Growth Performance of Carps Cultured Under Different Experimental Conditions at Akividu, West Godavari District, Andhra Pradesh

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Abstract: The objective of the present study is to assess the influence of different fertilizers, supplementary feed and probiotics on growth performance of major carps Catla (*Catla catla*), Rohu (*Labeo rohita)*, Mrigala (*Cirrhinus mrigala*) and Grass carp *(Ctenopharyngodon idella)* cultured under different treatments for a period of one year from August, 2014 to July 2015 at Akividu, West Godavari District, Andhra Pradesh, India. Four experimental ponds i.e. Control (C), Treatment-1 (T1), Treatment-2 (T2) and Treatment-3 (T3) were selected for this study. Among the four treatments, maximum average body weight of carps was recorded in T3. Among the four fish species, Catla showed the maximum average body weight (1313.4g) in treatment pond-3. The highest specific growth rate was observed in treatment-3. Overall the highest survival rate of four carps recorded in T3. The FCR varied from 1:2.70 to 1:3.28 in T2 and T3. The gross yield recorded as 3485.97, 4456.44, 6133.56 and 7311.98 kg/ha in Control, T1, T2 and T3 respectively. The physical and chemical characteristics of pond water remained within the favorable limits during culture. The lowest biomass of plankton (51.4 to 96.8mg/l) recorded in C, while the maximum plankton biomass (96.4 to 145.8 mg/l) recorded in T3.

Key word: Indian Major carps, supplementary feeds, probiotics, growth, survival and FCR

INTRODUCTION

Aquaculture is one of the most promising and fast-growing food- producing sectors, which provides rich animal protein, generates income and employment around the globe (FAO, 2010). The world aquaculture production reached to 179 million tons in 2018, up by 32.0% from 59 million tons in 2010. The estimated value of cultured fish food is US$ 263.6 billion. Aquaculture has contributed 46.0% to the world total fish production (FAO, 2020). Importance of aquaculture is increasing dramatically because of overfishing of the world's waters and exponential increase in demand for fish food. Sustained and enhanced production is the essential need in aquaculture. Various techniques such as intensive aquaculture, spatial and temporal expansion of aquaculture activities, introduction of new species for aquaculture, and improved health management strategies are some of the important reasons for the rise in aquaculture productivity in recent years (Panigrahi and Azad, 2007). Similar to the world scenario, India's aquaculture sector is increasingly becoming important with an annual growth rate of over 6% and is the second largest producer in the world, next only to China (Ayyappan and Modayil, 2007). Carps are the main species of Indian aquaculture and its culture practice has strong traditional knowledge. Three Indian major carps namely catla (*Catla catla*), rohu (*Labeo rohita*) and mrigal (*Cirrhinus mrigala*) contribute about 84% of India's aquaculture production.

The success of aquaculture depends significantly on the availability of well-balanced nutritionally complete and cost effective compounded feeds. In India, the aquaculture practices mainly revolve around a few species of finfish and shellfish, among which the Indian Major Carps and the Chinese major carps contribute substantially to the inland production. Fish require adequate nutrition in order to grow and survive. Nature offers a great diversity of food to fish including plants and animals. Artificial feed plays an important role in semi intensive fish culture where it is required to maintain a high density of fish than the natural fertility of the water can support (Jhingran, 1991).The artificial feed contains fishmeal and plant origin along with the manure plays a key role in enhancing productivity and performance in terms of weight gain and specific growth rate in carp culture system (Samantaray and Mohanty, 1997; Kalla *et al.,* 2004; Goda *et al.,* 2007).

Aquaculture is the world's fastest growing food production sector; however, fish culture is currently suffering from serious losses due to infectious diseases. The use of antimicrobial drugs, pesticides and disinfectants in aquaculture to disease prevention and growth promotion are led to the evolution of resistant strains of bacteria. Thus, the research into the use of probiotics for aquaculture is increasing with the demand for environment – friendly sustainable aquaculture. The benefits of such supplements include improved feed value, enzymatic contribution to digestion, and inhibition of pathogenic microorganisms, anti-mutagenic and anti-carcinogenic activity, and increased immune response. These probiotics are harmless bacteria that help the well-being of the host animal and contribute, directly or indirectly to protect the host animal against harmful bacterial pathogens (Lara-Flores *et al.,* 2003; Vine *et al*., 2004; Kesaecodi- Waston *et al.,* 2008; Soundarapandian and Sankar, 2008; Dimitroglou *et al.,* 2011; Iribarrel *et al.,* 2012; Gabriel *et al*., 2012; Maryam *et al.,* 2013; Perez-Sanchez *et al.,* 2013; Gupta *et al.,* 2014; Parvathi and Sivakumar,2016; Susmita Das *et al.,*2017).

The present study aims to understand the effects of fertilization, supplementary feeds and probiotics on growth and

survival of carps, *Catla catla, Labeo rohita*, *Cirrhinus mrigala* and *Ctenopharyngodon idella* in polyculture systems.

MATERIALS AND METHODS

Study area

The experiment was undertaken in four private fish farms located at Akividu, West Godavari District, Andhra Pradesh, India. The experiment was conducted for a period of one year from August, 2014 to July 2015 in carp culture ponds, to study the growth performance of major carps Catla (*Catla catla*), Rohu (*Labeo rohita)*, Mrigala (*Cirrhinus mrigala*) and Grass carp *(Ctenopharyngodon idella)* under different treatments. For this study, four ponds Control (C), Treatment-1 (T1), Treatment-2 (T2) and Treatment-3 (T3) were selected, which were rectangular- in shape having bunds on all sides, well exposed to sunlight. The water spread area of each pond was 2.0 ha. The ponds have inlets and outlets. The depth of all the four ponds ranged between 1.5 and 2.0 m.

Pond preparation

The experimental ponds were drained and dried for fifteen days before stocking. Purpose of sundried is to disinfect the pond and stabilization of pH, liming with CaO was applied at the rate of 125kg/ha with dusting method (Wahab *et al.*, 2002). Essential precautionary measures were taken to screen the water inlets to avoid the entry of unwanted fishes and other unimportant material in to the fishponds. After two weeks of pre stocking management, each pond watered up to 1.5 m and this water level maintained throughout the experimental period. All the ponds were fertilized with organic manure (cow dung) at the rate of 2000kg/ha as starting dose to stimulate the productivity of the ponds.

Stocking of fish species in experimental ponds

Two weeks after manuring, each pond was stocked with catla, rohu, mrigal and grass carp (15-16gm weight and 101-110 mm length) brought from Ananda Hatcheries Private Limited, Bhimavaram located in West Godavari District, Andhra Pradesh. Each species was held separately in oxygenated polythene bags. These seed bags were placed in the experimental ponds and acclimatized with pond water. Each pond stocked in the ratio of 3:20:3:1(catal; rohu: mrigal: grass carp). The stocking density of each pond was 8000 fingerlings/ha. High stocking density of rohu in the pond is due to high market demand in this area.

Fertilization and supplementary feed

The organic fertilizer (dry cow dung 12,000kg/ha/crop period) only applied to control pond, the dry cow dung (10,000kg/ha/crop period) and Di ammonium Phosphate 500 kg/ha/crop period) were applied to treatment pond-1. The dry cow dung (8,000 kg/ ha/ crop period) and the traditional supplementary feed having 25% crude protein which includes fishmeal, rice bran, groundnut oil cake, vitamins and mineral mix applied in Treatment pond-2. The dry cow dung (6,000 kg/ha/ crop period) and formulated slow sinking supplementary feed (Carpmax, Growel Feeds Pvt Ltd. Sri haripuram, Krishna District) having 25-26% crude protein along with feed probiotic (Aqualact, Biostadt India Ltd. Maharashtra) at the dose of 5g /kg feed and water probiotic (Progreeen, polyclone sciences, Bangalore) at the dose of 1000 g/ha/ 7 days were given in treatment pond-3. Fertilizers applied on every 15 days, whereas supplementary feed applied on daily basis at the rate of 5% of their biomass.

Water quality parameters

The physical parameters observed were surface water temperature and Secchi disc transparency. Chemical parameters of water estimated includes dissolved oxygen, pH, total alkalinity, total hardness, nitrite-N, nitrate-N, ammonia-N, orthophosphates and iron were analyzed by using standard methods (Golterman and Clymo,1969; Wetzel and Likens, 1979; APHA, 1999)

Fish growth parameters

Fish samples taken once in each month to record their length (mm) and weight (g). The growth parameters estimated by using the following methods (Das *et al*., 2005).

1. **Increment in body weight of fish (g):** Final body weight- Initial body weight.
2. **Survival rate:**

$$\text{Survival rate} = \frac{\text{No. of fish harvested}}{\text{No. of fish stocked}} \times 100$$

3. **Specific Growth Rate (**Vincent Lugert *et al.,* 2016)**:**

$$SGR = \frac{\log(W_f) - \log(W_i)}{t} \times 100$$

Where W_f =Final wet body weight, W_i =Initial wet body weight t = days of culture

4. Feed Conversion Ratio (FCR) (Aliyu-Paiko *et al*., 2010):

$$FCR = \frac{\text{Total feed intake (kg)}}{\text{Total wet weight gain (kg)}}$$

RESULTS

The water quality parameters

The water quality parameters maintained in the experimental ponds were presented in table 1. The temperature recorded varies between 26.0 and 33.9°C, DO ranges from 4.2 to 6.2 mg/l, pH ranges from 7.0 to 8.3, Nitrite-N ranges from 0.008 to 0.186 mg/l, Ammonia-N ranges from 0.50 to 0.98 mg/l, and Plankton biomass ranges from 51.4 to 144.8 mg/l during the study period. The highest DO and lowest values of Nitrite-N and Ammonia-N were reported in T3 pond.

Table 1: water quality parameters in cultured ponds

S. No.	Parameters	C	T1	T2	T3
1	Temperature (°C)	27.5-33.9	26.0-33.5	28.0-33.4	28.5-33.6
2	DO (mg/L)	4.2-6.1	4.8-5.9	4.4-6.1	4.9-6.2
3	pH	7.0-8.3	7.0-8.1	7.1-7.9	7.0-7.8
4	Alkalinity (mg/L)	130-175	125-165	145-185	144-174
5	Hardness (mg/L)	184-720	185-220	190-230	158-235
6	Transparency (cm)	28.0-42.0	30.0-42.0	30.0-40.0	30.0-38.0
7	Nitrate (mg/L)	0.04-0.35	0.06-0.38	0.12-0.52	0.10-0.41
8	Nitrite (mg/L)	0.009-0.186	0.010-0.183	0.009-0.182	0.008-0.162
9	Ammonia (mg/L)	0.55-0.98	0.64-0.97	0.58-0.94	0.50-0.70
10	Iron (mg/L)	0.35-0.91	0.39-0.91	0.32-0.88	0.29-0.84
11	Orthophosphate (mg/L)	0.70-1.24	0.92-2.71	0.64-1.42	0.332-1.24
12	Plankton biomass (mg/L)	51.4-96.8	52.8-99.6	92.8-125.1	96.4-144.8

Growth Performance of Fish

A. Total body weight of the fish

a) *Catla catla*

At the time of stocking**,** the initial average body weight of catla was recorded as 15 g in four treatments and the final average body weight was observed as 1032.0, 1145.9, 1232.0 and 1313.4 g in C, T1, T2 and T3 respectively. Overall, the maximum increment (159.8g) and final body weight (1313.4g) noticed in T3 (Fig 1a).

b) *Labeo rohita*

The initial average body weights of rohu were recorded as 15 g in four treatments, whereas the final average body weight were 638.8, 677.1, 957.7 and 1048.9g in C, T1, T2 and T3, respectively. Overall, the maximum increment (140.2g) and final body weight (1048.9g) noticed in T3 (Fig 1b).

c) *Cirrhinus mrigala*

The initial average body weight of mrigal was 16.0 g in four treatments, while the final average weight observed as 724.6, 737.6, 803.4, and 927.8 g for C, T1, T2, and T3 respectively. Overall, the maximum increment (122.4g) and final body weight (927.8g) noticed in T3 (Fig. 1c).

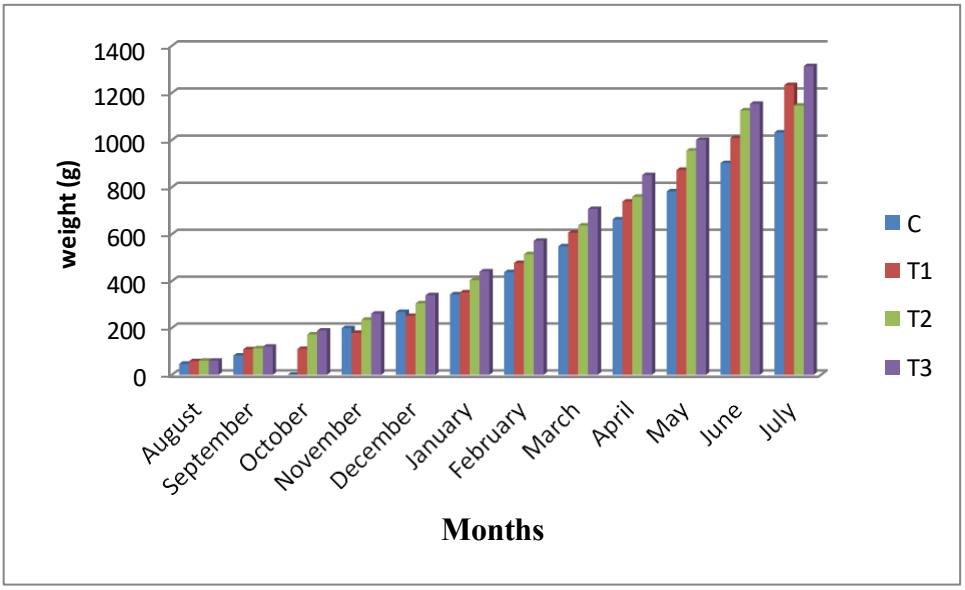
d) Ctenopharyngodon idella

The initial average body weight of grass carp was 15.0 g, while the final average weight observed as 843.0, 836.5, 929.0g and 972.0g for C, T1, T2, and T3 respectively. Overall, the maximum increment (125.8g) and final body weight (972.0g) noticed in T3 (Fig. 1d).

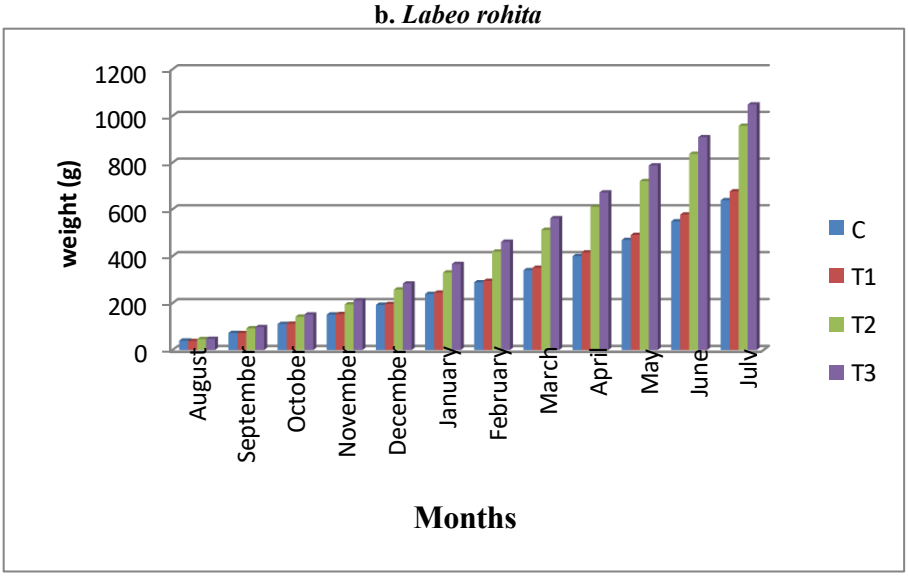
Analysis of variance revealed a significant difference ($P<0.05$) in the average body weight of carps in four experimental ponds during the study period.

Fig.1: Monthly increase in average body weight (g) of Carps under different treatments

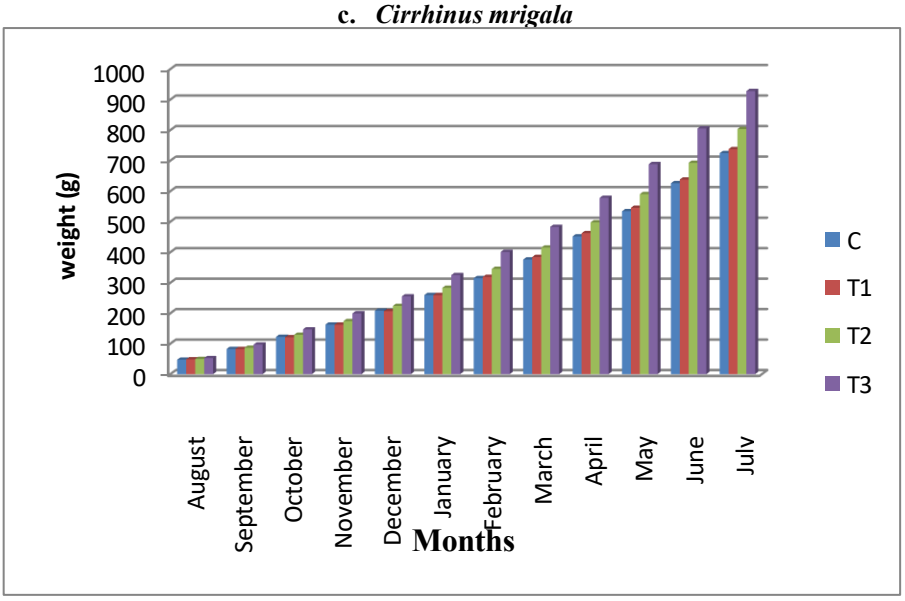
a. Catla catla



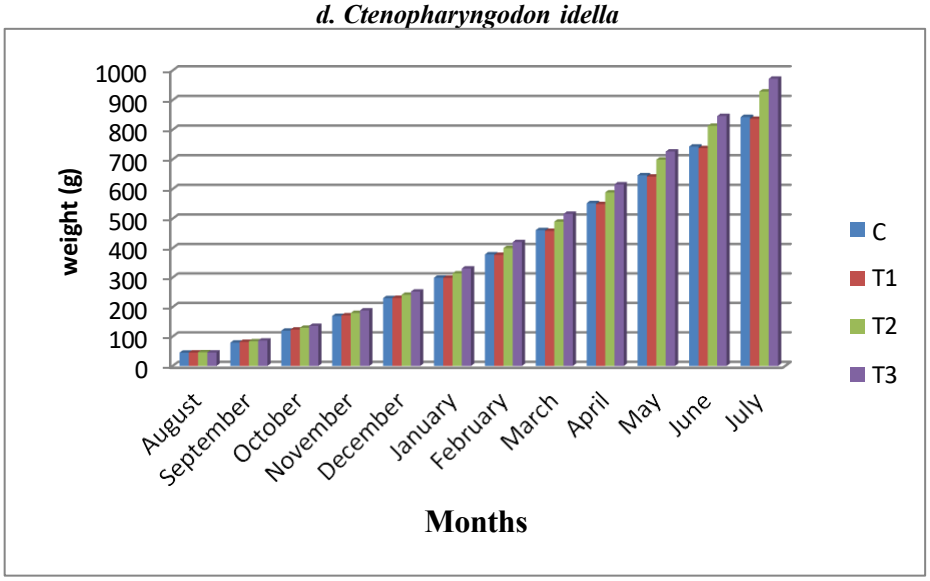
b. *Labeo rohita*



c. *Cirrhinus mrigala*



d. Ctenopharyngodon idella



B. Specific growth rate

a) *Catla catla*

Catla showed the minimum value of specific growth rate in C as 0.5034% /day and the highest value of specific growth rate recorded in T3 as 0.5321% /day. The overall specific growth rate in catla was observed as 0.5034, 0.5158, 0.5245 and 0.5321% /day in C, T1, T2 and T3 respectively (Fig. 2).

b) *Labeo rohita*

The specific growth rate of rohu was recorded in C, T1, T2 and T3 as 0.4462, 0.4532, 0.4944 and 0.5052% /day respectively. The minimum specific growth rate observed as 0.4462% /day in C and the highest value of specific growth rate was observed in T3 as 0.5052% /day (Fig 2).

c) *Cirrhinus mrigala*

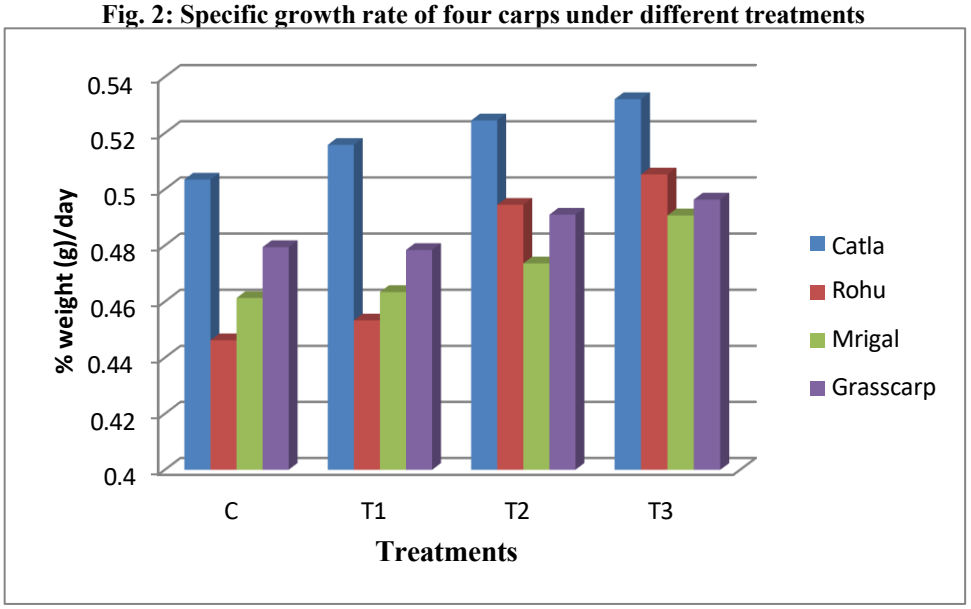
The specific growth rate of mrigal was observed in C, T1, T2 and T3 were noted as 0.4612, 0.4633, 0.4736 and 0.4906%/ day respectively. Highest specific growth rate was observed in T3 0.4906% /day, whereas the lowest value recorded in C as 0.4612% /day (Fig.2).

d) *Ctenopharyngodon idella*

The specific growth rate of grass carp was noticed in C, T1, T2 and T3 as 0.4793, 0.4783, 0.4909 and 0.4963% /day respectively. The minimum specific growth rate observed in C was 0.4783% / day. The highest specific growth rate was observed in T3 0.4963% /day, (Fig. 4).

Analysis of variance showed highly significant difference within the treatments and between the species for specific growth rate in terms of weight of all four species studied.

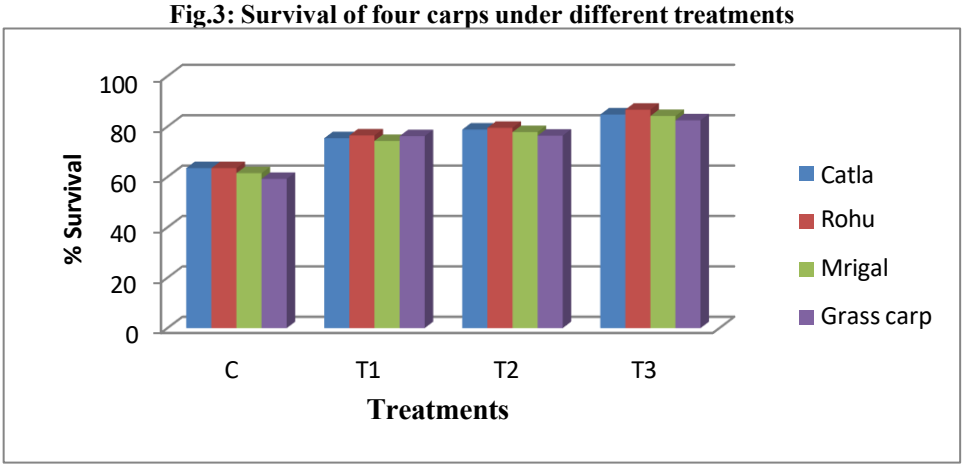
Fig. 2: Specific growth rate of four carps under different treatments



C. Survival

At the end of the experiment, an average survival rate of catla, rohu, mrigal and grass carp under different treatments was given in Fig.3. The survival rate of various species in treatments C, T1, T2 and T3 in the present study varied from 58.2 to 86.7%. The highest survival recorded in rohu in T3 and lowest survival rate recorded in grass carp in C over all highest survival of four carps recorded in T3.

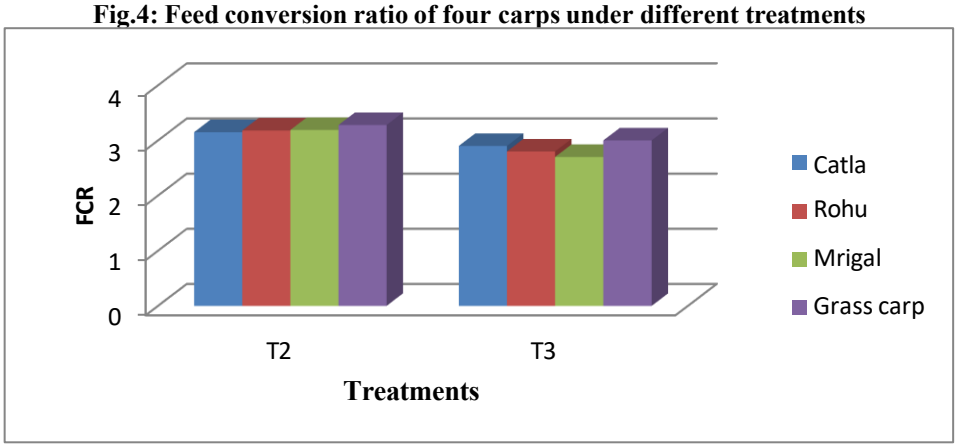
Fig.3: Survival of four carps under different treatments



D. Feed conversion ratio (FCR)

The average feed conversion ratio calculated for treatments 2 and 3 and varied from 1:2.7 to 1: 3.28. The highest FCR recorded in grass carp was 1: 3.28, whereas lowest FCR recorded in mrigal was 1:2.7. Comparatively lowest FCR recorded in T3 for all four species studied (Fig.4).

Fig.4: Feed conversion ratio of four carps under different treatments



E. Gross yield

The gross yield in different treatments obtained was 3485.97, 4456.44, 6133.56 and 7311.98 kg/ha in C, T1, T2 and T3 respectively. The highest yield recorded in T3, which influenced with application of formulated feeds along with probiotics apart from organic manure (Table 2).

Table 2: Total yield (Kg/ha) of major carps under four treatments

Species	C	T1	T2	T3
C. Catla	491.19	648.68	728.53	835.32
L. rohita	2535.40	3237.38	4758.81	5690.28
C. mrigala	334.32	411.03	468.78	585.91
C. idella	124.76	159.35	177.44	200.47
Total	3485.97	4456.44	6133.56	7311.98

DISCUSSION

The application of organic manure, inorganic fertilizers, supplementary feed and stocking of species ratio makes the maintenance of production in polyculture system. Organic manure, chemical fertilizers, supplementary feed including animal and plant based proteins utilized as a source of energy in the poly culture to increase the fish yield and primary

productivity of pond ecosystem (Veerina *et al*., 1999; Tanveer *et al*., 2001; Abdelghany and Ahmad 2002; Azim *et al*., 2002; Rahman *et al*., 2006; Keshavanath *et al*., 2006; Islam *et al*., 2008; Prabaharan and Senthil Murugan 2012; Vishnu Nair, 2014; Meraj *et al*., 2017). The quantity and quality of feed influenced have pronounced effect on survival, growth and feed conversion, efficiency and proximate composition of fish (Jena *et al.,* 1998; Erfanulla and Jafri, 1998; Krishna, 2006). Fish weight gain increased may indicate that increase in productivities of culture ponds perhaps as results of supplementary feeding.

The gross yield in different treatments in the present study obtained as 3485.97, 4456.44, 6133.56 and 7311.98 kg/ha in C, T1, T2 and T3 respectively. The results of present study revealed that the end of the experiment, all four species gained maximum weight in T3, which, influenced with application of formulated feeds along with probiotic apart from organic manure. The results are in co-ordinance with the findings of Mahboob and Sheri (1997), who obtained the fish production 7,400 to 9400 kg-1 ha-1 yr-1 by using broiler dropping and NPK fertilizer. Mahboob *et al*., 1995 reported that the use of supplementary feed is also recommended along with the chemical fertilizers and organic manure in order to get maximum production of fish from limited water bodies within the shortest possible time. The fertilization and provision of supplementary feed with additives such as mineral and vitamin premix had a positive influence on the growth of major carps (Diana *et al.,* 1994; Veerina *et al*., 1999). Azim *et al*., 2002 and Ahmed *et al*., 2005 stated that growth, specific growth rate of major carps were higher in fertilized pond with provision of supplementary feed than fertilized alone. The supplementary feeds like ground nut oil cake, cotton seed meal, de-oiled rice bran, sunflower meal and additives in the feed such as salt and mineral mix along with organic manure contribute to high yield in poly culture (Keshavanath *et al*., 2006; Rahman *et al*., 2006; Islam *et al*., 2008; Prabaharan and Senthil Murugan, 2012; Suresh Babu *et al*., 2013; Steffens, 1990). Ganesan *et al*., 2015 stated that the fish production was highest in artificial feeds than traditional feed.

According to Islam, (2002) feed with 30% protein is considered best, with respect to the growth and production performance of the fish and the per unit price of the feeds. Noor Khan *et al.,* (2011) reported that growth performance and economic assessment of catla, rohu and mrigal fed with 42% protein diet under monoculture semi-intensive system, catla and rohu showed higher growth than mrigal. In the present investigation optimum protein supplement in T2 and T3 used was 25-26%. Fish fed either natural (through fertilization) or supplementary diets showed regular weight increments during growth period. The growth rate of fish in both treatments (T2, and T3) used by supplementary was significantly different from fertilizer treatments (C, and T1). Besides the fertilization of organic and inorganic fertilizers and supplementary feed including animal and plant protein diets utilized as a source of energy and feed in polyculture to increase the fish production and primary productivity of pond ecosystem (Abdelghany and Ahmed, 2002). The quantity and quality of supplementary diet have a higher effect on growth rate, feed conversion efficiency (Erfanullah and Jafri, 1998; Jena *et al.,* 1998; Krishna, 2006; Chovatiya *et al.,* 2011).With a view of reducing feed input cost in aquaculture practices, it is necessary to develop better feeding strategies by incorporating plant and animal based feed in feeding practices (Saha and Ray, 1998a, 1998b).

The high percentage of survival obtained in all four carps in T3 suggests that factors such as fertilization and supplementary feed along with probiotic. Chaudhuri *et al.,* (1978) stressed the important of those factors in governing survival rate. Highest survival rate (82.5- 86.7 %) was found in T3, which is similar to Haque (1984) who recorded 76.0 to 93.33% survival rate in case of carp culture. Ash and Jaya, 2001 reported highest survival (95.7%) in carps fed with high protein diets. Das *et al*., 2005 recorded highest survival (98.7-100%) at Temperature between 31 and 33˚C. Krishna et al., 2015 also observed highest survival (86.8%) of carps fed with supplementary feed along with organic manure. Jhingran (1991) reported that assertion of supplementary feed enhanced the survival rate of carps in polyculture. The survival and growth of the fish depending upon the nutrients composition of feed also varies with methods of feeding, size of the fish, environmental factors such as temperature, dissolved oxygen and other water parameters may directly effect on the organisms (Krishna, 2006).

According to Azim *et al*. (2002) growth, specific growth rate of major carps were higher in fertilized pond with the provision of supplemental feed than in control (fertilization alone). Nandeesha *et al*., (2001) also noted that the specific growth rates, protein efficiency ratio as well as growth rate were more pronounced in animal and plant based diet as compared to animal based diet. There it's a need to grow fish on relatively cheap, readily available and nutritionally rich formulated feed. During present investigation, catla and rohu showed the maximum SGR with T3 treatment compare with other treatments. Data for SGR revealed the significant ($P < 0.01$) difference for all treatments, which coincide with the findings of Dhawan and Kaur (2002a, 2002b and 2002c) and Sahu *et al*. (2007) for these species. It was indicated that higher fish production was observed in T3 which was influenced with fertilizers and supplementary feed along with probiotic when compared with fertilizer alone in the present study.

In the present study the lowest FCR (2.7 to 3.00) recorded in T3 compared to T2 (which was not treated with probiotic). Ali *et al*., (2003) also stated that the prominent increment in weight of the fish gain, feed conversion ratio (FCR) at the rate of 6% feeding rate, appeared to be optimal, as it significantly supported the highest fish production and net profit as compared to other levels of supplementary feeding major carps.

The results of the present study substantiate the fact that probiotics have direct growth promoting effects on catla, rohu, mrigal and grass carp which is accordance with reports of FAO/WHO, 2001; Noh *et al*., 1994; Ringo and Galewoupe, 1998; Bogut *et al*., 1998; Chaudhary and Qazi, 2007; Krishna *et.al*., 2009; Abdul Kader *et al*., 2010; Gohila *et al*., 2013.

Probiotic bacteria can enhance the host enzyme secretion which increased the digestive efficiency of the complex protein and lipids included in the diet thus increasing food digestion and absorption by the host (Tovar *et al*., 2002; Ghosh *et al*., 2007 and 2008). Probiotic bacteria also effect the production of the vitamins particularly B-group vitamins (Goldin and Gorbach, 1992; Gosh *et al*., 2007). Krishna *et al*., (2015) reported that the concentration of ammonia, nitrite and orthophosphate are low in the experimental ponds treated probiotic compared with control pond. They further stated that growth and survival obtained higher in probiotic treated ponds than of control pond. Karthegaa *et al*., (2016) also stated that fish fed with isolated intestinal microbes along with formulated feed showed higher growth performance.

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