Compensatory growth response of freshwater prawn (*Macrobrachium rosenbergii)* polycultured with Indian major carp, *Catla (Catla catla)*

Abstract

With a view to evaluate the compensatory growth response, production and survival of prawn (*Macrobrachium rosenbergii*) and catla (*Catla catla*) under polyculture system, an experiment was conducted at the Faculty of Fisheries Field Laboratory in Bangladesh Agricultural University campus from 20 March 2006 to 20 June 2006. The experiment was consisted of three treatments with three replications for each. The three treatments were: fed to satiation twice a day (T_1), fed every alternate day (T_2) and fed every two days of interval (T_3). SABINCO prawn feed was used as supplementary diet for the experiment. The stocking densities for prawn and catla were 40/dec. and 12/dec., respectively. The initial weights at stocking were: 50 g for catla in all the treatments, and 5.8, 6.4 and 6.2 g for prawn in T_1, T_2 and T_3 respectively. The water quality parameters were almost similar in all treatments and also were within an acceptable range of fish culture. The survival rate for catla was 100.0% in T_1, 91.6% in T_2 and 83.3 % in T_3, while for prawn was 85.0% in T_1, 71.0% in T_2 and 69.0% in T_3, respectively. The average weight of prawn was much lower in T_3 and T_2 than those in T_1. The best FCR value was found in T_2 (1.80) followed by T_3 (1.85) and T_1 (1.98) in this order. The average highest gross yield was obtained from T_1 (1656 kg/ha) followed by T_2 (1077 kg/ha) and T_3 (1127 kg/ha), while the production of prawn was T_1 (791 kg/ha), T_2 (517 kg/ha) and T_3 (429 kg/ha), respectively. However, no significant differences were found in the total yield in T_2 and T_3. The total costs of production for the three treatments were: T_1 (125.93 Tk/kg), T_2 (143.21 Tk/kg) and T_3 (146.71 Tk/kg), while the profits were: T_1 (104.07 Tk/kg), T_2 (55.86 Tk/kg) and T_3 (24.60 Tk/kg) in which the benefit cost ratio were found to be 1:0.83, 1:0.39 and 1:0.17, respectively. The results indicate that every day feeding had provided good growth and economic returns and thus seemed to be most practicable and viable feeding options for prawn-fish polyculture. Therefore, prawn-fish polyculture with regular feeding provides satisfactory growth and production.

Keywords: polyculture, feed, growth response, fish, *Macrobrachium rosenbergii*

Mt Shamima Yasmin,[1] M Zahangir Alom,[1] M Aminur Rahman[2]

[1]Department of Fisheries, Matshya Bhaban, Dhaka-1000, Bangladesh
[2]Department of Fisheries and Marine Bioscience, Jashore University of Science and Technology, Jashore-7408, Bangladesh

Correspondence: Dr. Md. Aminur Rahman, Professor, Department of Fisheries and Marine Bioscience, Jashore University of Science and Technology, Jashore-7408, Bangladesh, Tel +88 0421-61097 (Ext. 353), +88 01734-142726, Email aminur1963@gmail.com, amin2019@just.edu.bd

Abbreviations: PL, post larvae; BAU, Bangladesh agricultural university; FCR, feed conversion ratio; ANOVA, analysis of variance; DO, dissolved oxygen; SGR, specific growth rate

Introduction

Fish is an essential daily food item for the people of Bangladesh and as such demand for fish is increasing with the increase of human population. In the early sixties, per capita annual fish consumption was 12 kg per person, which presently comes down to 9.0 kg in spite of the significant growth in fish production. Now, fish has not remained as bountiful as in the past due to man-made and natural ecological alterations, over fishing and resource use conflicts occurring over the last two or three decades. This has disturbed the nation and many have been realizing the fact that alike any other natural resource, fish also need scientific management, if it is to be sustained. However, the elements of fish culture have been introduced more recently and the country is in the process of slowly changing the source of fish production from hunting to an aquaculture pursuit. Though the production has increased, the present per capita fish intake (28 g/day) is still below the recommended amount (49 g/day) and the annual growth rate is gradually decreasing.[1] On the other hand, due to population growth, the demand for fish has been increasing tremendously, which is very difficult to overcome without having concerted efforts on getting increased production. As augmentation of fish production from rivers and estuaries is quite difficult, we need to depend on pond aquaculture for increased production and supply of fish, employment generation and poverty alleviation in the rural areas of Bangladesh.[2] Moreover, the farmers can manage and utilize the small water bodies properly and can minimize the production cost by adopting aquaculture system. Aquaculture sector is expected to contribute to the reduction in gap between demand and supply of fishery products in the country. In addition to domestic demand, export market is equally important for the country to ease the balance of payment.

Aquaculture is an age old practice in Bangladesh. Based on the habitat, there are two types of aquaculture in Bangladesh viz., freshwater and coastal aquaculture. Freshwater aquaculture is comprised mainly of pond aquaculture, especially polyculture of carps having native and exotic origin. Coastal aquaculture is comprised primarily of shrimp farming. Presently, high valued shrimp from coastal aquaculture is the main export earning commodity. Aquaculture system has now stepped towards semi-intensive type. Small scale resource-poor farmers have adapted to the improved traditional and semi-intensive farming system.

The major indigenous species for aquaculture in Bangladesh are comprised of catla (*Catla catla*), rohu (*Labeo rohita*), mrigal (*Cirrhinus*

mrigala) and calibaush (*Labeo calbasu*), while the exotic species in aquaculture are silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodon idella*), common carp (*Cyprinus carpio*), Thai pangas (*Pangasius hypophthalmus*), tilapia (*Oreochromis niloticus*), sharpunti (*Barbonymus gonionotus*) etc.

Polyculture, the simultaneous culture of several species of fish with different feeding habits, is an efficient means of increasing fish production. The success of this system lies in the choice of right combination of fish species.[3] The basic principle of polyculture is applied for the best utilization of natural foods of different strata and zones without any harm to each other. It is a fact that polyculture may produce an expected result if ponds are stocked with species having different feeding habits in proper ratios based on the assumption that fish growth is an expression of their reaction to among other things, the sources of natural food in the environment.[4] Polyculture can improve pond environmental conditions, first of all feeding conditions for fish, oxygen budget of ponds and control of aquatic weeds.[5] The key technique of polyculture is based on the relationship between participatory organisms at different levels of food chain of the environment. Selection of fish species plays an important role for any culture practice. Stocking density of different fish species in a polyculture system also plays a vital role on overall production.

The economy of Bangladesh is largely dependent on aquaculture. From this point of view, fish and fisheries are inseparable from the culture and heritage of Bangladesh. They play a significant role in the country's socio-culture and economic life, providing food, employment and foreign exchange.[6] Fish is the main source of animal protein to the people of Bangladesh where about 63% of the animal protein supply is provided by the fish.[7] Annual fish production in 2003-2004 was 2.10 million mt, which were 1.26 million MT in 1995-96 and 0.95 million in 1991-92.[7] About 63,377 mt fish and fisheries products are exported to foreign countries and earned about Tk. 25,371 million in 2004-05 fiscal year. The contribution of fish and fisheries products in foreign exchange craning is 5.76% and contribution to GDP was 4.92% in 2003-04.[1]

In 1988-89 fiscal year, Bangladesh earned Tk. 3,820.5 million by exporting frozen shrimp and prawn and this volume rose up to Tk.14, 478.0 million in 2001-2002 fiscal year. At the same fiscal year frozen shrimp and prawn alone contributed about 92.73% of the total export values through the export of various fisheries commodities.[7] Around 1.2 million people (10% of the total population) are directly involved with fisheries activities and about 3.08 million are involved indirectly. About 13% of the rural households are involved in this sector and it provides employment opportunity to about 7% of the total population.[8]

Now the slogan "quality seed and quality feed" is the prerequisite for better production in aquaculture operation. So, the importance of feed in aquaculture has increased with the intensification of fish culture and now fish production fully depends on quality feed. Feed cost is the highest single operational cost in all kinds of aquaculture. On the other hand, use of complete artificial diet is not possible in part of most of the farmers in Bangladesh due to lack of necessary financial support. Moreover, around 50% of the supplied feed is practically misused due to inappropriate feeding management and improper species combination in polyculture systems as reported by many authors. So, the farmers failed to get expected yield through utilizing the full growth potential of fish and productivity of the pond as well. Considering these important technical issues as influential factors in aquaculture production, this problem was undertaken in the present study to explore the possibilities of effective use of supplied feed and with a view to reduce the fish production cost of the poor farmers of Bangladesh.

The major objectives of the present study were to know the influence of feeding and feed rationing on the growth and production of fish and prawn under polyculture system and to develop a suitable technique to increase the production by minimizing the feed cost.

Materials and methods

Location of the experiment

The present research was carried out at the faculty of Fisheries field laboratory in Bangladesh Agricultural University, Mymensingh (Figure 1) during the month of March 2006 to June 2006.
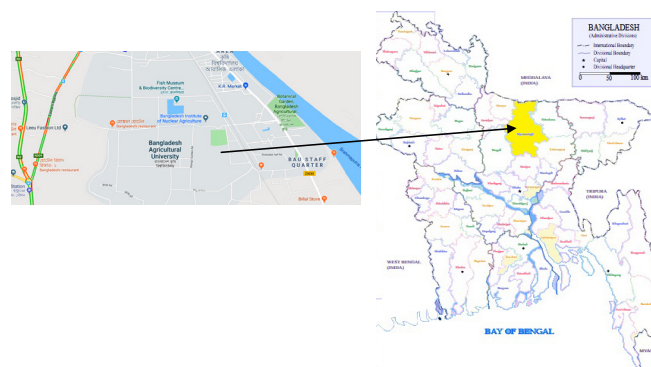

Figure 1 Map showing the location of the experimental site.

Experimental ponds

The experiment was conducted in 9 earthen ponds with 1.5 meter of water depth. The size of each experimental pond was 1.0 decimal.

Catchment basin

The catchment area of the study was at the Bangladesh Agriculture University, Mymensingh, located at the North-West part of Bangladesh (24.71°E and 90.42°N). It is typically the tropical zone of the county. Average lowest temperature (11°C) was recorded in the month of January, while the highest temperature (33.4°C) was in April. The Soil quality of the catchment area was clay and clay-loamy. There was a very little scope of contamination in the experimental area. Only the inorganic fertilizer and bottom soil was the source of potential contaminants in the experimental ponds.

Experimental design

The experiment was commenced with the establishment of groups of fish according to the following feeding regime. Each treatment had three replications.

Feeding trials of different treatments were as follows:

a. Treatment 1: No deprivation, hand feeding to satiation twice per day.

b. Treatment 2: 1 day deprivation, followed by 1 day feeding (1:1).

c. Treatment 3: 2 days deprivation, followed by 2 days feeding (2:2).

Pond preparation

Aquatic weeds, and other undesirable fish and organisms were removed from the ponds manually. All the ponds were prepared

Compensatory growth response of freshwater prawn (Macrobrachium rosenbergii) polycultured with Indian major carp, Catla (Catla catla)

Copyright:
©2019 Yasmin et al. **233**

and embankments were repaired by excavating the bottom and were kept exposed to sunlight, and lime was then applied to the ponds at the rate of 1 kg/dec. After 3 days of liming, ponds were filled with underground water through a flexible plastic pipe from a deep tube-well. Then the ponds were fertilized with inorganic (Urea and TSP @ 200 g/dec and 100 g/dec, respectively) and organic fertilizer (Cow dung @ 2.5 kg/dec), and left for 7 days to allow the development of natural foods in the healthy pond ecosystem.

Fingerling and post larvae (PL) collection and stocking

Netting was done in the experimental ponds to remove aquatic insects 3 days before stocking. Fingerlings were collected from Jhalak hatchery, Gouripur, Mymensingh. In this experiment, good quality fingerlings and juveniles were selected, and then transported in the oxygenated polythene bags to the field laboratory of the Faculty of Fisheries, Bangladesh Agricultural University (BAU), Mymesingh. Before releasing the fingerlings and juveniles into the experimental ponds, the initial length and weight of fishes and prawns were recorded in 'cm' and 'g' with the help of a measuring scale and a sensitive portable battery operated balance (Model HL 400EX), respectively. Prior to releasing the fish fingerlings in the ponds, they were acclimatized with the pond water for half an hour.

Feeding

Pelleted feed (SABINCO fish feed limited, Trisal, Mymensingh) at the rate of 5% body weight of prawn was applied for during the experiment. On each feeding day, the prawns were fed at 9.0 am and 5.0 pm. The proximate composition of the used feed is shown in Table 1.

Table 1 Proximate composition of feed used in the experiment

Components	Percentage (%)
Moisture	11
Protein	25
Lipid	4
Ash	17

Fertilization

The experimental ponds were inspected twice daily between 8.00 am to 9.00 am and between 4.00 pm to 5.00 pm to observe any abrupt change in water condition or behavior of fish and prawn. All the treatments were subjected to the same regime of feeding and fertilization. All ponds were fertilized with Urea and T.S.P. at the rate of 100 g/dec. at weekly intervals. After stocking of fish and prawn, liming was done at the rate of 0.5 kg/dec. in all the ponds at fifteen days of interval.

Sampling of fish and prawn

The fishes and prawns were sampled fortnightly by using a cast net and in each sampling, ten fishes and prawns were weighed separately to assess the health condition of fish and their growth, using a portable electrical balance (Model OHAUS).

Study on water quality parameters: Water quality parameters (temperature, dissolved oxygen, pH etc.) of the experimental ponds were monitored and recorded at every ten days interval throughout the culture period. All the parameters were measured using surface water at the pond site.

Methods used for water quality analysis

1) Water temperature (°C)

Temperature of pond water (°C) was recorded with the help of a thermometer (YSL Model 58, USA) between 9.00 am and 10.00 am.

2) Dissolved oxygen (ppm)

Dissolved oxygen was measured directly using a portable water proof digital oxygen meter (HANNA Instrument Model: HI-9142, Portugal), from 9.00 am to 10.00 am.

3) Transparency (cm)

Transparency was measured with a secchi disc of 20 cm diameter between 9.00 am and 10.00 am.

4) Hydrogen ion concentration (pH)

pH was determined with the help of a portable pH meter (HANNA Instruments, Model:HI-9142, Portugal) between 9.00 am and 10.00 am.

Harvesting of fish and prawn

After 90 days of rearing, the fishes and prawns were harvested on June 20, 2006. Primarily harvesting was done by repeated netting using a berjal. Final harvesting was done by dewatering the ponds with low lift Pedrollo pump (2 HP). During harvesting all the fishes and prawn were counted and weighed individually for each pond to assess the survival rate and production.

Analysis of experimental data

Experimental data collected during the whole experimental period were analyzed as follows:

a. Weight gain (g)

Weight gain = Mean final fish weight - Mean initial fish weight

b. Percent weight gain (%)

$$\text{Percent weight gain} = \frac{\text{Mean final fish weight - Mean initial fish weight}}{\text{Mean initial fish weight}} \times 100$$

c. Average daily gain (ADG)

$$\text{ADG} = \frac{\text{Mean final fish weight - Mean initial fish weight}}{T_2 - T_1}$$

d. Specific growth rate (SGR) (% per day)

$$\text{SGR}\ (\%\ \text{day}) = \frac{\text{Loge} W_2 - \text{Loge} W_1}{T_2 - T_1} \times 100 \quad \text{(After Brown, 1957)}$$

Where,

W_1 = Initial live body weight (g) at time T_1 (day).

W_2 = Final live body weight (g) at time T_2 (day).

$T_2 - T_1$ = Time interval

e. Estimation of production of fish and prawn

Total production = No. of fish harvested × Average final weight of fish.

Compensatory growth response of freshwater prawn (Macrobrachium rosenbergii) polycultured with Indian major carp, Catla (Catla catla)

Copyright:
©2019 Yasmin et al.   **234**

f. Estimation of survival rate (%)

The survival rates of fish and prawn for each treatment were estimated on the basis of number of fish harvested at the end of the experiment. The survival rate was calculated as

$$\text{Survival rate } (\%) = \frac{\text{No. atcual of fish survived}}{\text{No. initial of fish stocked}} \times 100$$

g. Feed conversion ratio (FCR)

FCR = Total feed consumed/Total live weight gain

Cost benefit analysis

Cost-benefit ratio was calculated by the following formula:

Total cost (Tk.) = Fertilizer + Lime (Tk.) + Feed (Tk.) + Fry (Tk.) + Miscellaneous (Tk.)

Miscellaneous (Tk.) = Labor + Maintenance cost

Total yield (kg/ha) = Gross production

Total income (Tk.) = Commodity selling price per unit × Total yield

Total net income (Tk.) = Total income (Tk.) – Total cost (Tk.)

Rate of return (%) = (Total income/Total cost) × 100

Benefit cost ratio = Total income/Total cost

Statistical analysis

A one-way ANOVA (analysis of variance) was applied for statistical analysis of the data. Computer handling for data analysis was done by statistical package state graphics version. Significance was assigned at 0.05% level.

Results

Water quality parameters

Temperature: The water temperature varied between 24.0 and 31.0˚**C** in the ponds of T_1. The highest average temperature (31.0˚**C**) in T_1 was recorded on May 29, 2006. In T_2 ponds, the water temperature varied between 24.3 and 31.7˚**C**. The average highest temperature (31.7˚**C**) in T_2 was recorded on April 29, 2006, while the lowest (24.3˚**C**) was recorded on April 9, 2006 (Figure 2). The average highest water temperature of T_1, T_2 and T_3 were found to be 31.0, 31.5, and 31.4˚**C**, respectively. The water temperature was found to fluctuate in all the treatments during the study (Figure 2).
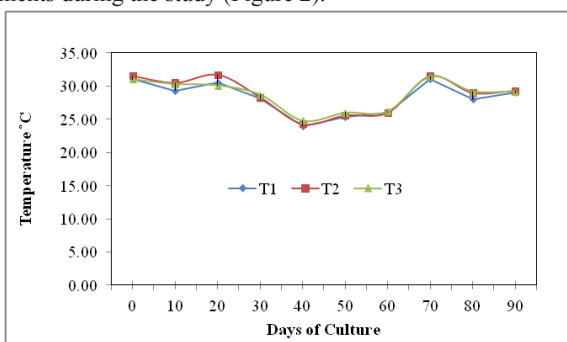
Figure 2 Temperature fluctuations in different treatments during the study period.

pH

The pH values of water in all the experimental ponds under different treatment were varied between 7.1 and 8.3. In treatment T_1, the average highest value of pH (8.3) was recorded on May 9, 2006, while the lowest (7.1) was recorded on April 9, 2006 (Figure 3). In case of T_2 ponds, the pH of water varied from 6.8 to 8.4, within which the highest value (8.4) was recorded on June 28, 2006, while the lowest (6.8) was found on March 30, 2006. The pH values of T_3 were found to be fluctuated sharply. The highest value (8.4) was recorded on 30 March 2006, while the lowest value (6.2) was found on June 18, 2006 (Figure 3).
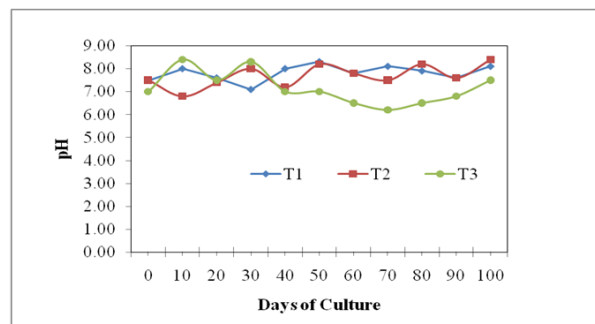
Figure 3 pH values of water in the ponds under three treatments during the study period.

Dissolved oxygen (DO)

The dissolved oxygen level was observed to be varied unevenly between 4.5 and 6.4 ppm in T_1, 4.0 and 5.5 ppm in T_2, and 3.2 and 4.5 ppm in T_3 during the entire study period. Therefore, DO levels were obtained to be within the suitable range only in T_1 and T_2 in the present study. However, dissolved oxygen level was found to be fluctuated among all the three treatments (Figure 4).
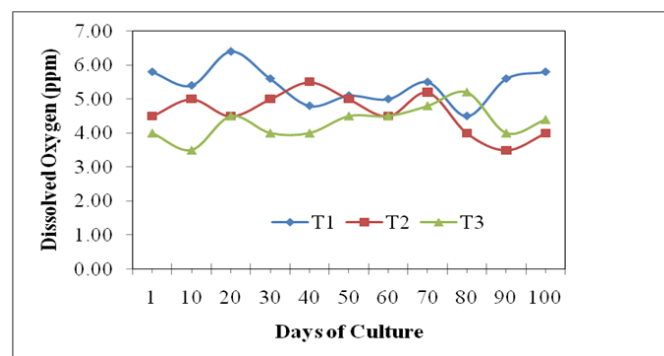
Figure 4 Dissolved oxygen (DO) level as recorded from ponds belonging to the different treatments during the study period.

Transparency

The water transparency values of the experimental ponds in all the treatments were varied from 28.5 to 44.0 cm. In case of T_1, the highest transparency value (34.5 cm) was recorded on March 25, 2006, while the lowest value (29.4 cm) on June 18, 2006. In T_2, the highest value (32.3 cm) was recorded on March 30 and April 9, 2006, while the lowest (29.0 cm) on June 18, 2006. The transparency value (31.2 cm) was recorded on March 25, 2006, while the lowest value (29.5 cm) on June 18, 2006 (Figure 5).
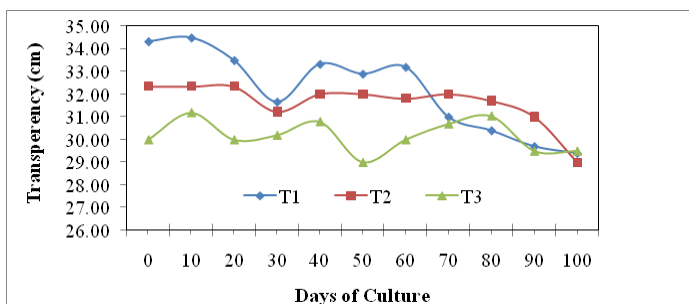
Compensatory growth response of freshwater prawn (Macrobrachium rosenbergii) polycultured with Indian major carp, Catla (Catla catla)

Copyright:
©2019 Yasmin et al. **235**

Figure 5 Variations of water transparency in the experimental ponds under different treatments during the study period.

Growth and production performances of prawn and fish

Survival rate

The average survival of *M. rosenbergii* was estimated to be 85.0% in T_1, 71.0% in T_2 and 69.0% in T_3, while the survival of *C. catla* in T_1, T_2 and T_3 was found to be 100.0%, 91.6% and 83.3%, respectively (Table 1) (Figure 6).
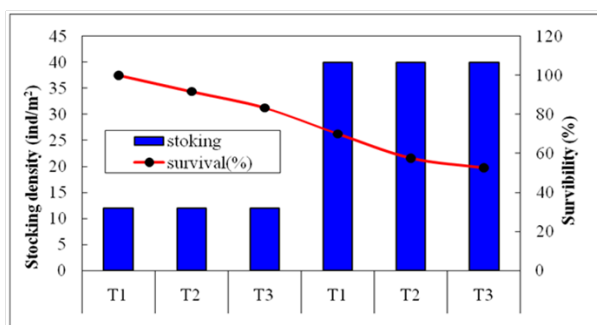

Figure 6 Stocking and Survival rate of catla (*Catla catla*) and golda (*Macrobrachium rosenbergii*) in the experimental ponds under different treatments.

Cumulative growth of *Catla catla*

After 90 days of culture, the average body weight of catla in the three treatments T_1, T_2 and T_3 were found to increase from 50 g to 292.0, 206.0 and 282.7 g, respectively. The growth performance was found to be better in T_3 than that in T_2, which might be due to the lower survival rate in T_3. The cumulative growth trends of catla in the ponds at the three treatments are shown in Figure 7.
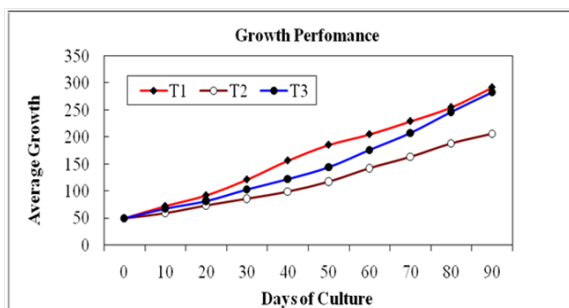

Figure 7 Cumulative growth (g) performance of *Catla catla* obtained from different treatments.

Specific growth rate (SGR) of *Catla catla*

The daily growth rate or specific growth rate (SGR %/day) of *C. catla* by weight in all the treatments is presented in Figure 8. The SGR was 5.68%/day in treatment T_1, 4.28%/day in T_2, while 5.33%/day in T_3, respectively (Figure 8).
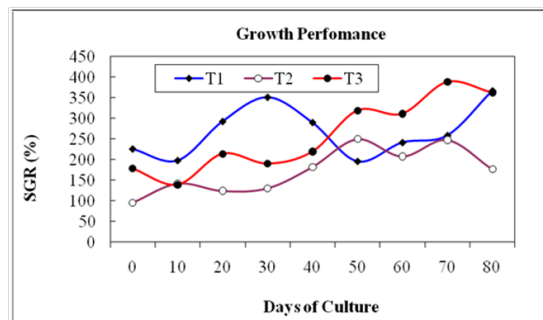

Figure 8 Specific growth rate (SGR %day) of *Catla catla* obtained from different treatments.

The analysis of variance proved that the variation in the specific growth rate of catla obtained from different treatments were not significantly different ($p < 0.05$) (Table 3).

Table 2 Stocking and Survival rate (%) of catla and golda

	Treatment	No. stocked/ m²	No. harvested	Survival (%)
	T_1	12	12	100.0
Catla	T_2	12	11	91.6
	T_3	12	10	83.3
	T_1	40	34	85.0
Golda	T_2	40	29	71.0
	T_3	40	28	69.0

Table 3 Analysis of variance (ANOVA) for the specific growth rate (SGR %day) of *Catla catla*

ANOVA

Source of variation	SS	df	MS	F	P-value	F crit
Between groups	39930.65	2	19965.32	3.853956	0.035361	3.402826
Within groups	124331.4	24	5180.475			
Total	164262	26				

Cumulative growth of *Macrobrachium rosenbergii*

The cumulative growth of *M. rosenbergii* by weight obtained from the three treatments is presented in Figure 9. A gradual increasing trend was seen in all the treatments throughout the culture period. The initial average body weight of shrimps in T_1, T_2 and T_3 was 5.8, 6.4 and 6.3 g, respectively, which became 94.2, 73.8 and 63.0 g in T_1, T_2 and T_3, respectively. T_1 showed a comparatively higher growth pattern than the other two treatments.

Compensatory growth response of freshwater prawn (Macrobrachium rosenbergii) polycultured with Indian major carp, Catla (Catla catla)

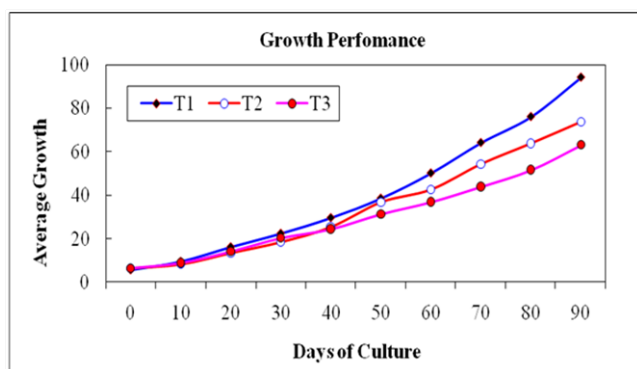Copyright:
©2019 Yasmin et al. **236**

Figure 9 Cumulative growth of *Macrobrachium rosenbergii* obtained from different treatments.

Specific growth rate (SGR) of *Macrobrachium rosenbergii*

The daily growth rate or specific growth rate (SGR) of *M. rosenbergii* by weight in all the treatments is presented in Figure 10. The highest growth rate of 5.2%/day was observed in T_1, followed by 4.7%/day in T_3 and 4.6%/day in T_2 in that order. Comparatively high growth was obtained in T_1 than those in other two treatments.
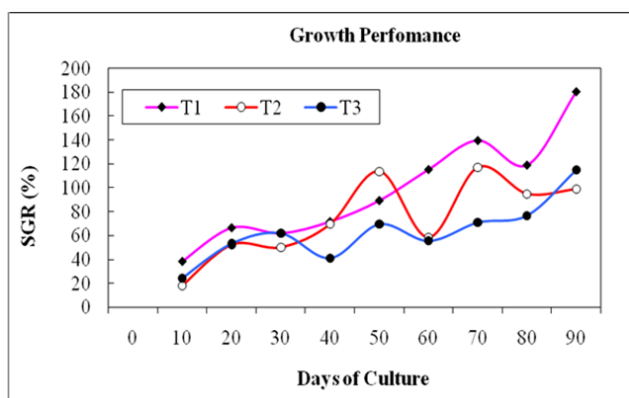

Figure 10 Specific growth rate of *Macrobrachium rosenbergii* obtained from different treatments.

The analysis of variance (ANOVA) indicated that the variation in specific growth rates of prawn as obtained from different treatments were varied significantly ($p > 0.05$) (Table 4).

Table 4 Analysis of variance (ANOVA) for the specific growth rate (SGR %/day) of *Macrobrachium rosenbergii*

Source of variation	SS	df	MS	F	P-value	F crit
Between groups	65.70	2	32.85	0.33345	0.72	3.68
Within groups	1477.74	15	98.52			
Total	1543.44	17				

Average daily growth of *Catla catla*

The average daily growth of *C. catla* was observed to be 3.24, 2.88 and 3.14 g in T_1, T_2 and T_3, respectively. The highest average daily growth in T_1 was 3.66 g during the 90 days of culture while the lowest value was 1.96 g during the 60 days of culture. In T_2, the highest average daily growth was 2.5 g during the 60 days of culture

and the lowest was 0.96 g during the first 10 days of culture. In T_3, the highest daily growth rate was 3.19 g during the 60 days of culture and the lowest 1.39 g was during the 20 days of culture. The average daily growth of the three treatments is shown Figure 11.
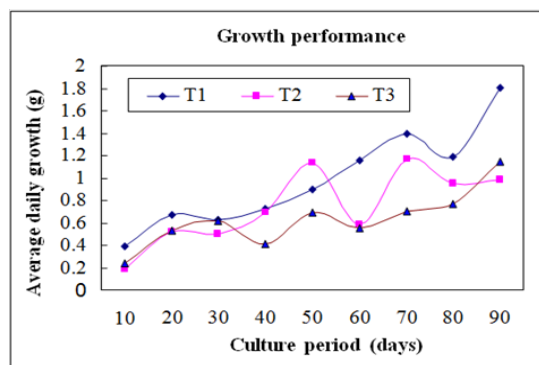

Figure 11 Average daily growth of *Catla catla* as obtained from the three treatments.

Average daily growth of *Macrobrachium rosenbergii*

The average daily growth of *M. rosenbergii* was observed to be 1.05 g, 0.82 g and 0.70 g in T_1, T_2 and T_3, respectively. The highest average daily growth for T_1 was found to be 1.82 g during the 90 days of culture and the lowest value was 0.39 g during the 10 days of culture. In T_2, the highest average daily growth was found to be 1.17 g during the 70 days of culture and the lowest was 0.18 g during the first 10 days of culture. In T_3, the highest daily growth rate was 1.44 g during the 90 days of culture and the lowest 0.24 g was during the 10 days of culture. The average daily growth of the three treatments is shown in Figure 12.
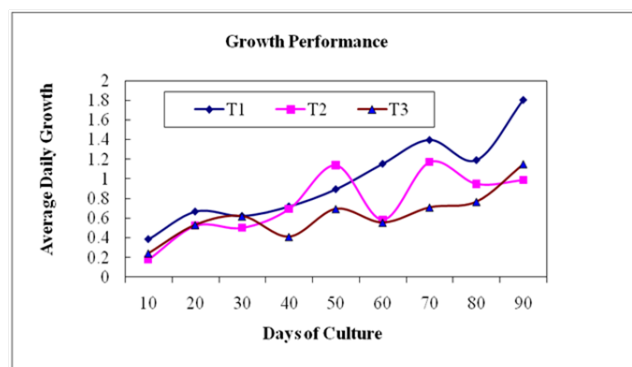

Figure 12 Average daily growth (ADG) of *Macrobrachium rosenbergii* as obtained from the different treatments.

Production of fish and prawn

The production of *M. rosenbergii* in all the treatments is presented in Figure 13. Total production (kg/ha) of *M. rosenbergii* in T_1, T_2 and T_3 was found to be 791.00, 517.34 and 429.48, respectively while for *C. catla* that was 865.48, 559.70 and 698.19 in T_1, T_2 and T_3, respectively. The gross production (kg/ha) of *M. rosenbergii* and *C. catla* was found to be the highest (1,615.48) in T_1 followed by T_2 (1,077.00) and T_3 (1,127.48).

Feed conversion ratio: Feed conversion ratio obtained from the treatments is shown in Figure 14. FCR in T_1, T_2 and T_3 was 1.98, 1.8 and 1.85, respectively.

Citation: Yasmin MS, Alom MZ, Rahman MA. Compensatory growth response of freshwater prawn (*Macrobrachium rosenbergii*) polycultured with Indian major carp, Catla (Catla catla). *MOJ Eco Environ Sci.* 2019;4(5):231–240. DOI: 10.15406/mojes.2019.04.00159

Compensatory growth response of freshwater prawn (Macrobrachium rosenbergii) polycultured with Indian major carp, Catla (Catla catla)

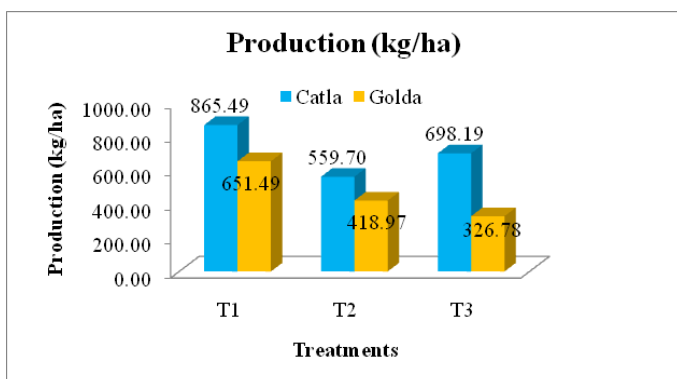Copyright:
©2019 Yasmin et al.   **237**

Figure 13 Production (kg/ha) of Macrobrachium rosenbergii and Catla catla.
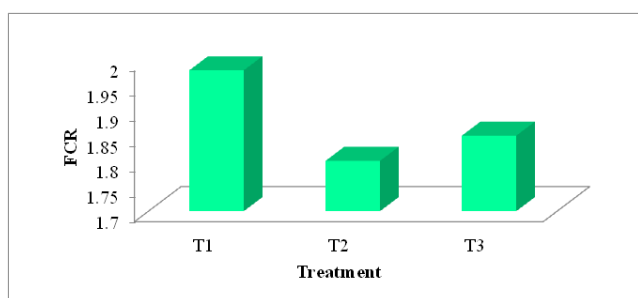

Figure 14 Feed conversion ratio (FCR) obtained from different treatments.

Discussion

Water quality parameters

Water temperature: Temperature is one of the most important physicochemical parameters (others are: salinity, pH, water transparency and water depth) that have direct effect on the growth of prawn.[9] Growth of shrimp was found to be directly related with the water temperature in all the treatment in the present study. Chiu[10] reported that the optimum temperature for *M. rosenbergii* culture lies between 25°C and 32°C. Apud[11] mentioned a range of water temperature from 25°C to 30°C would be favorable for *M. rosenbergii* farming. The recommended range of temperature for prawn is about 25°C to 30°C.[12] The results obtained from the present study are comparable with that of Rahman et al.[13] The present findings also agree well with those of Paul.[14]

pH

The best range of water pH for shrimp culture lies between 7 and 9.[15] The pH values as recorded from the experimental ponds under different treatments in the present study were within this range. Chiu[10] noted that optimum range of pH was 6.8–8.7 for prawn culture. Kohinoor[16] recorded pH values of 6.5 to 8.0, Raihan[17] found pH values ranged from 6.80 to 9.24 and Uddin[18] recorded pH values of 6.14 to 8.88 in the polyculture ponds at BAU campus. Low pH reduces ammonia toxicity[19–21] and mobilizes metals, including iron and aluminum, which can reduce yields in aquaculture ponds.[22] Low pH can also reduce natural pond productivity presumably by reducing the availability of nutrients including phosphorous and carbon sources (e.g. bio-carbonates and alkalinity) for photosynthesis.[23]

Dissolved oxygen

The dissolved oxygen contents in the experimental ponds throughout the study were ranged from 3.2 to 6.4 ppm. The result obtained in the present study was more or less agree with those of Wahab et al.,[24] who recorded dissolved oxygen ranging from 3.4 to 7.79 ppm, Kohinoor[16] reported dissolved oxygen from 2.0 to 7.4 ppm and Uddin[18] from 2.2 to 8.8 ppm, and they also reported that, this range of dissolved oxygen is good for fish production, and water having dissolved oxygen below 5 ppm is unproductive. It may be concluded that dissolved oxygen content in the ponds under present study was more or less suitable for fish production.[25]

Water transparency

The recommended level of water transparency for prawn farming is between 35 and 60 cm.[26,27] The water transparency was higher than the recommended values during the culture period in all the ponds during this study. The lower daily growth rate of *M. rosenbergii* in all the treatments may be due to the high water transparency as well as the declination of natural food organisms. Boyd[23] recommended a transparency range of 15–40 cm as appropriate for pond fish culture. Wahab et al.[24] reported that the transparency of productive water bodies should be 40 cm or less. However, the transparency in the present experimental ponds was slightly higher than the recommended level for the carp-golda polyculture.

Growth and production performances of catla and prawn

Stocking and survival of fish and prawn: In case of prawn (*M. rosenbergii*), the survival rates (85.0%, 71.0% and 69.0%) obtained at a stocking density of 40/dec in the present study are more or less similar to those of D'Abramo et al.,[28] who noted that the survival rate of prawn was ranged from 54.3% to 89.0% in earthen ponds. Siddiqui and Al-Hinty[29] obtained the survival rate of fresh water prawn (*M. rosenbergii*), which was varied from 71.0% to 93.0%. Islam et al.[30] reported that a stocking density of 90 PL/dec was optimum in India. Ang[31] investigated the potential of *M. rosenbergii* culture in Malaysia and obtained the total production of 977 kg/ha/158 days cycle with a survival rate of 32.4% at the stocking density of 10PL/m². Daniels et al.[32] reported the higher survival rates of 73.7% to 81.9% in *M. rosenbergii* when fed with formulated diet in earthen ponds. The survival of *C. catla* was high and ranged from 83.3% to 100.0% in all the treatments, which is more or less similar to that of Miah et al.[33] The use of inorganic and organic fertilizer, and supplemental feed might have resulted in good survival for the fish in all the treatments in the present study. Similar results have also been reported by Lakshmanan et al.[34] However, the highest survival (100.0%) found in T_1 was higher than that obtained by Ali et al.[35–37]

Growth of fish and prawn

In the present study, the non-significant difference in growth between T_1 and T_2 was probably due to the fact that prawn could not compensate their growth due to feed deprivation. While the existence of significant difference among the three treatments was due to different feeding methods. Chand et al.[38] reported that the daily weight gains of catla, rohu and prawn were 3.29, 2.79 and 0.21 g/day, respectively. The results of the present study were higher than the findings of Sadek and El-Gayer,[39] who found that the daily weight gain of *M. rosenbergii* was ranged between 0.318 and 0.319 g. The maximum SGR was found in T_1 (5.2) and minimum in T_3 (3.2) in the present study, which was in some extent higher than the findings

Compensatory growth response of freshwater prawn (Macrobrachium rosenbergii) polycultured with Indian major carp, Catla (Catla catla)

Copyright:
©2019 Yasmin et al. **238**

of Sharma and Reddy,[40] might be due to stocking of juveniles and everyday feeding. Islam et al.[41] reported that this variation in SGR might be due to the culture environment, feeding trial, stocking densities and season of the study.

Feed conversion ratio

The FCR values obtained from different treatments in the present study for catla and prawn were more or less similar to the values reported by Siddique et al.[42] The FCR of T_1 (1.98) is highly satisfactory when compared with the findings of Liao[43] and Biswas.[44]

Production of fish and prawn

The highest production of prawn and catla in T_1 and the lowest production in T_3 were probably due to the fact that the growth rate of prawn has been inhibited because of the minimum utilization of supplementary feed. Ali et al.[35] conducted a study to observe the effect of different periods of starvation and subsequent re-feeding on growth, survival and daily food demand etc. of prawn (*M. rosenbergii*) and catla (*C. catla*) and reported that prawn could be cultured at alternate day feeding protocol and thus feed cost should be substantially reduced. Mia[45] obtained the highest production of prawn and fish as 122 and 4,200 kg/ha in the first year, and 96 and 3,945 kg/ha, respectively in the second year. He concluded that the low production might be due to low temperature. Huq et al.[46] found the survival of prawn in monoculture and polyculture as 65% and 75%, respectively while the survival of both rohu and catla was 90%. They obtained the total production of prawn in monoculture and polyculture system as 606.8 and 605.2 kg/ha, while the production of rohu and catla in polyculture were 619.1 and 584.2 kg/ha, respectively. Jose et al.[47] reported a gross production of 106-25 kg/ha of prawn from 160 days of culture in India, where *M. rosenbergii* was stocked at 10,000/ha with catla, rohu and mrigal (2:2:1) at a density of 1,000/ha. On the other hand, Islam et al.[30] reported a production of 172 kg/ha/12 months, where *M. rosenbergii* was stoked at 15,000/ha with silver carp, catla rohu and mrigal (1.75:0.75:1.50:1.0) at a stocking density of 5,000/ha in each pond. Hoq et al.[48] reported a production of 428 kg/ha of prawn in 10 months, where prawn and fish density was 18,000/ha. Haque et al.[49] used prawn stocking densities at 15, 20, 25, 30, 35 and 40/decimal in each treatment, and obtained the productions of 120.9 to 216.1 kg/ha/4 months, while that of carps was 2,248.8 to 2,359.2 kg/ha/4 months. The production range of prawn in the present study was higher than the findings of Haque et al.[49] even with a low stocking density. This might be due to the lower stocking density of carp. In the present study, it was found that the growth and production of the prawn and carp were remarkably affected by supplemental feeding. The findings also revealed that the highest production in T_1 was due to regular twice daily feeding and the lowest production was found in T_3, where supplemental feed was applied once in every two days.

Conclusion

The results of the study revealed that prawn fed to satiation twice a day (T_1) had better growth performances and survival than those of the other two treatments. In T_2 (fed every alternate day) and T_3 (fed every two days of interval), prawn could not compensate their growth and the average weight at final harvest was much lower than that of T_1. Though, better FCR of prawn was seen in T_2 followed by T_1 and T_3 but the mean weight at harvest was the highest in T_1. Finally, the overall production of prawn was found to be the highest in T_1 (791.0

kg/ha) and the lowest in T_3 (429.5 kg/ha).

The net profit of prawn was much higher in T_1. So, in terms of production cost and gross returns, T_1 is more profitable than the other two treatments. In this way, farmers can get more profit and save the feed cost by maintaining proper feeding management. The study has provided evidence that prawn could be cultured in feeding regime with feeding at everyday with satisfactory growth and final production. Feed cost is perhaps the largest operational cost in all kind of aquaculture. So, it has become necessary to produce the maximum quantity of fish with minimum amount of feed to reduce the fish production cost to a greater extent. Prawn needs commercial pelleted feed to grow, while catla does not need any extra feed if they are released at a low density. However, to save feed cost, commercial diet should be used in a more efficient way. Moreover, the gross production of fish and prawn can be enhanced much with the minimum feed cost through adoption of proper culture practices, administration of good quality feed and maintenance of proper species combinations. However, it needs further studies with many more variables to develop the sustainable prawn-carp polyculture technology.

Acknowledgements

Conflicts of interest

The author declares there is no conflict of interest.

References

1. DoF. Fish fortnight compendium 2005. Department of Fisheries, Bangladesh; 2005:63–68.

2. FAO/UNDP. Twenty year fishery development plan in Bangladesh. USA: J.C. Marr Associates; 1985. 321 p.

3. Cruz EM, Landencia IL. Polyculture of milkfish *(chanos chanos* Forskal*),* in freshwater ponds with supplemental feeding. *Aquaculture.* 1980;20(3):231–237.

4. Shepherded J, Bromage N. Intensive fish farming. Oxford, UK: Blackwell scientific publications; 1988. 404 p.

5. Opuszynski K. Polyculture in carp ponds. In: Billard R, Marcel J, editors. *Aquaculture of Cyprinids*. Paris: INRA; 1986:269–281.

6. Ahmed N. Socio-economic aspects of fresh water prawn culture development in Bangladesh. Ph.D. Thesis, Institute of Aquaculture, UK: University of Stirling; 2001. 320 p.

7. DoF. Fish fortnight compendium. Department of Fisheries, Ramna, Dhaka, Bangladesh: Government of the People Republic of Bangladesh; 2002:44–45.

8. Haque ME. Statistics of fisheries resource in Bangladesh. In: Mazid MA, editor. *Technology and Management for Fisheries Development*. Mymensingh: Fisheries Research Institute; 1996:127–131.

9. Lester LJ, Pante MJR. Penned temperature and salinity responses. In: Fast AW, Lester LJ, editors. *Marine Shrimp Culture: Principles and Practices*. Amsterdam: Elsevier; 1992:515–534.

10. Chiu YN. Site selection for intensive prawn farms. In: Chiu YN, Santos LM, Juliano RO, editors, *Technical consideration for the management and operation of intensive prawn farms*. IIoilo City, Philippines:

Compensatory growth response of freshwater prawn (Macrobrachium rosenbergii) polycultured with Indian major carp, Catla (Catla catla)

Copyright:
©2019 Yasmin et al.   **239**

Aquaculture society; 1988:25–28.

11. Apud FD. Recent developments in prawn pond culture. Aquaculture extension pamphlet no. 1 May, 1989. Aquaculture Department, Tigbauan, IIoilo, Philippines: SEAFDC; 1989. 24 p.

12. Annon. Shrimp culture: pond design, operation and management. Selected pub. No. 2 for commemorating World food day. Bangkok, Thailand: Network of Aquaculture Centre in Asia; 1986:15–48.

13. Rahman MS, Chowdhury MY, Haque AKMA, et al. Limnological studies of four ponds. *Bangladesh J Fish*. 1982;25(1–2):25–35.

14. Paul S. *Comparison between carp polyculture system with silver carp (Hypophthalmichthys molitrix) and small indigenous fish species (SIS) mola (Amblypharingodon mola)*. M.S. Dissertation, Department of Fisheries Management, Mymensingh: Bangladesh Agricultural University; 1998. 85 p.

15. Boyd CE, Fast AW. Pond monitoring and management. In: Fast AW, Lester LJ, editors. *Marine Shrimp Culture: Principles and Practices*. Amsterdam: Elsevier; 1992:497–508.

16. Kohinoor AHM. Development of culture technology of three small indigenous fish mola *(Amblypharyngodon mola),* punti *(Puntius sophore)* and chela *(Chela cachius)* with notes on some aspects of their biology. Ph.D. thesis, Department of Fisheries Management, Faculty of Fisheries, Mymensingh: Bangladesh Agricultural University; 2000:91–102.

17. Raihan A. To assess the effects of adding punti *(Puntius sophore)* and mola *(Amblypharyngodon mola)* in carp polyculture. M.S. Dissertation, Department of Fisheries Management, Mymensingh: Bangladesh Agricultural University; 2001. 65 p.

18. Uddin MM. Effects of addition of small fish on pond ecology and production in polyculture. M.S. dissertation, Department of Fisheries Management, Mymensingh: Bangladesh Agricultural University; 2002. 91 p.

19. Whitfield M. The hydrolysis of ammonium ions in sea-water; a theoretical study. *J Mar Biol Assoc*. 1974;54:565–580.

20. Avault JW. Seven years of pond research with the prawn *(Macrobrachium rosenbergii)* in Louisiana. *Magazine*. 1986;12(4):51–54.

21. Swingle HS. Relationship of pH of pond water and their suitability for fish culture, *Proc Pacific Sci Congrss*. 1961;9(10):72–75.

22. Simpson HJ, Ducklow HW, Deck B, et al. Brackish water aquaculture in pyrite-bearing tropical soils. *Aquaculture*. 1983;34:333–350.

23. Boyd CE. Water quality management for pond fish culture. New York, USA: Elsevier Sci Publ Co; 1982. 318 p.

24. Wahab MA, Ahmed ZF, Islam A, et al. Effect of introduction of common carp, *Cyprinus carpio* (L.) on the pond ecology and growth of fish inpolyculture. *Aquacult Res*. 1995;26:619–628.

25. Ferdous MJ. A study on the effect of Feed deprivation in freshwater prawn (*Macrobrachium rosenbegii*) and Indian major carp, catla (*Catla catla*), and rohu (*Labeo rohita*) Polyculture. M.S. Thesis, Department of Fisheries Biology and Genetics, Mymensingh: Bangladesh Agricultural University; 2004.

26. Annon. Prawn Raising Manual. The B-MEG shrimp technical service group, the shrimp sales group and the calatrava research group. Feed Business San Miguel Foods Inc; 1992:8–15.

27. Hossain MA, Siddeque MAL, Miaje MAH. Development of low-cost feed for culture of giant freshwater prawn (*Macrobrachium rosenbergii,* de Man) in ponds. *Bangladesh J fish Res*. 2000;4:127–134.

28. D'Abramo LR, Heinen JM, Robinette HR, et al. Production of the Fresh water prawn *(Macrobrachium rosenbergii)* stocked as juveniles

at different densities in temperate zone ponds. *J World Aquacult* Soc. 1989;20(2):81–89.

29. Siddiqui AD, AI-Hinty HM. Feasibility of fresh water prawn, *(Macrobrachium rosenbergii)* culture in the central region of Saudi Arabia. Effect of destiny on growth, yield and population structure. In: *Proc. First International Symposium of Aquaculture Technology and Investment Opportunities*. Riyadh, Saudi Arabia: Ministry of Agriculture and water; 1993:304–320.

30. Islam MR, Saha SB, Mollah MFA, Rokeya JA. Polyculture of *Macrobrachium rosenbergii* (de Man) with carps in ponds. *Bangladesh J Fish*. 1999;22(1):39–44.

31. Ang KJ. Evaluation of the production potential of *Macrobrachium rosenbergii* in monoculture in Malaysia. In: Hirano R, Hanyu I, editors. Second Asian Fisheries Forum, Manila, Philippines: Asian Fisheries Society; 1990:103–106.

32. Daniels WH, Abramo LRD, Fonderen MW, et al. Effects of stocking densities and feed on pond production characteristics and revenue. Graded Juveniles. *J World Aquacult Soc*. 1995;26(1):38–47.

33. Miah MS, Uddin MS, Shah MS. Effect of stocking densities on the growth and production of fishes in mixed polyculture systems. *Bangladesh J Fish*. 1997;20(1–2):15–138.

34. Lakshmanan MAV, Sukumaran KK, Murty DS, et al. Preliminary observation on intensive fish farming in fresh water ponds by the composite culture of Indian and exotic species. *J Inland Fish Soc*. 1991;2:1–21.

35. Ali MO, Sarker MK, Lucky NS, et al. Effect of feed deprivation on growth and survival of freshwater prawn *(Macrobrachium rosenbergii)* and Indian major carp catla, *Catla catla* in a polyculture system. *Progress Agric*. 2003;14(1&2):103–108.

36. Jena JK, Mukhopadhyay RT, Aravandakshan PK. Evaluation of formulated diet for raising carp fingerling in field conditions. *Appl Ichthyol*. 1998;15:188–192.

37. Hossain MY. *Effects of iso-phosphorous organic and inorganic fertilizer on water quality parameters and biological production*. M.S. Thesis, Department of Fisheries Management, Mymensingh: Bangladesh Agricultural University; 2000. 74 p.

38. Chand BK, Patra BC, Das SK. Growth and production of freshwater prawn and carp under polyculture system. *J Interacademicia*. 2002;6(2):210–215.

39. Sadek SS, L-Gayer FMHE. Production of the giant fresh water prawn *(Macrobrachium rosenbergii)* reared in brackish water ponds (Egypt). *International Symposium on Aquaculture Technology and Investment Opportunities*. Ministry of Agriculture and water, Riyad, Saudi Arabia. 1993;296–303.

40. Sharma M, Reddy AK. Intensive culture of fresh water prawn *(Macrobrachium rosenbergii)* in cement tanks. *Fish Chimes*. 1996;16(9):25–26.

41. Islam MS, Sadek QAM, Mohiuddin M, et al. A brief progress report of farming systems research. On farm Research Division, Milk Vita Road, Dewla, Tangail, Bangladesh: Bangladesh Agricultural Research Institute; 1991. 26 p.

42. Siddique MAL, Hossain MA, Miaje MAH. Polyculture of giant freshwater prawn, *Macrobrachium rosenbergii* with Indian major carps in ponds with supplemental feed. *Bangladesh J Fish*. 1999;22(2):67–74.

43. Liao IC. Status and problems of prawn culture in Taiwan. Paper presented at the ROC-Japan Symposium on Mariculture, Taipei, Taiwan; 198:1–7.

44. Biswas NC. An economic Analysis of fish culture under different pond size. *Bangladesh J Aquacult*. 1996;2:99–110.

45. Mia MY. Cultivation of prawn in polyculture with some species of Indian and Chinese major carps. *Pak J Sci Indust Res.* 2004;47(2):107–111.

46. Huq KA, Monir SMI, Rahman MM, et al. Production performance of *Macrobrachium rosenbergii* (de Man) monoculture vursus polyculture system. *Bangladesh J Fish.* 2004;2(1):141–149.

47. Jose S, Nair CM, Thampy DM. Culture of *Macrobrachium rosenbergii* in homestead ponds. In: Silas EG, editors. Fresh water prawns. Thrissur, India: Kerala Agricultural University; 1992:147–152.

48. Hoq ME, Islam MM, Hossain MM. Polyculture of fresh water prawn (*Macrobrachium rosenbergii)* with Chinese and Indian major carps in

farmar's pond. *J Aqua Trop.*1996;11:135–141.

49. Haque MM, Narejo NR, Salam MA, et al. Determination of optimum stocking density of *Macrobrachium rosenbergii* in carp polyculture in earthen pond. *Pak J Bio Sci.* 2003;(16):898–901.