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POLYCULTURE OF CARPS WITH SMALL INDIGENOUS SPECIES (SIS) MOLA (*Amblypharyngodon mola*) AT GAZIPUR AREA OF BANGLADESH

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ABSTRACT

An experiment was carried out to evaluate the impact of pond sizes on the production potential of mola, *Amblypharyngodon mola* with carps for a period of 5 months from mid August 2003 to mid January 2004 at Sreepur Upazila in Gazipur district. Fifteen ponds were divided into three treatments each with five replicates. Rohu (*Labeo rohita*), catla (*Catla catla*), mrigal (*Cirrhinus cirrhosus*) and exotic silver carp (*Hypophthalmichthys molitrix*) were stocked at the stocking densities of 10,000/ha at the ratio of 1:0.5:0.5:1, while small indigenous fish mola (*Amblypharyngodon mola*) were stocked at 25,000/ha and grass carp (*Ctenopharyngodon idella*) was stocked at 500/ha. Major carps and mola were common in all treatments. All ponds were subjected to same regime of feeding and fertilization. The commonly available agricultural byproduct rice bran (100%) was used once per day as supplementary feed at the rate of 3% body weight of standing crop of fish. Soft grasses and banana leaves were supplied for grass carp on daily basis up to satiation. All ponds were fertilized with manure (cow dung) at the rate of 1,000 kg/ha at fortnightly intervals. All feeds and fertilizer inputs were supplied from farmers' households. Various water quality parameters such as water temperature, transparency, dissolved oxygen, pH, alkalinity and chlorophyll-*a* were monitored at monthly interval and found almost similar in three treatments. The mean values of various water quality parameters were within the suitable ranges for freshwater aquaculture in Bangladesh. The survival rates of carp species were fairly high and ranged from 79.63 to 91.67%. The production of carps and small fish were together 2,413.25, 2,492.94 and 2,346.66 kg/ha in treatments 1, 2 and 3, respectively, which were not significantly different. The overall best production was obtained in Treatment 2 where the pond size was 10-20 decimal. It was observed that if partial harvesting is made, polyculture of major carps with small fish, mola is a better proposition in terms of biological, nutritional and economic point of view. The farmers can keep the small fish for their family consumption and can sell the large carps as cash crop.

Keywords: polyculture, carp, SIS, survival, growth

INTRODUCTION

Fish is the major source of protein contributing about 63% of total animal protein intake. At present, fish consumption per capita per day only 20.8 g, whereas the needed requirement is about 49 g. To meet up animal protein deficiency of the people, greater emphasis should be given to boost up fish production in this country (DoF, 2002). Fish culture in this country has taken place as elsewhere in Asia through the culture of commercial species of both native and exotic species. Through the development of fish culture, production per unit area has increased but the diversity of fish has decreased because of given attention to fewer large fish species. But the smaller fish, which once provided a large bulk of fish supply to the majority people of this country, especially the rural poor people and the fishermen are now completely wiped out from the fishponds and other cultured water bodies.

This is because of the fact that small fish are regarded as undesirable species in the present aquaculture management practices. It is assumed that due to the unavailability of the small fish, the poor and under-privileged people have been facing serious malnutrition.

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This malnutrition and other public health problems can be overcome through aquaculture of small indigenous fish (SIS) because of their higher micro-nutrients content. For doing this, a change in the species combination of the existing carp polyculture technology through inclusion of SIS along with has to be made. Carp culture production system together with SIS might be helpful for rural household (Roos, 2001). These small indigenous fish species (SIS) provide food and nutrition, subsistence and supplemental income to the great majority people in this country, particularly the poor and disadvantaged.

There are many small fishes such as mola (*Amblypharyngodon mola*), dhela (*Ostreobrama cotiocotio*), punti (*Puntius* sp.), chela (*Chella cachius)* etc. Their production potential for freshwater aquaculture mostly remained. SIS used to be abundantly available in rivers, streams, ponds, beels, ditches and flood plains in the past, but these species have gradually been disappearing from the natural system due to loss of habitat, fishing pressure, use of insecticides and pesticides and outbreaks of EUS disease, which in turn severely affect biodiversity. So special attention is needed to culture the SIS, because they are important source of vitamin-A and minerals (Thilsted *et al.*1997).

Most of the rural people of Bangladesh have neither capacity to buy a large fish from the market nor can effort to sacrifice to the pond grown large carp for their family consumption. To provide the poor farmers with both financial and nutritional support, it is essential to develop a polyculture technology with both large carps and small indigenous fish species (SIS). Then the farmers will be able to sell large carps into the market as cash crop and can consume the small fish to fulfill their nutritional requirement. For this reason, culture of large major carps and small indigenous species (SIS) of fish together has been proposed for last few years.

However, SIS in aquaculture is suitable for home consumption as frequent (weekly or even daily) harvesting of small amounts of fish is possible since many of these fish species reproduce in the pond. By introducing SIS in polyculture along with normally cultured large carp, the poor households can potentially increase nutrient uptake as well as family income. With regard to the beneficial effect on food and nutrient intake, culture of SIS can be compared to home gardening which is promoted as a strategy to combat vitamin deficiency and to increase the total production and finally to ensure availability for the poor.

Despite a consistent success of the new carp SIS polyculture in the on station trials, technology has not yet been tested in the rural ponds. Therefore, an initiative has been made to promote the new culture technology in the rural ponds at Gazipur. The proposed research has been set and to address the following objectives-

(a) To understand the environmental quality of the rural ponds
(b) To determine the growth and production of large carps and small fish in farmers' ponds and
(c) To evaluate the performance of SIS (mola) based polyculture technology in relation to pond size.

MATERIAL AND METHODS

The experiment was consisted of three treatments with five replications for a period of five month from August 2003 to January 2004 at Gararon and Tengra village under Sreepur Upazila of Gazipur district. Ponds were selected based on size small (<10 decimal), medium (<20 decimal) and large (<30 decimal). A total of 15 ponds were used for the experiment. Treatment-1 comprised of 5 ponds each with area of below 10 decimal, Treatment-2 comprised of 5 ponds each with area of below 20 decimal and Treatment-3 comprised of 5 ponds each with area of below 30 decimal. The stocking density of Indian major carps rohu (*Labeo rohita*), catla (*Catla catla*), mrigal (*Cirrhinus cirrhosus*) and silver carp (*Hypophthalmichthys molitrix*) were 10,000 fish/ha at the ratio of 1.0:0.5:0.5:1.0 while small indigenous fish mola (*Amblypharygodon mola*) were stocked at 25,000fish/ha and grass carp (*Ctenopharyngodon idella*) stocked at 500 fish/ha. Indian major carp were common in all treatments and mola were also common in all treatments. The average depth of ponds was 1.2-2.0 m. The ponds were free from aquatic vegetation, completely independent and well exposed to sunlight. The sources of water in the ponds were rainfall.

All predatory and other fishes were removed from the experimental ponds by repeated netting. The embankment were repaired and lime (CaCO3) was applied at the rate of 250 kg/ha. All ponds were fertilized with cow dung (at the rate of 1,000 kg/ha) and Urea (100 g) and TSP (100 g) at fortnightly intervals. Fertilizer and cow dung were applied at the interval of 30 days during the sampling days. After seven days of liming, fertilizer application were started and after five days of fertilization, fish were stocked when sufficient quantities of both phytoplankton and zooplankton appeared. Rice bran was used as supplementary feed at the rate of about 3% body weight of standing crop. Soft grasses and banana leaves were supplied for grass carp on daily basis up to satiation.

Water quality parameter such as temperature, pH, dissolved oxygen, transparency, total alkalinity and chlorophyll-a were measured at 30 days interval at 9.00-10.00 am. Temperature, dissolved oxygen and transparency were measured on the spot.

Partial harvesting of small fish mola from all treatments was done two months after stocking and then continued onwards fortnightly until final harvest of all fish. The partial harvesting of small fish mola was performed by the cast net and fine meshed seine nets. At the end of the experiment all fishes were harvested by netting repeatedly with a fine meshed seine net from each pond and then counted species wise. During the harvest, all fishes were counted and weighed separately to assess the survival rate and production. The mean value of growth, survival and yields obtained were compared statistically. Data were analyzed by using SPSS 12 software package to observe the performance of fishes in different treatments.

RESULTS AND DISCUSSION

Water quality parameters

Various physical, chemical and biological properties of pond water under three treatments were determined. The mean values of water quality parameters of the treatments are presented in Table 1.

Table 1. Mean value of water quality parameters during the experimental period

Parameters	Treatment-1 (<10 decimal)	Treatment-2 (<20 decimal)	Treatment-3 (<30 decimal)
Temperature (°C)	26.38±0.64	26.90±0.73	26.46±0.68
pH	7.23	7.03	7.14
Dissolved oxygen (mg/L)	5.11±0.20	5.35±0.23	5.38±0.18
Transparency (cm)	21.00±0.59	20.88 ±0.85	19.56±0.37
Total alkalinity (mg/L)	112.88±7.77	73.52±3.27	77.44±7.77
Chlorophyll (μg/L)	178.50±94.16	202.20±90.42	153.22±75.31

NS=Non significant (P>0.05) at 5% level, SD (±)

The mean values of water temperature were 26.3±0.64, 26.9±0.73 and 26.46±0.68 in treatments 1, 2 and 3 respectively. The maximum water temperature (32^{0}C) was found in September in Treatment-3, while the minimum (20^{0}C) was found in January in all treatments. The pH values were found to fluctuate from 6.3 to 8.9 with the highest value (8.9) observed in August in Treatment-3 and the lowest value observed in Treatment-1 in October. Mean value of pH was found to be 7.23, 7.03 and 7.14 for Treatments-1, 2 and 3, respectively (Table 1). The values of oxygen were found to range from 3.4 to 8.1 mg/L in Treatment-1, 3.9 to 7.9 mg/L in Treatment-2, and 3.4 to 7.3 mg/L in Treatment-3. The mean values of dissolved oxygen in three Treatments were 5.11±0.20, 5.35±0.23, and 5.38±0.18 mg/L respectively. The highest value of dissolved oxygen was recorded 8.1 mg/L in Treatment-1 and lowest value was 3.4 mg/L in Treatment-1 and 3 (Table 1). The mean values of temperature, pH and dissolved oxygen in three treatments showed no significant difference among the treatments.

Transparency values of pond water varied between and within the treatments with time. Gradual decrease of secchi readings towards the end of the experiment was observed. The mean values of transparency were 21.00±0.59 in Treatment-1, 20.88±0.85 in Treatment-2, and 19.56±0.37 in Treatment-3 (Table 1). The value of transparency ranged from 18 to 29 cm in Treatment-1, 17 to 36 cm in Treatment-2 and 17 to 23 in Treatment-3. The highest value of Transparency (36 cm) was recorded in Treatment-2 in September, whereas the minimum (17 cm) from Treatment-2 and 3 in January.

The level of chlorophyll-*a* varied considerably throughout the experimental period, ranges from 35.70 to 436.73 µg/L in Treatment-1, 51.17 to 390.70 µg/L in Treatment-2 and 42.84 to 436.01µg/L in Treatment-3. The mean value of chlorophyll-*a* was 178.50±18.83, 202.20±18.08 and 153.22±15.06 µg/L in Treatment-1, 2, and 3 respectively (Table 1). The highest value 436.73 µg/L and the lowest value 35.70 µg/L was observed in Treatment-1 in August and September respectively. The mean values of transparency and chlorophyll-*a* were not significantly among the treatments.

The values of total alkalinity as recorded from water of the ponds under Treatments-1, 2 and 3 were found to vary from 54 to 176, 50 to 114 and 42 to 120 mg/L respectively (Table 1). The mean values of total alkalinity were 112.88±7.77 in Treatment-1, 73.52±3.27 in Treatment-2 and 77.44±5.05 mg/L in Treatment-3 (Table 1). The highest alkalinity was 176 mg/L in January in Treatment-1, and the lowest value was 42 mg/L in the month of November in Treatment-3. The mean values were significantly different among the treatments. Treatment-1was significantly different from Treatment-2 and Treatment-3, but there was no significant difference between Treatment-2 and 3.

Growth and production of fish

Mean weight during stocking and harvesting, survival rate and production of fish species (kg/ha/150 days) are presented in Table 2. The production of fish from different pond showed a wide difference in net yield of fish with 2,413.25 kg in Treatment-1, 2,492.94 kg in Treatment-2 and 2,346.66 kg in Treatment-3. The highest total production obtained in Treatment-2, where the pond size was below or equal to 20 decimal. The lowest total production obtained in Treatment-3 (Table-2).

After stocking, mola started to breed within two month with increase in the number and thus the ultimate production had increased. At the end of the experiment, the average net production of mola was 55.49, 77.40 and 80.53 kg/ha/150 days in Treatment-1, Treatment-2 and Treatment-3 respectively. The highest yield of mola was 80.53 kg in Treatment-3. The total production of mola showed significant different (P>0.05) among the treatments. Treatment-1 was significantly different than Treatment-2 and 3.

Table 2. Survival and production of fish as obtained in different treatments during culture period

Treatment	Name of species	During stocking		During harvesting		Yield (kg/ha/150 days)	
		No. of fish	Mean wt (g)	Mean wt. (g)	Survival (%)	Species wise	Total
Treatment-1	Silver carp	600	42.7 ± 0.29	542.97± 88.52	85.94	1390.21	2413.25
	Catla	300	11.47± 0.36	153.95± 43.71	82.33	188.02	
	Rohu	650	11± 0.50	151.33± 39.25	79.97	406.81	
	Mrigal	350	13.6± 0.69	184.1± 64.94	80.83	257.97	
	Grass carp	100	12.6± 0.71	274.14± 83.84	84.75	114.42	
	Mola	5000	2.37± 0.39	3.89± 0.86	-	55.82	
Treatment-2	Silver carp	936	40.1± 0.51	549.79± 81.85	83.28	1356.21	2492.94
	Catla	464	11.9± 0.33	221.04± 55.25	81.94	268.00	
	Rohu	1014	11.21± 0.53	177.95± 40.87	81.19	463.87	
	Mrigal	546	14.3± 0.74	226.19± 51.86	80.93	316.65	
	Grass carp	156	13.1± 0.55	295.42± 66.25	82.67	120.81	
	Mola	7800	2.46± 0.48	4.39± 1.07	-	77.40	
Treatment-3	Silver carp	1500	41.3± 0.29	488.22± 84.31	87.04	1257.61	2346.66
	Catla	750	13.13± 0.39	173.49± 41.19	81.91	210.88	
	Rohu	1625	11.38± 0.57	155.51± 33.39	80.84	404.39	
	Mrigal	875	13.8± 0.79	201.95± 41.18	82.28	287.35	
	Grass carp	250	13.7± 0.32	261.41± 62.35	81.94	105.90	
	Mola	12500	2.38± 0.44	3.53± 0.99	-	80.53	

NS=Non significant (P>0.05) at 5% level, SD (±)

Silver carp reached an average weight of 543.97 g in Treatment-1, 549.79 g in Treatment-2 and 488.22 g in Treatment-3. Silver carp showed no significant difference (P>0.05) in growth performance among the treatments. Among all the species silvercarp showed highest production in all treatments. Survival rates 85.7, 83.3 and 87.0%, mean weight of 542.97, 549.79 and 488.22 g and net yields of 1390.21, 1356.21 and 1257.61 kg/ha were obtained from Treatment-1, 2 and 3 respectively.

Catla reached an average weight of 153.96 g in Treatment-1, 221.04 g in Treatment-2 and 173.49 g in Treatment-3. The LSD value showed significant difference among the treatments. Treatment-2 showed significant difference from Treatment-1 and Treatment-3, but there are no significant difference between Tretament-1 and Treatment-3 (P>0.05). Mean weight of 153.95, 221.06 and 173.49g were obtained from Treatment-1, 2 and 3 respectively. The highest survival rate 83.3% of catla was found in Treatment-3. The highest yield of catla was 268.00 kg/ha/150 days in Treatment-2.

Mean weight of rohu was 151.33, 177.95 and 155.11g in Treatment-1, 2 and 3 respectively. The mean weight was not significantly different among the treatments. The highest survival rate 88.5% of rohu was found in Treatment-1. The highest yield of rohu was observed in Treatment-2, which was 463.87 kg/ha/150 days.

Mean weight of mrigal was 184.10, 226.19 and 201.95 g in Treatment-1, 2 and 3 respectively. The mean weight was not significantly different among the treatments. Survival rates of 80.8, 80.9 and 82.3% and net yields of 257.97, 316.65 and 287.35 kg/ha were obtained from Treatments-1, 2 and 3 respectively. The highest survival rate 82.28% of mrigal was found in Treatment-3. The highest yield of mrigal was observed in Treatment-3, which was 287.35 kg/ha/150 days.

Grass carp reached an average weight of 274.14g in Treatment-1, 295.42g in Treatment-2 and 261.41g in Treatment-3 respectively. Survival rate of 81.0, 82.1 and 82.0 and net yield was 114.42, 120.81 and 105.90 kg/ha were obtained from Treatment-1, 2 and 3 respectively. The highest survival rate 82.05 of grass carp was found in Treatment 2. The highest yield of grass carp was 120.81 kg/ha/150 days in Treatment-2.

The ranges of water temperature measured in the present study were 20 to 32°C. The highest temperature recorded during the month of September1993 was due to relative high intensity of sunlight. The present findings agree with the findings of Wahab *et al.* (1995), Kohinoor (2000) and Uddin (2002). Dewan *et al.* (1991) reported a surface water temperature ranged from 30.2 to 34.0°C in polyculture with Indian and Chinese carps. Most water bodies have pH within the range of 6.5 to 8.5. The pH range (6.3 to 8.9) recorded in the present study was suitable for fish culture. The mean dissolved oxygen content in water was 5.28±0.12 mg/L. Dissolved oxygen content were varied from 3.4 to 8.1 mg/L. The fluctuation in dissolved oxygen value might be due to alteration in the rate of photosynthesis in the pond and due to the rate of dissolved oxygen consumption by the fish through respiration. However, the dissolved oxygen content of the experimental ponds was within the good productive range. The transparency record indicated that there are available foods for the fish in all treatments. Wahab *et al.* (1994) reported that the transparency range (17-36 cm) as recorded in the present study which was similar for the findings of Rahman (1999), who recorded secchi values ranging from 12-46.5 cm. Total alkalinity values ranged between 42 to 176 mg/L and was within the suitable range for fish culture. Chlorophyll-*a* is an indicator of pond productivity. Chlorophyll-*a* value ranges from 35.70-436.76 μg/L, which was more or less similar with the findings of Rahman (2000), Kohinoor (2000), Raihan (2001). The higher chlorophyll-*a* concentration of pond water in feed-driven ponds might be due to the addition of supplemental feed, which partly fertilized the ponds and enhanced phytoplankton production.

In this study, mean survival rates for various large carps in different treatments varied between 79.63 to 91.67%. Similar types of survival rates were observed by Raihan (2001) in a carp-SIS polyculture system. Experiment done by Rahman (1999) in controlled environment indicated that survival rates varies from 66 to 98% in carp-SIS polyculture system. The highest survival rate was observed in Treatment-1 followed by Treatment-2 and 3. Among the entire species relatively higher survival rate was recorded in silver carp. This might be due to the fact that the initial weight of silver carp (42 g) was higher than others. The lowest survival rare was recorded in catla. This might be due to the fact that it could not compete with other surface feeding species (especially silver carp and mola) for their food and space.

The growth and production of fish in different treatments were different. Silver carp gained maximum weight among the treatments. This might be due to the fact that silver carp being a planktivorous fish and utilized phytoplankton properly. The weight gain of catla was found lower in Treatment 3 and 1. This might be due to the fact that it could not compete with other species especially silver carp and mola for food and space. Silver carp, catla and mola competed for same food and space. Chlorophyceae as the most dominant and Cyanophyceae as the next dominant food group in the gut content of silver carp and catla. These two groups were also recorded as important food of mola by

Dewan (1973). Silver carp are surface feeder and similar feeding habit showed by catla. From the above findings it can be concluded that silver carp, catla and mola are mainly plankton feeder with surface feeding habit. The weight gain of rohu was found lower among the treatments. This might be due to the fact that it could not compete with other fishes for food and space. Rohu and catla are plankton feeder and mrigal are omnivore and bottom feeder and they prefer also aquatic vegetation, as well as submerged grass and debris. Mola is omnivore in nature with higher feeding preference for debris and plants foods (Miah and Siddique, 1992). With the introduction of mola the growth and production of rohu and catla was reduced. This might be due to the fact that mola have competed for food and space with carps. Mola are surface and column feeder and feeding on phytoplankton and zooplankton (IFADEP, 1996). Rohu is an omnivore with preference for debris and vegetation (Miah *et al.* 1981) and cyanophyceae, bacillariophyceae, aquatic higher plants, rotifers, cladocerans and copepods are the food items of rohu. Fry and fingerlings of catla were absolutely animal feeder and catla showed feeding performance for zooplankton as it increased in size. The food types and feeding behaviour of rohu, catla and mola confirmed strong competition for food among them. Expected weight gain of mrigal was found in all treatments. Growth performance of bottom feeder mrigal was not affected by mola. It might be possibly due to the fact that mola did not compete for food and space with mrigal because of their difference in food habits. Grass carp gained expected weight in all treatments. Grass carp being an herbivorous fish feed mostly on soft grasses and banana leaves and enough grasses and banana leaves were supplied for their daily basis up to satiation during the experimental period. As a result, they could grow independently without facing any competition for space and food with other species.

Among the treatments, the highest total production (kg/ha/150 days) of fish 2492.94 kg was obtained from Treatment-2 which was subsequently followed by Treatment-1 and 3. The reason behind the highest production in Treatment-2 might be the role of both supplementary and natural foods are used properly and the contribution of mola in this treatment was 77.4 kg. The reason might be the mean value of individual final weight and survival rate were found to be averagely higher and the pond size in this treatment were medium (below or equal to 20 decimal) than the rest of the treatments. Hasan (1998) obtained 1,863 to 2,128 kg/ha/6 months polyculture with SIS, Kohinoor *et al.* (1998) obtained 1,126 kg/ha/4 months from carps with mola polyculture system where the contribution of mola was 59.0 kg only and Roos *et al.* (1999) found 2,500 kg/ha/7 months in polyculture of mola with carps. The total productions of fish of the present experiment were within profitable production level when compared with the above findings.

Mola was introduced in this study to observe the growth and production in different pond sizes with large carps. The expected production was found in Treatment-3 and 2, where the pond size was below 30 decimal and below 20 decimal. But the lower production was found in Treatment-1. This might be due to the fact that below 10 decimal ponds is not suitable for carp-SIS polyculture. Because, in carp culture there is a positive correlation between pond size and production (Ameen *et al.* 1986). However, this study clearly indicated that there is potential for developing a polyculture technology with carps and SIS for Bangladesh as well as for this region. The medium size ponds with range from 10-20 decimal has been suitable for carp-SIS polyculture in rural farmers' ponds. Further research can be done to decide if silver carp, catla and mola could be cultured together in polyculture. In this case, catla may be replaced by silver carp or vice versa.

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