EFFECTS OF FERTILIZATION AND LOW-COST FEED ON GOLDA-CARP POLYCULTURE

Approved as to style and content

By

Professor Dr. Khairul Azam

Head

Fisheries and Marine Resource Technology Discipline

Khulna University, Khulna

DECLARATION

The results in this project thesis are entirely the candidate's own investigation and no part of the results has been accepted for any degree, nor it is being concurrently submitted for any degree.

SUPERVISOR

Dr. Khandaker Anisul Huq

Associate Professor

Fisheries and Marine Resource Technology Discipline

Khulna University, Khulna

CANDIDATE

Bijan Kumar Nandi

Bijan Kumar Nandi

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ABSTRACT

A preliminary study was conducted on the effects of feed and fertilizer on growth of golda-carp polyculture in 6 (six) ponds at Khulna university campus during the period from 3 September, 2002 to 3 march, 2003. Indian major carps (*Labeo rohita* and *Catla catla*) and golda (*Macrobrachium rosenbergii*) were stocked with a percentage of 33.3, 44.4 and 22.2 respectively. Artificial feeds were given in 3 ponds (treatment-1) and fertilization was done in other 3 ponds (treatment-2). Artificial feed consisting of rice polish (40%), soyabean cake (10%), wheat flour (15%), wheat bran (20%), mustard oil cake (5%) and snail (10%) was applied in T_1 at the rate of 5% of the total fish biomass. Only fertilization with 200g raw cow dung/decimal / day; 7g TSP /decimal / day; and 3g Urea /decimal / day were given in T_2. The initial weight of rohu, catla and golda were 18 ± 5.02 g, 11.94 ± 4.25 and 9.94 ± 3.33 g respectively in T_1 whereas the final weight of rohu, catla and golda were 120 ± 17.17, 60.28 ± 13.23 and 58.33 ± 16.98 g respectively. In T_2 the weight of rohu, catla and golda were 20 ± 7.17, 11.94 ± 3.49 and 9.78 ± 3.46 g respectively at the time of stocking. After 180 days of culture the final weight of rohu, catla and golda were 97 ± 32.00, 53 ± 14.14 and 51.94 ± 16.73 g respectively in T_2. The net gain in weight over a period of six months were found to be 101.11, 48.33 and 48.39 g for rohu, catla and golda respectively in T_1 whereas the net gain in weight were 77.50, 41.39 and 42.17 g for rohu, catla and golda respectively in T_2. In T_1 and T_2, the average growth rates were 0.56 and 0.43 g/day for rohu, 0.27 and 0.23 g/day for catla, 0.27 and 0.23 for golda respectively. Some physico-chemical factors such as water temperature, transparency, dissolved oxygen and pH were recorded fortnightly. Except water temperature in winter, the physico-chemical condition was found to be within the range of optimum level. The growth rates of all species are seriously hampered by low temperature in December and January. The result of the study showed that the growth performance of rohu, catla and golda slightly higher in T_1 where supplementary feed was used. But polyculture with only fertilization may acceptable for poor marginal farmer who are unable to buy feed for fish.

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CHAPTER ONE

INTRODUCTION

1.0 INTRODUCTION

Bangladesh is blessed with the vast water resources in the form of ponds, beel, haor, baor, river, canal, flood plain, reservoir, ditches, impounded brackish water etc. which have been considered as the main sources of fish production. About half a century ago, fish was available and people just used to catch fish to fulfill their diet. Day by day capture fisheries depleted in the country due to various reasons particularly by over exploitation and environmental pollution. Therefore culture practices of fish become essentials. There are many causes for low production of fish of which two are most important. Firstly, lack of proper utilization and management of water resources and secondly lack of adequate knowledge and research related to fish culture that are suitable for rural poor farmers. To increase the fish production unused low land and pond should be included into proper culture practices and management. Fertilization may be the most important and suitable technique for the rural poor people to increase fish production. Trough fertilization natural food of fish i.e. plankton is increased. On the other hand low-cost hand made artificial feed application is another most important technique to increase the fish production.

The role of plankton has a direct bearing on well-being of fishes. The existence of an organism can not be thought without its food and in case of fishes no exception to this role. The plankton furnishes the direct food of fishes. Fertilization is the cheapest and simplest means of increasing plankton productivity of a waterbody. Plankton constitutes the foundation of food chain in aquatic ecosystem. Inorganic fertilizers increase mainly the phytoplanktonic population of pond water and organic fertilizers increase mainly zooplankton (Rahman, 1997). Both organic and inorganic fertilizers are used in fish pond. Cowdung is the cheapest among the commonly used fertilizers in the country. Ball (1949) reported that inorganic fertilizers increased planktonic fish-food in Micigan lack by as much as 3.3 times. The nutrient elements from inorganic fertilizers dissolve more readily in water and consequently affect at once. A combination of organic and inorganic fertilizers has been reported to be better than the application of only one of them (Rabanal, 1967).

The composition of supplementary feed should be simpler and les expensive so that the poor rural farmers get them easily.

Successful fisheries management and scientific fish culture depends upon the various information about limnological aspects of the water bodies. According to Hickling (1968) fish farming is a practical application of limnology and fresh water biology. According to Reid (1961) the chemical analysis for dissolved gasses and solids are highly important for the study of natural waters. Reid (1971) reported that fish culture can be enhanced by the improvement of substratum by the use of fertilizers along with other pond management measures.

It is based on concept that each species participating in the polyculture has its won food niche and therefore does not compete for natural food with other species (Tang, 1970) and increase fish yield per unit area. Composite fish with Indian major carps and Chinese carps together, utilizing all the ecological niches of a pond, has made it possible to increase the fish production manifold from fresh water pond during the decade of seventy in deferent parts of India (Lakshmanam *et al.*, 1971; Sinha *et al.*,1973; Chakraborty *et al.*,1974; Chowdhury *et al.*,1975; Das *et al.*,1975 and Sinha, 1976). Under this system of culture, the cultivable varieties of carps are: rohu (*Labeo rohita*), catla (*Catla catla*), mrigal (*Cirrhinus mrigala*), silver carps (*Hypophthalmicththys molitrix*), grass carp (*Ctenopharyngodon idella*) and common carp (*Cyprinus carpio*). However fish farmer, at times faced difficulty in getting the seed of Chinese carp (silver carp and grass carp) since these were not yet available so easily. In this case farmers might have cultured Indian major carps with any other suitable species.

Pollyculture is generally perceived as an efficient means of occupying all the ecological niches in ponds in order to obtain the maximum biomass of cultured species from a unite area or volume of water. For this purpose, compatible combinations of species or age groups that do not compete in feeding habits, or contribute to the maintenance of favorable environmental conditions or stock composition, are to be used (Pillay, 1994).

Polyculture improved the ecological balance of the pond water preventing the formation substitute for demonstrated for cattle manure (Ling, 1967) and swine manure (Malecha *et al.*, 1981; Buck *et al.*, 1983) is a means of drastically reducing production cost, which may account for 30-40% of total cost in prawn monoculture (Roberts and Bauer, 1978). Beside bispecies culture, composite culture, and polyculture of *M. rosenbergii* has been done in earthen pond successfully by several researchers in defferent part of the world (Cohen *et al.*, 1983; Malecha *et al.*, 1981 and Jonh *et al.*, 1995) but very few works has been under undertaken in Bangladesh (FRI, 1992; Humayun *et al.* 1986; Hoq *et al.* 1996).

However it has been shown that even a balanced polyculture system, interaction among fish species may hinder or stimulate there growth (Yashouv 1963, 1969). These interactions affect either the food resources or the environment. Since the aquaculture tendency is to increase stocking density so as to utilize food resources maximum and increase yields per unit area, these interactions become more pronounced. Being at high density, the regular feeding habits of different fish species may change diverting them to food which is more available in the pond, usually with a higher utilization of detritus (Schroedr, 1980).

The type and extent usage of different supplementary feeds for the polycultre of carp-golda on farms in our country is scanty. Moreover, the increased revenue possible from fish along with prawn gives polyculture of prawn a high potential for use in economical prawn culture (Siddique *et al.*, 1999).

In the view of the above facts, the present study was undertaken with the following objective:

- To study the effects of fertilization and low-cost feed on the growth of golda and [illegible]

2.0 REVIEW OF LITERATURE

Kriigal and Heinrich (1939) stated that fertilization with mineral substances was the most effective, the simplest and the cheapest, means of increasing fish production. They concluded that the superphosphate was the most important nutrient and the main factor in pond management and should be applied at a regular interval.

Ganapati (1942) observed a fairly high amount of phosphate during south-west monsoon and its low value in winter due to consumption by the chlorophyll bearing organism..

Moyle (1946) form a study of a large number of lakes and ponds, gave the phosphorus fertility scale as 0.00-0.02 mg/l (low), 0.2-0.05 mg/l (fair), 0.05-0.10 mg/l (good), 0.10-0.20 mg/l (very good) and above 0.20 mg/l (excessive).

Ball (1949) reported that inorganic fertilizers increased planktonic food in some Michigan by as much as 3.3 times.

McCombie (1953) in his study in plankton of a fresh water fish pond reported that the transparency of water was affected by silt, microscopic organisms and responded organic matter.

Ellis (1937) indicated that under average conditions, 3.0 ppm DO or less should be regarded as hazardous for fish and for a good varied fish fauna, the level should be 5.00 ppm or more.

Mckee and wolf (1963) stated that DO for worm water fish habitat should not be less than 5ppm at least 16 hour of any day. It may, however, be less than 5ppm for a period less than 8 hours but at no time DO should be less than 3.0ppm.

Reid (1961) stated that temperature of natural water was mainly from solar radiation.

Hepher (1962) reported that only small amount of the nature is consumed directly by the fish. The mineralized fraction of the dung-urine mixer provides basic chemicals for growth of plankton.

Reid (1971) reported that the transparency of water was affected by several factors such as silting, microscopic organisms, suspended organic matter, latitude, season, the angle and intensity of entering light.

Pahwa and Mehrotra (1966) observed the maximum values of dissolved oxygen during the winter and minimum values of the same during the month of July and august.

Ali *et al.* (1982) observed temperature range of 20.5-36.5 ^{0}C, pH range of 7.5-9.5, dissolved oxygen 7.2-10.5 mg/L, throughout the period of investigation in a fresh water ponds which are favorable for pond fish culture.

Banerjea (1967) stated that ponds were unproductive when oxygen ranged from 3.0 to 5.0 mg/l and also reported that 7.0 mg/l dissolved oxygen of water body is good for productivity.

Dewan (1973) investigated into the ecology in a Mymensingh lake (Bangladesh Agricultural University Campus). He observed higher oxygen concentration during winter and lower oxygen concentration during monsoon. He pointed out that the dissolved oxygen bears an inverse relationship with temperature and free carbon-di-oxide; a direct relationship with pH and total alkalinity.

George (1961) found that dissolved oxygen varied from 4.5 ppm to 9.9 ppm. He noted the highest value at 5.30 PM and lowest at 5.30 AM and stated that high O_2 content were associated with high rate of photosynthesis.

Goolish and Adelman (1984) recorded maximum growth rate at 30 ^{0}C temperature of juvenile common carp. They also observed that the temperature of natural inland waters in the temperate regions generally varies between 0 ^{0}C and 30 ^{0}C, the maximum values occurring particularly in shallow waters in summer and the minimum exceptionally fall below zero in winter.

Kohinoor *et al.* (1993) compared the growth performances of *Puntius gonionotus* with and without using fertilizer and rice bran. They used urea, TSP and rice bran at 8 kg/ha, 16 kg/ha and 750 kg/ha, respectively and recorded a yield of 2,384.26 kg/ha/6 months. Production of Rajputi *(Puntius gonionotus) was* 2,129.72 kg/ha/6 months under condition of supplemental feeding with rice bran.

Macan and Maudsley (1966) concluded that the body temperature of water vary considerably in different months. They also observed that water temperature was influenced by its size.

Martyshev (1983) stated from the study of the chemical parameters characterizing the suitability of water for carp and trout farms; he observed more than 4 ppm dissolved oxygen and pH 7.0 is optimum values for carps.

Mirza *et al.* (1978) studied the physico-chemical characteristics of the river Old Brahmaputra at Mymensingh for a period of one year. The physical factor temperature was found to play important role in aquatic medium and the value of dissolved oxygen was positively correlated with photosynthetic activities of the phytoplankton population.

Verma (1969) made an investigation on a tropical impoundment in India. He observed the highest values of pH during summer and lowest values of the same during winter. Heavy influx of water decreases the pH values.

Zafar (1964) studied the physical and chemical parameters of certain fishponds at Hyderabad in India. He recorded pH (7.8-8.4), phosphate (0.0028-0.0044 mg/L), dissolved oxygen (6.16 - 8.12 mg/L) and bicarbonate alkalinity (0.05-4.44 mg/L).

Hepher (1967) reported phosphorus concentration in fertilized waters declined sharply and within a short period reached almost the same level as before fertilization. He stated that sometimes phytoplankton uptake an extensive amount of phosphorus.

Micheal (1968) studied different types of bottom fauna in a tropical fresh water fish pond in India. He found most of the organism showed peaks in the months of January to April.

David *et al.* (1969) concluded that the causative factor for increasing the amount of phosphate and nitrate was rainfall.

Islam *et al.* (1978) observed minimum values of dissolved oxygen during summer months and maximum in winter months.

Saha and Sinha (1969) recorded the highest values of transparency in august and September during increased rainfall.

Bhuyan (1970) reported that concentration of phosphate ranged from 0.2 to 0.4 mg/l; nitrate from 0.06 to 0.1 mg/l and dissolved oxygen from 5.0 to 7.0 mg/l are within good production range.

Dewan (1973) investigated on the ecology of a lake in Bangladesh Agricultural University Campus, Mymensingh. He observed higher oxygen concentrations during winter and lower oxygen bears an inverse relationship with temperature and free carbondioxide; a direct relationship with pH and total alkalinity.

Islam *et al.* (1974) recorded that the higher amount of dissolved oxygen was found in the surface water than in the bottom water.

Mann (1974) showed in feeding test with pond fish that clear but limited improvements in efficiency could be achieved by increasing the protein level from 26.8% to 45%.

Ariza and Romero (1993) stated that silver carp has higher growth rate than other species. In four months of culture, weights of 683 g for silver carp were obtained.

Schroeder (1974) found that the oxygen depletion resulting from the addition of dung-urine mixture could be quantatively predicted from measurement of the one day Biological oxygen demand (BOD) of the organic waste at pond temperature.

Burke *et al.* (1986) assessed the impact of bighead and silver carp on the plankton population of the channel catfish ponds in Alabama, USA. Their observation lead to the conclusion that a reduction in the zooplankton was brought out by both the species.

Chaudhuri *et al.* (1975) conducted a comprehensive study on culture of the Indian major carp, *Catla catla, Labeo rohita and Cirrhna mrigala* together with the Chinese carp, grass carp and the Indonesian strain of common carp *(Cyprinus carpio)* in experimental ponds, In the first year, production varied from 3,889 to 5,600 kg/ha/yr. and this rose to an average of 8,200 kg/ha/yr. with a minimum of 9,389 kg/yr. in the second year. The important management tools schedule was increased stocking densities, greater use of feed and fertilizers, and provision of more weeds for grass carp.

Davis *et al.* (1984) conducted fish culture trials in managed farmer's ponds with different feeding and stocking regimes. The species were employed, silver carp, catla, rohu, mrigal, common carp and grass carp while the feed were rice bran, mustard oil cake and rice bran + mustard oil cake and compost. Average fish production from 16 ponds was 2830 kg/ha with a range from 1890 to 3820 kg over the 12 months study period.

Dey *et al.* (1979) suggested that the competition between silver carp and rohu was possibly not a serious one. Although, the feeding habits of silver carp (surface feeder) and rohu (column feeder) are somewhat different and the two are considered as quite compatible species and recommended in composite fish culture.

Dunseth and Smitlierman (1977) conducted an experiment to find out the effectiveness of polyculture using carp and bighead carp in catfish grow-out ponds. They noted a slight reduction in catfish yield but the total fish production increased from 2371 lbs/acre/yr. in monoculture to 4118 lbs/acre/yr. in polyculture.

Gupta *et al.* (1990) showed that the total production of Indian and exotic carps were 4917 kg/ha/yr. with supplementary feed. The ponds with supplementary feed i.e. rice bran and mustard oil cake (1:1) was provided at the rate of 3 % of body weight.

Halver (1984) stated that polyculture may produce an expected result if the fish with different feeding habits are stocked in proper ratios and combinations.

Jauncey and Matty (1979) conducted a research on growth of mirror carp. They showed that the mirror carp (*Cyprinus carpio*) has excellent growth rates for culture purposes. Specific growth rate (SGR) can reach 3.5, if an average SGR of 3 were attained a fish would grow from 1 g to 1 kg in 33 weeks. With carp an SGR of 5 or 6 might be possible; they also showed that carp would also tolerate high stocking density, up to about 225 kg of fish per cubic meter. It would also tolerate a wide range of temperature, up to 40^0C and rapid temperature fluctuations.

Kader *et al.* (1989) conducted a polyculture experiment with exotic silver carp in different stocking combinations. Silver carp and catla when stocked in 2:1 ratio gave higher yield. A severe food competition between these two species was clearly noticed.

Mathew *et al.* (1988) reported the result of a study on composite culture of six species viz., catla, rohu, mrigal, common carp, silver carp and grass carp. They stocked in proportion of 10:5:10:25:30:20 respectively at a density of 8000/ha, yielding a record production of 10183 kg/ha after rearing over a period of one year.

Murty *et al.* (1978) conducted an experiment on composite fish culture through nitrogenous fertilization with and without supplemental feed. In their experiment three Indian carps and three exotic major carps were used at a stocking density of 5000 fingerling/ha. The yields of fish obtained though fertilization alone was 2275.37 kg/ha/yr., as against 3858.58 kg/ha/yr. obtained by using feed and fertilizers which indicate that combined use of feed and fertilizer have a significant effect on fish production.

Nandeesha and Rao (1989) reported that in polyculture grass carp largely feeds on macro vegetation and does not compete for food with other carps, while silver carp, a voracious feeder of phytoplankton and common carp which feeds on detritus compete to some extent for food with the Indian major carp.

Sahabuddin *et al.* (1987ab) conducted a series of field experiments to determine the growth and survival rate of Indian and Chinese carp fingerling in ponds and organic fertilizer. Ponds fertilized with urea and TSP at 100 and 150 g/decimal/15 days were found to be optimal for the growth of carps.

Schroeder (1974, 1975) studied the effects of manuring on the production of natural fish food organisms and fish yield. He found that carps when stocked at the rate of 5,000 fish/ha grew 25-100 percent faster in manured pond than in unmanured ponds. He concluded that the increased production of zooplankton and chironomids were due to the result of increase in the production of bacteria and protozoa developing on the organic matter.

Schroeder and Hepher (1979) reported the results of their experiments on polyculture by applying cow manure. The rate of stocking density and manuring were 16,000 fish per ha and 5 g/sq./day (or about 100 kg dry matter of manure/ha/day) respectively. The fish production was 0.300-g/sq. m/day.

Sutton (1974) found the growth rates of small fish to be more sensitive to changes in temperature than those of large ones. A water temperature increase from 23-29^{0}C correlated with increased growth in 0.1 kg fish but not in 1.0 kg specimens. Otherwise the growth rate of fishes is slower during winter.

Saha *et al.* (1975) noted that polyculture of fish has been practiced with the aim that different species stocked in the ponds occupy different niches with their complementary feeding habits, utilizing all the natural food available in the ponds and increasing the total fish production of the ponds (Sinha and Gupta,). They also reported that higher fish production could be achieved by manuring the ponds with the right type of nitrogen fertilizers.

Wahab *et al.* (2001) reported that several species composition, usually with 6-7 species of carps, is practiced in polyculture system of Bangladesh.

Malecha *et al*, (1981) polyculture of *Macrobrachium rosenbergii* has been investigated with Chinese and Indian carps elsewhere.

Grover *et al.* (1976) conducted an experiment on the production and growth of milkfish, common carp and catfish in some newly constructed ponds. They used as fertilizers chicken manure and inorganic fertilizers or a combination of manure and organic fertilizer. That found that fertilized ponds gave much higher yields than unfertilized ponds.

Chowdhury *et al.* (1978) observed on the relative usefulness of different feeds for common carp (*C. carpio*). Hisporocorixa sp. Powdered alone and a mixture of silk worm pupae, rice bran and Bengal gram flour is found to be superior to the traditionally used mixture of mustered oil cake and rice bran.

CHAPTER THREE

MATERIALS AND METHODS

3.0 MATERIALS AND METHODS

3.1 Study area and description of ponds

The study was conducted for a period of six months from 3rd September,2002 to 3rd February, 2003 in six ponds adjacent to the 2nd academic building, Khulna University, Khulna, Bangladesh. All the ponds were rectangular in size. Each of the ponds was of the area of about 2.5 decimal. All the ponds were situated side by side in the same area. The dikes of all the new constructed ponds were grassed for better construction of dikes. The all ponds were interconnected with each other with the feeder canal by PVC pipe.

3.2 Numbering of ponds

The ponds were numbered at T1P1, T1P2, and T1P3 of the three ponds at treatment-1 and T2P1, T2P2, and T2P3 of three ponds at treatment-2 for the sake of recording data and publishing the result.

3.3 Preparation of ponds

Preparation of ponds is the most important factor to increase the survival rate and for the better production. All ponds were prepared properly before stocking. For the preparation of proper water condition and produce natural fish feed, Liming (1-2kg/decimal) and fertilization (both organic and inorganic) were done. After 3 days of liming 8 kg cow dung, 250gm urea and 250 gm TSP per decimal were sprayed in liquid form throughout the pond. Azola/duck weeds were stocked to supply natural feed. During culture period both inorganic and organic fertilization were used at the rate of needed according to the observation of transparency.

3.4 Experimental fishes

The *Catla catla*, *Labeo rohita* and *M. rosenbergii* were stocked about one week after fertilization when sufficient natural feed were produced in pond. The number of different species of fish per decimal were according to the table -1.

Table -1: Species composition per decimal

Name of fish species	No. of individuals
Catla (*Catla catla*)	20
Rohu(*Labeo rohita*)	15
Golda (*Macrobrachium rosenbergii*)	10
Total	45

3.5 Experimental procedure/design

The experiment was done according to the following experimental design:

Treatment No.	Description of the treatment	Pond numbers under the treatments
Treatment-1 (T1)	Artificial feeding with Rice polish (40%), Soya bean cake (10%), Wheat flour (15%), Wheat bran (20%), Mustard oil cake (5%) and Snail (10%).	T1P1, T1P2, and T1P3
Treatment-2 (T2)	Only fertilization with 200gm raw cow dung/decimal / day; 7gm TSP /decimal / day; and 3gm Urea /decimal / day.	T2P1, T2P2, and T2P3

3.6 Preparation of feed

The ingredients of feed like rice bran wheat bran, wheat flour, mustard oil cake, soybean cake, and snail were applied for preparation of feed. The required amount of feed ingredient was mixed with a little amount of water to make it thick 'dough' rolled into balls. The balls were then thrown in to the ponds of T_1.

Table-2: Formulation and price of the experiment diet.

Ingredients	% Inclusion	Quantity (g/kg)	Price of ingredients (Tk/kg)	Price of ingredients Used (Taka)
Rice bran	40	400	7	2.8
Mustard oil cake	5	50	12	0.6
Soybean cake	10	100	15	1.5
Wheat flour	15	150	12	1.8
Wheat bran	20	200	7	1.4
Snail	10	100	4	0.4
Total	**100**	**1000**	**Price of feed =8.1Tk/kg**	

3.7 Fertilization

Organic fertilizer such as cowdung and inorganic fertilizer such as urea and triple super phosphate (TSP) were used for experimental work. TSP contains 20% phosphorus and urea contain 46% N2 (Buckman and Bardy, 1980). There were 200gm raw cowdung/decimal / day; 7gm TSP /decimal / day; and 3gm Urea /decimal / day sprayed in liquid form throughout the ponds in treatment-2 (ICLARM, 2000). At times, the fertilization rates were changed depending upon the transparency of pond water.

3.8 Amount of Supplementary feed

The supplementary feeds were supplied at the rate of 7% of the body weight of the total fish biomass at the first month (3rd September to 3rd October, 2002) of culture. From 3rd October to 3rd December, 2002 supplementary feeds were supplied at the rate of 5% of the total fish biomass (Huq, 2003). Then from 3rd December, 2002 to 3rd February, 2003 supplementary feeds were supplied at the rate of 2-3% of the total fish biomass due to low temperature. Lastly, from 3rd February to 3rd March the feeds were supplied at the rate of 5%. Sampling was done fortnightly to adjust the feeding rate by measuring the weight of fish. Everyday a test tray was used during feeding time and observe the feeding performance of fishes.

3.9 Mode of feeding

The supplementary feeds were supplied twice a day, in the morning between 9:00-10.00 AM and in the afternoon between 16:00-17:00 PM. The required amount of feed was measured with a normal balance and taken in a plastic pan and it supplied as thrown by hand in a same position of a pond daily.

3.10 Water supply

The water depth of all ponds generally maintain above 1 meter. The ponds of university campus were filled up by water by a 550 feet deep tube well that was situated near the pond. The two hors power motor of deep tube well was set in the guardhouse. Waters of tube well firstly introduced in the feeder canal and next day it was supplied to the experimental ponds by inter joining PVC pipe.

3.11 Sampling time and frequency

The physico-chemical parameters of pond water and biological data of the fishes were studied fortnightly. All the sampling was done in the morning.

3.12 Water sampling

The water quality parameters such as temperature, dissolved oxygen (DO), pH, salinity and transparency were taken fortnightly. The temperature and DO of the water were determined by the DO meter (Digital oxygen meter, model DO-5510). The pH of water was determined by the digital pH meter (HANNA instrument, model RI 02895, Portugal). Salinity was determined by the Hand Refractometer (ATAGO, 2442-W02, Japan). Transparency was measured by the Secchidisc.

3.13 Fish sampling

The biological data such as length and weight of fishes were recorded fortnightly at the rate of more than 15% of the stocked fish. Fishes were caught with cast net and kept in a big pan and then aeration was done with an Air pump (model AC-2000, China). The individual length was recoded by the ordinary scale to the nearest centimeter. And weight was also recorded by the Kitchen scale weighing balance (CAMRY) to the nearest gram (plate of measurement). The fishes were visually examined to determine the possible out break of disease.

3.14 Growth of fishes

Growth in terms of length and weight were calculated by subtracting the initial length and weight of fishes (at the time of stocking) from final length and weight (at the end of the study period).

$$\text{Percentage of growth in length} = \frac{\textit{Mean final length} - \textit{Mean initial length}}{\textit{Mean initial length}} \text{x} 100$$

$$\text{Percentage of growth in weight} = \frac{\textit{Mean final weight} - \textit{Mean initial weight}}{\textit{Mean initial weight}} \text{x} 100$$

3.15 Average daily gain

Average daily gain of each species was computed by subtracting the initial body weight from the final body weight and then dividing by the number of days of culture.

3.16 Specific growth rate (SGR)

The specific growth rate of *Catla catla, Labeo rohita* and *M. rosenbergii* were determined by using the following formula:

$$SGR = \frac{Log\, w_2 - Log\, w_1}{T_2 - T_1} \text{ X } 100$$

Where,

W_2 = Weight (g) at time T_2

W_1 = Weight (g) at time T_1

$T_2 - T_1$ = Time interval (days)

3.17 Analysis of data

Statistical analysis for average, percentage, range, standard deviation, correlation coefficient, t-value and graphical representation etc. were conducted on PC using Microsoft excel (office 2000).

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 RESULTS AND DISCUSSION

The results of the experiment regarding the physico-chemical parameters (water temperature, transparency, dissolved oxygen and pH) and biological parameters (growth performance) have been presented in tables 3 to 31 and figures 1 to 28 and have been discussed bellow:

4.1 Physico-chemical parameters

4.1.1 Water temperature

During the period of investigation monthly average water temperature at the experimental pond varied from 19.07 to 33.63 °C (Table-3). The lowest and highest average water temperature were recoded in the month of January and September respectively. The lowest water temperature was recorded on January in pond no. T2P2 which was 19.07 °C and the highest water temperature was recorded on September in pond T2P1 which was 33.63 °C. The temperature was low in January due to winter season (Fig.-1).

Table 3: Monthly average temperature (^{0}C) of the ponds under T_1 and T_2.

Pond No.	Sep	Oct	Nov	Dec	Jan	Feb	Max	Min
T1P1	33.43	30.87	26.07	21.93	19.13	23.43	19.13	33.43
T1P2	33.50	30.80	25.97	22.00	19.17	23.27	19.17	33.50
T1P3	33.27	30.50	25.90	21.93	19.10	23.30	19.10	33.27
T_1	33.40	30.72	25.98	21.96	19.13	23.33	19.13	33.40
T2P1	33.63	30.83	25.93	21.87	19.13	23.40	19.13	33.63
T2P2	33.53	30.73	26.13	21.93	19.07	23.43	19.07	33.53
T2P3	33.27	30.47	26.13	22.03	19.10	23.33	19.10	33.27
T_2	33.48	30.68	26.07	21.94	19.10	23.39	19.10	33.48

Ali *et al.* (1982) stated that 20.5-36.5^0 C is favorable for fish culture but Rahaman *et al.* (1982) stated the favorable temperature is 26.06-31.97^0 C. The low growth might be explicable by the observed lower temperature. Ling (1967) suggested that optimum temperature for growth of post juvenile prawn was in the range of 28-31^0 C. In the present study the growth rate of experimental species was greatly hampered during January due to lower temperature.

4.1.2 Transparency

Monthly average transparency ranged from lowest 19.33 cm in the pond T1P1 to highest 38 cm in the T1P1 (table 4). The average results of transparency of all the six ponds were high in the month of October and low in the month of January (Fig.-2).

The high values of transparency in October were probably due to rainfall and decreased concentration of plankton. Saha and Sinha (1969) recorded that highest value of transparency in august and September during increased rainfall. The present study supports this statement. The lower values of water transparency were due to high plankton growth in January as the feeding rate of fishes is decreased because of low temperature.

Table 4: Monthly average transparency (cm) of the ponds under T_1 and T_2.

Pond No.	Sep	Oct	Nov	Dec	Jan	Feb	Min	Max
T1P1	37.50	38.00	35.00	29.67	26.33	28.50	26.33	38.00
T1P2	35.00	35.67	33.33	29.00	24.67	26.50	24.67	35.67
T1P3	31.50	32.67	30.33	27.67	24.33	24.67	24.33	32.67
T_1	34.67	35.44	32.89	28.78	25.11	26.56	25.11	35.44
T2P1	27.00	26.00	25.33	23.00	21.67	24.00	21.67	27.00
T2P2	26.00	26.00	26.00	25.00	21.00	24.00	21.00	26.00
T2P3	25.50	29.00	23.67	22.33	19.33	21.67	19.33	29.00
T_2	26.17	27.00	25.00	23.44	20.67	23.22	20.67	27.00

4.1.3 Dissolved oxygen

The concentration of dissolved oxygen (DO) varied from 5.43 mg/l to 7.03 mg/l in the pond in T_1 and from 5.27 mg/l to 7.05 mg/l in the pond in T_2 (Table-5). The highest concentration of DO was found on January in the pond T1P2 that was 7.05 mg/l and the lowest concentration of DO was found on September in the pond T2P2 that was 5.27 mg/l. Bhuyan (1970) reported that dissolved oxygen content from 5.0mg/l to 7 mg/l is required for high production. In the present study, the DO level remains within the range of suitable production.

The monthly average DO ranged from 5.2 7mg/l to 7.05 mg/l. The highest concentration of DO was in the month of January and the lowest was September (Fig.-3). The highest value of dissolved oxygen was probably due to low temperature. There may be another cause is that is concentration of phytoplankton was high in the rainless days of January so that they could produced more oxygen by photosynthesis. Rahaman (1997) stated that oxygen concentration is higher in winter season and lower in summer in the summer season due to inverse relation of dissolved oxygen with temperature or due to cold temperature of water as the cold water has the greater oxygen holding capacity. Phwa and Mehrota (1966) Dewan (1973) and Islam *et al.* (1978) found almost same results.

Table 5: Monthly average dissolved oxygen in mg/l of the ponds T_1 and T_2.

Pond No.	Sep	Oct	Nov	Dec	Jan	Feb	Min	Max
T1P1	5.43	5.43	5.93	6.63	6.33	5.64	5.43	6.63
T1P2	5.95	6.37	6.33	6.13	7.03	6.53	6.13	7.03
T1P3	6.50	6.30	5.97	5.87	6.57	6.23	5.87	6.57
T_1	5.96	6.03	6.08	6.21	6.64	6.14	5.96	6.64
T2P1	5.65	5.87	6.03	6.30	6.17	5.60	5.60	6.30
T2P2	5.27	5.30	5.40	6.03	6.40	6.10	5.27	6.40
T2P3	5.90	5.77	6.27	6.63	7.05	6.13	5.77	7.05
T_2	5.61	5.64	5.90	6.32	6.54	5.94	5.61	6.54

4.1.4 pH

The monthly average pH value varied from 7.77 to 8.27 in the ponds in T_1 and from 7.93 to 8.27 in the ponds T_2 (Table-6 and Fig.-4). The highest value of pH (8.27) was found on October in the pond T1P2 and the lowest value of pH (7.77) was found on January in the pond T1P1. The average highest value of pH was found on October and the lowest value of pH was found on January for both treatments.

Verma (1969) stated the highest value of pH during summer and the lowest of the same during winter. The low pH value during winter probably due to low water temperature, less alkalinity, high dissolved oxygen and low rainfall. Banerjea (1967), while correlating productivity of large numbers of ponds with various soil and water properties, observed neutral to slightly alkaline ph range to be most favorable for fish pond.

The present investigation showed the pH values were in alkaline range in all the ponds that were in productive range in fish culture. Alikunhi (1957) stated that water on acid soil is usually less productive than those on alkaline soil. Michael (1969) reported the pH ranging between 7.3 and 8.4 are the most suitable for fish culture.

Table 6: Monthly average pH of the ponds under T_1 and T_2.

Pond No.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Min	Max
T1P1	8.13	8.17	7.87	8.00	7.77	8.00	7.77	8.17
T1P2	8.07	8.27	8.13	8.03	7.97	8.17	7.97	8.27
T1P3	8.13	8.10	7.93	8.13	8.00	8.17	7.93	8.17
T_1	8.11	8.18	7.98	8.06	7.91	8.11	7.91	8.18
T2P1	7.97	8.20	8.03	7.97	7.87	7.93	7.87	8.20
T2P2	7.93	8.20	8.13	7.97	8.17	8.17	7.93	8.20
T2P3	8.10	8.20	8.07	8.10	7.93	8.23	7.93	8.23
T_2	8.00	8.20	8.08	8.01	7.99	8.11	7.99	8.20

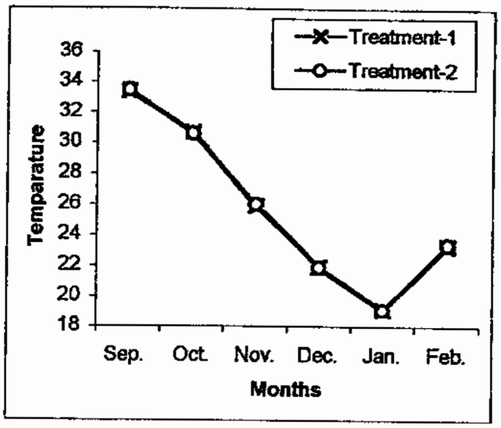

Fig.-1: Monthly variation of mean water temperature(0c) under treatment-1 and treatment-2.

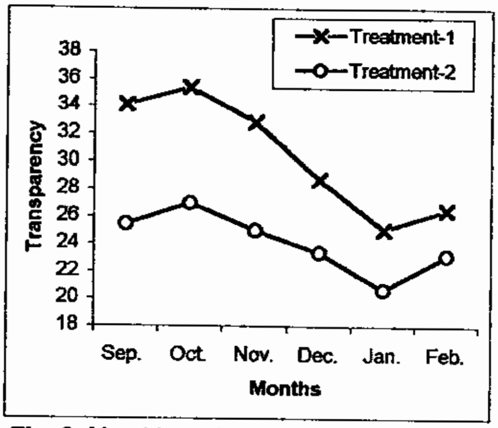

Fig.-2: Monthly variation of mean transparency (cm) under treatment-1 and treatment-2.

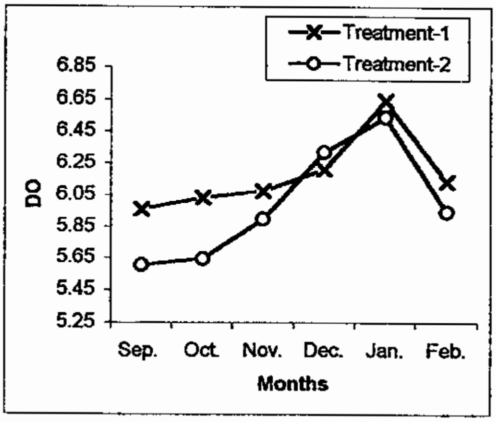

Fig.-3: Monthly variation of mean dissolved oxygen(mg/l) under treatment-1 and treatment-2.

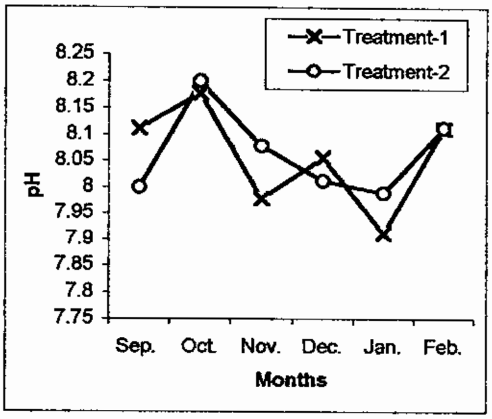

Fig.-4: Monthly variation of mean water pH under treatment-1 and treatment-2.

4.2 Growth in relation to weight and length

Data on growth profile of rohu, catla and golda in relation to gain in weight and length under two treatments over a period of six months are presented in table 7 to 24 and figure 4 to28.

4.2.1 Growth in terms of weight under two different treatments

The initial weights of rohu under $T_1$and T_2 were 18 ± 5.02 and 20 ± 7.17 g respectively and the final weight were 120 ± 17.17 and 97 ± 32.00 g respectively (Table 7). It is evident that the monthly maximum and minimum gain in weight of rohu, were 37.22 and 7.78 g in T_1 and 29.17 and 5.63 g in T_2 respectively (Table 10 and Fig.-5). Under T_1 and T_2, the growth in terms of weight was highest in February and lowest in December. The net gain in weight over a period of six months in T_1 and T_2 were found to be 101.11 and 77.50 g respectively (Table 10). The net gain in weight expressed in percentage at the end of the study in T_1 and T_2 were 538.64 and 388.40 respectively (Table 13). The maximum monthly rate of gain in T_1 and T_2 were 89.13% and 66.52% in the month of September and the minimum were 12.62% and 10.88% in the month of December respectively. (Table 13)

The initial weight of catla in T_1 and T_2 were 11.94 ± 4.25 and 11.94 ± 3.49 g respectively and the final weight were 60.28 ± 13.23 and 53.33 ± 14.14 g respectively (Table 8). It is marked that the maximum and minimum gain in weight of catla were 11.94 and 3.89 g in T_1 and 10.28 and 2.50 g in T_2 respectively (Table 11). The net gain in weight over a period of six months in T_1 and T_2 were found to be 48.33 and 41.39 g respectively. The monthly gain and net gain in weight expressed in percentage are shown in table 14. The maximum, minimum and net gain in weight expressed in percentage were 76.83, 9.93 and 404.59 m in T_1, and 60.39, 6.08, and 347.71 g in T_2 respectively. In T_1, the growth in terms of weight was highest in September and lowest in December, and in T_2, it was highest in September and lowest in January (Fig.-6).

It is found that the golda attained the final weight of 58.33 ± 16.98 and 51.94 ± 16.73 g in $T_1$and T_2 respectively where the initial weight at the time of stocking were 9.94 ± 3.33 and 9.78 ± 3.46 g in $T_1$and T_2 respectively (Table 9). In $T_1$and T_2, the growth in terms of weight was highest in February and lowest in December (Fig.-7). The net gain in weight over a period of six months in T_1 and T_2 were found to be 48.39 and 42.17 g (Table 12) respectively. The net growth in weight expressed in percentage at the end of the study in T_1 and T_2 were 486.64 and 431.31 g respectively (Table 15). The maximum monthly rate of gain in T_1 and T_2 were 92.86% and 70.42% in the month of September and the minimum were 9.04% and 9.78% in the month of December respectively (Table 15).

Table 7: Average cumulative growth in weight (g) of rohu (*Labeo rohita*) in ponds under two different treatments for a period of 6 months.

Dated	3 Sep.	3 Oct.	3 Nov.	3 Dec.	3 Jan.	3 Feb.	3 Mar.
Treatment-1	18.89 ± 5.02	35.56 ± 7.84	49.17 ± 12.40	61.39 ± 14.53	69.17 ± 20.31	82.78 ± 20.88	120.00 ± 17.17
Treatment-2	20.28 ± 7.17	33.33 ± 8.74	43.33 ± 9.39	53.61 ± 15.13	59.44 ± 13.81	68.61 ± 24.90	97.78 ± 32.00

Table 8: Average cumulative growth in weight (gm) of catla (*Catla catla*) in ponds under two different treatments for a period of 6 months.

Dated	3 Sep.	3 Oct.	3 Nov.	3 Dec.	3 Jan.	3 Feb.	3 Mar.
Treatment-1	11.94 ± 4.25	21.11 ± 6.54	31.94 ± 9.57	39.17 ± 11.28	43.06 ± 11.52	48.33 ± 12.00	60.28 ± 13.23
Treatment-2	11.94 ± 3.49	19.17 ± 6.00	28.33 ± 10.00	36.67 ± 12.00	40.56 ± 13.16	43.06 ± 12.62	53.33 ± 14.14

Table 9: Average cumulative growth in weight (g) of golda (*Macrobrachium rosenbergii*) in ponds under two different treatments for a period of 6 months.

Dated	3 Sep.	3 Oct.	3 Nov.	3 Dec.	3 Jan.	3 Feb.	3 Mar.
Treatment-1	9.94 ± 3.33	19.17 ± 6.91	30.29 ± 10.53	36.94 ± 13.52	40.28 ± 16.04	45.00 ± 13.83	58.33 ± 16.98
Treatment-2	9.78 ± 3.46	16.67 ± 5.42	24.17 ± 7.52	28.33 ± 9.70	31.11 ± 9.63	35.56 ± 9.98	51.94 ± 16.73

Table 10: Monthly gain and net gain in weight (g) of rohu (*Labeo rohita*) in ponds under two different treatments for a period of 6 months.

Dated	3 Sep.	3 Oct.	3 Nov.	3 Dec.	3 Jan.	3 Feb	Net gain	Max.	Min.
Treatment-1	16.67	13.61	12.22	7.78	13.61	37.22	101.11	37.22	7.78
Treatment-2	13.06	10.00	10.28	5.83	9.17	29.17	77.50	29.17	5.83

Table 11: Monthly gain and net gain in weight (g) of catla (*Catla catla*) in ponds under two different treatments for a period of 6 months.

Dated	3 Sep.	3 Oct.	3 Nov.	3 Dec.	3 Jan.	3 Feb.	Net gain	Max.	Min.
Treatment-1	9.17	10.83	7.22	3.89	5.28	11.94	48.33	11.94	3.89
Treatment-2	7.22	9.17	8.33	3.89	2.50	10.28	41.39	10.28	2.50

Table 12: Monthly gain and net gain in weight (g) of golda (*Macrobrachium rosenbergii*) in ponds under two different treatments for a period of 6 months.

Dated	3 Sep.	3 Oct.	3 Nov.	3 Dec.	3 Jan.	3 Feb	Net gain	Max.	Min.
Treatment-1	9.22	11.13	6.65	3.33	4.72	13.33	48.39	13.33	3.33
Treatment-2	6.89	7.50	4.17	2.78	4.44	16.39	42.17	16.39	2.78

Table 13: Monthly growth and net growth in weight (g) expressed in percentage of rohu (*Labeo rohita*) in ponds under two different treatments for a period of 6 months.

Dated	3 Sep.	3 Oct.	3 Nov.	3 Dec.	3 Jan.	3 Feb.	Net gain	Max.	Min.
Treatment-1	89.13	38.40	24.82	12.62	19.51	45.39	538.64	89.13	12.62
Treatment-2	66.52	30.95	23.74	10.88	15.05	42.04	388.40	66.52	10.88

Table 14: Monthly growth and net growth in weight (g) expressed in percentage of catla (*Catla catla*) in ponds under two different treatments for a period of 6 months.

Dated	3 Sep.	3 Oct.	3 Nov.	3 Dec.	3 Jan.	3 Feb.	Net gain	Max.	Min.
Treatment-1	76.83	51.39	22.57	9.93	12.27	24.70	404.95	76.83	9.93
Treatment-2	60.39	47.92	29.82	10.66	6.08	23.93	347.71	60.39	6.08

Table 15: Monthly growth and net growth in weight (g) expressed in percentage of golda (*Macrobrachium rosenbergii*) in ponds under two different treatments for a period of 6 months.

Dated	3 Sep.	3 Oct.	3 Nov.	3 Dec.	3 Jan.	3 Feb.	Net gain	Max.	Min.
Treatment-1	92.86	57.68	22.25	9.04	11.69	29.62	486.64	92.86	9.04
Treatment-2	70.42	45.08	17.26	9.78	14.26	46.13	431.31	70.42	9.78

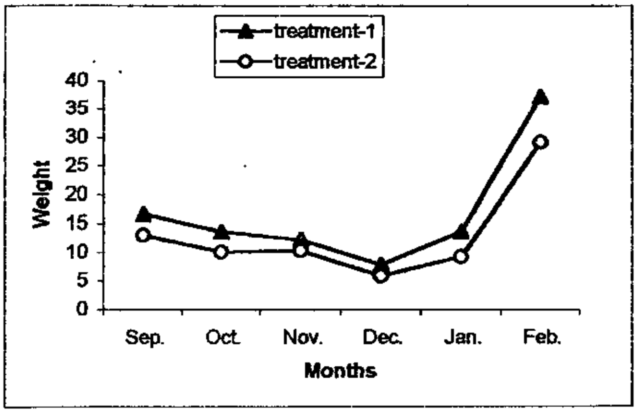

Fig.-5: Monthly gain in weight (g) of *Labio rohita* under two different treatments for a period of 180 days.

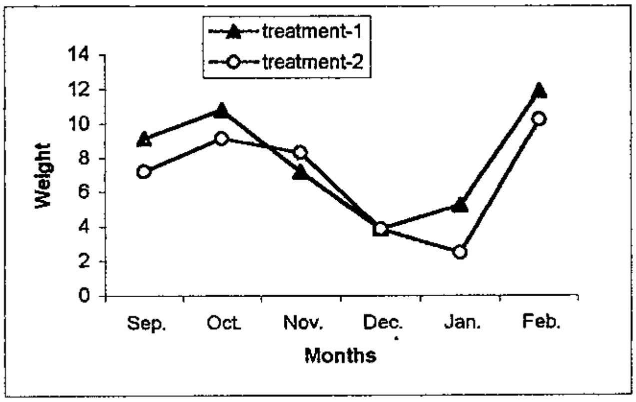

Fig.-6: Monthly gain in weight (g) of *Catla catla* under two different treatments for a period of 180 days.

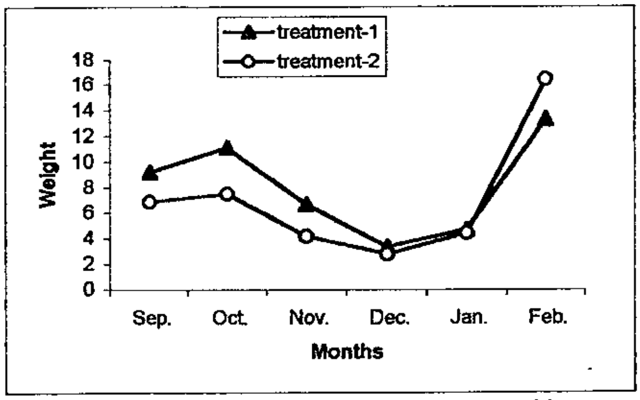

Fig.-7: Monthly gain in weight (g) of *Macrobrachium rosenbergii* under two different treatments for a period of 180 days.

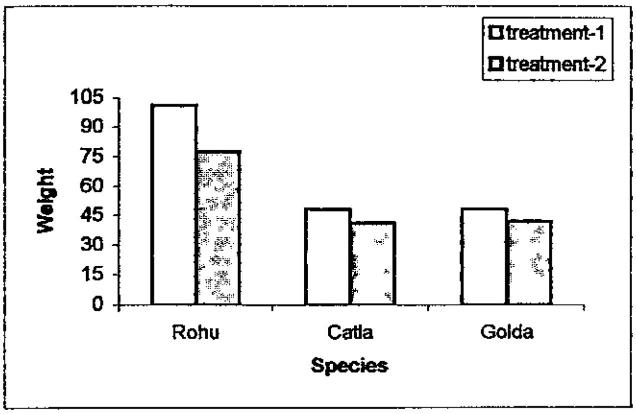

Fig.-8: Net gain in weight (g) of different species under two different treatments for a period of 180 days.

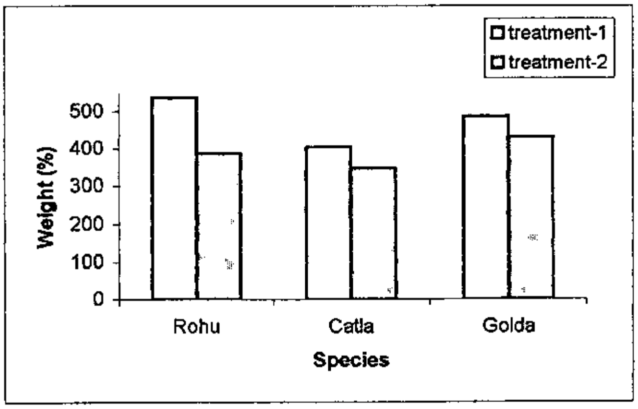

Fig.-9: Net gain in weight (g) of different species expressed in percentage under two different treatments for a period of 180 days.

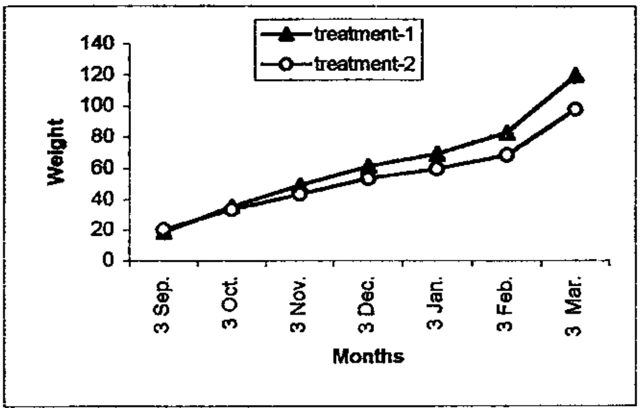

Fig.-10: Average cumulative growth in weight (g) of *Labio rohita* under two different treatment for a period of 180 days.

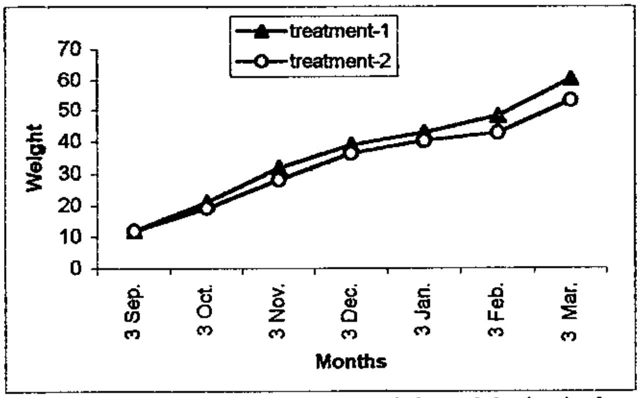

Fig.-11: Average cumulative growth in weight (gm) of *Catla catla* under two different treatments for a period of 180 days.

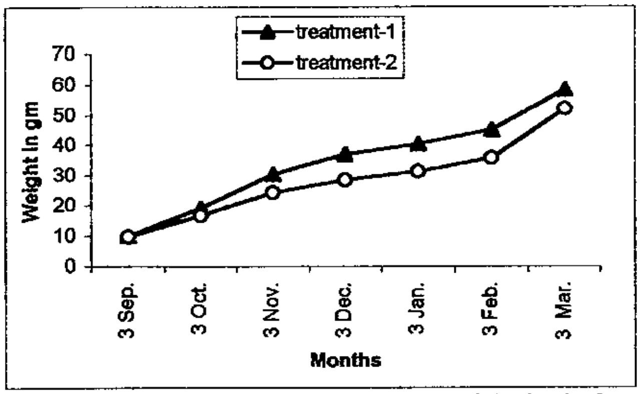

Fig.-12: Average cumulative growth in weight (gm) of *Macrobrachium rosenbergii* under two different treatment for a period of 180 days.

4.2.2 Growth in terms of gain in length under two different treatments

The information on growth performances of rohu, catla and golda in terms of increment in length under two treatments for a period of 6 months are shown in table 16 to 24 and Fig. 13 to20.

It is found that the rohu attained the final length of 21.71 ± 1.48 cm and 20.29 ± 2.47 cm in $T_1$and T_2 respectively where the initial length at the time of stocking were 12.40 ± 1.10 cm and 12.21 ± 1.29 cm in $T_1$and T_2 respectively (Table 16). The net gain in length was 9.31cm in T_1 and 8.08 cm in T_2. There was a marked variation in the monthly gain in length. The monthly gain in length was found to be highest (2.54 cm) in February under T_1 while the same was maximum (2.68 cm) in February under T_2 (Fig.-13). The monthly gain in length was found to be lowest (0.78 cm) in December in T_1 while it was minimum (0.43 cm) in December in T_2 (Table 19 and Fig.-13). At the end of the study, the net gain in weight expressed in percentage were 80.61 and 66.25 in T_1 and T_2 respectively (Table 22). The maximum monthly rate of gain in T_1 and T_2 were 20.30% and 17.19% and the minimum were 4.57% and 2.66% respectively.

The average initial length of catla in $T_1$and T_2 were 9.16 ± 1.00 cm and 9.64 ± 0.80 cm respectively at the time of stocking and reached to an average size 15.76 ± 1.52 cm and 15.19 ± 1.36 respectively (Table 17). Maximum and minimum monthly gain in length of catla was recorded to be 1.86 cm and 0.42 cm in September and December respectively in T_1, and to be 1.47 cm and 0.36 cm in September and January respectively in T_2 (Table 20 and Fig.-14). The net gain in length was 6.14 cm in treatment-1 and 5.54 cm in treatment-2. The net gain in length expressed in percentage at the end of the study in T_1 and T_2 were 63.91and 57.51 cm respectively (Table 23). The maximum monthly rate of gain in T_1 and T_2 were 19.31%and 15.22% and the minimum were 3.09% and 2.63% respectively.

The mean initial length of golda under T_1 and T_2 were 8.78 ± 1.29 cm and 8.76 ± 1.20 cm at the stocking time and reached to a mean length 16.78 ± 1.76 cm and 16.01 cm respectively (Table 18). Maximum and minimum monthly gain in length of golda was recorded to be 2.49 cm and 0.50 cm in September and December in respectively T_1, and to be 1.89 cm and 0.52 cm in September and December respectively in T_2 (Table 21 and Fig.-15). The net gain in length was 7.99 cm in T_1 and 7.25 cm in T_2. The net gain in length expressed in percentage at the end of the study under T_1 and T_2 were 91.07% and 82.81% respectively. The maximum monthly rate of gain under T_1 and T_2 were 28.41% and 21.64% and the minimum were 3.53% and 3.97% respectively (Table 24).

For all the experimented species the maximum growth in length expressed in percentage was found to be in the month of September and the minimum value was found to be December except rohu under T_2. The minimum growth of rohu under T_2 was in the month of January.

In the experiment the growth of catla was relatively low than another two species (Fig.-8 and 9). All species showed the higher rate of growth in all respect in treatment-1than treatment-2 (Fig.-8) which was probably due to supplementary feeding application. This result is similar to the result of Harish (1979), Rabanal (1967) and Rahaman (1997). There were a little variations of growth rate observed between the two treatments. Saha *at al.* (1978) recorded enhanced growth of phytoplankton and zooplankton which in tern induced better growth of fish by applying of fertilizer. Grover *et al.*, (1976) observed much high yields of fishes in fertilized ponds than unfertilized ponds. The growth of all the species in T_2 was satisfactory regarding T_1which was probably due to high production of phytoplankton and zooplankton by applying of fertilizer.

Table 16: Average cumulative growth in length (cm) of rohu (*Labeo rohita*) in ponds under two different treatments for a period of 6 months.

Dated	3 Sep.	3 Oct.	3 Nov.	3 Dec.	3 Jan.	3 Feb.	3 Mar.
Treatment-1	12.40 ± 1.10	14.45 ± 0.78	15.87 ± 1.24	16.97 ± 1.47	17.74 ± 1.91	19.16 ± 1.73	21.71 ± 1.48
Treatment-2	12.21 ± 1.29	14.28 ± 1.05	15.32 ± 1.09	16.37 ± 1.43	16.80 ± 1.31	17.61 ± 2.07	20.29 ± 2.47

Table 17: Average cumulative growth in length (cm) of catla (*Catla catla*) in ponds under two different treatments for a period of 6 months.

Dated	3 Sep.	3 Oct.	3 Nov.	3 Dec.	3 Jan.	3 Feb.	3 Mar.
Treatment-1	9.61 ± 1.00	11.47 ± 1.18	13.05 ± 1.18	13.63 ± 0.98	14.06 ± 0.91	14.55 ± 1.11	15.76 ± 1.52
Treatment-2	9.64 ± 0.80	11.11 ± 1.24	12.41 ± 1.69	13.25 ± 1.43	13.68 ± 1.50	14.04 ± 1.13	15.19 ± 1.36

Table 18: Average cumulative growth in length (cm) of golda (*Macrobrachium rosenbergii*) in ponds under two different treatments for a period of 6 months.

Dated	3 Sep.	3 Oct.	3 Nov.	3 Dec.	3 Jan.	3 Feb.	3 Mar.
Treatment-1	8.78 ± 1.29	11.28 ± 1.63	13.29 ± 1.92	14.14 ± 1.93	14.64 ± 1.98	15.32 ± 1.55	16.78 ± 1.76
Treatment-2	8.76 ± 1.20	10.65 ± 1.48	12.38 ± 1.62	13.01 ± 1.82	13.52 ± 1.70	14.27 ± 1.45	16.01 ± 1.94

Table 19: Monthly gain and net gain in length (cm) of rohu (*Labeo rohita*) in ponds under two different treatments for a period of 6 months.

Dated	3 Sep.	3 Oct.	3 Nov.	3 Dec.	3 Jan.	3 Feb.	Net gain	Max.	Min.
Treatment-1	2.05	1.42	1.10	0.78	1.42	2.54	9.31	2.54	0.78
Treatment-2	2.07	1.04	1.04	0.43	0.81	2.68	8.08	2.68	0.43

Table 20: Monthly gain and net gain in length (cm) of catla (*Catla catla*) in ponds under two different treatments for a period of 6 months.

Dated	3 Sep.	3 Oct.	3 Nov.	3 Dec.	3 Jan.	3 Feb.	Net gain	Max.	Min.
Treatment-1	1.86	1.58	0.58	0.42	0.49	1.21	6.14	1.86	0.42
Treatment-2	1.47	1.29	0.84	0.43	0.36	1.14	5.54	1.47	0.36

Table 21: Monthly gain and net gain in length (cm) of golda (*Macrobrachium rosenbergii*) in ponds under two different treatments for a period of 6 months.

Dated	3 Sep.	3 Oct.	3 Nov.	3 Dec.	3 Jan.	3 Feb.	Net gain	Max.	Min.
Treatment-1	2.49	2.02	0.85	0.50	0.68	1.46	7.99	2.49	0.50
Treatment-2	1.89	1.73	0.63	0.52	0.75	1.73	7.25	1.89	0.52

Table 22: Monthly growth and net growth in length (cm) expressed in percentage of rohu (*Labeo rohita*) in ponds under two different treatments for a period of 6 months.

Dated	3 Sep.	3 Oct.	3 Nov.	3 Dec.	3 Jan.	3 Feb.	Net gain	Max.	Min.
Treatment-1	20.30	9.80	6.93	4.57	7.95	13.34	80.61	20.30	4.57
Treatment-2	17.19	7.29	6.82	2.66	4.78	15.15	66.25	17.19	2.66

Table 23: Monthly growth and net growth in length (cm) expressed in percentage of catla (*Catla catla*) in ponds under two different treatments for a period of 6 months.

Dated	3 Sep.	3 Oct.	3 Nov.	3 Dec.	3 Jan.	3 Feb	Net gain	Max.	Min.
Treatment-1	19.31	13.80	4.47	3.09	3.53	8.28	63.91	19.31	3.09
Treatment-2	15.22	11.69	6.82	3.27	2.63	8.13	57.51	15.22	2.63

Table 24: Monthly growth and net growth in length (cm) expressed in percentage of golda (*Macrobrachium rosenbergii*) in ponds under two different treatments for a period of 6 months.

Dated	3 Sep.	3 Oct.	3 Nov.	3 Dec.	3 Jan.	3 Feb.	Net gain	Max.	Min.
Treatment-1	28.41	17.73	6.54	3.53	4.65	9.51	91.07	28.41	3.53
Treatment-2	21.64	16.23	5.08	3.97	5.54	12.14	82.81	21.64	3.97

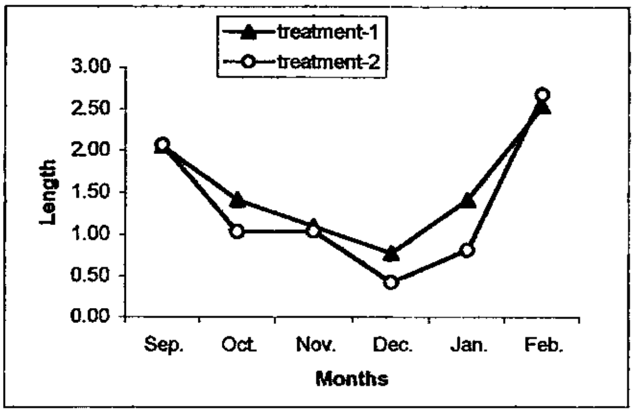

Fig.-13: Monthly gain in length (cm) of *Labio rohita* under two different treatments for a period of 180 days.

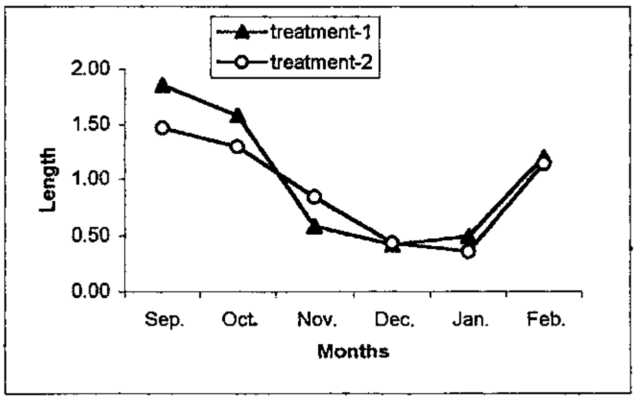

Fig.-14: Monthly gain in length (cm) of *Catla catla* under two different treatments for a period of 180 days.

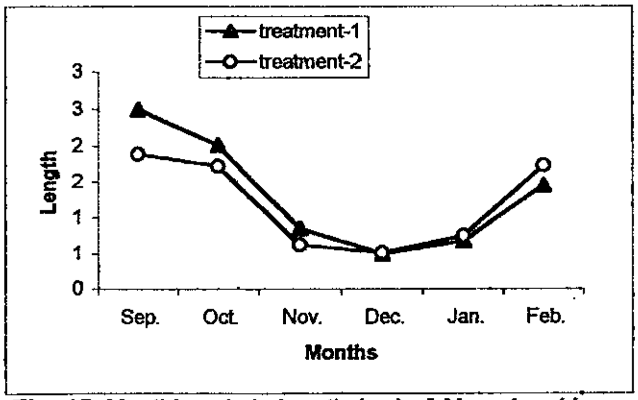

Fig.-15: Monthly gain in length (cm) of *Macrobrachium rosenbergii* under two different treatment for a period of 180 days.

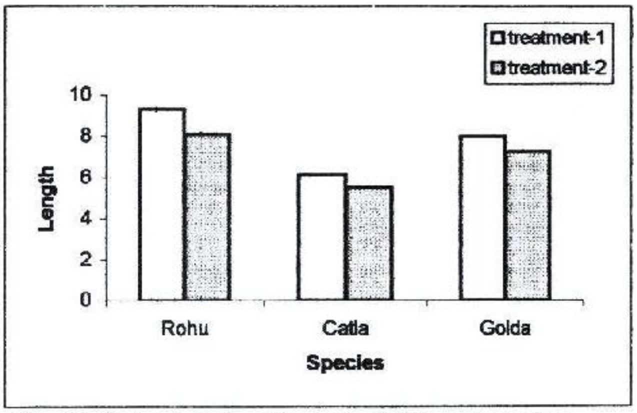

Fig.-16: Net gain in length (cm) of different species under two different treatments for a period of 180 days.

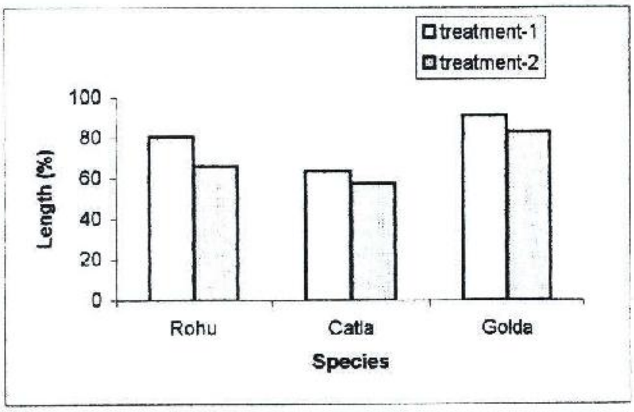

Fig.-17: Net gain in length (cm) of different species expressed in percentage under two different treatments for a period of 180 days.

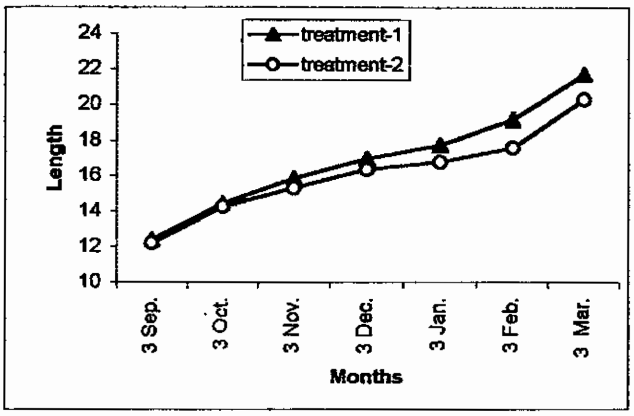

Fig.-18: Average cumulative growth in length (cm) of *Labio rohita* under two different treatments for a period of 180 days.

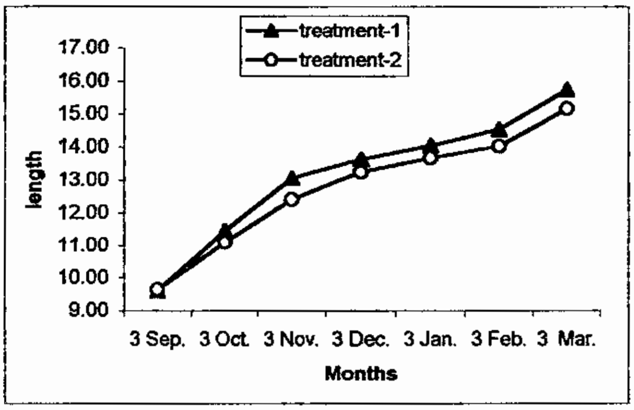

Fig.-19: Average cumulative growth in length (cm) of *Catla catla* under two different treatments for a period of 180 days.

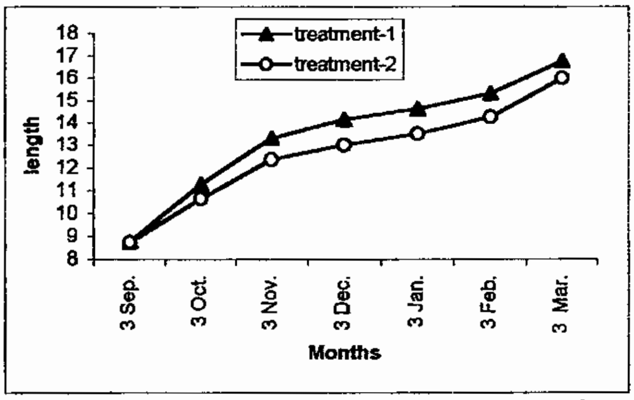

Fig.-20: Average cumulative growth in length (cm) of *Macrobrachium rosenbergii* under two differents treatments for a period of 180 days.

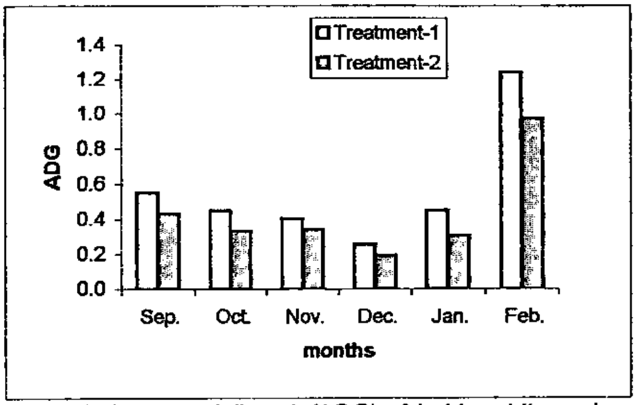

Fig.-21: Average daily gain(ADG) of *Labio rohita* under two different treatments for a period of 180 days.

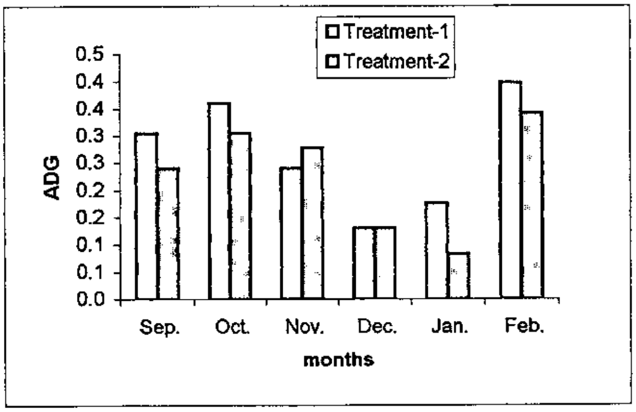

Fig.-22: Average daily gain (ADG) of *Catla catla* under two different treatmenst for a period of 180 days.

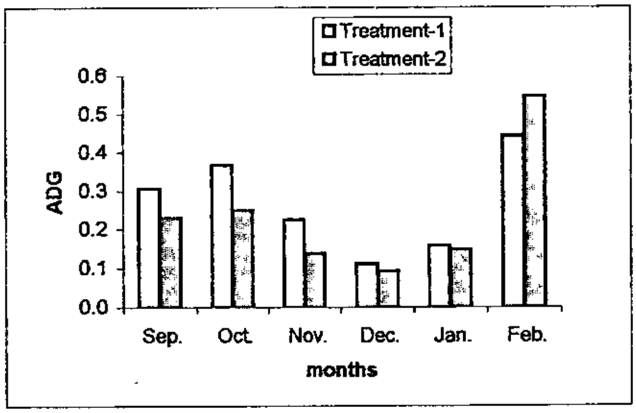

Fig.-23: Average daily gain (ADG) of *Macrobrachium rosenbergii* under two different treatment for a period of 180 days.

4.4 Specific growth rate

The values of specific growth rate of experimented species under two different treatments are presented in table 28 to 30. The average specific growth rate of rohu, catla , golda were 1.03%, 0.90%,0.98% under T_1 and 0.88%, 0.83%, 0.93% under T_2 respectively (Fig.-24, 25 and 26). The monthly variations of specific growth rate were same as the average daily gain varied.

Table 28: Monthly specific growth rate and net specific growth rate of rohu (*Labeo rohita*) in ponds under two different treatments for a period of 6 months.

Dated	3 Sep.	3 Oct.	3 Nov.	3 Dec.	3 Jan.	3 Feb	Net gain	Max.	Min.
Treatment-1	2.12	1.08	0.74	0.40	0.59	1.25	1.03	2.12	0.56
Treatment-2	1.69	0.90	0.71	0.34	0.47	1.17	0.88	1.69	0.44

Table 19: Monthly specific growth rate and net specific growth rate of catla (*Catla catla*) in ponds under two different treatments for a period of 6 months.

Dated	3 Sep.	3 Oct.	3 Nov.	3 Dec.	3 Jan.	3 Feb.	Net gain	Max.	Min.
Treatment-1	1.90	1.38	0.68	0.32	0.39	0.74	0.90	1.90	0.32
Treatment-2	1.57	1.30	0.87	0.34	0.20	0.71	0.83	1.57	0.20

Table 30: Monthly specific growth rate and net specific growth rate of golda (*Macrobrachium rosenbergii*) in ponds under two different treatments for a period of 6 months.

Dated	3 Sep.	3 Oct.	3 Nov.	3 Dec.	3 Jan.	3 Feb.	Net gain	Max.	Min.
Treatment-1	2.19	1.52	0.67	0.29	0.37	0.86	0.98	2.19	0.29
Treatment-2	1.78	1.24	0.53	0.31	0.44	1.26	0.93	1.78	0.31

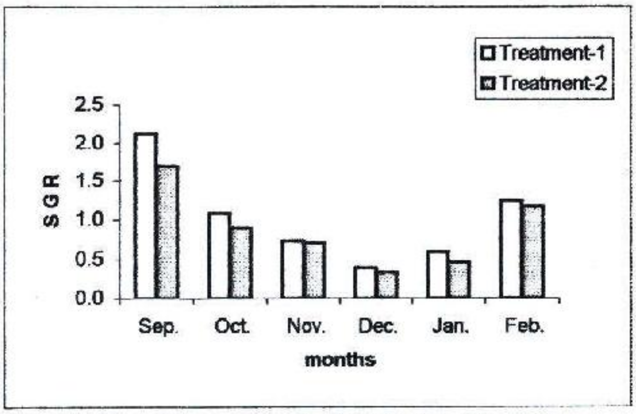

Fig.-24: Specific growth rate (SGR) of *Labio rohita* under two different treatments for a period of 180 days.

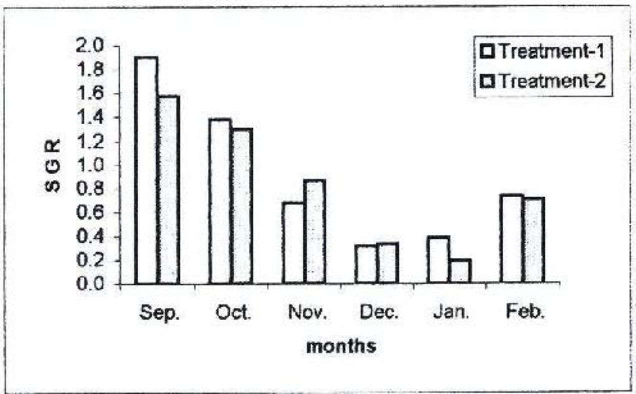

Fig-25: Specific growth rate (SGR) of *Catla catla* under two different treatments for a period of 180 days.

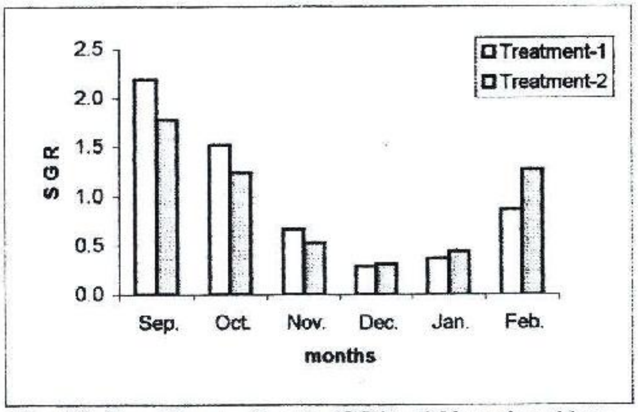

Fig.-26: Specific growth rate (SGR) of *Macrobrachium rosenbergii* under two different treatments for a period of 180 days.

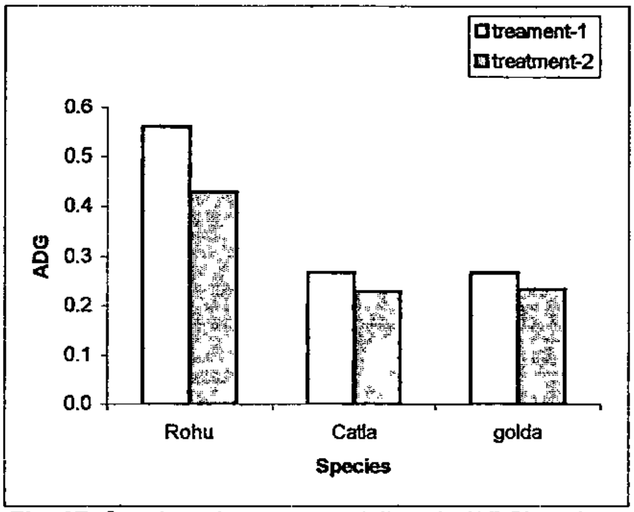

Fig.-27: Species-wise average daily gain (ADG) under two different treatments for a period of 180 days.

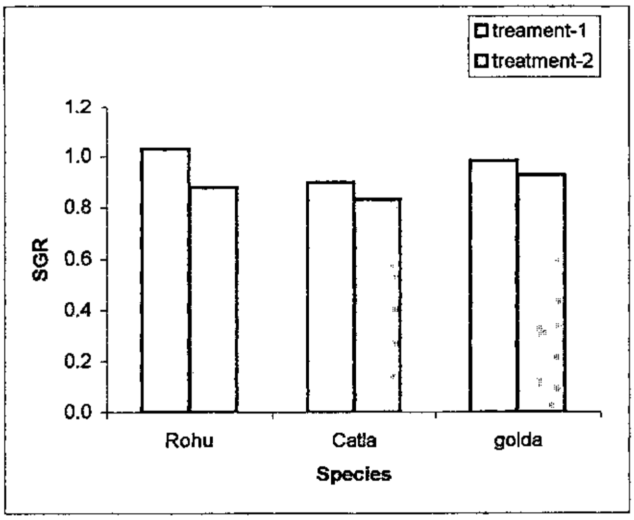

Fig.-28: Species-wise specific growth rate (SGR) under two different treatments for a period of 180 days.

4.5 Correlation between growth rate and water quality parameters

The Regression equation between growth rate and observed water quality parameters (Water temperature, Water pH, dissolved oxygen and transparency) are shown in table 31-33. The correlations between growth rate and water quality parameters are shown in Figures 29 to 52.

Growth rate was found to be positively correlated with water temperature and water pH for all experimented species under treatment-1 and treatment-2 (Fig.-29-40). The correlation between growth rate and dissolved oxygen varied with species, also with treatments. Dissolved oxygen was positively correlated with growth rate of rohu and catla under treatmen-1 but negatively correlated with growth of rohu, catla under treatment-2. For golda this relationship was negative under both the two treatments (Fig.-41-46). In case of transparency, the correlation varied only with experimented species. It was positively correlated with growth rate of catla and golda but negatively correlated with the growth rate of rohu under treatment-1 and treatment-2 (Fig.-47-52).

Table 31: Co-relation and regression between observed water quality parameters (x) and growth rate (y) of rohu (*Labio rohita*) under T_1 and T_2.

Relationship	Treatments	Regression equation (y = a + bx)	Correlation coefficient "r"	Value of "t"
Water temperature (x) and growth rate (y)	1	y = 0.2206x + 2.8071	0.22	9.04*
	2	y = 0.1946x + 1.5047	0.24	11.22*
Water pH (x) and growth rate (y)	1	y = 17.916x - 136	0.53	0.25**
	2	y = 10.63x - 79.442	0.36	1.35**
Dissolved oxygen (x) and growth rate (y)	1	y = 0.8708x + 3.0455	0.05	1.49**
	2	y = -3.9425x + 30.201	-0.37	0.35**
Transparency (x) and growth rate (y)	1	y = -0.1438x + 12.346	-0.13	9.53*
	2	y = -0.1418x + 10.756	-0.01	12.29*

Table 32: Co-relation and regression between observed water quality parameters (x) and growth rate (y) of catla (*Catla catla*) under T_1 and T_2..

Relationship	Treatments	Regression equation (y = a + bx)	Correlation coefficient "r"	Value of "t"
Water temperature (x) and growth rate (y)	1	y = 0.2013x - 1.0985	0.62	16.84*
	2	y = 0.1944x - 1.5001	0.66	17.51*
Water pH (x) and growth rate (y)	1	y = 5.4809x - 40.154	0.50	8.54*
	2	y = 4.8562x - 35.791	0.45	10.81*
Dissolved oxygen (x) and growth rate (y)	1	y = 0.0334x + 3.8213	0.01	4.31*
	2	y = -1.7509x + 14.081	-0.46	5.16*
Transparency (x) and growth rate (y)	1	y = 0.0854x + 1.4393	0.26	18.17*
	2	y = 0.1178x - 0.1206	0.57	32.49*

Table 33: Co-relation and regression between observed water quality parameters (x) and growth rate (y) of golda (*Macrobrahium rosenbergii*) under T_1 and T_2.

Relationship	Treatments	Regression equation (y = a + bx)	Correlation coefficient "r"	Value of "t"
Water temperature (x) and growth rate (y)	1	y = 0.2396x - 2.071	0.63	17.30*
	2	y = 0.1412x - 0.0817	0.31	15.04*
Water pH (x) and growth rate (y)	1	y = 7.3421x - 55.153	0.57	7.28*
	2	y = 7.3377x - 55.778	0.43	6.71*
Dissolved oxygen (x) and growth rate (y)	1	y = -0.4905x + 7.0628	-0.11	3.56*
	2	y = 0.888x - 1.9228	-0.07	3.56*
Transparency (x) and growth rate (y)	1	y = 0.1068x + 0.7955	0.28	18.19*
	2	y = -0.047x + 4.9397	0.09	20.86*

*Significant in 5% level

**Insignificant in 5% level

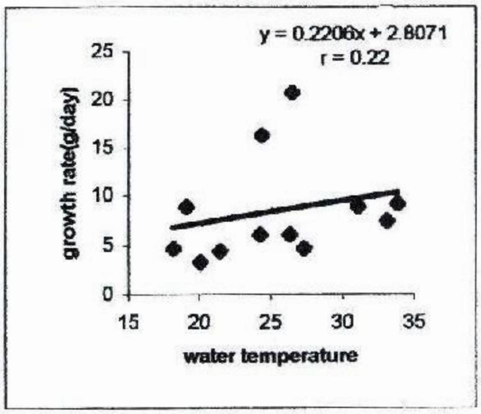

Fig.-29: Regression of y (mean growth rate) on x (mean water temperature) of rui (Lebio rohita) in treatment-1

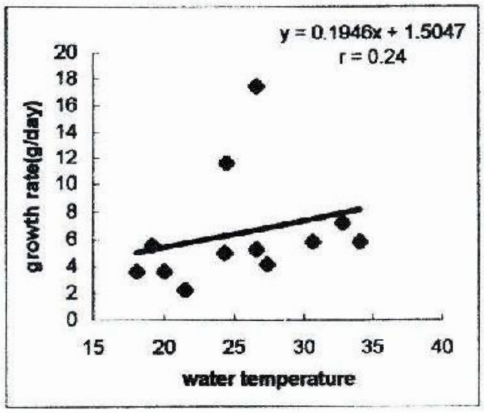

Fig.-30: Regression of y (mean growth rate) on x (mean water temperature) of rui (*Lebio rohita*) in treatment-2

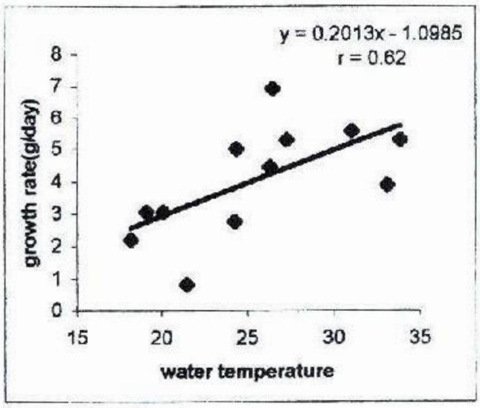

Fig.-31: Regression of y (mean growth rate) on x (mean water temperature) of catla (*Catla catla*) in treatment-1

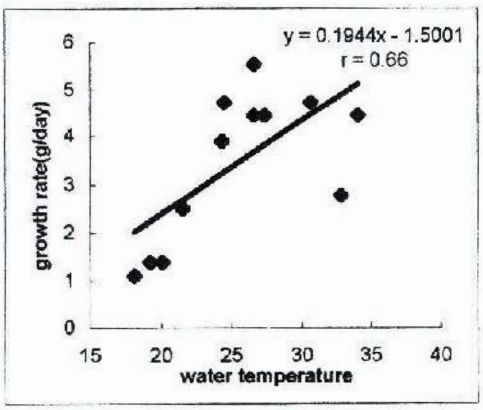

Fig.-32: Regression of y (mean growth rate) on x (mean water temperature) of catla (*Catla catla*) in treatment-2

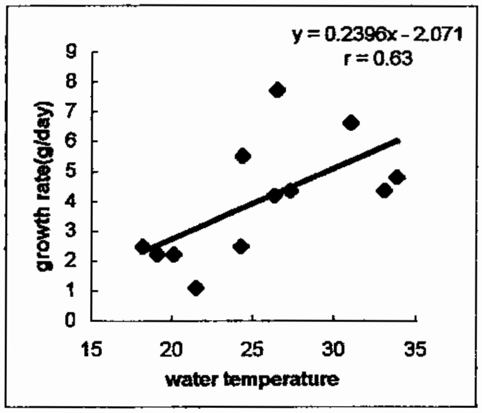

Fig.-33: Regression of y (mean growth rate) on x (mean water temperature) of galda (*Macrobrachium rosenbergii*) in treatment-1

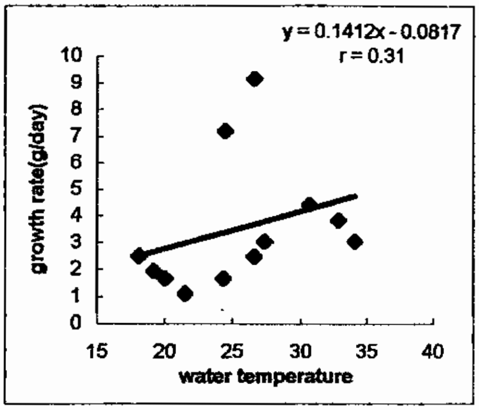

Fig.-34: Regression of y (mean growth rate) on x (mean water temperature) of galda (*Macrobrachium rosenbergii*) in treatment-2

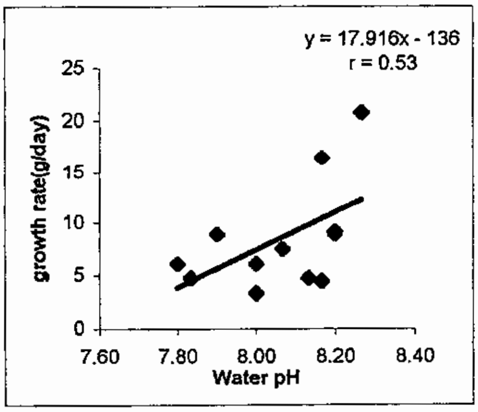

Fig.-35: Regression of y (mean growth rate) on x (mean water pH) of rui (*Lebio rohita*) in treatment-1

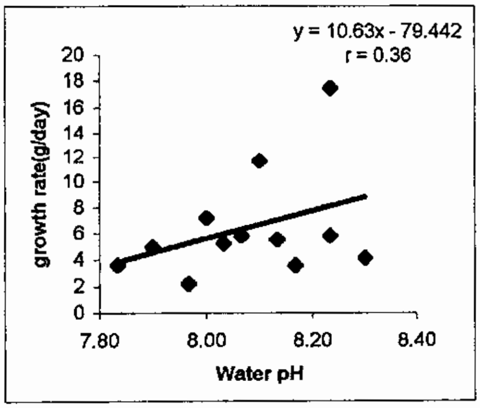

Fig.-36: Regression of y (mean growth rate) on x (mean water pH) of rui (*Lebio rohita*) in treatment-2

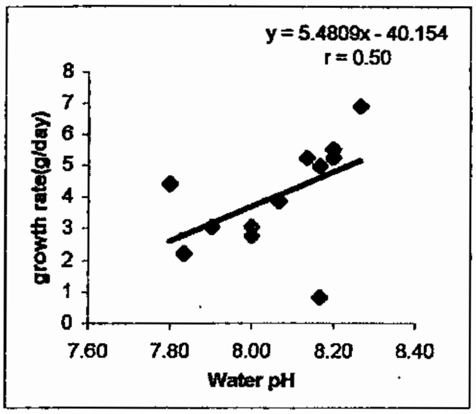

Fig.-37: Regression of y (mean growth rate) on x (mean water pH) of catla (*Catla catla*) in treatment-1

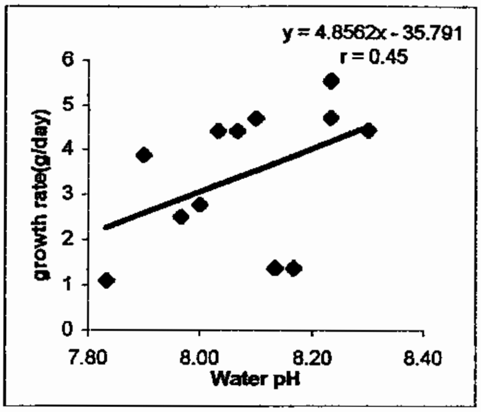

Fig.-38: Regression of y (mean growth rate) on x (mean water pH) of catla (*Catla catla*) in treatment-2

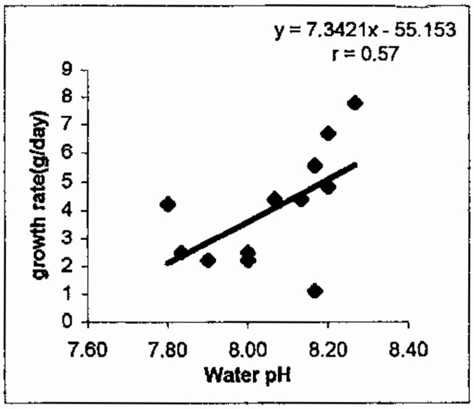

Fig.-39: Regression of y (mean growth rate) on x (mean water pH) of galda (*Macrobrachium rosenbergii*) in treatment-1

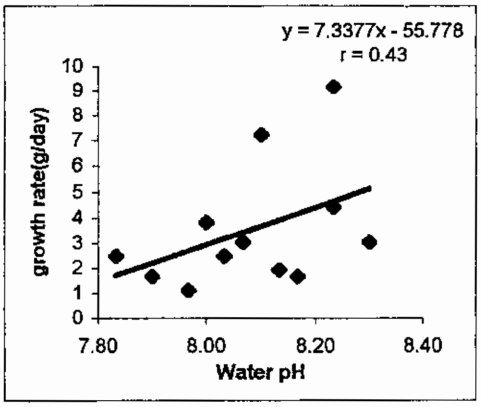

Fig.-40: Regression of y (mean growth rate) on x (mean water pH) of galda (*Macrobrachium rosenbergii*) in treatment-2

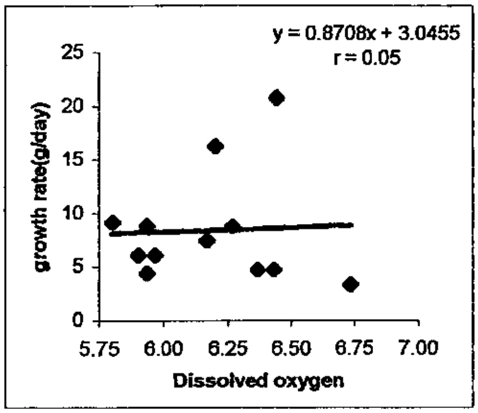

Fig.-41: Regression of y (mean growth rate) on x (mean dissolved oxigen) of rui (*Lebio rohita*) in treatment-1

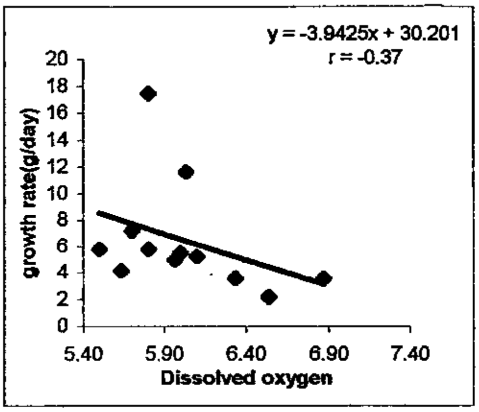

Fig.-42: Regression of y (mean growth rate) on x (mean dissolved oxigen) of rui (*Lebio rohita*) in treatment-2

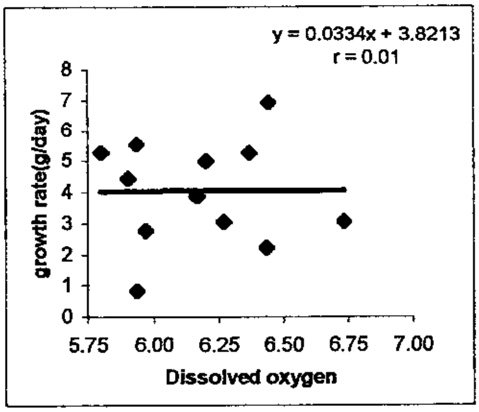

Fig.-43: Regression of y (mean growth rate) on x (mean dissolved oxigen) of catla (*Catla catla*) in treatment-1

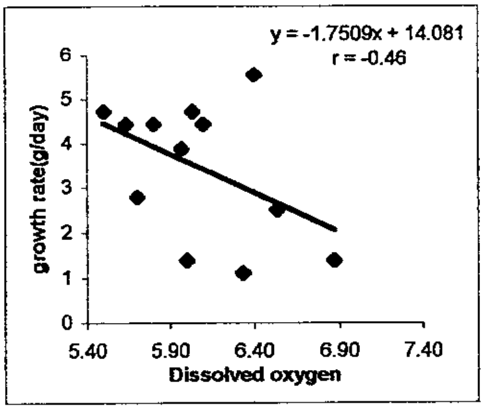

Fig.-44: Regression of y (mean growth rate) on x (mean dissolved oxigen) of catla (*Catla catla*) in treatment-2

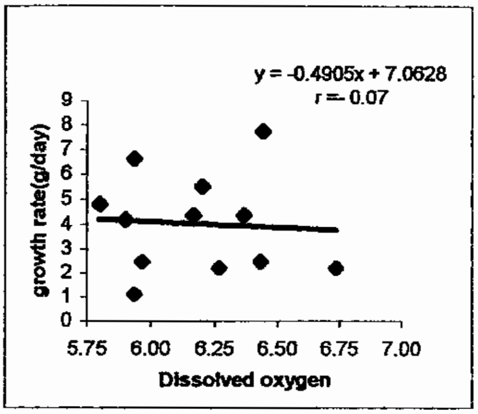

Fig.-45: Regression of y (mean growth rate) on x (mean dissolved oxigen) of galda (*Macrobrachium rosenbergii*) in treatment-1

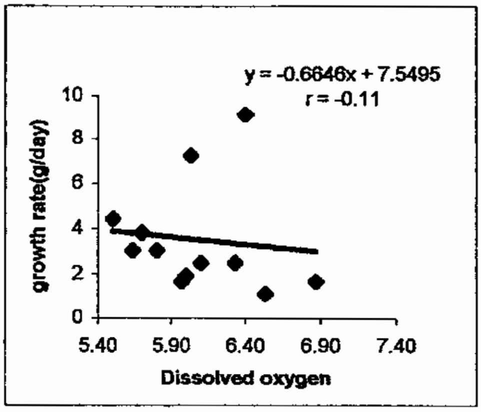

Fig.-46: Regression of y (mean growth rate) on x (mean dissolved oxigen) of galda (*Macrobrachium rosenbergii*) in treatment-2

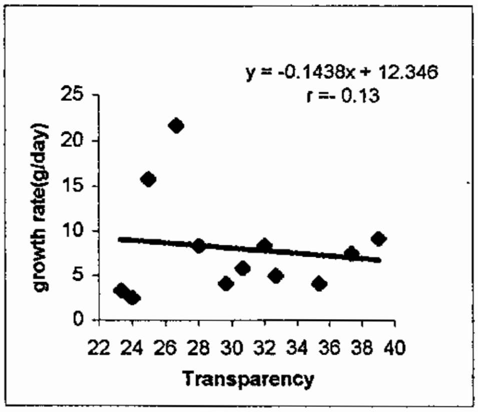

Fig.-47: Regression of y (mean growth rate) on x (mean transparency) of rui (*Labio rohita*) in treatment-1

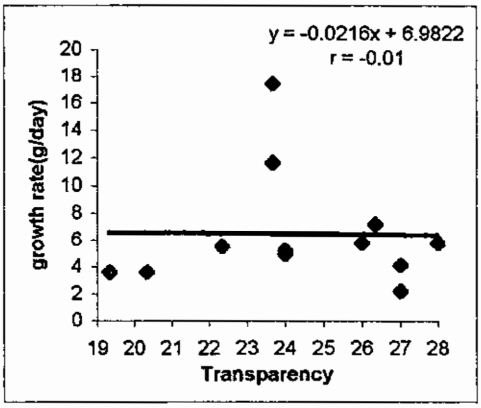

Fig.-48: Regression of y (mean growth rate) on x (mean transparency) of rui (*Labio rohita*) in treatment-2

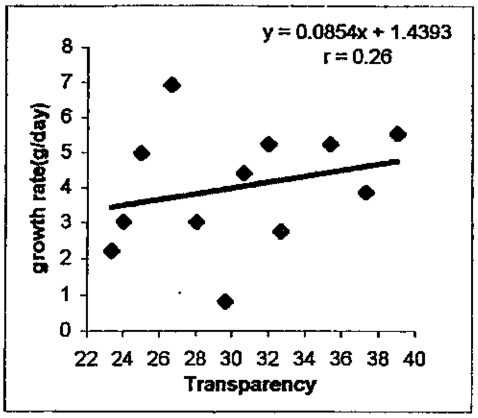

Fig.-49: Regression of y (mean growth rate) on x (mean transparency) of catla (*Catla catla*) in treatment-1

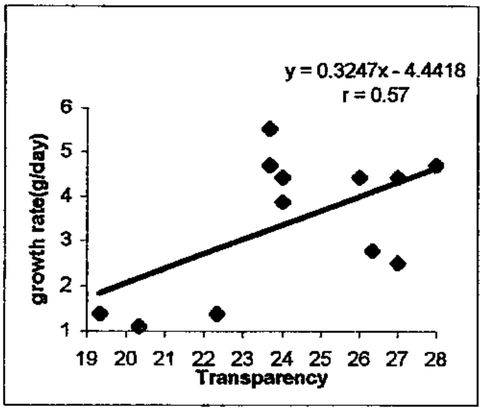

Fig.-50: Regression of y (mean growth rate) on x (mean transparency) of catla (*Catla catla*) in treatment-2

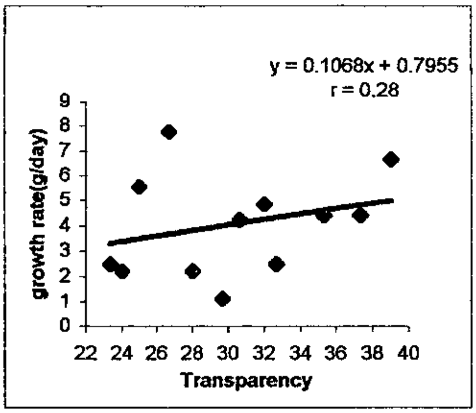

Fig.-51: Regression of y (mean growth rate) on x (mean transparency) of galda (*Macrobrachium rosenbergii*) in treatment-1

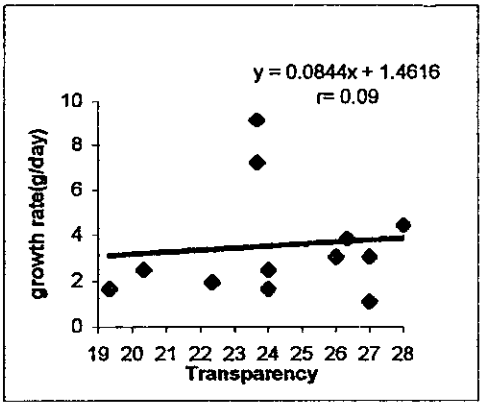

Fig.-52: Regression of y (mean growth rate) on x (mean transparency) of galda (*Macrobrachium rosenbergii*) in treatment 2

CHAPTER FIVE

CONCLUSION

5.0 CONCLUSION

The present study identified the effects of feed and fertilizer on growth of Golda and carps fishes in polyculture system. Artificial feed was supplied in 3 ponds of T_1 and fertilizer was used in other 3 ponds of T_2. Some of the water quality parameters of the pond were studied. Except water temperature, there were no adverse conditions of the limnologial factors found during the study period. The growth rates of all species are seriously hampered by low temperature in December and January. The average growth rate were 0.56, 0.27 and 0.27 g/day for rohu, catla and golda respectively in T_1 where artificial feed was supplied and at the same time the growth rate were 0.43, 0.23 and 0.23 g/day for rohu, catla and golda respectively in T_1 where only fertilization was done. Absence of artificial feed in T_2 the growth rates of all species were slightly lower than T_1. There were a little variation in growth rate between two T_1 and T_2.

Finally it was concluded that only fertilization may be the simplest and cheapest means of increasing fish production. This study is very much important rural marginal farmers who are unable to buy feed for fish.

CHAPTER SIX

REFERENCE

6.0 REFERENCES

Alikunhi, K.H., 1957. Fish culture in India. Fm. Bull. Indian Counc. Agr. Res. New Delhi, 20: 144.

Ali, S., Rahman, A.K.A., Patwary A.R. and Islam, K.H.R., 1982. Studies on the diurnal variations in physico-chemical factors and zooplankton in a freshwater pond. *Bangladesh J. Fish,* 2-5 (1-2): 15-23.

Ariza, G.S. and Romero, G.P., 1993. Assessment of a white cachama *(Piaractus brachypomus),* red tilapia *sp. (Oreochromis sp.)* and silver carp *(Hypophthalmichthys molitrix)* polyculture. *Bol. cient. INPA no.* L, pp. *4-15.*

Ball, R.C., 1949. Experimental use of fertilizer in production of fish food organigm and fish. Mich. State Coll. Agr. Exp. Sta. Tech. Bull. 210:5-28.

Banerjea, S.M., 1967. Water quality and soil condition of fish ponds in some states of India in relation to fish production. *Indian J. Fish.*14: 115-144.

Bhuyan, B.R., 19●70. physico-chemical qualities of water of some ancient Tanks in Sibsagar, Assam. Environmental Health, 12: 129-134.

Buck, H., Malecha., S.R. and Bauer, R.J., 1983. Prawn fish production using different types and loadings of swine manure. *J. World Mariculture Soc.,* 14: 531-532.

Buckman, H.O. and Brady N.C., 1980. the nature and properties of soils. The Macmillan Co., New York.

Burke, J.S. Bayne, D.R. and Rea, H., 1986. Impact of silver and bighead carp on plankton community of channel catfish pond. Aquaculture. 55: 59-68.

Cohen, D., Ra'anan, Z. and Barnes, A., 1983. Production of the freshwater prawn *Macrobrachium rosenbergii*, in Israel. I. integration into fish polyculture systems. *Aquaculture*, 31: 67-76.

Chakraborty, R.D., Murty, D.S., Sen, P.R., Nandy, A.C. and Chakraborty, .D. P., 1974. Periodic harvesting to enhance production in composite culture of Indian and exotitic carps. J. Inland Fish. Soc. India, 4: 167-171.

Choudhury,H., Chakraborty, R.D., Sen, P.R., Rao, N.G.S. and Jena, S., 1975. Record yields by composite fish culture in fresh water ponds. Aquaculture, 6(4): 343-355.

Chowdhuri, H., Rao, N.G.S., Saha, G.N., Rout, M. and Ranaujia, D.R., 1978. Record fish production through Intensive fish Culture in a fanner's ponds *J. Inland Fish. Soc., India*, 10: 19-27. .

Das, P., Kumar, M.K. and Roy M. K.G., 1975. National demonstration on composite fish culture in West Bengle. J. Inland Fish. Soc. India, 7: 112-115.

David, A., Ray, P., Govind, B.V. and Banerjee, K.V., 1969. Limnology and Fisheries of Tungabhadra Reservoir. Central Inland fish. Res. India, Bull., 13: 70-83.

Davis, G.H., Bhuiyan, A.R. and Ammen, M., 1984. Fish Production in managed farmer's ponds with different feeding and stocking regimes. In Proc. 4th Seminar Max. Livestock Production from minimum land. Department of Animal Science, Bangladesh Agricultural University, Mymensingh.

Dewan, S., 1973. Investigation into the ecology of fishes of Mymensingh lake. Ph.D.Thesis submitted to the Department of Aquiculture and Management. Faculty of Fisheries, B.A.U., Mymensingh, 335p.

Dey, R.K., Reddy, P.V. Singh, B. and Murty, D.S., 1979. Notes on compatibility and competition between silver carp and rohu. *J. Inland Soc., India,* 11 (1): 125 - 135.

Dunseth, D.R. and Smitherman, R.O., 1977. Polyculture of catfish, tilapia, and silver carp. *Proc. Annu. Commercial Fisheries Workshop.* 6: 25 -26

Ellis, M.M., 1937. Detection and Measurement of stream pollution. Bull 22, US bureau of fisheries.

F.R.I., 1992. Pukoorea Macher Misrachash (Polyculture of fish in ponds). Manual of fish polyculture in ponds. Extension Material Series No. 9. Fisheries Research Institute, Maymensingh.

Ganapatti, S.V., 1942. An ecological study of a garden pond containingabundent zooplankton, papers read before the first annual meeting of the Indian Ecological Society, Baroda.

George, M.G., 1961. Diurnal variations in two shallow ponds in Delhi, India. *Hydroblol,* 18:265-273.

Goolish, E.M. and Adelman, L.R., 1984. Effects of ration size and temperature on the growth of juvenile common carp (*Cyprinus carpio*) Aquaculture, 36: 27-35.

Grover, J.H., Recometa, R.D. and Dureja, V.A., 1976. production and growth of milk fish, common carp and cat fish in fertilized fresh water ponds. Philipp. J. Biol., 5(2) 193-206.

Gupta, V. K., Sharma, J. P. and Srivastava, J.B., 1990. Polyculture of Indian and exotic carps using cattle manurer with and without supplementary feed. *Recent-Trends-In Limnol.*, pp 439-446.

Halver, J.E. 1984. Special methods in pen fish husbandry. *Akademiai Nyomda, Budapest. pp* 146.

Harrish, H., 1979. Studies on the relatives mariteof three locally available organic manures in combination with N. P. K. for fish culture. M. Sc. Thessis, university of agricultural Sciences, Bangalore, India, 131 p.

Hepher, B., 1962. Primary fish production in fish ponds and its application to fertilization experiments, Limnol. Ocean, 7: 131-136.

Hepher, B., 1967. Some aspect of the phosphorous cycle in fish pond. Intern. Ver. Theoret. Angew. Limnol. Verhendi, 16:1293-1297.

Hickling, C. F., 1968. The farming of fish, 1st.,Pergamon Press Ltd., Acadington Hill Hall, Oxford.

Hoq, M. E., Islam, M.M. and Hossain M.M., 1996. Polly culture of fresh water prawn (*Macrobrachium rosenbergii*) with Chinese and Indian carps in farmer's pond. J. Aqua. Trop., 11: 135-141.

Humayun, N. M., Alam, A. K. M. N. and Islam, M. A., 1986. Culture and production of *Macrobrachium rosenbergii* in a fresh water pond with *Catla catla. Bangladesh J. Fish.*, 9(1-2): 1-7.

Huq, K. A., 2003. Optimum species composition in the polyculture technique of thai pangus (*Pangasius hypopthalamus*) with carps and prawn. Research paper, supported by DFID-UGC.

ICLARM, 2000. Training Manual for Extension Personnel on Low-cost Environment Friendly Sustainable Aquaculture Practices.

Islam, A.K.M.N., Haroon A.H.Y. and Zaman K.M., 1974. Limnological studies of the river Buriganga 1. Physical and chemical aspect. Dhaka univ. Stud. Part. BXXII(2): 99-111.

Islam, M.A., Chowdhury M.Y. and Karim R., 1978. A comparative study of major carps in ponds. Bangladesh J. Aqui. Cult., 1: 61-71.

Islam, M.R., Saha, S.B., Mollah, M.F.A. and Rokeya, J.A., 1999. Polyculture of *Macrobrachium rosenbergii (de Man)* with carps in ponds. *Bangladesh J. Fish.* 22 (1): 39-44.

Jauncey, K., Matty, A.J., 1979. Mirror carp–fast grower with room temperature for expantion. *Fish farmer.* 2 (5): 29.

John, K. R., Venkataswamy, M. and Sundararaj, V., 1995. Monoculture, bispecies culture and composite culture of *Macrobrachium rosenbergii* and *M. malcolmsonii. J. Aquacult. Trop.*, 10 (1): 37-41.

Kader, M., Mirza, J.A., Zaman, N. and Dewan, S., 1989. Observations of growth performances of exotic silver carp under polyculture system with Indian major carps. *Bangladesh J. Fish.* 12(2): 25-34.

Kohinoor, A.H.M., Akhteruzzaman, M. and Shah, M.S., 1993. Production of *Pungasius gonionotus* (Bleeker) in ponds, *Bangladesh J. Zool.*, 21(2): 77-83.

Kriigal, C. and Heinrich, H., 1939. Fertilizations of ponds. Abstract in Superphosphate, 12: 101-106.

Lakshmanan, M.A.V, Sukumaran, K.K., Murty, D.S., Chakraborty, D.P. and Philipose, M.T., 1971. Preliminary observation on intensive fish culture of Indian and exotic species. *J. Indian Fish.* Soc. India. 3: 1-21.

Ling, S.W., 1967. Foods and feeding of warm water fishes in ponds in Asia and the Far East. FAO Fish. Rep. 44 vol. 3, 291-309.

Macan, T.T. and Maudsley, R., 1966. The temperature at moorland fish pond. *Hydrobiol.* 27: 1-22.

Mahmud, Y., Ahmed, S.U. and Moula, G., 1993. Studies on the limnology of two experimental shrimp ponds at FRI Campus, Chandpur. *Bangladesh J. Fish.* Sciences, 5 (1): 65-70.

Martyshev, F.G., 1983. Pond Fisheries. *Amerind Publishing Co. Pvt. Ltd., New Delhi. India,* 29 p.

Malecha, S.R., Buck, D.H., Baur, R.J. and Onizuka, D.R., 1981. Polyculture of fresh water prawn *Macrobrachium rosenbergii,* Chinese and common carps in ponds enriched with swine manure. I. Initial trials. *Aquaculture,* 25: 110-116.

Mann, H. 1974. Protein requirement and protein utilization in pond fish. Fisch. Twichwirt, 25(5): 44-46.

Mathew, P. M., Singh, B.K., Chakraborty, D.P., 1988. A case study - stocking of fry in six species composite Fish culture. *J. Maharashtra Agric. Univ.,* 13 (1): 79-82.

McCombie, A.M., 1953. Factors influencing the phytoplankton. J. Fish. Res. Bd. Canada., 10: 203-230.

McKee, J.E. and Wolf, H.W., 1963. Water quality criteria. State of Calif. State Water Quality control Board. Publ. No. 3-A sacramento. pp 548.

Michael, R.G. 1968. Studies on the bottom fauna in tropical freshwater fish pond. Hydrobiologia, 31: 203 -230.

Michael, R.G. 1969. Seasonal treands in physico-chemical factors and plankton of a fresh water fish pond and their role in fish culture. Hydrobiologia, 31(1): 144 -160.

Mirza, J.A., Islam, R., Haque, A.K.M.A. and Chowdhury, M.Y., 1978. Studies on the physico-chemical characteristics of the river Old Brahmaputra at Mymensingh. *Bangladesh J, Aquaculture.* 1 (1) : 33-4 1.

Moav, R., Wohlfarth, G.W., Schroeder, G.L., Hulata, G.L. and Barash, H., 1977. Intensive polyculture of fish in fresh water ponds. *Aquaculture,* 10: 25-43.

Moyle, J.B., 1946. Some indices of lake productivity. Trans. Hydrabad, India, I. The Biotope. Hydrobiologia, 36(1): 105-128.

Murty, D.S., Saha, G.N., Selvaraj, C., Reddy, P.V.G.K. and Dey, R.K., 1978. Studies on increased fish production in composite fish culture through nitrogenous fertilization with and without supplementary feeding. *J. Inland Fish. Soc. India.* 1039745.

Nandeesha, M.C. and Rao, K.G., 1989. Recent developments in carp culture technology in India with special reference to the state of Andhra Pradesh.

Pahwa, D.V. and Mehrotra, S.N., 1966. Observations of fluctuations in the abundance of plankton in relation to certain hydrobiological condition of river the Ganga. Proc. Nat. Acad. Sci., India, Soc., B, 36: 157-189.

Parameswarn, S., Jehanger, M.I. and Aridill, J.D., 1977. Introduction of Indian and Chinese carps and preliminary observation on polyculture in Mauritius. *Rev. Agric. Suc. Ile Maurice,* 56: 124-140

Pillay T.V.R., 1994. Aquaculture Development (progress and prospect). Fishing news books. p 69-74.

Rabanal, H.R., 1967. Inorganic fertilizers for pond fish culture. FAO Fish. Rep. 44: 164-173.

Rahman, H.S., Chowdhury, M.Y., Haque, A.K.M.A. and Haq, M.S., 1982. Limnological studies of four ponds. *Bangladesh J. Fish.,* 2-5(1-2): 25-35.

Rahman, M.A., 1997. Effects of artificial feeds on the growth and production of fishes in polyculture. M.S. Thesis. Department of Fisheries Biology and Limnology, Bangladesh Agricultural University, Maymensingh.

Reid, G.K., 1961. Ecology of Inland water and Estuaries. Reinhold Publishing Corporation, New York, 1109-1127.

Reid, G.K., 1971. Ecology of Inland water and Estuaries. Reinhold Publishing Corporation, New York, Amsterdam.

Robert, K. J. and Bauer, L. L., 1978. Cost and returns for freshwater prawn *Macrobrachium rosenbergii* growout in South Carolina, U. S. A. *Aquaculture,* 15: 383-390.

Saha and Sinha, 1969. Investigation on bio-ecologi of Indian waters of Gorrakhpur, India. Hydrobiol., 34: 433-447.

Saha, Rahaman, G.N.K.,Chatterjee, D.K. and Ghosh, S.R., 1975. Relative response of three nitrogenous fertilizers in different pond soils in relation to primary productivy, plankton and survival and growth of *Labio rohital* spawn. J. Inland Fish. Soc. India, 7: 162-172.

Schroeder, G.L., 1974.Use of fluid cowshed manure in fish ponds. Bamidgeh, 26: 84-96.

Schroeder, G.L. and Hepher, B., 1979. Use of Agricultural and Urban wastes in fish culture. In: T.V.R. Pillay, and W.A. Dill (Eds.) Advances in Aquaculture. pp. 487-489. Fishing News Books Ltd., Farnham, England.

Schroeder, G.L., 1980. Fish farming in manure loaded ponds. In: Pullis, R.S.V. and Shehadeh, Z.H. (eds.). Integrated Agriculture-Aquaculture Farming Systems. International center for living aquatic Resources Management, India, and Southwest Asian Regional Center for Graduate Study and Research in Agriculture, Collage, Los Banos, Laguna, Philippines. ICLARM Conf. Proc. 4: 73-86.

Shahabuddin, M., Malek, A., Deppert, D., Perschbaer, P. and Shah, M.S., 1987a. Effect of inorganic fertilizers. 1. On the growth of carp fingerling in composite culture. *Bangladesh Fish.* 10 (2): 57-61.