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Growth and production performance of carps in shaded pond in Barisal, Bangladesh

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Abstract

The shaded nature of ponds in Barisal region constrained the pond polyculture. The present study was conducted with such shaded ponds to evaluate the growth and production performance of different carp species including rohu (*Labeo rohita*), catla (*Catla catla*), mrigal (*Cirrhinus cirrhosus*) and common carp (*Cyprinus carpio*) in polyculture system. In this experiment, polyculture of carps at similar densities were conducted in two different types of shaded ponds selecting nine ponds at Dinar village in Charkawa Union of Barisal Sadar sub-district. Out of 9 ponds, 5 were heavily shaded ponds (HSP) and 4 were moderately shaded ponds (MSP) considered as T₁ and T₂, respectively. The average area of HSP and MSP was 0.03±0.01 and 0.07±0.03 ha, respectively which were experimented for a period of 180 days from July to December 2013. Carps were stocked at the rate of 14820/ha with the ratio of rohu, catla, mrigal and common carp - 2:1:2:1. Carps were fed with supplementary feed of the mixture of rice bran, wheat bran and mustard oilcake at the rate of 10% body weight for first 3 months and 5% body weight for last 3 months. The water quality parameters such as temperature, dissolved oxygen, pH, nitrite and ammonia were recorded. The highest weight gain was found in common carp (467.00±0.00 g) in T₁ and lowest weight gained in mrigal (172.46±26.80 g) in T₁. Apart from common carp, the individual growth and production of other species was higher in MSP compared to HSP. The higher production was obtained in T₂ (2122.92±333.60 kg/ha/year) compared to T₁ (1547.79±132.94 kg/ha/year).

Keyword: Carp polyculture, Heavily shaded ponds, Moderately shaded ponds, Barisal

Introduction

Bangladesh is a country blessed with vast fisheries resources including rivers, flood plains, lakes, ponds, ox-bow lakes, etc. which are full of 260 different fish species (DoF, 2014). The total annual fish production in Bangladesh was estimated at 3.41 million MT in 2012–13 fiscal year, of which 1.86 million MT (54.54%) were obtained from inland aquaculture (DoF, 2014). The production of fish per hectare in Bangladesh is much lower than other fish producing countries of the world. This is due to the lack of proper knowledge on the scientific fish culture and management practices. Pond fish culture is the main aquaculture system in Bangladesh contributing to the bulk of production. Among different technologies of fish culture, pond polyculture is one of the most important culture techniques.

Polyculture is the practice of culturing more than one species of aquatic organism in the same pond. Polyculture gives higher production than monoculture in extensive systems because more available natural food is utilized by different fish species efficiently (Wahab et al., 2001). Polyculture may produce expected results if fish with different feeding habits are stocked in proper ratio and combination (Halver, 1984). In Asian polyculture, a wide variety of fish species are cultured of which rohu (*Labeo rohita*), catla (*Catla catla*) and mrigal (*Cirrhinus cirrhosus*) are very popular (Rahman et al., 2006). The farmers prefer to stock Common carp as a bottom feeder instead of mrigal because common carp grows faster than mrigal and the overall production is higher when combined with rohu and catla in polyculture ponds (Wahab et al., 2002). Polyculture is more productive, capital intensive and profitable activity compared to other culture systems (Dev, 2009).

Barisal district is a part of the south-central region of Bangladesh, located on the northern shore of the Bay of Bengal, which was developed by the alluvial flow of the Kirtankhola River. The livelihoods of a considerable proportion of rural people in this area depend entirely on fishing in inland open water bodies (mainly rivers and canals) and the sea, and poverty levels are particularly high (Haque et al., 2015). Rural households in Barisal region have perennial ponds which were mainly excavated as borrow pits in order

to raise the level of homesteads to avoid flooding (Rahman *et al.*, 1992). Availability of ponds in this area has the great potentiality of fish production applying the principle of polyculture system that generates more fish production through proper food utilization in different pond levels. Maximum pond in the rural areas become unused and are shaded by trees that can be brought under culture system, preferably polyculture system, by different native carps that will increase fish production as well as develop the economic condition of the country. The shortage of fish in the country increased day by day due to increasing population density and decreased in natural fish production. In order to meet up the shortage of fish and improving the socio economic conditions, it is essential to increase the pond fish production through adopting technology by the fish farmers in Bangladesh. The study was done in shaded ponds for carp polyculture which is an important factor for the promotion of aquaculture in Barisal district. Considering above facts, the present study was carried out to effects of stocking density on the growth performance and production of carps and to recommend suitable species for polyculture in shaded ponds in selected areas of Bangladesh.

Materials and Methods

Study area

The pond dykes in Barisal is full of trees which create shadow and reduced sunlight penetration which negatively impacts on fish culture (Haque *et al.*, 2015). Therefore, the study was done in shaded ponds for carp polyculture which is an important factor for the promotion of aquaculture in under Charkawa Union of Barisal Sadar, in Barisal district (Fig. 1).

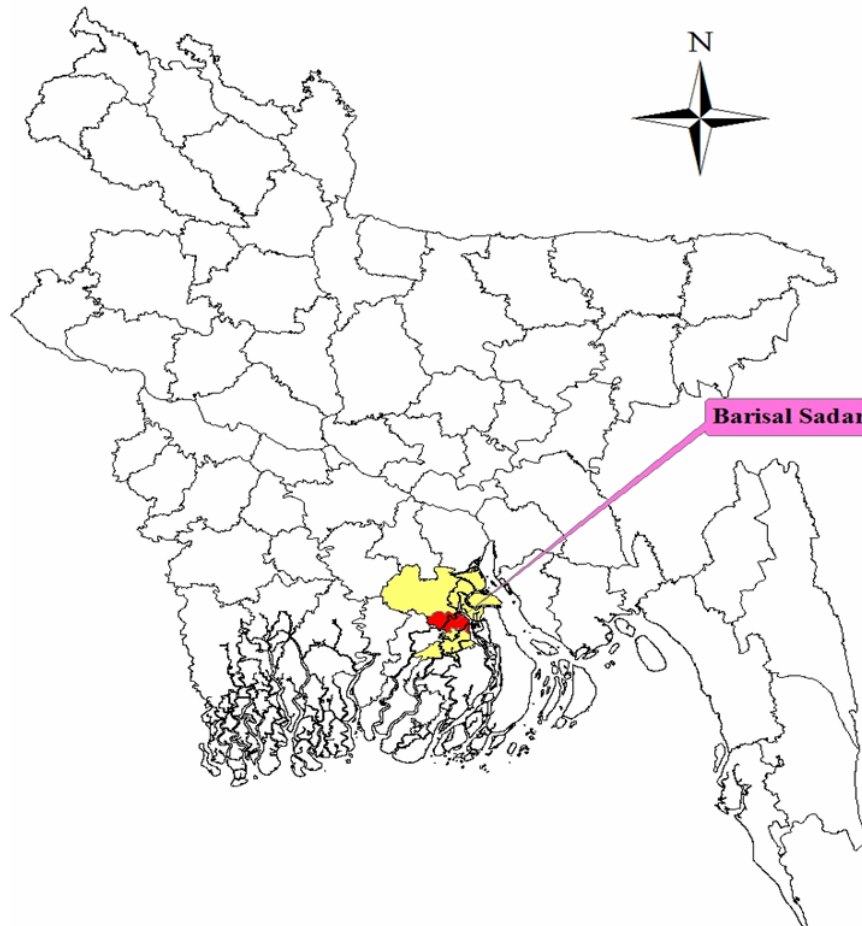


Fig. 1. Map of Bangladesh showing the study area in Barisal district

Experimental design

For the present study, nine ponds were selected of which five were heavily shaded ponds (HSP) T_1 including P1, P2, P3, P4, P5 and remaining four moderately shaded ponds (MSP) T_2 including P6, P7, P8 and P9, each pond depth ranged from 2-3 m. The average area of HSP and MSP was 0.03 ± 0.01 ha and 0.07 ± 0.03 ha, respectively. Before stocking of fish, ponds were prepared adequately by removing aquatic vegetation, unwanted and predatory species and finally treated with lime at the rate of 247 kg/ha. Carps were stocked both in HSP and MSP at the rate of 14,820/ha of rohu (*Labeo rohita*), catla (*Catla catla*), mrigal (*Cirrhinus cirrhosus*) and common carp (*Cyprinus carpio*) at the ratio of 2:1:2:1. The stocking density was similar in both HSP and MSP. Carps were fed with supplementary feed of the mixture of rice bran, wheat bran and mustard oilcake at the rate of 10% body weight for first 3 months and 5% body weight for last 3 months. To enhance the growth of natural food for the carps, fertilization was done with urea (400 kg/ha) and TSP (200 kg/ha) once a month. During the months of November and December, lime and salt was used at the rate of 247 kg/ha to improve water quality.

Water quality parameters

Water quality parameters of the experimental ponds were recorded throughout the study period. The water temperature ($^{\circ}\text{C}$), dissolve oxygen (ppm) and hydrogen ion concentration (pH), ammonia (NH_3) and Nitrite (NO_2) were monitored at the beginning and end of the experiment by using proper instrument.

Estimation of growth performance

Sampling was done monthly from each pond by cast net and the weight of fish was recorded by using electric balance (Model: HKD-620AS-LED). After harvesting of fishes final weight were recorded and following parameters were used to evaluate the growth and production of the fishes.

Mean length gain (cm) = Mean final length (cm) – Mean initial length (cm)

Mean weight gain (g) = Mean final weight (g) – Mean initial weight (g)

$$\text{Specific growth rate (SGR \%)} = \frac{\log_e W_2 - \log_e W_1}{T_2 - T_1} \times 100$$

Here, W_2 = the final live body weight (g) at time T_2 day
 W_1 = the initial live body weight (g) at time T_1 day
 T_2 = time duration at the end of the experiment
 T_1 = initial time of the experiment (day).

Fish production = No. of fish harvested \times final average weight

Data analysis

The recorded data were entered into the spreadsheet in MS Excel 2010 and then summarized properly before statistical analysis. After entering the data, the descriptive statistical analyses were done by MS Excel. The inferential T-test was carried out using SPSS (Statistical Package for Social Sciences) version 16.

Results

Length gain

Statistically, there were no significant differences ($p > 0.05$) of length gain in rohu, catla, mrigal and common carp between HSP and MSP. However relatively, length gain (cm) was higher in treatment T_1 in comparison with T_2 . The higher length in common carp in T_1 and the lower length gain in rohu in T_1 was observed (Table 1).

Table 1. Length gain performance (Mean \pm SE) of fish in polyculture ponds in HSP (T₁, n=5) and MSP (T₂, n=4)

Growth parameters	Treatments	Rohu	Catla	Mrigal	Common carp
Initial length (cm)	T ₁	6.06 \pm 0.00	6.41 \pm 0.00	6.20 \pm 0.00	5.40 \pm 0.00
	T ₂	6.06 \pm 0.00	6.41 \pm 0.00	6.20 \pm 0.00	5.40 \pm 0.00
Final length (cm)	T ₁	23.75 \pm 1.13	28.47 \pm 2.50	24.33 \pm 1.20	37.00 \pm 0.00
	T ₂	24.39 \pm 1.69	27.18 \pm 2.40	25.17 \pm 2.90	23.75 \pm 4.25
Length gain (cm)	T ₁	17.69 \pm 1.13	22.06 \pm 2.50	18.13 \pm 1.20	31.60 \pm 0.00
	T ₂	18.33 \pm 1.69	20.77 \pm 2.40	18.97 \pm 2.90	18.35 \pm 4.25

Weight gain (g)

During the study period, weight gain was varied in different treatment. In treatment T₁, weight gain was higher compared to the treatment of T₂. Higher weight gain in T₂ was possibly due to moderately shaded ponds (Table 2). In terms of individual species, there were no significant differences ($p>0.05$) of weight gain between two treatments (Table 2).

Table 2. Weight gain performance (Mean \pm SE) of fish in polyculture ponds in HSP (T₁, n=5) and MSP (T₂, n=4)

Growth parameters	Treatments	Rohu	Catla	Mrigal	Common carp
Initial weight (g)	T ₁	2.37 \pm 0.00	3.36 \pm 0.00	2.54 \pm 0.00	3.00 \pm 0.00
	T ₂	2.37 \pm 0.00	3.36 \pm 0.00	2.54 \pm 0.00	3.00 \pm 0.00
Final weight (g)	T ₁	188.08 \pm 22.90	373.43 \pm 122.30	175.00 \pm 26.80	470.00 \pm 0.00
	T ₂	235.11 \pm 47.60	409.58 \pm 140.80	220.08 \pm 87.60	390.40 \pm 160.40
Weight gain (g)	T ₁	185.71 \pm 22.90	370.07 \pm 122.30	172.46 \pm 26.80	467.00 \pm 0.00
	T ₂	232.74 \pm 47.60	406.22 \pm 140.80	217.54 \pm 87.60	387.40 \pm 160.40

Growth performance of fishes

Rohu and mrigal were stocked at 20 fingerlings where as catla and common carp were stocked in two treatments at the rate of 10 fingerlings per decimal. The average initial weight of rohu, catla, mrigal and common carp was 2.37 \pm 0.00g, 3.36 \pm 0.00g, 2.54 \pm 0.00g, 3.00 \pm 0.00g, respectively in both T₁ and T₂. In MSP, the average final weight of rohu, catla, mrigal and common carp was 188.08 \pm 22.90g, 373.43 \pm 122.30g, 175.00 \pm 26.80g, 470.00 \pm 0.00g and in HSP 235.11 \pm 47.60g, 409.58 \pm 140.80g, 220.08 \pm 87.60g and 390.40 \pm 160.40g, respectively.

Total production

The production of rohu, catla, mrigal and common carp ranged between 192.22 \pm 43 to 744.95 \pm 111.20 kg/ha/year in different treatments. The combined total production was higher in T₂ (2122.92 \pm 333.60 kg/ha/year) and lower in T₁ (1547.79 \pm 132.94 kg/ha/year). As per analysis, the growth performance of each individual fish was not similar in two treatments (Fig. 2).

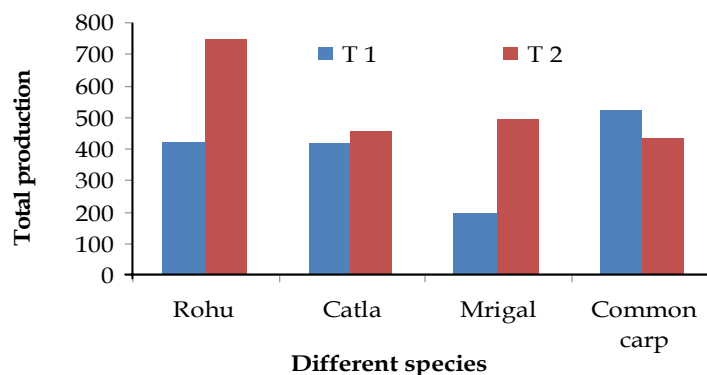


Fig. 2. Total production of individual fish in two treatments

Water quality parameters

Aquaculture production depends on physical, chemical and biological qualities of pond water to a greater extent. The successful pond management requires an understanding of water quality. Intensification of pond makes the water quality undesirable with a number of water quality parameters. Pond water quality is largely defined by temperature, pH, dissolved oxygen, nitrite and ammonia (Bhatnagar and Devi, 2013). Water quality parameters of the experimental ponds were recorded throughout the study period. In the present experiment, the mean values of water temperature was $22.60 \pm 0.40^\circ\text{C}$ in T_1 and $22.75 \pm 0.75^\circ\text{C}$ in T_2 , the pH values was recorded 7.3 ± 0.25 in T_1 and 7.4 ± 0.43 in T_2 . There were no major differences found in two treatments of the water quality parameters of pH, dissolved oxygen, nitrite and ammonia (Table 3).

Table 3. Average (Mean \pm SE) value of water quality parameters of different treatments

Treatments	Temperature ($^\circ\text{C}$)	Dissolved oxygen (ppm)	pH	Nitrite (ppm)	Ammonia (ppm)
T_1	22.60 ± 0.40	4.20 ± 0.49	7.3 ± 0.25	0.10 ± 0.03	0.22 ± 0.05
T_2	22.75 ± 0.75	4.75 ± 0.85	7.4 ± 0.43	0.08 ± 0.03	0.20 ± 0.07

Discussion

In the present study, length gain was the higher in common carp (31.60 ± 0.00) cm and lowest in rohu (17.69 ± 1.13) cm. Similarly the highest weight gain was found common carp (467.00 ± 0.00 g) in T_1 and lowest weight gained in mrigal (172.46 ± 26.80 g) in T_1 . Every species in the two treatments, rohu, catla and mrigal gave the more or less similar length gain in T_2 but common carp obtained the higher weight gain in T_1 . Individual growth of rohu was found much higher in T_2 compared to T_1 , probably due to the greater abundance of plankton in the T_2 . It might be due to the availability of decomposing plant debris, insect larvae living in the mud (chironomids) etc. in the bottom region of pond which was used as feed by the common carp (Billard, 1995).

Fish production

The variation of production of fishes was found in two treatments. Between two treatments, the higher production of fish was recorded in T_2 , followed by the production of T_1 . The reason behind the higher production in treatment might be moderately shaded ponds (MSP). Kadir *et al.* (2006) obtained 1970 kg/ha production in polyculture during 150 days culture period. Sagor (2008) obtained the average production of carp's 1676 kg/ha/year. Haque (2010) reported good results from the polyculture of Indian carps in three treatments with the productivity ranging from 2618.85 ± 57.5 to 2747.47 ± 116.47 kg/ha/year. However, the fish productions recorded in the present study was 1547 ± 132.94 kg/ha and 2122 ± 333.60 kg/ha in T_1 and T_2 , respectively which was lesser than the study of Haque (2010). This was possibly due to following higher stocking density of carps in the study of Haque (2010) and the shaded nature of ponds. On the other hand individual production of common carp (522.41 ± 22.16 kg/ha) was higher in T_1 because of the availability of decomposing plant debris, insect larvae living in the mud (chironomids) etc. in the heavily shaded pond bottom.

Water quality parameters

Aquaculture depends almost completely on the qualities of water, i.e. qualities of environment. Environment parameters exert an important role on the growth, production of fish and other aquatic organisms. The suitable water quality parameters are prerequisite for a healthy aquatic environment and for the production of sufficient fish food organisms. Bhatnagar and Devi (2013) suggested that the desirable water temperature for carp polyculture in pond from 20 to 30°C which was more or less similar in the present study. They also reported that the desirable dissolved oxygen was 5 ppm which was relevant in the present study and the dissolved oxygen content was recorded 4.20 ± 0.49 ppm in T_1 and 4.75 ± 0.85 ppm in T_2 . The present findings agree with the findings of Ahmed (2004) who found that pH ranged from 6.6 to 8.9 in different treatments. For pond fish culture, the suitable ranges of pH are 6.5 to 8.5 (Byod, 2008). Stone and Thomforde (2004) suggested that the desirable range 0-1 ppm NO_2 and

acceptable range less than 4 ppm NO₂. According to Bhatnagar *et al.* (2004) 0.02-1.0 ppm is lethal to many fish species, >1.0 ppm is lethal for many warm water fishes and <0.02 ppm is acceptable. Santhosh and Singh (2007) recommended nitrite concentration in water should not exceed 0.5 ppm. OATA (2008) recommended that it should not exceed 0.2 ppm in freshwater fishes. So the results of the present study were more or less similar to that of the above author. Maximum limit of ammonia concentration for aquatic organisms is 0.1 ppm (Santhosh and Singh, 2007). According to OATA (2008) the levels below 0.02 ppm were considered safe. Bhatnagar and Singh (2010) recommended the level of ammonia (<0.2 ppm) suitable for pond fishery. So, the result was safe for MSP but slightly harmful for HSP.

Conclusion

The shaded nature of ponds in Barisal region constrained the pond polyculture. However, there is a potential to practice carp polyculture which has been studied through the field experiment. From the above discussion, it was found that a higher level of individual fish growth was found for most carps in moderately shaded ponds (MSP), but common carp had higher growth in heavily shaded ponds (HSP). It could be argued that common carp was the most suitable species for polyculture in shaded ponds in Barisal region. This study was undertaken in a limited area of Barisal which does not represent the whole scenario of the shaded ponds of southern Bangladesh. Therefore, further studies need to be undertaken at different stocking density and species composition to explore ultimate potential of shaded ponds in that region for boosting up overall aquaculture production in Bangladesh.

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