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Effect of stocking ratio on the growth and production performance of Silver carp and Catla in Mola -carp polyculture system

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Abstract: An experiment was conducted to optimize the stocking ratio of silver carp and catla in mola-carp polyculture system at the department of Fisheries Management, Bangladesh Agricultural University, Mymensingh from November 2006 to March 2007. The experiment consisted of three treatments with three replications per treatment. All ponds ($100m^2$) were stocked with Silver carp (*Hypophthalmichthys molitrix*) and catla (*Catla catla*) @ 30 and 10 (3:1); 20 and 20 (1:1); and 10 and 30 (1:3) in treatment T_1 T_2 and T_3 respectively. In addition, 40 rohu (*Labeo rohita*), and 100 mola (*Amblypharyngodon mola*) were also stocked. Supplementary feed was applied daily @ 1.5% body weight of fishes throughout the study period. A number of water quality parameters such as temperature (°C), transparency (cm), pH and dissolved oxygen (mg/l) were monitored weekly and were within the suitable ranges for fish culture among all the treatments. The rate of survival of large carps ranged from 83 to 100% and was not affected by the presence of mola and/or SIS. The individual growth of catla was significantly higher ($P<0.05$) in treatment T_1 whereas, silver carp growth was significantly lower. Moreover, growth of silver carp was significantly higher ($P<0.05$) in both treatment T_2 and T_3, where growth of catla was significantly lower. It might be due to a negative or minor severe inter-specific food competition occurred between silver carp and catla. Total mean yields of fish recorded were 685±128, 735±135 and 653±50 kg/ha/120 days in treatment T_1 T_2 and T_3 respectively.
Key words: Growth, stocking ratio, water quality, silver carp and catla.

Introduction

Polyculture is one of the techniques through which maximum out-put can be obtained and higher production can be ensured than monoculture in extensive and semi-intensive systems because more of the available natural food in the pond is utilized by fish in polyculture (Hassan *et al*., 1997). Polyculture may produce an expected result if the fish with different feeding habits are stocked in proper ratios and combinations (Halver, 1984). *Amblypharyngodon mola*, locally known as mola or moia is particularly important as the fish contains more available vitamin-A than any other edible fish species in this country (Ahmed, 1981). A sustainable semi-intensive pond aquaculture technology including major carp species (Indian, Chinese and common carp) as cash-crop and small indigenous fish species (SIS) as food for the farmers' families is being optimized in Bangladesh (Wahab *et al*., 2003). Silver carp inclusion in the polyculture is now being considered, because this very efficient filter feeder has a strong impact on pond ecology (Milstein, 1992) and also on the farmers' family nutrition because it is a cheap fish that the family can afford to eat instead of selling. This fish has already been accepted as an important candidate species in the polyculture systems in this country (Wahab *et al*., 1995). But the addition of this fish in mola-carp polyculture system possesses new scientific and management questions in relation to its impact on the pond ecosystem. Again in case of polyculture of silver carp, catla and SIS, food competition and dietary overlap of at least between silver carp, catla (Dewan *et al*., 1991) and mola is expected in such species combination. Therefore, it is needed to optimize the stocking density of silver carp and catla in polyculture system to get the highest yield from the culture system. Much research in the South Asian countries including Bangladesh have been directed towards the biology and culture of Indian major carps and Chinese carps, but a very few research have been made to optimize the stocking ratio of Chinese carps and Indian major carps and to study their effects on pond ecology, small indigenous fish species and fish production. In view of the above facts, the present study has been undertaken to determine the stocking ratio, growth and production performance of silver carp and catla in mola-carp polyculture system.

Materials and Methods

The experiment was carried out for a period of four months from November 2006 to March 2007 at the department of Fisheries Management, Bangladesh Agricultural University (BAU), Mymensingh. Nine earthen ponds with an area of 100 m^2 (0.01 hectare) each and an average depth of 1.5 m were used for this study. The trial was conducted in a completely randomized block design (RCBD) into three different treatments with three replications. Three different stocking ratios of silver carp (*Hypophthalmichthys molitrix*) and catla (*Catla catla*) were compared. Stocking ratios of silver carp and catla were 3:1, 1:1 and 1:3 in treatment T_1, T_2 and T_3, respectively whereas, rohu and mola were stocked @16 and 40 fish/dec. All ponds were drained out and prepared by removing weeds, predators and other fishes from the ponds. Afterwards, the ponds were treated with agricultural lime @ 2.5 kg/pond (250 kg ha^{-1}). To promote algal growth ponds were fertilized with organic and inorganic fertilizers. Urea, TSP (Triple Super Phosphate) and cowdung were applied @ 250g, 250g and 7.5 kg/pond (750 kg/ha) respectively. Commercial feed (Saudi-Bangla fish feed) was applied daily @ 1.5% body weight of large fishes in each pond twice daily and all ponds were fertilized with organic (cow manure) and inorganic fertilizer (urea and TSP) in each 15 days interval. A number of water quality parameters such as temperature (°C), transparency (cm), pH and dissolved oxygen (mg/l) were recorded weekly using a commercial kit box (Model: FF-3, USA). Fishes were sampled monthly by using a seine net. Weight of 10 fishes of each species was measured separately to assess the health condition and growth of fishes using a portable balance (OHAUS, model No.CT-1200-S). Partial harvesting of fishes was performed by repeated netting, using a seine net. Final harvesting was done by de-watering the ponds. During harvesting all fishes of each pond were collected and

weighed individually to assess the survival rate and production.

Specific growth rate (SGR) was estimated as;

SGR = [Ln (final weight)-Ln (initial weight) x 100]/ culture period (days).

Survival and production of fish were measured by following formulas,

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

Production = No. of fish harvested × final weight of fish

For the statistical analysis of the data, a one-way ANOVA (Analysis of Variance) and DMRT (Duncan's Multiple Range Test) were done by using the SPSS (Statistical Package for Social Science) version-11.5 and the significance was assigned at 5% level.

Results

Water quality parameters

Temperature (°C): Temperature of pond water was found to be more or less similar in different treatments and was not varied significantly (Table 1). The ranges of water temperature were varied from 15 to 25°C in all the treatments. The maximum temperature of 24.60°C was found during March in T_3 while the minimum temperature of 15.90°C was found during January in T_1 and T_2.

Transparency (cm): Water transparency ranged from 15 to 60 cm with the highest (60 cm) and the lowest (15 cm) in treatment T_1 and T_3, respectively and significant difference ($P<0.05$) was observed among the treatments (Table 1).

Table 1. Water quality parameters of the studied ponds during the study period

Parameters	Treatments			F Value	Level of Significance
	T_1	T_2	T_3		
Temperature (^{0}C)	20.48±0 .298 (15.90-24.20)	20.46± 0.300 (15.90-24.30)	20.52± 0.298 (16.00-24.60)	0.010	NS
Transparency (cm)	41.82^a±1.71 (17.00-60.00)	36.00^b±1.264 (18.00-55.00)	28.62^c± 0.691 (15.00-37.00)	26.164	*
pH	7.73 (6.80-8.70)	7.73 (6.80-8.50)	7.82 (6.80-8.70)	0.539	NS
DO (mg/l)	7.22±0.157 (5.71-9.90)	7.21±0.161 (5.70-10.00)	7.24±0.160 (5.77-9.90)	0.009	NS

Means with the different superscripts in same row are significantly different (*P< 0.05*)

pH (Hydrogen ion concentration): pH values were found to fluctuate from 6 to 9 in various treatments. The lowest value was observed in January in all the treatments and the highest value was observed in both treatments T_1 and T_3 in March. Mean values of pH were 7.73, 7.73and 7.82 in treatments T_1, T_2 and T_3 respectively (Table 1) and no significant difference ($P>0.05$) were observed.

Dissolved oxygen (mg/ l): The ranges of different oxygen concentrations in different ponds were varied from 5.70 to 10.00 mg/l with the highest (10.00 mg/l) value in treatment T_2 and the lowest (5.70 mg/l) in treatment T_1. There was no significant difference ($P>0.05$) among the treatments (Table 1).

Growth and production performance of fish: Some differences in the yield of fish with, 685.20±128.58, 736.04±135.26 and 653.30±50.63 kg/ha/120 days were found in treatments T_1 T_2 and T_3 respectively. The highest total production of 736.04±135.26 kg ha^{-1} 120^{-1} days was obtained from treatment T_2 where the stocking ratio of silver carp and catla was 1:1. The survival rates of various large carps in different treatments varied from 83 to 100% (Table 2).

Table 2. Growth, survival and production (kg ha^{-1}) of fish

Treatments	Fish stocked		Fish harvested			Yield kg/ha/120 days	
	Name of Species	Mean wt (g)	Mean final wt (g)	Mean gain in wt (g)	Survival (%)	Species wise	Total Production
T_1	Rui	45.96±0.47	104.10^a±3.33	58.14	83.3	193.64±29.16	
	Catla	88.53±2.77	203.14^a±8.87	114.61	93.3	106.83±23.44	
	Silver carp	102.47±1.57	149.80^b±3.60	47.34	97.78	139.06±45.24	685±12
	Mola	1.563±0.03				9.10±0.57	
T_2	Rui	45.59±0.41	94.28^b±2.92	48.69	90	175.11±42.94	
	Catla	89.58±2.09	169.13^b±6.51	79.55	88.3	140.89±40.63	
	Silver carp	102.13±1.68	188.84^a±7.06	86.713	90	156.06±63.61	735±13
	Mola	1.493±0.03				8.97±3.48	
T_3	Rui	46.33±0.34	87.43^b±1.38	41.1	82.5	135.49±8.75	
	Catla	93.08±1.87	168.85^b±4.33	75.77	84.44	191.78±5.12	
	Silver carp	103.80±2.19	193.94^a±4.59	90.14	100	90.14±6.38	653±50
	Mola	1.480±0.02				6.27±1.23	

Means with the different superscripts in same column are significantly different (P< 0.05)

Performance of catla: Catla reached an average weight of 203.14±8.87 in treatment T_1, 169.13±6.51 in T_2 and 168.85±4.33 in T_3. The highest growth was recorded in T_1 and lowest growth was recorded in T_3. The survivals of catla were not significantly different (P>0.05) among the treatments. However, it was found that the production in T_3 was better than other treatments which were 191.78±5.12 kg/ha/120 days where the stocking ratio of silver carp and catla was 1:3. The harvesting weight of catla varied significantly (P<0.05) among the treatments. The trends in growth performance of catla in all treatments are shown in Fig. 1.

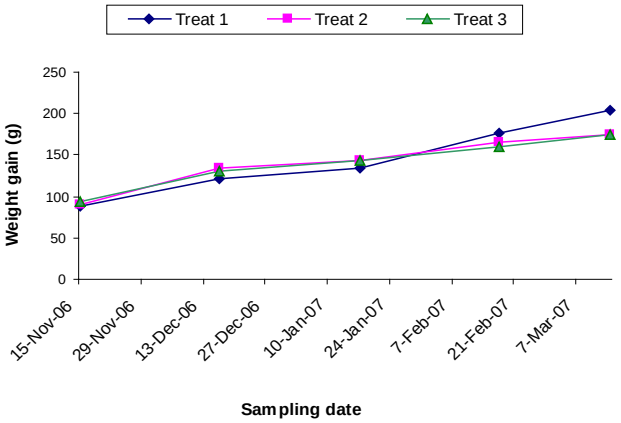

Fig.1. Growth trends of catla among the different treatments

Performance of silver carp: The highest yield of silver carp 156.06 ± 63.61 kg ha^{-1} 120^{-1} days was found in treatment T_2 and the lowest yield was observed in T_3 (90.14±6.38 kg $ha^{-1}120^{-1}$ days). However, it was found that the production in T_2 was better than other treatments. Harvesting weight of silver carp was recorded significantly different (P<0.05) among the treatments. Survival rates of silver carp were almost similar in different treatments. The growth performance of silver carp in all treatments is shown in Fig.2.

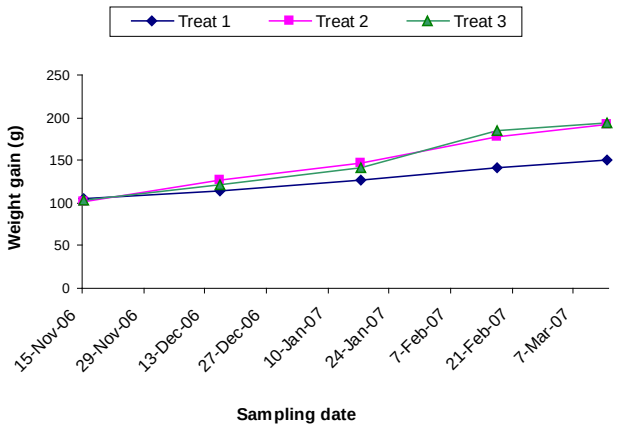

Fig. 2. Growth performance of silver carp among different treatments

Performance of rohu: The survival rate of rohu was recorded 82.5-90% and not significantly different among the treatments. The highest yield of rohu 193.64±29.16 kg ha^{-1} 120^{-1} days was observed in treatment T_1 and not significantly (P>0.05) different. However it was observed that the production of rohu in treatment T_1 was better than other treatments (Table 2). The growth performances of rohu in all treatments are shown in Fig. 3.

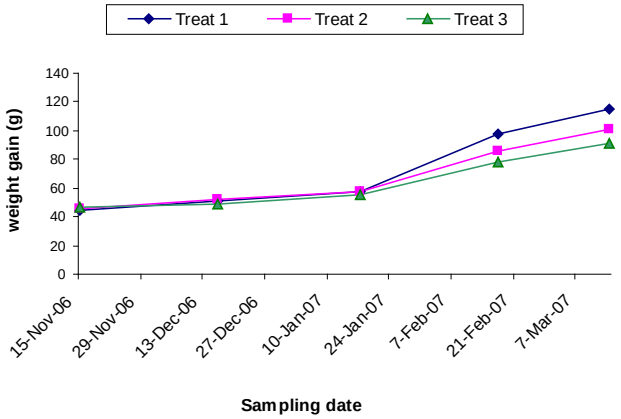

Fig. 3. Growth performances of rohu among different treatments

Performance of mola: The small indigenous fish species, mola was stocked @ 100 individuals in each treatment. The initial average weight of mola was 1.563±0.03, 1.493±0.03 and 1.480±0.02 g in treatments T_1, T_2 and T_3. After stocking, large sized mola started to breed in November and the number has increased. The highest production of mola was 9.10±0.57 kg/ha/120 days in treatment T_1 where the stocking ratio of silver carp and catla was 3:1. Mola addition to the large carp polyculture had no significant effect.

Discussion

Water quality parameters: Temperature is very important for pond fish culture and should be in a suitable range. This experiment was held in winter and temperature was found to vary from 15.90 to 24.60°C, which was suitable for growth of plankton, benthos and fish. The findings of the present study were similar to the findings of Azim *et al.* (1995) and Alim (2005). The transparency ranges from 15 to 60 cm recorded in present study is similar with the findings of Raihan (2001) as recorded values ranging from 11.5 to 50 cm and Alim (2005) as recorded ranging from 17-56 cm from the ponds in BAU campus. In the present study, the transparency values of different treatment indicated that pond water seemed to be within the productive range for fish culture. The pH ranging from 6.80 to 8.70 recorded in present study is suitable for fish culture. The present findings agree with the findings of Dewan *et al.*, (1991) and Ahmed (2004) who found the range of pH from 6.6 to 8.8 and 6.3 to 8.9 respectively. In the present study, the dissolved oxygen concentrations under different treatments were found to fluctuate from 5.71 to 9.90, 5.70 to 10.00 and 5.77 to 9.90 mg/l in treatments T_1, T_2 and T_3, respectively. Rahman

(1999) also recorded dissolved oxygen ranging from 2.0 to 7.4 mg l^{-1} from some research ponds in BAU campus that was similar with the findings of the present study.

Production performance of fish: The growth rate and yield of fish in different treatments were different. Survival rate of large carps in different treatments varied from 82.5% to 100% which was similar with the findings of Raihan (2001) who recorded survival rates of 81% to 90% in a carp-SIS polyculture system in BAU Field Laboratory ponds. Among the species, silver carp gained the highest weight (193.94 g) in T_3 and catla (203.14 g) and rohu (104.10 g) gained highest weight in T_1. On the other hand, the lowest weight gain (149.805 g) was observed in case of silver carp in T_1 and both catla (168.85 g) and rohu (87.43 g) was observed in T_3. This reverse result might be due to severe inter-specific food competition between silver carp and catla. Silver carp is a strong filter feeder but catla is upper layer feeder. Catla is an upper layer feeder mainly feed on zooplankton (Rahman, 1989) and this findings also agreed with the findings of Wahab *et al*. (1994). The lowest weight gain of rohu was found in T_3 where the stocking density of catla was higher than silver carp. It might be due to the competition between rohu and catla is higher than competition between rohu and silver carp. The highest production of mola was found in T_1 but the lowest production was found in T_3 where the stocking rate of catla was higher than silver carp.

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