spp. and *Nostoc* spp. were major species in both ponds. Composition of blue green algae was comparatively higher (18.8%) in control pond. Blue green algae were dominantly found in winter season and rarely occurred in rainy and Summer season in both ponds. They contributed 7.3% in experimental and 9.9% in control pond of the total density of phytoplankton.

Microcystis spp. *Anabaena* spp. and *Nostoc* spp. were major species of blue-green algae. *Anabaena* spp.was more prominent in experimental, while *Microcystis* spp, was prominent in control pond. *Dinoflagellates* were represented by *Peridinium* spp. which was more prominent in control pond and observed through outthe year with higher values during the month of July-September Among *Euglenofids* viz, *Euglena* spp and *Phacus* spp, were registered in both ponds. *Euglena* spp.

was preponderant in both ponds. They contributed 7.3% in experimental and 9.9% in control pond of the total density (Table 1-2 and figure 5-6) A total of 7 species of Zooplankton were collected during the course of the present study including 2 species of *Rotifera,* 3 species of *Cladocera* and 2 species of *Copepoda.* The number of species present in different months varied throughout the year. The maximum number of Zooplankton was observed during Winter season followed by Summer.

The Composition of *Rotifers* and *Cladocerans* was almost equal (40-41.5%) in experimental pond but it is quite different in control pond which was dominated (61%) by *Rotifers* . The composition of *Cladocerans* was higher (40.1%) in experimental pond than in control (20.3%) pond. Minimum composition was observed for *Copepods* in both ponds. Maximum number of *Rotifers* was noted in December, *Cladocerans* were present throughout the year with peak in winter season. Two species of *Rotifers* namely *Branchionus* spp. and *Keratella* spp. Consistently occurred in Zooplankton population. *Cladoceran* population included individuals of *Daphnia* spp. and *Monia* spp. were noticed round the year in both ponds. *Bosmina* spp. was predominant during winter and summer. *Copepoda* population consisted of *Cyclops* spp. And *Diaptomus* spp. with abundance in winter and summer (Table 3-4 Figure 2-3) The average survival rate of fishes in experimental pond was 86.63% while it was 83.27% in control pond. *Labeo rohita* showed (84.03%) higher survival while *Catla catla* low survival was recorded for *Catla catla* (81.25%) and (78.65%) in both ponds (Table 6) The average net weight of *Catla catla* was 844.2 g and 726.9 g experimental and control pond, respectively. *Labeo rohita* showed lower average net weight as 692.9 g an 576.6 g in experimental and control pond respectively. Individual fish of highest weight was recorded as *Catla catla* (1350 g) in experimental *Labeo rohita* (1200 g) in experimental pond. (Plate No. 1). The composition of phytoplankton in experimental and control pond (fig. 5 and fig. 6) shown the similarities with earlier findings of Mahajan (1996).

Plate 1: Experimental Pond Grown *Catla catla*

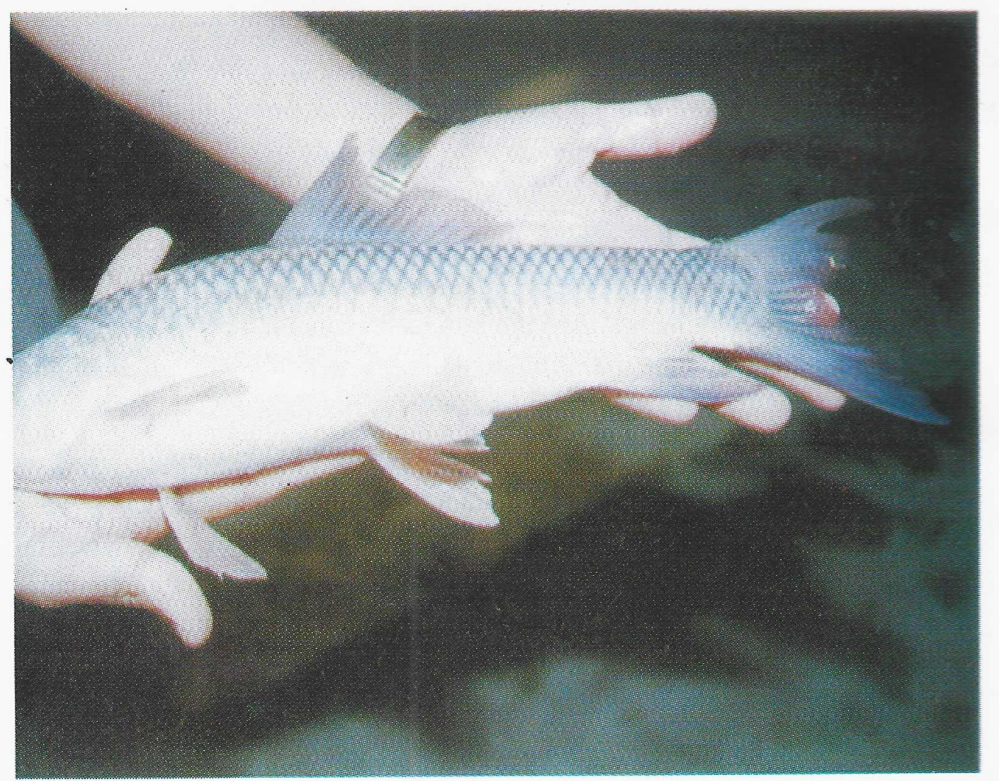

Plate 2 : Experimental Pond Grown *Labeo rohita*

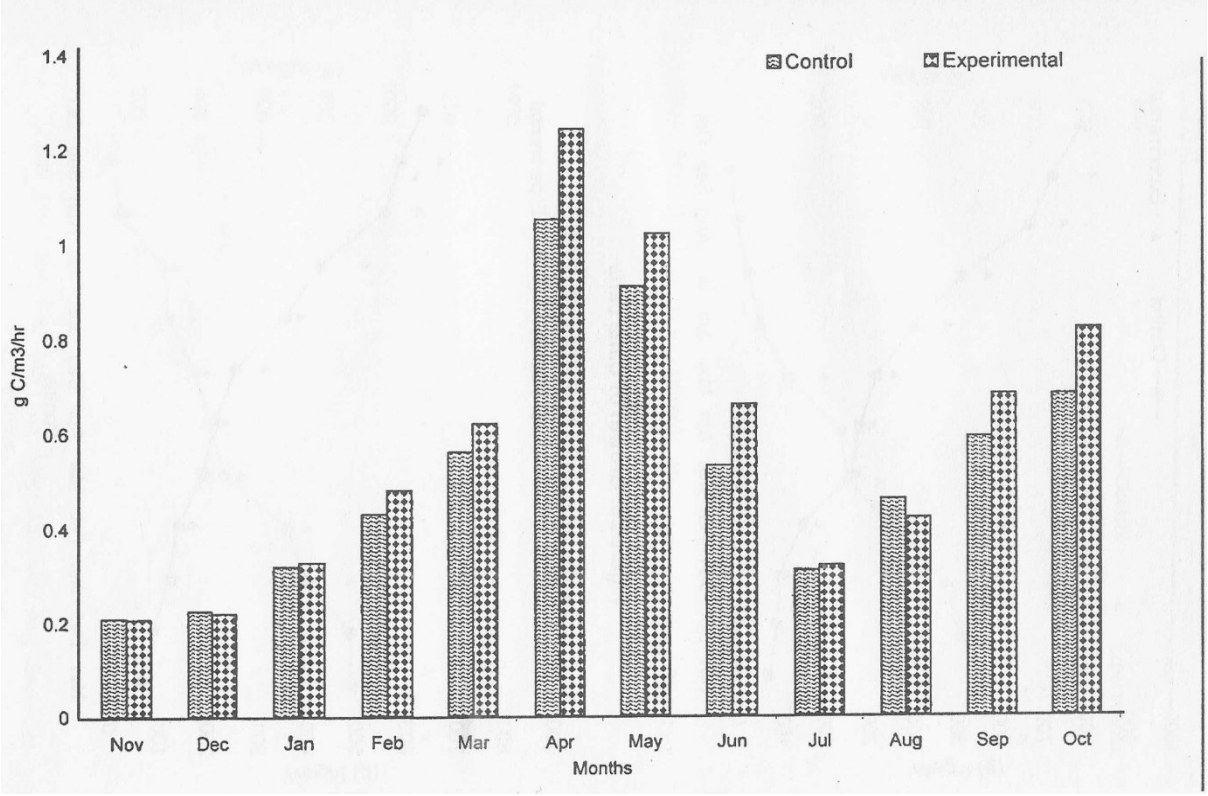

Figure 1 : Seasonal Variation in GPP Level

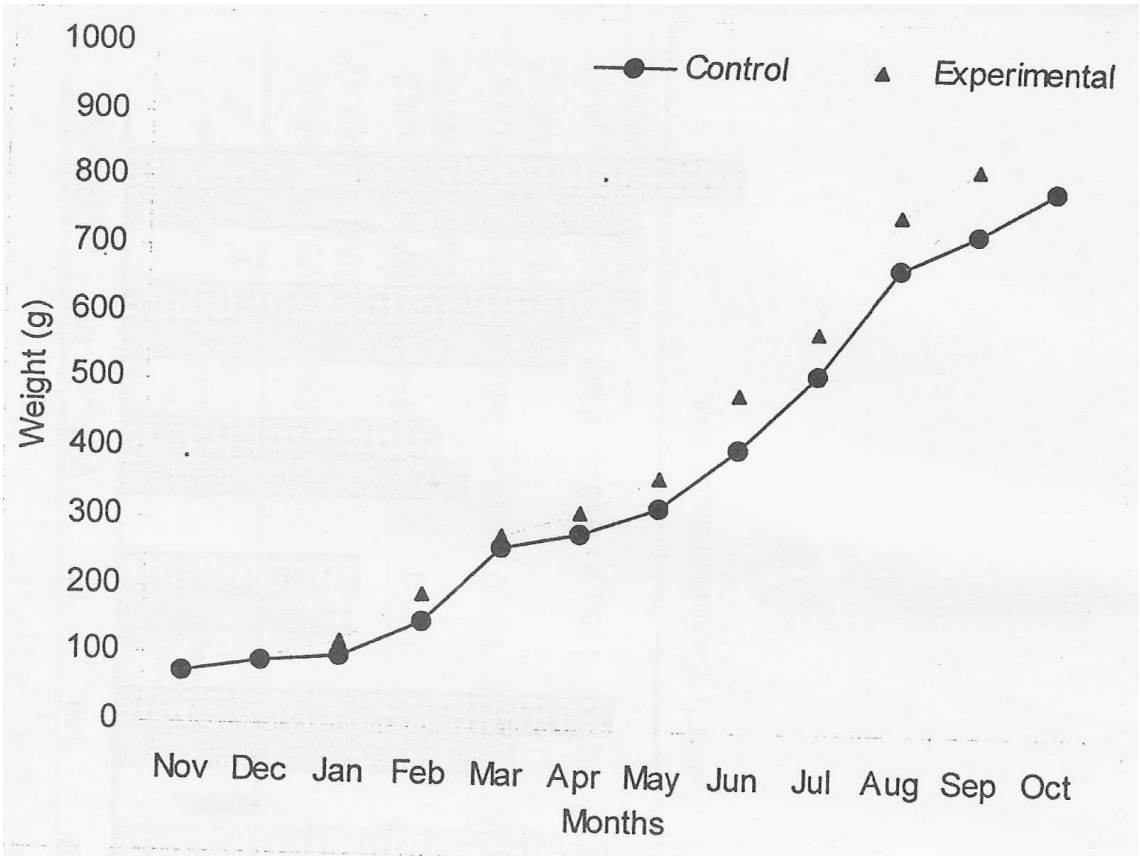

Figure 2 : Growth of *Catla catla*

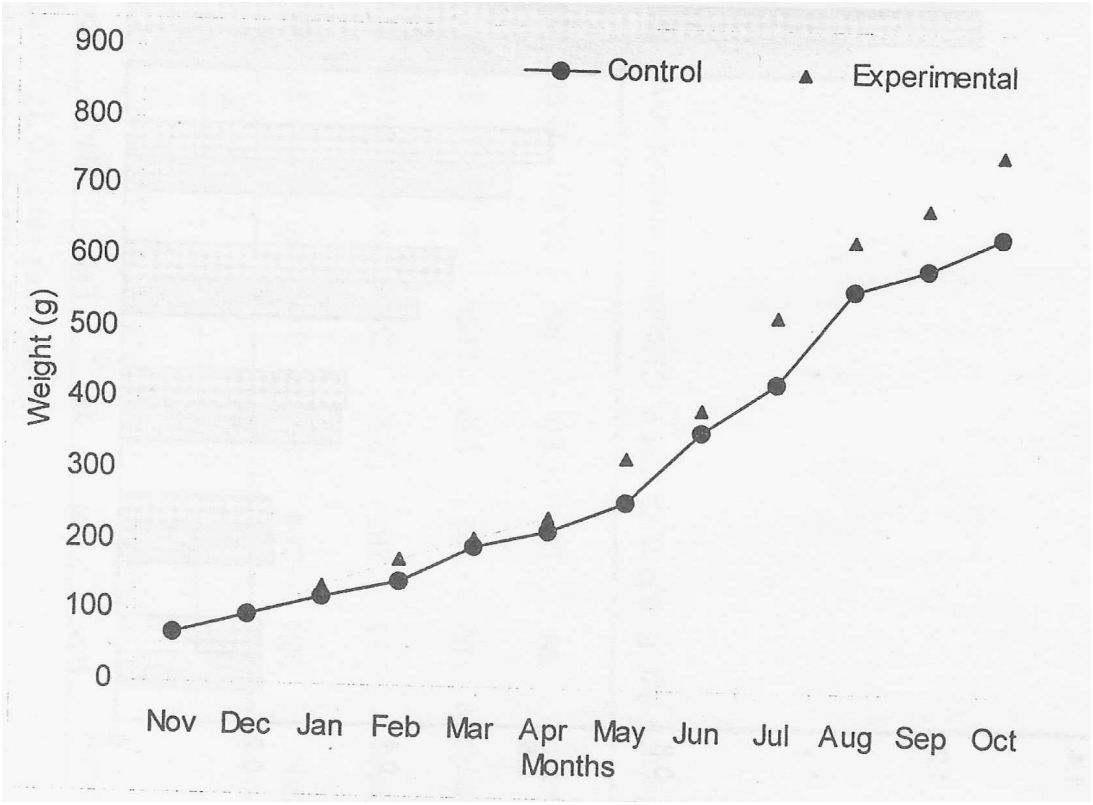

Figure 3 : Growth of *Labeo rohita*

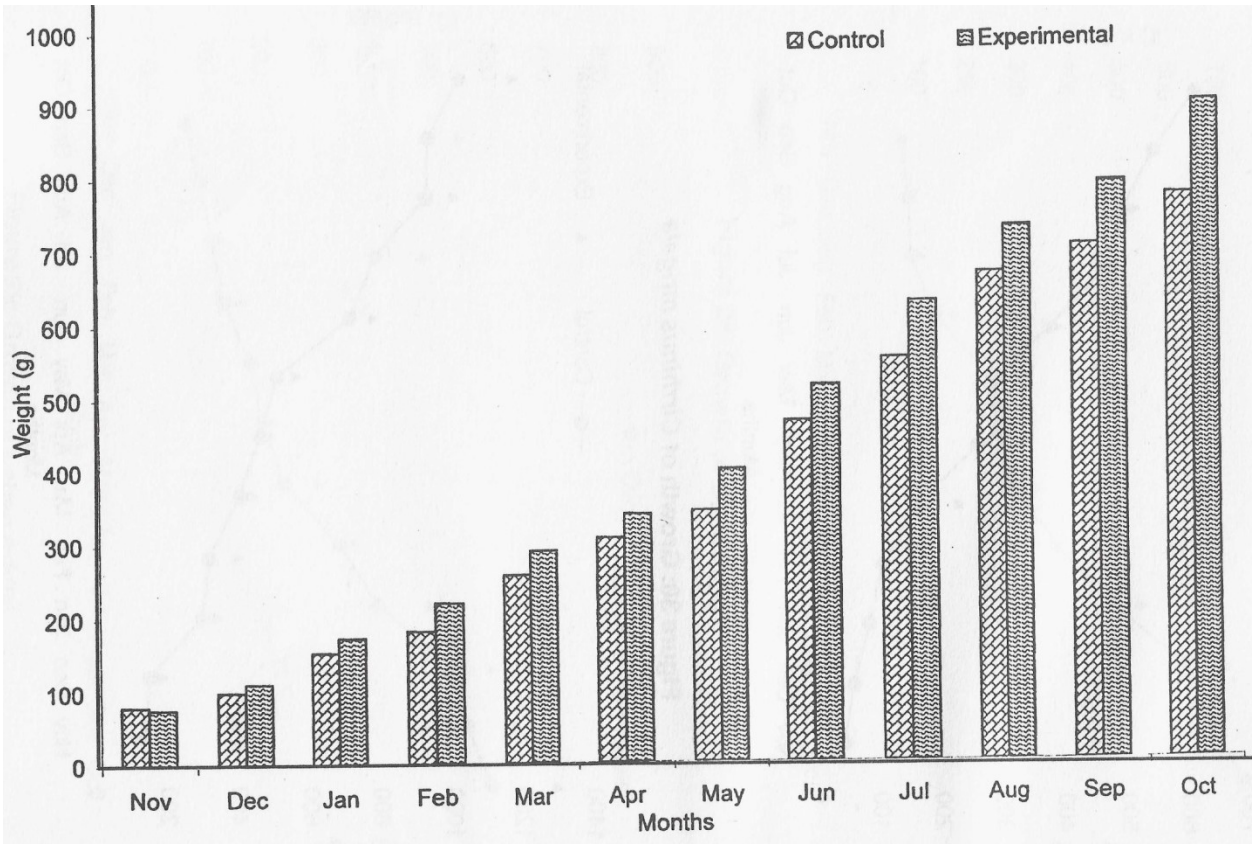

Figure 4 : Growth of all Fishes Pooled

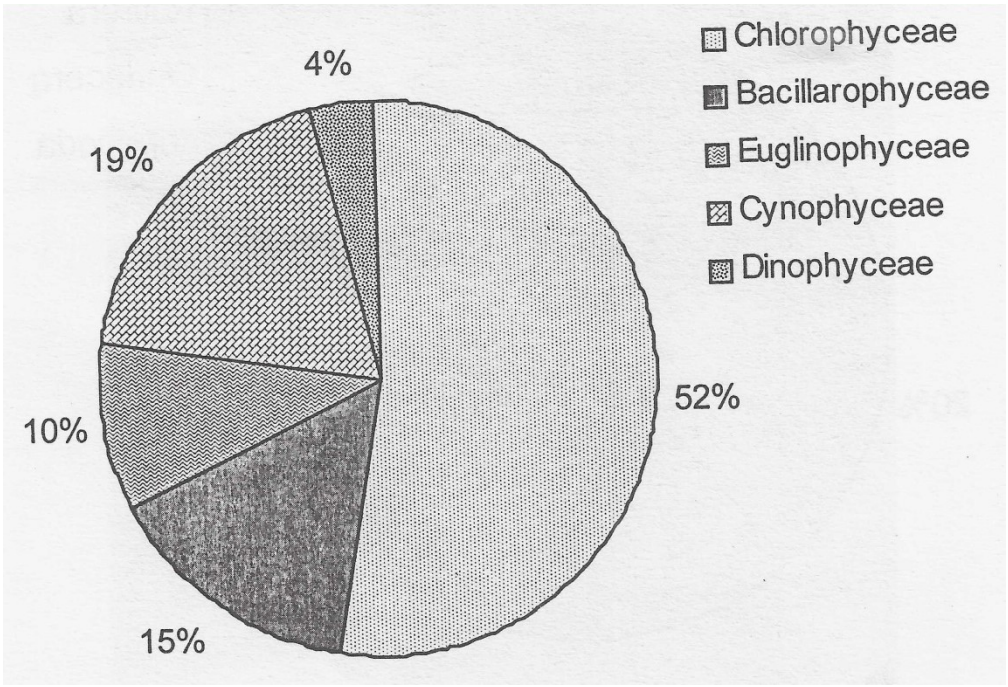

Figure 5 : Composition of Phytoplankton in Control pond

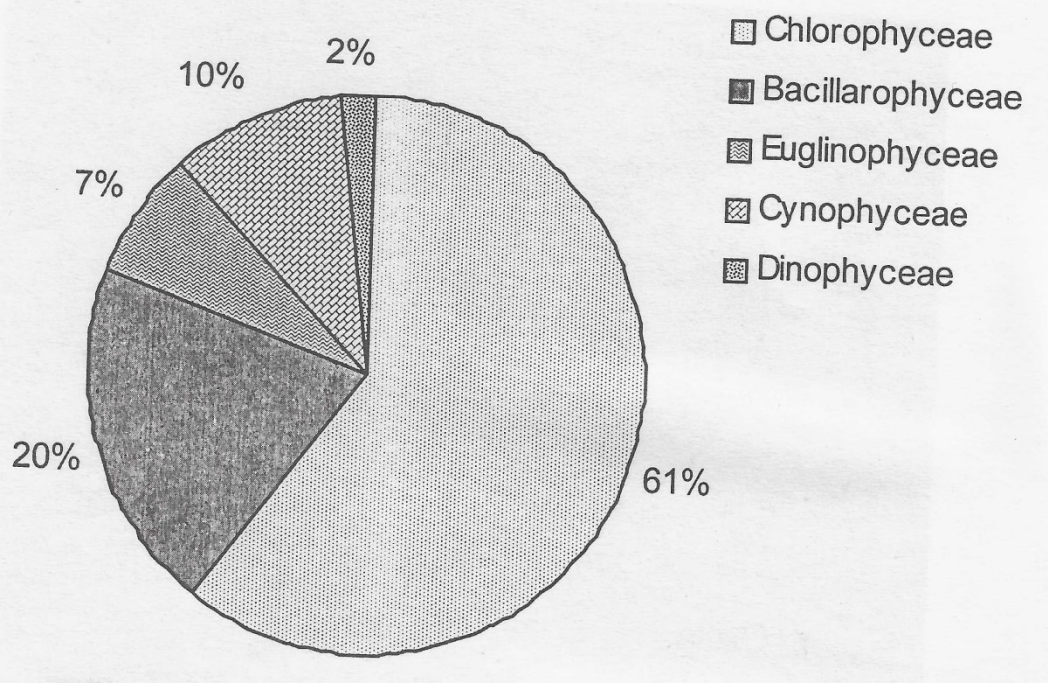

Figure 6 : Composition of Phytoplankton in Experimental pond

The growth rate was comparatively less from October to January and increasing from March onwards (figure 02-03) species wise growth are presented in (Table 04-05) The total fish production during 12 months was recorded as 637 kg in experimental and 531.2 kg in control pond.

The gross fish production was calculated to be 5179 kg /ha/yr in experimental and 4622 /kg/ha/yr in control pond. The total production was contributed as 60.53% *Catla catla,* 39.37% *Labeo rohita.*

Table No. 4 : Growth Performance of Fish in Experimental Pond

Months	*Catla catla*		*Labeo rohita*		Average of Both spp.	
	L*	W**	L	W	L	W
Nov.	15.7	74.0	16.5	69.1	16.1	71.55
Dec.	18.2	95.0	18.9	98.5	18.55	96.75
Jan.	19.9	123.0	22.0	139.5	20.95	131.25
Feb.	23.9	195.5	24.7	179.0	24.3	187.25
Mar.	26.9	281.0	26.2	211.5	26.55	246.25
Apr.	28.1	319.0	27.3	242.0	27.7	280.5
May	28.9	372.0	28.7	328.0	28.8	350.0
Jun.	31.6	495.0	30.5	396.0	31.05	445.5
Jul.	35.0	588.0	34.3	530.0	34.65	559
Aug.	37.8	760.0	36.8	640.0	37.3	700
Sep.	39.2	834.0	37.3	685.0	38.25	1176.5
Oct.	39.6	918.2	39.1	762.0	39.35	840.1

*** : Length in cm. ** : Weight in gm**

Table No. 5 : Growth Performance of Fish in Control Pond

Months	*Catla catla*		*Labeo rohita*		Average of Both spp.	
	L*	W**	L	W	L	W
Nov.	15.9	74.5	16.6	70.1	16.25	72.3
Dec.	17.7	90.5	19.1	98.0	18.4	94.25
Jan.	19.4	103.0	21.2	126.5	20.3	114.75
Feb.	23.4	154.0	23.3	149.0	23.35	151.5
Mar.	26.1	266.0	25.8	198.0	25.95	232
Apr.	27.0	288.0	26.5	222.5	26.75	255.25
May	28.6	324.0	27.4	265.0	28	589
Jun.	30.5	415.5	30.3	365.0	30.4	390.25
Jul.	32.0	526.0	31.8	435.0	31.9	480.5
Aug.	36.5	685.0	35.7	569.0	36.1	627
Sep.	38.0	735.0	36.6	600.0	37.3	667.5
Oct.	38.5	801.4	37.6	646.7	38.05	724.05

*** : Length in cm. ** : Weight in gm**

Table No. 6 : Survival, Growth and Production of Fish in Experimental (E) and Control (C) Ponds (Period of rearing 12 months, pond area 6.12 ha)

Fish Species	NOS. Stocked		NOS Harvested		Rate of Survival		Av. Initial Wt (gm)		Av. Final Wt (gm)		Growth Increment (gm)		Production	
	C	E	C	E	C	E	C	E	C	E	C	E	C	E
Catla catla	384	384	302	312	78.65	81.25	74.5	74.0	801.4	918.2	726.9	844.2	226.4 (219.5)*	258.5 (236.4)*
Labeo rohita	288	288	230	242	79.86	84.03	70.1	69.1	646.7	762.0	576.6	692.9	137.2 (132.6)*	169.3 (167.7)*

Total Production kg E : 5179.48 C: 4622.31 Calculated Production Per ha. E : 404.1 C : 352.1
*** Calculated Quantity.**

At the end of experiment 20.06% increase was recorded in fish production over the control pond, in which 4% increased due to better survival and 16.06% was due to better productivity of pond. The minute organisms which remain suspended in aquatic bodies were for the first time recognized in 1845 by John Miller, However, it was Victor, Hensen (1887) an Ocenographer who coined the term 'Plankton' for such organisms.

Phytoplankton such organisms are plant origin and are auto trops (producers) Zooplankton – The organisms are animal origin they are heterotrophs (Primary Consumers) Plankton serve as primary food for fish in their early stages. The Planktonic study is very useful tool for the assessment of water quality in any type of water body also contributes to understanding of the basic nature and general economy of the lake (Pawar et. al, 2006.) Composition of Zooplankton in experimental and control pond (fig. 7) shows similarities with earlier findings (Kulkarni et. al. (2007) (Mozumder et. al. 2009) and Pandit et. al. (2007)

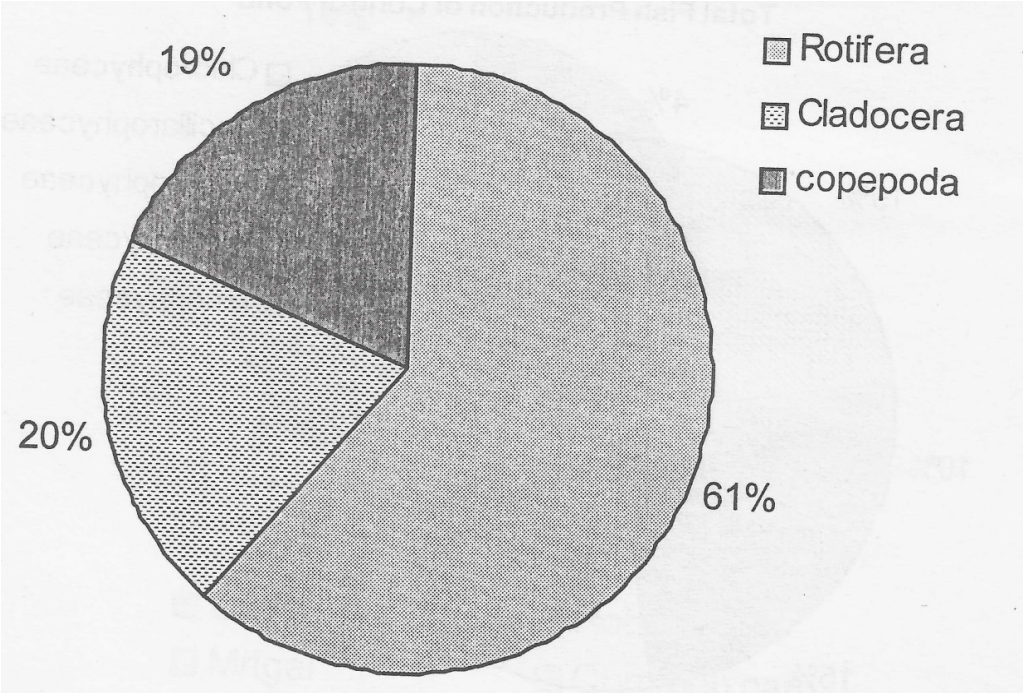

Figure 7 : Composition of Zooplankton in Control Pond

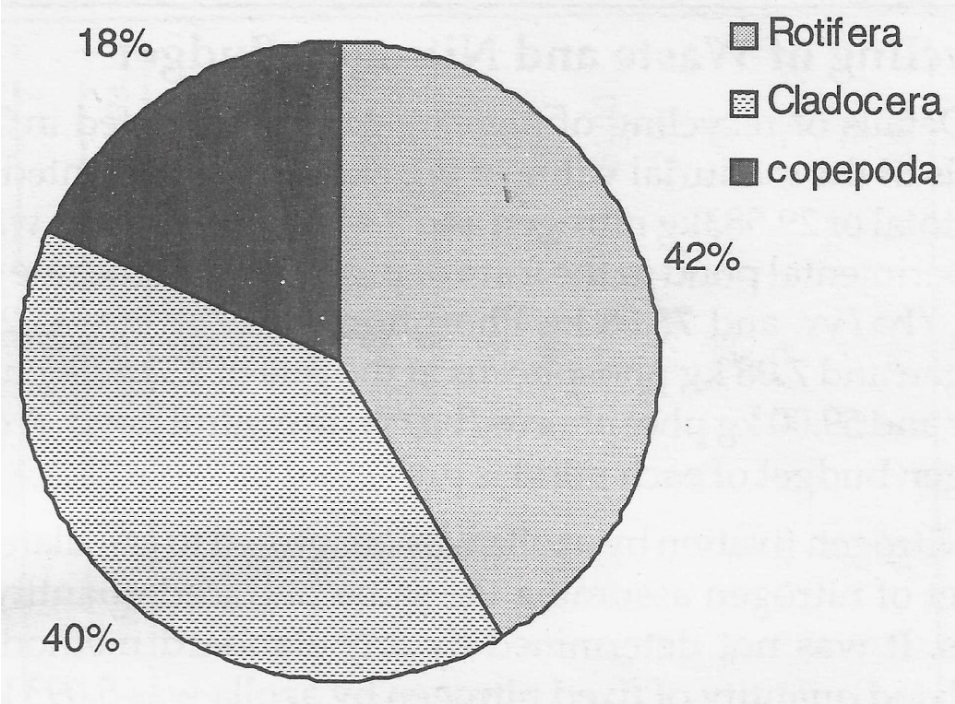

Figure 8 : Composition of Zooplankton in Experimental Pond

Hussain et al (2017) reported minimum density of Phytoplankton during monsoon and maximum during summer. Similarly Chaudhari (1995) reported minimum density of Phytoplankton during monsoon and maximum during summer in Chatla Lake, Assam. Mora et al (2011) reported the peak of Phytoplankton during April while lowest peak in July and August. These findings are positively correlates with the findings of present study.

The maximum number of Zooplankton was observed during winter season followed by summer. The total density of Zooplankton was comparatively higher in experimental pond. All biotic parameters have positively correlation with GPP in both ponds. Composition percentage of Plankton in experiment and control pond minimum *Dipnophyceae* 2.0 and maximum experimental 60.3 *Chlorophyceae* while minimum *Dipnophyceae* 3.6 minimum and maximum 52.9 in control pond respectively. *Rotifera* are 41.5 in experimental and 61.0 in control, *Cladocera* 40.1 in experimental and 20.3 in control, *Copepoda*18.4 in experimental and 18.7 in Control.

The feed supplementation to manure ponds led to significant increase in fish weight and yield (Avnimelech et al 1979) (Battis 1992) (IAAB 1998) concides their result with present study. (Agrawala 2008). The growth of *Catla catla* and *Labeo rohita* showed in the (fig. no. 1, 2 and fig. 3). The growth fishes placed in control and experimental pond shown (fig. 4)

Conclusion

The favorable conditions essential for Plankton and fish survival, growth and reproduction for the better yield of Indian major carps. A total 18 genera of Phytoplankton were observed and recorded 8 genera of *Chlorophyceae,* 4 genera of *Bacillariophyceae,* 3 genera of *Cynophyceae, 2* genera of *Euglenophyceae* and 1 genera of *Dinophyceae.* A total 7 species of Zooplankton were collected during the present study i.e. from November 2021 – October 2022. The study including 2 species of *Rotifera,* 3 species of *Cladoderma,* and 2 species of *Copepoda.* Keeping in view the great importance of Indian major carps as food and having fast growth, we investigated the composition of Plankton and better production for two major carps *Catla* and *Rohu.* The total fish production during 12 months was recorded 637.8 kg in experimental and 531.2 kg in control pond.

The gross fish production was calculated to be 5179 kg/ha/yr in experimental pond and 4622 kg/ha/yr in control pond. The total production was contributed as 60.53% *Catla catla* and 39.37% *Labeo rohita* Individual fish of highest weigh was recorded as *Catla catla* 1350 gm in experimental pond and *Labeo rohita* 1200gm in experimental pond.20.06% increase was recorded in fish production over the control pond, in which 4% increased due to better survival and 16.06% was due to better productivity of pond.

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