A Report on

"Study of growth and survival of carp seed in earthen ponds"

Final Report of Minor Research Project

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❖ **Introduction**

The immense food and economic values of fishes have attained considerable interest in the development of fisheries under natural and artificial conditions in India. The development of inland fisheries not only aims at culturing of edible varieties of fishes but also takes into consideration the various biotic and abiotic factors for their quick growth.

The culture of fish in ponds started more than 2000 yrs. in southeast Asia and in India. It has long been practiced in the state of West Bengal. However there are varieties of fresh water fishes in our country. Most of these are predatory and are unsuitable for culture because of low yield. Such fishes are avoided in culture. Non predatory, herbivorous and phytophagous fishes with fast growth rate and compatible feeding habits like the Indian, Chinese and common carps are preferred for culture as these give high yields (Hora and Pillay, 1962).

In India, Pakistan and Burma Indigenous species such as *Catla catla, Labeo rohita, Cirrhinus mrigala and labeo calbasu* are stocked and grown together in the same pond. In Bengal mixed fish culture is an old practice and *Catla, Rohu and mrigal* in the ratio 3:3:4 are reported to be commonly stocked in pond (Alikunhi, 1957).

A characteristic feature of the growth of fish is its periodicity. In certain season, fish grow rapidly while in other season they grow more slowly. This inequality in the growth rate throughout the year is well reflected in various bones of skeleton and scales. The period of slow growth are imprinted on the skeleton in the form of rings or stripes. These stripes consist of small flattened cells and they appear dark in direct light. Conversely, the period of fast growth are characterized on the scales and skeleton by wide fields or rings. Primary factors which affect fish growth are soil, water, temperature, dissolved gases, etc.

The gases, nutrients and pH constitute the chemical characteristics of a pond. Among the dissolved gases, oxygen is essential for respiration of animal life. However with abundant phytoplankton and submerged vegetation, diurnal fluctuation in oxygen content occurs in pond.

The present work has been undertaken to study the growth rate of carp seed of three Indian carps *Catla catla, Cirrhinus mrigala and Cyprinus carpio in* earthen ponds. The growth is studied by the use of different supplementary feeds in relation to physico-chemical condition of water in artificial ponds. This study is useful in fish culture system for composite fish farming.

❖ <u>**Review of literature**</u>

❖ **Natural feeding of Carps**

The main source of natural food for fish comprises phytoplankton and zooplankton. The natural fish food organisms grow profusely in pond water body with the presence of mineral rich organic matters in the form of manures and serves as living capsules of food which is composed of proteins, carbohydrates, fats, vitamins and minerals. In the ponds, the various natural food items make a substantial contribution to the food of carps and more production is based upon increasing the natural food concentration in the ponds (Hepher,1975)

It is generally considered best that natural food should represent about one half of the diet and artificial food should only be used as a supplement in carp cultivation. It has been observed that, natural food is an important factor in the growth of carps in ponds (Tal, 1967). Banerjee *et al*.,(1969) found better results of food supplementation for rearing carp spawn using poultry manure mixed with cowdung than those with cowdung alone for producing desirable planktons. In the carp culture, the natural food is indispensable both nutritionally as well as economically (Hickling, 1962 and Huet, 1975). Prolubnikov and kokova (1984) studied the effect of diversity of live food mixed with supplementary food on the development and growth of common carp larvae. (Gupta *et al*.,1985) investigated productive potentiality and economic viability of poultry manure alone and in combination with pig dung in carp culture.

Higher growth was observed in *Rohu* fry with *Moina* species, may be due to higher protein content which act as a body building material for the fish growth.

The plankton generated in nurseries due to manuring is depleted within few days after spawn is introduced and it therefore, becomes necessary to resort supplementary feeding to ensure good survival and high growth of fish (Alikunhi, 1957).

❖ **Artificial feeding of Carps**

Supplementary feeding is very much essential in the success of pond culture technique. Fish culture has been further intensified by using various types of food ingredients in supplementary foods, thereby, resulting in enhanced production of fish. Investigations on supplementary feeding of the carp spawn, fry, fingerlings and adult fishes have been carried out in India and abroad by a number of scientists with various feed ingredients of plant and animal origin. Das and Moitra (1956) studied the food and feedings habits of Indian fishes and categorized fishes according to the nature of food intake. Alikunhi (1957) studied the supplementary food and feeding habits of Indian major carps spawn and reported that carp spawn take supplementary feeds two days after commencement of feeding. Hickling (1962) has reviewed the work done on supplementary feeding prior to sixties.

Das (1959) has made a study of the effect of various feeds on Carp spawn when reared in manured nurseries and give artificial feeds with different combinations of protein, fat, carbohydrate, roughage, Vitamin and cobalt nitrate. The maximum growth of spawn obtained with the feed having a combination of hydrolyzed protein and carbohydrates (50:30). Das (1959) also observed that vitamin B12 and cobalt nitrate combined with stomach extract of goats. significantly enhanced the survival rate of major carp spawn.

In Egypt, experimental feeding of carps has shown the highest growth when fed on a mixture of 75% rice bran and 25% cotton seed cake (Bishai *et al*., 1972). In India, the commonly used supplementary feed for carps consists of a mixture (1:1) of rice bran and one of the locally available oil cakes. This conventional feed in nutritionally imbalanced to achieve fast growth of fish (Verghese *et a.l*, 1976) . Many workers have formulated pelleted feeds by using commonly available, low cost feed ingredients mainly to feed common carp. (Jayachandran and Paulraj, 1977; Verghese *et al.,* 1976; Zaki *et al.*, 1994; showed a positive correlation between the protein content of feed and the daily increment in the weight of fish (5% level) and also between the fat content of the feed and daily weight increment of the fish. Verghese *et al.* (1976) using protein rich pelleted feed containing fish meal, rice bran, groundnut oil cake, rice flour and mineral mix has given 50% more production of common carp compared to those fed with a mixture (1.1) of rice bran and ground nut oil cake. Meske (1976) has reported feeding of carps with fish meal free dry pelleted feed, formulated using a mixture of soya granules, soya milk powder, fat, scenedesmus powder (alga), casein and yeast.

According to Huet (1975), the best water for fish culture is one which is neutral or slightly alkaline with a PH between 7.0 to 8.0 The optimum oxygen level of cyprinids should be around 6. to 7.0 mg/L. Viasov (1990) studied the effect of water, PH on growth of carps. Banergea (1967) observed that oxygen concentration above 5.0 mg/L is indicative of productivity while below that level, the water is unproductive.

Fish pond manuring is mainly to provide ample amounts of a essential nutrients for plankton production, (Steinberg *et al*., 2006). Manuring is widely practiced in fish pond for natural fish production as it is important for sustainable aquaculture and to minimize expenditure of artificial feeds which form more than 55% of the total input cost, (Oribhabor and Ansa, 2006).

A number of studies focused on the role of fertilizers in fish production (Garg and Bhatnagar, 2000; Dhawan and Kaur, 2002b; Das *et al*., 2005; Sayeed *et al*., 2007) and of supplementary feed in systems receiving fertilizers. (Aziz *et al*., 2002; Virk and Saxena, 2003; Ahmed *et al*., 2005; Waidbacher *et al*., 2006; Manjappa *et al*. ,2009 and Elnady *et al*., 2010).

❖ Material and Method

To study the effect of supplementary feed along with natural food on the growth and survival of carp seed, the experiments were carried on M/S. Pioneer Fisheries, Fish breeding and fish culture centre at Anjale Tal. Yawal, Dist.- Jalgaon four ponds with their replicates were selected to study the growth.

Eight ponds of following sizes were selected as –

Sr. No.	Pond	Size of pond		Area in sq.mtrs.		Volume Cum.	Area Hactre	Seed/Ha 200000/ Ha
		Length in mtrs	Width in mtrs					
1	Pond No 1+1	20.30	16.6	326			0.032	64000
		20	15	300	626	939	0.03	60000
2	Pond No 2+2	20.30	15	304.5	604.05	906.75	0.030	60000
		20	15	300			0.03	60000
3	Pond No 3+3	29.6	13.3	393.68	729.68	1093.5	0.039	78000
		28	12.0	336			0.033	66000
4	Pond No 4+4	29.6	10.3	304.88	574.88	862.32	0.030	60000
		27	10	270			0.027	54000

The ponds are on the bank of Mor river near the junction of Tapi river. The topography of the sight Anjale is 21^{oc} 05’ 31.27’’ N latitude 75^{oc} 45’ 38.92” east longitude it is 586AMSL (Above mean sea level).

The soil of the pond is clay with stones of calcium carbonate. The soil has good water holding capacity. NPK value and micronutrients present in the soil are tested in the laboratory of Madhukar Sahakari Sakhar Karkhana Ltd. Nhavi Marg, Faizpur.

The water for fish culture was taken from bore well which is 45 feet deep with full ground water.

To get profit in fish culture, it is necessary to select such species which can utilize natural and artificial feed to maximum extent and grow rapidly to attain large size major carp and common carp is selected for present study. They have fast growth rate, they are able to use not only the natural food of pond efficiently but artificial food also to maximum advantage. Common carp is able to survive under stressed water quality also.

Present work done from June 2012 to September 2012. The ponds were dried in may. Liming was done with the help of calcium carbonate 250kg/Ha. Manuring was in the ponds PE1, PE2, PE3 and CP nursery ponds. Ponds PE1, PE2, PE3 were experimental ponds while CP was control pond. Manuring was done by adding following components to all ponds.

1. Cowdung @ of 10000 kg/ Ha - 350 kg. for each pond.
2. Urea @ of 250 kg./Ha - 8.5 kg. for each pond.
3. Super phosphate @ 250kg./Ha - 8.5 kg. for each pond.

The ponds were filled with borewell water and manuring was done in the second week of June to produce phytoplankton and zooplanktons. The aquatic insects, predators were removed from all nursery ponds.

The fish seed of *Catla catla, Cirrhinus mrigala & Cyprinus carpio* was procured from private party in the form of fry and it was stocked. The stocking rate of fry was 2 millions fry/Ha.

Sr.No.	**Pond**		**No. of seed at fry stage**
1	Pond No 1+1	PE1	124000
2	Pond No 2+2	PE2	120000
3	Pond No 3+3	PE3	144000
4	Pond No 4+4	CP	114000

The water samples were collected once in month. The time was fixed at 9.00 a.m. the water is collected from four corners and centre of each nursery pond in a 5 litre clean plastic cans. Separate can were used for each nursery pond.

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They were carried to laboratory for analysis of physic chemical characters.

The selected physico-chemical parameters of water were analysed by water quality analyser. The parameters like Temperature, pH, Dissolved Oxygen, Free CO_2 chloride, alkalinity, total hardness were analysed.

❖ ANALYSIS OF PLANKTON

Collection of Samples –

Water sample were collected and filtered through a bolting silk plankton collection net made of standard bolting silk cloth (No.21 with 77 mesh/cm^3) once in a month. The plankton net has a diameter of 25 cm and a length of 50 cm. the lower end of the cone of plankton net was fitted to a glass tube of 50 ml capacity. 50 litres of water from four corners and centre of each nursery pond was passed carefully through plankton net.

The filtrant was transferred to a marked glass stopper bottles. The samples were preserved in 5% formaline and density of zooplanktons was calculated by following formula :

$$\text{Zooplanktons g/L} = \frac{Vz}{Vs}$$

Vz= volume of zooplanktons

Vs = volume of water filtered.

Experimental pond PE1 with replicate

Experimental pond Pe2 with replicate

Experimental pond PE3 with replicate

Controlled pond CP with replicate

Catla catla

Cirrhinus mrigala

Cyprinus carpio

❖ Observations and Results

Fish culture in India has long been carried out only in West Bengal. The most important species used in India as food are *Catla catla*, *Labeo rohita*, and *Cirrhinus mrigala* (Hora and Pilley, 1962).

The present work is based on the growth of carp seed of three Indian major carps in relation to physico-chemical factors in artificial pond under composite fish farming using ground water as major source of water.

Physico-chemical parameters of water

The data of physico-chemical parameters such as temperature, pH, dissolved $O_{2,}$ free carbon dioxide, alkalinity, hardness, chlorides were recorded monthly basis throughout the period of experiment and has been presented in the table 1.8. Water parameters were found to be in optimum range throughout the experimental period.

Table 1 - Fluctuation in the pond water temperature in experimental pond.

Date of sampling	Control pond	PE1	PE2	PE3
5.7.2012	30.1^{0C}	30^{0C}	30^{0C}	30.3^{0C}
5.8.2012	32.09^{0C}	33^{0C}	32.9^{0C}	32.96^{0C}
5.9.2012	28.7^{0C}	28.7^{0C}	28.6^{0C}	28.66^{0C}

Table 2 Fluctuation of pH of water in experimental ponds.

Date of sampling	Control pond	PE1	PE2	PE3
5.7.2012	8.2	8.1	8.1	8.0
5.8.2012	8.4	7.5	8.5	7.9
5.9.2012	8.4	8.2	8.7	8.3

Table 3 Variation of dissolved oxygen in experimental ponds

Date of sampling	Control pond	PE1	PE2	PE3
5.7.2012	12	10.4	12	11
5.8.2012	10	8.6	10	12
5.9.2012	8.4	8.5	9	9.2

Table 4 – Variation of free Carbon dioxide in experimental ponds.

Date of sampling	**Control pond PC in mg/l**	**PE1**	**PE2**	**PE3**
05.07.2012	264	156.2	121	129.8
05.08.2012	15.5	105.6	24.2	88
05.09.2012	8.80	26.4	11	15.4

Table 5 - Variation of alkalinity in experimental ponds.

Date of sampling	PA as $caco_3$ mg/l in CP	PE1	PE2	PE3
05.07.2012	50	50	50	50
05.08.2012	50	50	50	50
05.09.2012	20	50	25	50

Table – 6 variation in total alkalinity in experimental pond.

Date of sampling	TA as $caco_3$ in mg/l in CP	PE1	PE2	PE3
05.07.2012	312.5	322.5	325	340
05.08.2012	370	410	350	385
05.09.2012	895	650	710	695

Table 7 - Fluctuations of chloride contents of water in experimental ponds.

Date of sampling	Control pond PC	PE1	PE2	PE3
05.07.2012	215.13	210.16	225.07	229.33
05.08.2012	370	410	350	385
05.09.2012	374.88	369.2	369.2	376.3

Table 8 - Fluctuations of Hardness of water in experimental ponds.

Date of sampling	CP	PE1	PE2	PE3
05.07.2012	138	127	125	188
05.08.2012	186	142	200	196
05.09.2012	858	734	764	816

❖ PLANKTON ANALYSIS

❖ Qualitative analysis of zooplankton

❖ Zooplankton :-

Zooplankton are the smallest, organisms in water bodies ranging in size from about 0.5 to 10 mm. Protozoans, rotifers, crustaceans(Cladocera, copepoda and ostracoda) and small insect constitute zooplankton communities. They provide food for many species of fish and are therefore, vital in the food web or ponds and rivers they are also used as an index of productivity, eutrophication and pollution of water. In the present study zooplankton observed were as –

Protozoans constitute paramecia –

Rotifera – they constitute the bulk of zooplankton population. They dominated over all the zooplankton groups and were represented by a maximum number of genera and species their maximum density is noted in the month of July. These are Brachionus, Asplancha, Keratella, Rotaria and Filinia. In the present study it is observed that Rotifers higher population density prefers higher temperature, higher DO and lower chloride and higher free CO_2.

Crustacean include following sub-order –

Ostracoda are small crustaceans and are the important components in the food chain of aquatic organism. Among ostracoda cypris species was observed in the pond water.

Copepoda- The number of copepoda individuals was always next to the rotifera in the total zooplankton population. Copepoda are very important component of food chain in aquatic ecosystem.

Copepoda- copepoda represented by cycopes and diaptomus out of these Cyclops was dominant.

Cladocera – This group contain Daphnia and Ceriodaphnia. Daphnia is very important and forms the food of fishes.

- **Soil analysis**

The soil of control pond CP and experimental ponds PE1, PE2, PE3 was collected. The soil from 4 corners and centre of each pond was collected and it was analysed in soil testing laboratory of Madhukar Sahakari Sakhar Karkhana Ltd. Jivramnagar, Faizpur. Its report is shown in table

Character	**Control pond**	**PE1**	**PE2**	**PE3**
pH	8.3	8.2	8	8.5
Electro conductivity	1.55	1.24	2.26	0.82
Organic carbon %	0.30	0.39	0.61	0.50
Phosphate kg/Ha	14	13	18	16
Potash kg/Ha	173	134	196	162

CP-Controlled pond, PE1 –Experimental pond 1, PE2-Experimental pond 2, PE3 –Experimental pond 3

Table 11 -Average Length - weight of fish seed in control pond(CP).

Days	*Catla catla*		*Cirrhinnus mrigala*		*Cyprinus carpio*	
	Length in cm	Weight in gm	Length in cm	Weight in gm	Length in cm	Weight in gm
First	1.33	0.017	1.36	0.019	1.36	0.019
7	1.63	0.089	1.66	0.047	1.66	0.047
14	2.2	0.24	2.26	0.95	2.26	0.95
21	3.7	1.13	2.96	1.25	2.96	1.25
28	4.2	2.25	3.56	1.6	3.56	1.6
35	4.9	3.1	4.28	1.85	4.28	1.85
42	5.5	4.2	4.95	2.05	4.95	2.05
49	6.2	5.1	5.61	3.78	5.61	3.78
56	7	6.85	6.8	5.55	6.8	5.55
63	7.6	8.6	7.5	7.4	7.5	7.4
70	8.2	10	8.2	9.95	8.2	9.95
77	9	11	8.92	12	8.92	12
84	9.8	14.12	9.6	14.05	9.6	14.05
91	11.5	18	10.75	16.42	10.75	16.42

Table 12- Average Length - weight of fish seed in Experiment pond 1(PE1).

Days	***Catla catla***		***Cirrhinnus mrigala***		***Cyprinus carpio***	
	Length in cm	Weight in gm	Length in cm	Weight in gm	Length in cm	Weight in gm
First	1.33	0.018	1.38	0.022	1.4	0.023
7	1.93	0.26	1.86	0.085	2.52	0.275
14	3.2	1.75	2.8	1.05	3.85	1.95
21	4.23	2.22	4	2.9	4.76	3
28	5.28	3.43	5.2	4.25	5.82	5.8
35	6.93	6.37	6.13	7.06	6.85	7.61
42	7.8	9.6	6.8	9.75	7.62	9.2
49	9.2	12.12	7.5	12	8.32	12.7
56	10.8	16.3	9	15	9	15.65
63	11.7	20.22	9.7	18.56	9.72	18
70	12.4	24.1	10.5	20.35	10.6	21.05
77	13	28.21	11.2	23.6	11.3	23.12
84	14	31.05	12	26.72	12	27.45
91	15.5	33.25	13.1	29.52	12.6	30.92

Table 13 - Average Length - weight of fish seed in Experiment pond 2(PE2).

Days	*Catla catla*		*Cirrhinnus mrigala*		*Cyprinus carpio*	
	Length in cm	Weight in gm	Length in cm	Weight in gm	Length in cm	Weight in gm
First	1.46	0.023	1.4	0.02	1.38	0.021
7	1.63	0.039	1.66	0.044	2.13	0.26
14	2.68	0.282	2.64	0.85	3.45	1.62
21	3.83	1.22	3.9	1.08	4.13	2.15
28	4.53	2.85	4.18	1.97	4.76	2.97
35	5.06	3.9	5.01	2.12	5.3	4
42	6.12	5.05	5.7	3.2	5.95	5.76
49	7	7.11	6.4	6.4	6.7	7.8
56	8	9.05	7.3	9.25	7.5	11.1
63	8.6	10.2	8	11.8	8.4	13.45
70	9.1	12.14	8.4	12.45	8.9	16.2
77	9.7	15.42	9.12	15.6	9.5	19.3
84	10.6	18.3	10	18.72	10.2	22.75
91	12	22	11	21.06	11	25.65

Table 14- Average Length - weight of fish seed in Experiment pond 3 (PE3).

Days	*Catla catla*		*Cirrhinnus mrigala*		*Cyprinus carpio*	
	Length in cm	Weight in gm	Length in cm	Weight in gm	Length in cm	Weight in gm
First	1.36	0.019	1.4	0.02	1.4	0.022
7	1.83	0.18	1.66	0.044	2.66	0.27
14	2.96	0.29	2.69	1	3.58	1.84
21	4.03	2.05	3.94	1.82	4.5	2.27
28	4.9	3.76	4.96	2.03	5.1	3.05
35	6.46	5.09	5.94	3.62	5.95	4.15
42	6.92	6.2	6.42	4.25	6.21	6.35
49	7.85	8	6.9	6.42	7	9.7
56	9.3	10.12	7.8	9.75	8.2	12.82
63	10.6	13.1	8.5	12.60	8.6	16.6
70	11	16.12	9.3	16.40	9.3	19.3
77	11.8	19.3	10	19.75	10	22.75
84	12.4	22.4	10.7	22.40	10.8	25.22
91	13.12	25.1	11.8	25.60	11.5	28.15

Table 27- Specific growth rate of *Catla catla* in control pond (CP).

Sr.No.	Days	Length in cm	specific growth rate	Weight in gms.	specific growth rate
1	First	1.4		0.022	
2	7	2.66	0.4040	0.27	-0.3318
3	14	3.58	0.4932	1.84	0.3461
4	21	4.5	0.5741	2.27	0.3182
5	28	5.1	0.6143	3.05	0.4334
6	35	5.95	0.6734	4.15	0.5489
7	42	6.21	0.6824	6.35	0.7145
8	49	7	0.7318	9.7	0.8721
9	56	8.2	0.7931	12.82	0.9669
10	63	8.6	0.8040	16.6	1.0618
11	70	9.3	0.8350	19.3	1.1113
12	77	10	0.8616	22.75	1.1733
13	84	10.8	0.8906	25.22	1.2079
14	91	11.5	0.9131	28.15	1.2492

Table 28-Specific growth rate of *Catla catla* in Experimental pond (PE1).

Sr.No.	Days	Length in cm	specific growth rate	Weight in gms.	specific growth rate
1	First	1.33		0.0176	
2	7	1.93	0.2679	0.26	-0.3344
3	14	3.2	0.4644	1.75	0.3266
4	21	4.23	0.5542	2.22	0.3116
5	28	5.28	0.6332	3.43	0.4858
6	35	6.93	0.7375	6.37	0.7277
7	42	7.8	0.7720	9.6	0.8674
8	49	9.2	0.8363	12.12	0.9432
9	56	10.8	0.8957	16.3	1.0574
10	63	11.7	0.9206	20.22	1.1326
11	70	12.4	0.9408	24.1	1.1955
12	77	13	0.9577	28.21	1.2530
13	84	14	0.9870	31.05	1.2849
14	91	15.5	1.0266	33.25	1.3086

Table 29-Specific growth rate of *Catla catla* in experimental pond (PE2).

Sr.No.	Days	Length in cm	specific growth rate	Weight in gms.	specific growth rate
1	First	1.46		0.0233	
2	7	1.63	0.1887	0.039	-1.1757
3	14	2.68	0.3978	0.282	-0.3485
4	21	3.83	0.5220	1.22	0.1649
5	28	4.53	0.5728	2.85	0.4425
6	35	5.06	0.6104	3.9	0.5261
7	42	6.12	0.6862	5.05	0.6189
8	49	7	0.7327	7.11	0.7514
9	56	8	0.7824	9.05	0.8350
10	63	8.6	0.8055	10.2	0.8719
11	70	9.1	0.8255	12.14	0.9401
12	77	9.7	0.8498	15.42	1.0332
13	84	10.6	0.8843	18.3	1.0927
14	91	12	0.9327	22	1.1621

Table 30-Specific growth rate of *Catla catla* in Experimental pond (PE3).

Sr.No.	Days	Length in cm	specific growth rate	Weight in gms.	specific growth rate
1	First	1.36		0.019	
2	7	1.83	0.2434	0.18	-0.4988
3	14	2.96	0.4338	0.29	-0.4312
4	21	4.03	0.5380	2.05	0.3886
5	28	4.9	0.6037	3.76	0.5307
6	35	6.46	0.7116	5.09	0.6245
7	42	6.92	0.7244	6.2	0.6914
8	49	7.85	0.7749	8	0.7899
9	56	9.3	0.8406	10.12	0.8762
10	63	10.6	0.8870	13.1	0.9737
11	70	11	0.8949	16.12	1.0478
12	77	11.8	0.9231	19.3	1.1131
13	84	12.4	0.9403	22.4	1.1666
14	91	13.12	0.9617	25.1	1.2068

Table 31-Specific growth rate of *Cirrhinus mrigala* in control pond (CP).

Sr.No.	Days	Length in cm	specific growth rate	Weight in gms.	specific growth rate
1	First	1.36		0.019	
2	7	1.66	0.2010	0.047	-1.0820
3	14	2.26	0.3227	0.95	0.1674
4	21	2.96	0.4207	1.25	0.1001
5	28	3.56	0.4841	1.6	0.1903
6	35	4.28	0.5527	1.85	0.2380
7	42	4.95	0.6044	2.05	0.2736
8	49	5.61	0.6497	3.78	0.5330
9	56	6.8	0.7255	5.55	0.6618
10	63	7.5	0.7561	7.4	0.7629
11	70	8.2	0.7888	9.95	0.8736
12	77	8.92	0.8198	12	0.9366
13	84	9.6	0.8465	14.05	0.9935
14	91	10.75	0.8911	16.42	1.0514

Table 32-Specific growth rate of *Cirrhinus mrigala* in experimental pond (PE1).

Sr.No.	Days	Length in cm	specific growth rate	Weight in gms.	specific growth rate
1	First	1.38		0.0216	
2	7	1.86	0.2495	0.085	-0.8326
3	14	2.8	0.4087	1.05	0.1741
4	21	4	0.5382	2.9	0.4594
5	28	5.2	0.6300	4.25	0.5623
6	35	6.13	0.6852	7.06	0.7590
7	42	6.8	0.7200	9.75	0.8677
8	49	7.5	0.7561	12	0.9379
9	56	9	0.8292	15	1.0219
10	63	9.7	0.8505	18.56	1.1006
11	70	10.5	0.8802	20.35	1.1273
12	77	11.2	0.9033	23.6	1.1860
13	84	12	0.9293	26.72	1.2307
14	91	13.1	0.9631	29.52	1.2663

Table 33- Specific growth rate of *Cirrhinus mrigala* in experimental pond (PE2).

Sr.No.	Days	Length in cm	specific growth rate	Weight in gms.	specific growth rate
1	First	1.4		0.02	
2	7	1.66	0.1992	0.044	-1.1138
3	14	2.64	0.3902	0.85	0.1232
4	21	3.9	0.5308	1.08	0.0435
5	28	4.18	0.5367	1.97	0.2897
6	35	5.01	0.6111	2.12	0.2843
7	42	5.7	0.6559	3.2	0.4585
8	49	6.4	0.6982	6.4	0.7340
9	56	7.3	0.7482	9.25	0.8510
10	63	8	0.7798	11.8	0.9339
11	70	8.4	0.7953	12.45	0.9420
12	77	9.12	0.8280	15.6	1.0367
13	84	10	0.8629	18.72	1.1019
14	91	11	0.8985	21.06	1.1417

Table 34-Specific growth rate of *Cirrhinus mrigala* in Experimental pond (PE3).

Sr.No.	Days	Length in cm	specific growth rate	Weight in gms.	specific growth rate
1	First	1.4		0.02	
2	7	1.66	0.1992	0.044	-1.1138
3	14	2.69	0.3983	1	0.1938
4	21	3.94	0.5341	1.82	0.2601
5	28	4.96	0.6104	2.03	0.2703
6	35	5.94	0.6744	3.62	0.5148
7	42	6.42	0.6970	4.25	0.5486
8	49	6.9	0.7235	6.42	0.7178
9	56	7.8	0.7723	9.75	0.8736
10	63	8.5	0.8020	12.6	0.9591
11	70	9.3	0.8357	16.4	1.0576
12	77	10	0.8616	19.75	1.1220
13	84	10.7	0.8865	22.4	1.1652
14	91	11.8	0.9248	25.6	1.2153

Table 35-Specific growth rate of *Cyprinus carpio* in control pond (CP).

Sr.No.	Days	Length in cm	specific growth rate	Weight in gms.	specific growth rate
1	First	1.4		0.02	
2	7	2.1	0.3013	0.172	-0.5218
3	14	3.12	0.4481	1.2	0.1884
4	21	3.86	0.5160	1.98	0.2854
5	28	4.12	0.5311	2.35	0.3287
6	35	4.7	0.5843	2.85	0.4018
7	42	5.24	0.6233	3.35	0.4601
8	49	6.1	0.6826	4.52	0.5801
9	56	6.62	0.7087	5.75	0.6661
10	63	7.2	0.7401	6.55	0.7077
11	70	8	0.7806	8.45	0.8103
12	77	8.6	0.8055	10.2	0.8762
13	84	9.4	0.8396	13.85	0.9974
14	91	10.7	0.8904	17.25	1.0737

Table 36-Specific growth rate of *Cyprinus carpio* in Experimental pond (PE1) with feed ground nut oil cake.

Sr.No.	Days	Length in cm	specific growth rate	Weight in gms.	specific growth rate
1	First	1.4		0.023	
2	7	2.52	0.3805	0.275	-0.3266
3	14	3.85	0.5281	1.95	0.3701
4	21	4.76	0.5940	3	0.4357
5	28	5.82	0.6681	5.8	0.6953
6	35	6.85	0.7264	7.61	0.7723
7	42	7.62	0.7626	9.2	0.8379
8	49	8.32	0.7941	12.7	0.9661
9	56	9	0.8228	15.65	1.0368
10	63	9.72	0.8513	18	1.0846
11	70	10.6	0.8842	21.05	1.1439
12	77	11.3	0.9066	23.12	1.1750
13	84	12	0.9287	27.45	1.2437
14	91	12.6	0.9462	30.92	1.2847

Table 37-Specific growth rate of *Cyprinus carpio* in experimental pond (PE2).

Sr.No.	Days	Length in cm	specific growth rate	Weight in gms.	specific growth rate
1	First	1.38		0.021	
2	7	2.13	0.3084	0.26	-0.3453
3	14	3.45	0.4909	1.62	0.2931
4	21	4.13	0.5391	2.15	0.3025
5	28	4.76	0.5896	2.97	0.4253
6	35	5.3	0.6275	4	0.5345
7	42	5.95	0.6710	5.76	0.6744
8	49	6.7	0.7154	7.8	0.7835
9	56	7.5	0.7571	11.1	0.9179
10	63	8.4	0.7993	13.45	0.9794
11	70	8.9	0.8174	16.2	1.0483
12	77	9.5	0.8421	19.3	1.1128
13	84	10.2	0.8689	22.75	1.1733
14	91	11	0.8973	25.65	1.2152

Table 38-Specific growth rate of *Cyprinus carpio* in Experimental pond (PE3).

Sr.No.	Days	Length in cm	specific growth rate	Weight in gms.	specific growth rate
1	First	1.4		0.022	
2	7	2.66	0.4040	0.27	-0.3318
3	14	3.58	0.4932	1.84	0.3461
4	21	4.5	0.5741	2.27	0.3182
5	28	5.1	0.6143	3.05	0.4334
6	35	5.95	0.6734	4.15	0.5489
7	42	6.21	0.6824	6.35	0.7145
8	49	7	0.7318	9.7	0.8721
9	56	8.2	0.7931	12.82	0.9669
10	63	8.6	0.8040	16.6	1.0618
11	70	9.3	0.8350	19.3	1.1113
12	77	10	0.8616	22.75	1.1733
13	84	10.8	0.8906	25.22	1.2079
14	91	11.5	0.9131	28.15	1.2492

❖ Discussion

❖ Physico-chemical factors :-

Physical condition of water, depth temperature,- transparency and light constitute the physical parameters which are responsible for productivity of ponds. Physical and chemical conditions depend upon depth of pond because penetration of sunlight depends upon depth of water. It regulates the temperature circulation pattern of water and photosynthetic activity, however it is considered that depth of 200 cm is congenial from the point of biological productivity of a pond (Jhingran 1975). In the present work depth in the controlled and experimental ponds remained almost 1.5 meters.

❖ Water temperature :-

Water temperature is the most important factor which governs the rate of physiological functions of the organism. In the present study temperature range was from 28.6^{o}C to 33^{o}C. During the experiment minimum temperature 28.6^{o}C was recorded in the pond PE2 & PE3 in the month of September and maximum temperature 33^{o}C was recorded in pond PE1 in August.

Several authors recorded temperature ranges of water of various Indian rivers. Dad (1981),in his study recorded a temperature range of 20^{o}C to 34.4^{o}C from Chambal river., Rao *et al.,* (1987) recorded a temperature range between 21^{o}C to 26^{o}C from Kshipra river.

Fish as cold blooded animal is easily influenced by the surrounding water temperature that shows prominent effect on body temperature, growth rate, food consumption, FCR and other metabolic function (Britz *et al.,* 1997). Temperature and other ecological conditions are responsible for fluctuation of salt content which in turn influence the production and growth of Fish. (Hayat *et al.,* 1996, Jena *et al.,* 1998).

The present investigation corresponds with the investigations observed by different workers. In the present study the significant effect of higher temperature (32°C to 33°C) is the increased rate of biochemical activity of microbiota so that there is release of nutrients by decomposition of organic matter at bottom.

❖ **Turbidity :-**

Turbidity is an important physical factor which restricts the penetration of sunlight and hence reduces photosynthetic activity, this is related to productivity of water mass. Light penetration is very important factor in aquatic ecosystem and variable in nature. By the use of inorganic fertilizers, light penetration was reduced (Qin *et al.,* 1995b). Duration of photoperiod on the growth of fish is related to its feeding and social habits of species (Piaia *et al.,* 1999). Light enhances fish growth through improving feed intake and its conversion efficiency (Boeuf and Bail, 1999).

❖ Hydrogen ion concentration

In the present study the pH value ranged from 7.5 to 9.1. Variation of pH is linked with species composition and life processes of aquatic life. Fluctuation in pH values in various Indian rivers were recorded by several workers. Pahwa and Mehrotra (1966) observed a pH range of 7.45 to 8.5 in river Ganga. Verma and Shukla (1967) recorded pH range 7.8 to 8.4 in river Harwaha.

According to Ness (1964) weak alkaline nature (pH 7 to 8) of water has been found to be the most productive and acidic water undesirable. The alkaline status of pond water is suitable for pisciculture activity but consistent high alkalinity may affect the reproductive capability of fishes (Robert *et al.,* 1940 and Alikunhi 1957) Das (1978) studied the pH values between 7.3 to 8.4 are considered to favor the growth of planktonic organisms which serves as a food for fish. Similar conditions of pH 7.5 to 9.1 were also observed in the present experiment. Increase in pH at high temperature may be due to the increase in photosynthetic activity in these ponds. This close link between pH and photosynthetic activity has been recorded by Kannan and Job (1980) and Mortain and Bayil (1977). Organic manuring reduces the pH while inorganic fertilizers increases the pH.

❖ **Dissolved oxygen –**

Oxygen is one of the most significant factors in all constituents present in pond water. Oxygen comes in pond water from two sources by absorption from atmosphere at the surface of water and by photosynthesis of chlorophyll bearing organisms inhabiting the pond.

In the present study the dissolved oxygen content varied from 12 to 8 during the experimental period. The dissolved oxygen content was found maximum 12mg/l at the beginning of experiment in the month in July. It gradually decreased towards the end of experiment in the month of October.

Dissolved oxygen range of river Ganga was 5mg/l to 10.2 mg/l Pahwa and Mehrotra (1966) Verma and Shukla (1967) noted D.O. range of 4.2 mg/l to 9.8 mg/l in Harwha river. Rao and Saxena (1983) observed D.O. range 0mg/l to 9.6 mg/l in Khan river. Rao *et al.,* (1987) in their study recorded D.O. range of 4mg/l to 12mg/l from Kshipra river. Kulshreshtha *et al.,* (1989a) reported D.O. range of 2.4 mg/l to 8mg/l in Kshipra river.

Adekoya *et al.,* (2004) recommended dissolved oxygen level between 4-8 mg/l in the pond. It was prescribed 3mg/l as minimum for fish life.

Reported pattern of fluctuations in the above studies was conformations with the result obtained in the present study. However the dissolved oxygen content was not found below 5mg/l which is considered to be optimum level to favor fish growth. However above that threshold or below, the growth rate would be decreased (Braun *et al.,* 2006).

❖ CO_2

In the present study the variation in free CO_2 ranges from 8.80 mg/l to 264mg/l. It was maximum 264/mg/l found in pond CP in the month of July. While it was minimum 8.80 mg/l found in the month of September in the same pond. The free CO_2 was absent in pond CP and pond PE2 in October. The level of free CO_2 was higher in the July probably it may be due to manuring but afterwards environment never get disturbed and photosynthesis was also never inhibited. Water rich in CO_2 were comparatively less alkaline where as water deficient in the CO_2 were more alkaline as observed in all experimental ponds. Similar observations have been made by pearsall (1930), Zafar (1964a) and More (1997).

Free CO_2 is directly related with DO, bicarbonates, total alkalinity in all experimental and control ponds while total hardness is less in all experimental and control ponds. Same observations were made by Mahajan (2002) in Hartala lake of Jalgaon district.

❖ Carbonate Alkalinity :-

The values of carbonate alkalinity observed in the present experiments varied from 20mg/l to 55mg/l. Maximum carbonate alkalinity 55mg/l was recorded in pond PE2 in the month of October. While in Pond CP, PE1 and

PE3 it was recorded 50mg/l. Available literature on CO_3 alkalinity of Indian rivers. shows a range of 1 to 12 mg/l from December to June in river Ganga (Pahwa and Mehrotra 1966) and 1.2 mg/l to 10.2 mg/l from December to May in river Harwaha (Verma and Shukla 1967). Ray *et al.,* (1966) made similar studies. Rao and Diwan (1977) in their study reported a range of 2.5 to 5mg/l in Khan river. In the present study carbonate values as are higher than in Indian rivers.

In the present study, variation in total alkalinity observed was from 312.5 mg/l to 895 mg/l. it was minimum 312.5mg/l in pond CP in the month of July while it was maximum 895 mg/l in the same pond CP in the month of September.

Presence of carbonate and bicarbonate makes the pond water slightly alkaline which proves to be suitable for aquatic organisms (Pandey and Lal 1995, Terziyski *et al.,* 2007, El-Saidy and Gabar,2003, Swelium *et al.,* 2005).

Fertilizer dose influences the level of alkalinity and dissolved oxygen. These parameters increase with the increasing fertilization level upto certain limit and decline with higher doses (Garg and Bhatnagar, 1999, Bhakta *et al.,* 2006).

❖ **Hardness :-**

In the present study, the values of hardness varied from 125mg/l in pond PE2 in the month of July while it was maximum 858 mg/l in pond CP. Organic inputs alone significantly increase total hardness as compared to organic manure and inorganic fertilizers. (Das *et al.,*, 2005).

❖ **Plankton Analysis :-**

❖ **Zooplankton :-**

Zooplankton are the smallest, organisms in water bodies ranging in size from about 0.5 to 10 mm. Protozoans, rotifers, crustaceans(Cladocera, copepoda and ostracoda) and small insect constitute zooplankton communities. They provide food for many species of fish and are therefore, vital in the food web or ponds and rivers they are also used as an index of productivity, eutrophication and pollution of water.

Aquaculture ponds are fertilized to increase the available natural food (Phytoplankton and zooplankton) for fry or larvae fish or for species that are efficient filter feeder (Brunson *et al.,*, 1999) Animal manures exploited in fish pond as a source of soluble phosphorous, nitrogen and carbon to maximize the algal growth and natural food production (Ali,1993, Abbas *et al.,*, 2004) Organic manure contain almost all essential nutrient elements and are less expensive chemical fertilizers (Jana *et al.,*, 2001). Traditionally organic manures are added in fish ponds to release inorganic nutrients which stimulate the growth of plankton (Wurts 2000, Ansa and Jiya 2002). Organic manure in carp polyculture induces significant results in terms of specific growth rate and fish performance of major carps in respects to fish production (Kanwal *et al.,*, 2003). High doses of cow dung and poultry manuring is found to reduce the value of dissolved oxygen (D.O.) while optimum dose i.e. 0.26 k.g.m^{-3} maintain better water quality and abundance of planktonic biomass, which improves the growth of carp species (Jha *et al.,* 2004) pond manured with cattle dung shows higher production by encouraging plankton metabolism (Terziyski *et al.,* 2007) the common carp attained the maximum fish growth in poultry manure as compared to duck and cattle manure treatment in monoculture system (Garg 1996).

Jhingran (2002) reported that *Catla catla* feeds on algae, plants, rotifers, crustaceans and vegetable debris etc.. However it prefers zooplankton for food. *Labeo rohita* feeds on crustaceans and insect larvae in early stages while mud and vegetation when adult. *Cirrhinus mrigala* feeds on decayed plant, animal matter, algae detritus and mud.

Introduction of live zooplankton into fish culture pond increases the growth rate of carp species (Jha *et al.,* 2006). *Cirrhinnus mrigala* and *Cyprinus carpio* responded best in manured ponds with instead of organic wastes (Parvez *et al.,* 2006).

Earthen ponds are proved to be the best medium, providing the best optimum conditions for effective fish growth as compared to the concrete ponds. Manuring in earthern ponds is found to be efficient tool for maintaining water quality due to higher assimilation capacity and plankton population which increases fish growth (Jha *et al.,*2006). Organic manuring proven to benefit the farmer economically as it serves to reduce 50% cost of inorganic fertilizer and supplementary feed (Yadava and Garg, 1992).

Fertilizers regulate pond ecosystem, through their buffering capacity (Das and Jana, 2003). Fish biomass production and water quality is affected by fertilizer, fish feed or both. It manages water quality by enhancing plankton production through efficient manipulation of nutrients (Umesh *et al.,* 1999, Lane, 2000 Rehman, *et al.,* 2004). Inorganic fertilizers containing nitrogen and phosphorous (Shrestha and Lin 1996) are recommended for the enhancement of natural primary productivity in fish ponds (Boyd, 2003). Pond fertilization with NPK fertilizers promote phytoplankton more efficiently.

Hossain *et al.,* (1997) reported that cow dung fertilization exerted significant effect on growth performance of major carps. These results are also in agreement with those of Aziz *et al.,* (2002) who studied the growth performance of major carps in fertilized ponds supplemented with feed containing 28% crude protein and reported that a planktonic productivity of 22.14 mg/l produced on average fish yield of 7826.08 gm. These workers through regression studies calculated the contribution of primary productivity towards increase in fish yield to be 57.40%.

Triple super phosphate (TSP) resulted the significant and higher yield of major and exotic carps as compared to unfertilized ponds (Tabina and Ayub, 2009).

Catla catla, Labeo rohita and *Cirhinnus mrigala* positively responded to inorganic fertilization with nitrophos in terms of fish weight, total length and gross fish yield (Shahzadi and Ahemad, 2000, Khan *et al.,* 2002). Nitrophos is found to superior to cattle manure in improving net fish production of major carps (Asghar *et al.,* 2001, Rehman *et al.,* 2004). Fertilizer type (Anetekhai *et al.,* 2005) and dosage. (Bhakta *et al.,* 2006) strongly influences the quality and quantity of plankton which contribute to better growth performance of fish species. Fish species like *Catla catla, Labeo Bata, Cyprinus Carpio* responded positively to increase the fertilizer dosage upto a certain level, thereafter a decline in growth rate was observed (Bhakta *et al.,* 2006).

Organic manure in combination with inorganic fertilizer has been proved to be useful in enhancing the growth performance of fish species like silver carp, Rohu, and Mrigal in polyculture (Azim *et al.,* 2004) and Tilapia monoculture (Hassan *et al.,* 1977).

Organic manure like cow dung and poultry droppings in combination with inorganic fertilizers like NPK provide conductive environment for *Clarius gariepinus* fry that showed best weight increment with a condition factor (k) under the influence of organic manure NPK combination (Anetekhai *et al.,* 2005). Combination of organic and inorganic fertilizers is encouraging in polyculture of bighead carp with major carp and Chinese carps (Afzal *et al.,* 2007). Application of cow dung, urea and TSP @ 4500, 150 and 150 kg/Ha is found to be the best for the optimum production of major carps (Azim *et al.,* 2001).

In the present study, organic manure cow dung and inorganic fertilizers like urea, super phosphate are used to produce plankton yield. Lime was also used to maintain the pH of pond water. The quantitative and qualitative analysis of zooplankton was done. Among the zooplankton, the rotifers like Brachionus, Asplancha, Keratella, Rotaria and Filinia were found. Among the crustaceans, the copepods like Cyclops and diaptomus were found. Cyclops were dominant. Amoung cladoceran, the Daphnia and Ceriodaphnia were formed. Daphnia forms main food of fishes. The number of zooplankton were more in pond in PE1 which produced better growth of fish seed, the use of organic manure and inorganic fertilizers increase the number of zooplankton which favors the growth of fish seed of *Catla catla, Cirrhinus mrigala and Cyprinus carpio.* This view is supported by number of authors.

❖ Effect of supplementary feed on growth rate

Indian major carp viz, *Catla catla, Labeo rohita,* and *Cirrhinus mrigala* are produced primarily in fertilized ponds with the use of supplementary feeds (Stickney, 2000). Supplementary feed is found to be a useful tool for providing nutrient components and energy required for better fish growth and production (Abdelghany *et al.,* 2002). Animal based protein feed like fish meal is the most common ingredient of supplementary feed in fish culture practices which is the major source of protein as observed by Oliva-teleles *et al.,* (1999). Supplementary feed is the artificial source of dietary nutrients like proteins, fats, and carbohydrates. A feed comprises of 30-35% protein, 4% fat and 35 % carbohydrates is proved to influence the growth performance of *Catla catla* positively (Seenappa and Devraj, 1995).

Different agricultural and animal byproducts (Maize gluten, Cotton seed, rice polish, oil cake, wheat bran and fish meal etc.) are utilized as source of dietary nutrients in fish culture. Exotic carps like *Cyprinus carpio* performed best in ponds supplemented with artificial feed @ 5% of body weight per day as compared to major carp like *Catla catla, Labeo rohita* and *Cirrhinus mrigala* (Alam *et al.,* 1996, Abbas *et al.,* 2008).

Combination of fish meal, sesame oil cake and mustard oil cakes proved to be cost effective and significantly affect the growth performance, increase in terms of higher growth rate, net fish production and protein utilization of major carps in polyculture system (Mazid *et al.,* 1997).

Plant based supplementary feed in combination with animal origin feed, optimizes more significantly the growth rate in terms of live weight gain (%), SGR (%) and FCR in Rohu culture (Saha and Ray 1998).

The major carps fed with rice polish with inorganic fertilizers and cowdung gave higher fish yield than without fertilizers (Sarwar *et al.,* 2003, Ahemad *et al.,* 2005). Supplementary feed with ingredients like ground nut oil cake (Liang *et al.,* 1999 Keshavanath *et al.,* 2001). A supplementary diet containing 10% protein with a supplement like vitamin and mineral showed better weight increment and fish yield as compared for diet without supplements (Robinson *et al.,* 2005). Diet comprising of rice bran, Soyabean meal, fish meal, vegetable oil, vitamin and mineral mixture (40:20:10:3:2) influences the growth and survival of carp fingerlings on the basis of specific growth rate and harvest fish biomass (Jena *et al.,* 1999, Islam *et al.* 2008).

Artificial feed containing 35% protein and 12% lipid P/E ratio of 18.51/mg protein $kgJ^{-} gm^{-1}$ is optimized for best growth performance and specific growth rate of *Catla catla* (Murty and Naik 2000) whereas, diet containing 40% protein is reported to be the best for common carp (Cho *et al.,* 2001). Fish meal along with sesbinia aculate seed meal (23%) gave the maximum growth rate in common carp. Fish meal contributed to best growth performance and feed utilization in common carp (Hossain *et al.,*

2001) and for Rohu fingerlings in terms of weight gain and specific growth rate (Khan *et al.,* 2003). But in some cases, *Labeo rohita* gave the best growth response, feed conversion ration by the utilization of feed comprises of deoliod soaked sal seed meal (*Shorea robusta*) (Mukhopadhyay and Ray, 1966). *Lebeo rohita* fingerlings gain maximum and significant growth rate, FCR and FCE with the incorporation of 30% termented grass pea seed meal (Ramchandran *et al.,* 2005).

Protein of plant origin is preferred as compared to animals origin in the culture of carps (Singh *et al.,* 2004). The supplementary feed with 40% crude protein of plant origin along with the manuring plays a key role in enhancing productivity and performance in terms of weight gain and specific growth rate in caro culture system (Kalla *et al.,* 2004, Samantaray and Mohanty 1997).

The supplementary feed with 6% fish oil level with low protein (24% crude protein) in nitrogenous diet is reported as the best combination for the growth of common carp. The increment of dietary lipid level also increases feed conversion ratio, protein efficiency ratio (Manjappa *et al.,* 2002). Diet containing 5% maize gluten is optimized as a replacement fish meal at 25% level which caused maximum increment in weight gain of *Catla catla, Labeo rohita* and *Cirrhinus mrigala*. Soyabean is reported to give maximum increment in fish weight and specific growth rate of *Cirrhinus mrigala* and *Labeo rohita* fingerlings (Garg *et al.,* 2002).

Amaranthus seed inclusion as a replacement of rice bran and groundnut oil cake, increases the fish body weight as reported in common carp and Rohu under semi intensive fish culture system. Amaranthus seeds are excellent source of good quality protein (Virk and Saxena 2003).

Azolla, Soyabean and oil cakes were also found superior to fish meal in terms of total fish yield and growth rate of carp under polyculture system (Tuladhar, 2003). Common carp is reported to perform best with carbohydrate rich diet, substituting fish meal components with maize while it does not affect significantly the specific growth rate and feed conversion ratio (Keshavnath *et al.,* 2002). The ration size of 4-6% body weight per day is reported to be the best suitated for *Cirrhinus mrigala* in terms of feed conversion ratio, specific growth rate and protein efficiency ratio (Al Hafedh and Ali, 2004; Khan *et al.,* 2004).

Along with the regular manuring supplementary feed, consisting if fish meal, oil cake, rice bran (Dharambir *et al.,* 2004) slaughter house waste, vitamin and mineral mixture and soyabean oil (Singh *et al.,* 2005) exhibited best growth performance and feed conversion efficiency in culture of fingerlings of *Labeo rohita* and C*yprinus carpio.*

Fish size is an important factor which can be used as indicator to determine the best dietary protein level for optimum growth and fish yield.

Final mean weight FCR condition factor was higher in supplementary diet with a large size of fish (Okumus and Mazlum, 2002).

Combination of low and high protein with different feeding schedule also influences the specific growth rate (SGR) and feed conversion ratio (FCR), while successive application of low and high protein after two days interval, proved to be most cost effective in rainbow trout culture system (Sevagil *et al.,* 2006).

When seed of *Catla catla* were kept in control pond, the length varied from 1.33 to 18.00 c.m. The weight varied from 0.0169 gm to 18 gm

When the *Catla catla* seed at fry stage were fed with groundnut in pond PE1, the variation of length was obtained from 1.33 cm to 15.5 cm. The growth was constantly increased. The weight at initial stage of fry seed was 0.018gm. It was increased to 3.2 gm on the 91st day of experiment.

The *Catla catla* seed was fed with wheat flour in the pond PE2 it resulted variation in the length. There were constant increase in the length of fish seed. The weight in the initial stage was 0.023 gms while on 91st day it was 22gms. This showed that there was constant increase in the weight.

When the seed of *Catla catla* was fed by fish meal, the variation in the length observed was between 1.36 cm to 13.12cm. This shows the constant increase in length from beginning to the last day of the experiment. Similar results were found for variation in weight also. The initial weight was 0.019 gm and final weight was obtained 25.1 gm on 91st day.

The seed of C*irhinus mrigala* at fry stage when reared in control pond CP without supplementary food the variation in length was observed between 1.36 cm to 10.75cm The weight of seed varied from 0.019 gm to 16.42 gm.

Variation in growth rate in length observed were from 0.04 cm. to 0.16cm. It was same at three stages on 14th day 28th day & 49th day . The growth rate in weight differed from 0.04 gm to 0.17gm. It was minimum 0.04gm on 7th day while maximum 0.17 recorded on the 56th day.

When the seed of *Cirrhinus mrigala* was fed with groundnut oil cake in pond PE1, the variation in length was observed from 1.38 cm to 13.1 cm.

When the seed of *Cirhhinus Mrigala,* was fed with wheat flour, the variation in length was observed between 1.4cm to 11 cm. The constant increase in length when they feed with wheat flour in pond PE2/. This variation was observed from beginning up to 91st day of experiment. The variation in weight was observed between 0.02gm to 21.06 gm. The weight was found minimum 0.020 gm on the first day while it was maximum 21.06gms.

When the first seed of *Cirrhinus mrigala* fed with fish meal in pond PE3, they exhibit the variation in length from 1.4cm to 11.8 cm. Thus the constant increase in length was observed beginning from 1st to 91st day. The variation in weight was observed from 0.02 gm to 25.60 gm it was minimum 0.020 gm on first day and maximum 25.60 gm on 91^{st} day. The constant increase in weight was observed from first day to 91^{st} day.

When the fish seed of *Cyprinus carpio* is rared in the control pond CP, the variations observed in the length was between 1.4cm to 10.7cm. The variation in weight was observed from 0.02 to 17gm.

When the seed of *Cyprinus carpio* fed with groundnut oil cake in pond PE1, they showed variations in length and weight. The variation in the length was observed from 1.4cm to 12.6cm. The weight was found minimum 0.023gm on first day and was maximum 30.92gm on 91^{st} day.

When seed of *Cyprinus carpio* was fed with wheat flour in pond PE2, the variation observed in the length was between 11cm to 1.38cm.

The variation in weight was observed between 0.021gm to 25.65gm.

When the fish seed of *Cyprinus carpio* fed with fish meal in pond PE3, it showed variations in length and weight. Variation in length and weight was found between 1.4cm to 11.5cm.

Variation in weight was found between 0.022gm to 28.15gm

- **Specific growth rate**

Erfanullah and Jafri (1998) observed maximum weight gain (%) and specific growth rate (SGR%) in *Catla catla* and *Labeo rohita* which were fed on diet with 36% carbohydrate and 4% lipids corresponding to CHO:L ratio of 8.93. They observed highest weight gain (%) and SGR (%) in *Cyprinus mrigala* fed on 27% carbohydrate and 85% lipid corresponding a CHO:L ratio of 3.38.

In the present study, SGR of *Catla catla* in pond CP ranged between -0.3318 to 1.2492. It was minimum -0.3318 on 7th day and was maximum 1.2492 on 91th day of experiment. SGR of the same fish species in pond PE1 ranged between -0.3344 to 1.3086 when they were fed with groundnut oil cake. SGR was minimum -0.3344 on 7th day and maximum 1.3086 on 91th day when these fishes were fed with wheat flour in pond PE2, the SGR ranged between -1.1757 to 1.1621. It was minimum -1.1757 on 7th day and was maximum 1.1621 on 91th day. When they were fed with fish meal in PE3, the SGR ranged between -0.4988 to 1.2068. It was minimum -0.4988 on 7th day and was maximum 1.2068 on 91th day.

SGR of *Cirrhinus mrigala* in controlled pond CP was ranged between -1.0820 to 1.0514. It was minimum -1.0820 on 7th day and was maximum 1.0514 on 91th day. When this fish seed was fed with groundnut oil cake in pond PE1, SGR ranged between -0.8326 to 1.2663. It was found minimum –0.8326 on 7th day and maximum 1.2663 on 91th day. In pond PE2 when they were fed with wheat flour, the SGR ranged between -1.1138 to 1.1417. It was minimum -0.1138 on 7^{th} day and was maximum 1.1417 found on 91th day.

In pond PE3, when the fries were fed with fish meal, the SGR ranged between -1.1138 to 1.2153. It was minimum -1.1138 on 7^{th} day and maximum 1.2153 on 91th day.

SGR of *Cyprinus carpio* fries in controlled pond CP ranged between -0.5218 to 1.0737. it was obtained minimum -0.5218 on 7^{th} day and was maximum 1.0737 on 91th day. When these fries were fed with groundnut oil cake in pond PE1, SGR ranged between -0.3266 to 1.2847. it was minimum -0.3266 on 7^{th} day and was maximum 1.2847 on 91th day. In pond PE2 the fries were fed with wheat flour, where the SGR ranged between -0.3453 to 1.2152. It was minimum o.3453 on 7^{th} day and was maximum 1.2152 on 91th day. When the fries of *Cyprinus carpio* were fed with fish meal in pond PE3, the SGR ranged between -0.3318 to 1.2492 it was minimum -0.3318on 7^{th} day and was maximum 1.2492 on 91th day.

In the present study in all four ponds the fries of *Catla catla, Cirrhinus mrigala and Cyprinus carpio* were fed with feed groundnut oil cake, wheat flour and fish meal. In all cases the SGR was low on 7^{th} day of culture and then it increased gradually upto 91th day. SGR of *Catla catla* was found highest 1.3086 on 91th day.

❖ Summary

The present study was conducted to delineate the effects of various environment parameters and food on fish growth. For this study we selected replicate of three experimental ponds namely PE1, PE2, PE3 and replicate of control pond CP. We selected the seed of three fishes *Catla catla, Cirrhinus mrigala and Cyprinus carpio.* The fish seed was purchased from private party and it is released in these ponds after liming and manuring. The predators were removed from the ponds before releasing the seed. The water is taken from bore well. The growth parameters were studied after feeding them with food of varying compositions and in different ponds. The food composition selected were i] Groundnut oil cake ii] Wheat flour iii] Fish meal. Our results showed that when the fries of *Catla catla* were fed with ground nut oil cake in pond PE1, the fishes attained the length of 15.5 cm and their weight gained was found to be 33.25gms on 91th day of experiment. The seed of *Cirrhinus mrigala* were fed with groundnut oil cake in the same pond and their length was found increased to 13.1cm. Under the same food composition the weight gained by *Cirrhinus mrigala* was found to be 29.52gms on 91th day., Similarly at the same time the fries of C*yprinus carpio* were fed with ground nut oil cake in pond PE1 and their length and weight were increased to 11.6cm and 30.90gm respectively.

When the fries of *Catla catla, Cirrhinus mrigala and Cyprinus carpio* were fed with the fish meal in pond PE3, the length was increased to 13.11cm, 11.8cm

and 11.5cm respectively. While their weight gained was found to be 25.1gm, 25.60gm & 28.15gm respectively.

When the fries of *Catla catla, Cirrhinus mrigala and Cyprinus carpio* were fed with wheat flour in pond PE2, their length increased to 12cm, 11cm and 11cm respectively. While their weight gained was found to be 22gm,21.06gm and 25.65gm respectively.

In control pond CP, the length of fries of *Catla catla, Cirrhinus mrigala and Cyprinus carpio* observed were 11.5cm, 10.75cm, 10.7cm respectively and their weight gained was 18gm,16.42gm and 17.25gm respectively.

The above observations showed the comparative higher increase in length and weight of all fishes seed feed on groundnut oil cake than the feed consisting of fish meal and wheat flour meal. The lowest growth viz length and weight of fishes were observed in control pond CP.

Organic and inorganic fertilizers and supplementary feed are very important for fish growth and their yield. In earthen ponds, the required nutrients for proper growth of fishes are limited because nutrient food is lost in pond sediments. This loss of nutrients in pond ecosystem can be substituted through the addition of fertilizers and supplementary feed in semi intensive culture system. The objectives of the present experiments is to assess the influence of fertilizers and supplementary feed like groundnut oil cake, wheat flour and fish meal on the growth of carp seed performance in earthen and on physico-chemical characteristic of pond water.

To compare the growth performance of *Catla catla, Cirrhinus mrigala and Cyprinus carpio* under the influence of fertilizers and supplementary feed the experiments were conducted in four earthen ponds. The earthen ponds have the area of 0.251 ha with two replicates for each treatment.

After the manuring and liming, each ponds (PE1,PE2,PE3 and CP) were stocked with *Catla catla, Cirrhinus mrigala and Cyprinus carpio* seed as 124000, 120000, 144000, 114000 respectively.

The weekly manuring of cow dung along with inorganic fertilizers were added. The supplementary feed groundnut oil cake, wheat flour and fish meal were added in pond PE1 , PE2, and PE3 respectively. The feed was supplied on daily basis. The pond CP was the control pond.

The fish samples were captured randomly by net from each pond and their total body length and total body weight were recorded after every 7 days. After obtaining the data, fish seed were released back into their respective ponds. For limnological studies water samples were collected on monthly basis and analyzed for different physico-chemical characteristics.

The average body length of *Catla catla* with feed groundnut oil cake, wheat flour and fish meal observed was 15.5cm, 11 cm and 13.12cm on 91th day in ponds PE1, PE2 and PE3 respectively while their length in control pond observed was 11.5 cm. The total body weight of fish seed observed was 33.25gm, 22gm,25.1gm respectively and the weight of seed in control pond was 18 gms. The average body length and body weight of *Cirrhinus mrigala* in pond

PE1, PE2, and PE3 with feeds groundnut oil cake, wheat flour and fish meal were observed to 13.1cm, 11cm 11.8 cm and their total body weight was 29.52gm, 21.06gm and 25.6 gm. The average length and body weight of fish seed in control pond was 10.75cm and 16.42gm. The average length of *Cyprinus carpio* with different feeds in pond PE1,PE2 and PE3 observed were 12.6cm,11cm, 11.5cm while their total body weight was 30.92gm, 25.65gm and 28.15gm. the length and body weight of fish seed of this species in control pond CP observed was 10cm and 17.25gm.

These three species attained the maximum average body weight when grown in manured pond with supplementary feed. Among the three fish species, *Catla catla* showed maximum average length and total body weight. It was followed by *Cyprinus carpio and Cirhinus mrigala.* All the fish species showed better growth in feed consisted of ground nut oil cake.

Among the aboitic factors, water and temperature played major role towards fish growth. The growth of all three species under all treatments was higher at higher temperature viz 33^{o}C.

Specific growth rate of all the three species of fishes was observed to be higher in the feed consisted of groundnut oil cake and it was highest in *Catla catla.* However, it was relatively lower in feed consisted of fish meal and then least in the feed consisted of wheat flour.

The regression equation of average body weight and total length showed the positive and highly significant relationship among these morphometric parameters. The value ‘r’ coefficient correlation were found to be significant amoung the fish.

The physico-chemical characteristics of pond water remained within the favourable limits for fish culture. The dissolved oxygen concentration showed an inverse relationship with water temperature. The correlation coefficient between water temperature and planktonic biomass remained positive.

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