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Culture potential of *Amblypharyngodon mola* with carps in polyculture in farmers' ponds of Northern regions of Bangladesh

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Abstract
To assess the culture potential of mola (*Amblypharyngodon mola*) along with carps in polyculture systems, an experiment consisted of three treatments each with five replications was conducted for 4 months in two villages of Parbatipur upazilla under Dinajpur district. In the first treatment (SS), catla, rohu, mrigal, grass carp, Thai punti, common carp and a higher density of silver carp (8 per $40m^2$) were stocked. In the second treatment (SM), stocking density of silver carp was reduced to half and mola was added at a stocking density of 12,500/ha with all other fishes used in SS. In the third treatment (MM), no silver carp was stocked and mola was added at a stocking density of 25,000/ha with all other fishes used in SS. All treatments were subjected to the same regime of feed and fertilizers. The yields of large carps were 2035 kg/ha, 1757 kg/ha and 1326 kg/ha for treatments SS, SM and MM, respectively. Catla, grass carp and carpio showed better growth and production performance in presence of mola at a higher density, while rohu, Thai punti and mrigal showed better performance when stocking density of mola was relatively low. Mola yield was almost two times higher (184 kg/ha) in absence of silver carp (MM) than (62 kg/ha) in presence of silver carp (SM). The result showed that there was a significantly ($p<0.01$) lower total fish production in treatment MM. But there were no significant difference in total production between treatment SS and SM.

Key words: *Amblypharyngodon mola,* Polyculture, Carps

Introduction

The small indigenous fish, such as mola, punti, chela, chapila, colisa etc. have now great demand in the rural as well as urban markets. There is a tendency that, farmers' once stock fingerlings at the culture season and sell their entire crop at the harvest season, keeping their family unfed. If small and large fish could be cultured together, farmers would have the opportunity to harvest small fish periodically round the year and feed the members of the family with nutrient rich small fish and could sell their large carps as cash crop.

Amblypharyngodon mola, locally known as mola or moia was once abundantly found in the rivers, canals, ponds and ditches etc. (Ahmed 1984, Rahman 1989). Mola is particularly important as the fish contains more available vitamin A than any other edible fish species in this country (Ahmed 1981). Over ten years, efforts have been made at Bangladesh Agricultural University to develop a carp-SIS polyculture technology including small indigenous species of fishes (mola, punti, chela, dhela etc.). As part of this effort, dissemination of the new technology and potentials of its introduction in different major agro-ecological zones have tried. Considering the many fold benefits, culture potential of mola with major carps in the polyculture in the farmers' pond of northern region of Bangladesh has been tried.

Materials and methods

The experiment was carried out in farmers' ponds at Nowdapara and Kalaighati village of Parbatipur Upazilla, Dinajpur from July to November 2005. Pond size ranging from 6 to 21 decimals (decimal = $40m^2$) with 1 to 1.5m water depth. All ponds were rain-fed, well exposed to prevailing sunlight and without an inlet or outlet.

Design of the experiment

The experiment was conducted with 3 treatments each with 5 replicates. Replicates of each of three treatment groups were assigned by stratified random selection of ponds. Stocking density Thai punti and all Indian major carps were same in all treatments. In the control treatment (SS) stocking density of silver carp was 8 per decimal which was partially replaced with mola (4 silver carp and 50 mola per decimal) in the second treatment (SM). Silver carp was fully replaced by mola (100 mola per decimal, no silver carp) in the third treatment (MM) (Table 1).

Table 1. Fish species composition and stocking density in each treatment

Species	Common name	SS (Ctr)	SM	MM
Catla catla	Catla	6	6	6
Hypophthalmicthys molitrix	Silver carp	8	4	–
Labeo rohita	Rohu	4	4	4
Ctenopharyngodon idella	Grass carp	3	3	3
Chirhinus cirrhosus	Mrigal	6	6	6
Cyprinus carpio	Carpio	3	3	3
Barbodes gonionotus	Thai punti	10	10	10
Amblypharyngodon mola	Mola	–	50	100

Pond preparation & stocking of fish

All predatory and other fishes were removed from the experimental pond by repeated netting. Ponds were prepared properly with lime at the rate of 1 kg per decimal and initial fertilization with urea, TSP and cowdung at the rate of 400 g, 400 g and 5 kg per decimal, respectively. Fingerlings of carps and Thai punti were collected from the hatchery of the Northwest Fisheries Extension Project (NFEP), Dinajpur. Mola fry was collected both from local farmers and NFEP hatchery ponds. Initial length and weight of fingerlings were measured before releasing into the pond.

Post stocking management

Mustard oil cake and rice bran were used as supplementary feed at the rate of 2% body weight of fish. After stocking of fish urea, TSP and cowdung were used at 10 days interval at the rate of 100 g, 100 g and 4 kg per decimal, respectively. Fishes were sampled monthly using a seine net. The length and weight of 20 individuals of each species were recorded in prescribed format. Length was taken by using a centimeter scale and weight by using a portable balance.

Water quality determination

Water quality parameters such as temperature (^{0}C), transparency (cm), dissolved oxygen (mg/L) and pH were measured on the spot once in a month. Water transparency was measured with a secchi disc. Temperature and dissolved oxygen of water was measured by portable digital DO meter (YSI model 85-10 FT). pH was measured by direct reading with a digital pH meter (HANNA HI-98107) on spot.

Study of growth and production of fish

Fish were harvested at the end of experiment by repeated netting with seine net and were measured and weighed. The following parameters were used to evaluate the growth:

a) Average weight gain = Mean final fish weight- mean initial fish weight

b) Specific growth rate:

$$\text{Specific Growth Rate (\% day)} = \frac{\text{Log}_e W_2 - \text{Log}_e W_1}{T_2 - T_1} \times 100$$

Where, W_1 = the initial live body weight (g) at time T_1 (day)

W_2 = the final live body weight (g) at time T_2 (day)

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

e) Production of fishes:

Yield = No. of fish caught × Average final weight

Statistical analysis

The data obtained in the experiment were analyzed statistically by analysis of variance (ANOVA) and Duncan's Multiple Range Test (DMRT) as post-hoc test using SPSS (version 11.5) statistical software (SPSS Inc., Chicago, USA). Differences were considered significant at an alpha of 0.05, and means were given with ± standard error (SE).

Results

Water quality parameters

The result of water quality parameters in different ponds such as temperature, transparency, dissolved oxygen and pH are shown in Table 2. Water temperature over the study period was found to vary from 27.7 to 31.0 ^{0}C. The mean water temperature was 29.2±0.1 ^{0}C, 29.1±0.2 ^{0}C and 29.0±0.2 ^{0}C in treatment SS, SM and MM, respectively. The mean water transparency was 14.9±0.9 cm, 13.9±0.9 cm, and 15.1±0.9 cm in treatment SS, SM and MM, respectively. The ranges of water transparency varied from 9 to 26 cm. Dissolved oxygen varied from 2.6 mg/L to 8.2 mg/L without significant difference among the treatments. Overall mean of DO were found 4.20±0.19 mg/L, 3.93±0.26 mg/L and 4.25±0.23 mg/L in treatment SS, SM and MM, respectively. pH of pond water was found to be approximately neutral or slightly alkaline. The highest and lowest values of pH under treatment SS were 8.7 and 7.3 with an average of 7.94±0.09, treatment SM were 8.5 and 7.0 with an average of 7.54±0.08 and treatment MM were 9.2 and 7.2 with an average of 7.77±0.10.

Table 2. Mean values of water quality parameters of 15 ponds under three treatments

Parameters	SS	SM	MM
Temperature (°C)	29.2±0.1 (28.4-30.5)	29.1±0.2 (27.7-31.0)	29.0±0.2 (28.0-30.4)
Transparency (cm)	14.9±0.9 (10-26)	13.9±0.9 (9-23)	15.1±0.9 (9-26)
Dissolved oxygen (mg/L)	4.20±0.19 (2.6-6.6)	3.93±0.26 (2.6-8.1)	4.25±0.23 (3.3-8.2)
pH	7.94±0.09^a (7.3-8.7)	7.54±0.08^b (7.0-8.5)	7.77±0.10^{ab} (7.2-9.2)

* Mean values with different superscripts in the same row were significantly different ($P < 0.05$).

Fish growth and production performance

Details of growth parameters and production of fish are presented in Table 3. Among all species silver carp attained the maximum weight at harvest (531.13-632.29g). Among the two treatments where silver carp was stocked, better growth performance in terms of weight gain (624.77g) and SGR (4.75%) was observed in treatment SM, where it was stocked with mola. But survival of silver carp was higher in treatment SS (77.68%) than in treatment SM (73.98%). Yields of silver carp in treatments SS and SM were 794.32 kg/ha and 457.3 kg/ha, respectively.

Table 3. Growth and production performance of fish as obtained from treatments

Performance	SS	SM	MM
Silver carp			
STOCKING			
Mean weight (g/fish)	7.52	7.52	–
Stock biomass (kg/ha)	14.86	14.86	–
HARVEST			
Mean weight (g/fish)	531.13±80.7	632.29±49.85	–
Weight gain (g/fish)	523.6±80.17	624.77±49.85	–
Survival (%)	77.68±8.10	73.98±5.74	–
SGR (% bw/day)	4.55±0.16	4.75±0.09	–
Yield (kg/ha/4 months)	794.32±64.42[a]	457.3±21.48[b]	–
Catla			
STOCKING			
Mean weight (g/fish)	7.13	7.13	7.13
Stock biomass (kg/ha)	10.56	10.56	10.56
HARVEST			
Mean weight (g/fish)	224.72±26.72	250.92±8.84	330.34±53.39
Weight gain (g/fish)	217.59±26.72	243.79±8.84	323.21±53.29
Survival (%)	85.11±2.07	79.47±4.76	90.63±6.43
SGR (% bw/day)	3.70±0.12	3.83±0.04	4.09±0.18
Yield (kg/ha/4 months)	264.25±9.85[b]	295.46±20.23[b]	434.83±46.49[a]
Rohu			
STOCKING			
Mean weight (g/fish)	5.37	5.37	5.31
Stock biomass (kg/ha)	5.31	5.31	5.31
HARVEST			
Mean weight (g/fish)	227.58±8.82	270.24±76.57	194.07±29.47
Weight gain (g/fish)	222.21±8.82	264.87±76.57	188.70±29.47
Survival (%)	72.62±5.87	71.62±3.17	86.62±1.92
SGR (% bw/day)	4.03±0.04	4.13±0.28	3.83±0.16
Yield (kg/ha/4 months)	163.29±15.09	194.91±57.24	167.20±29.09
Grass carp			
STOCKING			
Mean weight (g/fish)	6.51	6.51	6.51
Stock biomass (kg/ha)	4.83	4.83	4.83
HARVEST			
Mean weight (g/fish)	121.46±13.74	119.33±24.50	206.44±73.21
Weight gain (g/fish)	114.94±13.74	112.82±24.50	199.93±73.21
Survival (%)	85.98±4.26	64.62±11.44	87.54±2.85
SGR (% bw/day)	3.13±0.12	3.09±0.21	3.57±0.40
Yield (kg/ha/4 months)	78.22±12.81	53.60±5.02	131.42±42.69
Thai punti			
STOCKING			
Mean weight (g/fish)	9.89	9.89	9.89
Stock biomass (kg/ha)	24.43	24.43	24.43
HARVEST			

Mean weight (g/fish)	136.87±18.10	155.29±14.09	140.71±30.16
Weight gain (g/fish)	126.98±18.10	145.40±14.09	130.82±30.16
Survival (%)	80.32±1.93[a]	61.60±6.89[b]	67.53±0.74[b]
SGR (% bw/day)	2.81±0.15	2.95±0.10	2.81±0.22
Yield (kg/ha/4 months)	270.92±33.55	237.90±41.61	233.91±48.33
Mrigal			
STOCKING			
Mean weight (g/fish)	1.95	1.95	1.95
Stock biomass (kg/ha)	2.89	2.89	2.89
HARVEST			
Mean weight (g/fish)	204.64±53.79	268.48±59.72	180.67±16.47
Weight gain (g/fish)	202.69±53.79	266.55±59.72	178.72±16.48
Survival (%)	77.25±8.01	62.39±7.70	77.10±6.97
SGR (% bw/day)	4.94±0.26	5.25±0.22	4.86±0.10
Yield (kg/ha/4 months)	221.71±32.15	242.59±44.17	203.04±1.87
Common carp			
STOCKING			
Mean weight (g/fish)	11.29	11.29	11.29
Stock biomass (kg/ha)	8.37	8.37	8.37
HARVEST			
Mean weight (g/fish)	170.79±25.99	266.86±59.76	256.77±3.80
Weight gain (g/fish)	159.50±25.99	255.57±59.76	245.48±3.80
Survival (%)	60.85±5.29	53.98±8.21	81.74±8.16
SGR (% bw/day)	2.89±0.18	3.35±0.22	3.36±0.02
Yield (kg/ha/4 months)	77.63±14.69[b]	99.96±7.10[b]	155.82±17.37[a]
Large fish			
Yield (kg/ha/4 months)	2035.01±111.84[a]	1757.24±92.08[a]	1326.21±16.04[b]
Mola			
Yield (kg/ha/4 months)	–	62.09±9.68[b]	183.67±21.45[a]
Total			
Yield (kg/ha/4 months)	2035.01±111.84[a]	1819.19±85.94[a]	1509.88±23.39[b]

Mean values with different superscripts in the same row were significantly different ($p < 0.05$).

Catla showed highest survival 85.11%, 79.47% and 90.63% in treatment SS, SM and MM, respectively. Among the treatments, highest weight gain (323.21g) and SGR (4.09%) were found in treatment MM, where no silver carp was stocked. Yield of catla was significantly higher ($p<0.05$) in treatment MM (434.83 kg/ha), than other two treatments 295.46 kg/ha and 264.25 kg/ha in treatment SM and SS, respectively. Highest weight gain 264.87g and production 194.91 kg/ha of rohu were found in treatment SM. SGR (%) value of rohu was 4.03, 4.13 and 3.83 in treatments SS, SM and MM, respectively. Highest production of grass carp 131.42 kg/ha obtained in treatment MM, where no silver carp was stocked, which was almost double compared to that of the other two treatments.

Thai punti survival was significantly higher ($p<0.05$) in treatment SS, than that in the other two treatments. However, growth in terms of weight gain was highest in

treatment SM (145.40 g). Yield of Thai punti in treatments SS, SM and MM were 270.92 kg/ha, 237.90 kg/ha and 233.91 kg/ha, respectively. Compared to all other species specific growth rate of mrigal was higher in all three treatments (4.94%, 5.25% and 4.86% in treatments SS, SM and MM, respectively). Among the treatments, highest weight at harvest, SGR and yield were observed in treatment SM (Table 3). However, there were no significant differences in mrigal yield among the treatments. Common carp survival was remarkably low in the treatments, where silver carp was stocked. The lowest common carp survival was observed in treatment SM (53.98%), which was also the lowest survival among all species. Common carp yield was high in treatment, where no silver carp was stocked. Mola yield was almost two times higher (183.67 kg/ha) in absence of silver carp (MM) than in presence of silver carp (62.06 kg/ha), though the stocking ratio of mola between the two treatments was SM:MM::1:2. Total production of fish obtained in this experiment was 2035 kg/ha, 1819 kg/ha and 1510 kg/ha/4 months in treatment SS, SM and MM, respectively. The results showed that there was a significantly lower total fish production, when no silver carp was stocked with mola in carp-mola polyculture system. There were no significant differences in total production between the treatments where silver carp was stocked at a different ratio.

Discussion

Water quality parameters

The range of water temperature (27.7 to 31.0°C) as observed to prevail in the experimental ponds appeared to be suitable for fish culture, which agrees with the findings of Paul (1998) who recorded temperature range of 26.7-33.7°C in water of carp polyculture with silver and mola fish rearing ponds at the BAU Campus, Mymensingh. Kohinoor (2000) also recorded water temperature to vary from 18.5 to 32.9°C in the experimental ponds. The values of transparency range (9.0-26.0 cm) as recorded in the present study indicate that the ponds were productive and a little bit turbid. The turbidity that appeared might be due to presence of common carp which is reported to be the most common natural reason for turbidity apart from plankton population. Wahab *et al.* (2002) reported that common carp damages pond embankments by searching for food or burrowing to build nests which results reduced transparency. pH is an important factor in a fish pond and also called the productivity index of a water body. Kohinoor *et al.* (1998) observed the pH range 7.18 to 7.24 in carp-mola polyculture ponds at the Fisheries Field Laboratory, Complex, Bangladesh Agricultural University, Mymensingh. The significant difference in pH that was observed among the treatments might be due to interacting effects of different species composition and stocking densities to the water column.

The concentration of dissolved oxygen (DO) in the experimental ponds had generally fluctuated and ranged from 2.6 to 8.2 mg/L. DoF (1996) also reported the ranges of dissolved oxygen suitable for fish culture would be 5.0 to 8.0 mg/L. Ophenheimer *et al.* (1978) and Wahab *et al.* (1995) recorded similar dissolved oxygen values that ranged from 3.18-7.58 and 2.2-7.1 mg/L, respectively. Roy (2004) recorded

3.65 to 7.65 mg/L dissolved oxygen in carp-mola polyculture ponds in rural farmers pond.

Growth and production performance

Compared to all other species silver carp showed the best performance in terms of growth and production. Silver carp production ratio was similar to the ratio of stocking which implies that production of silver carp was not affected by stocking of mola. Roy (2004) also reported that silver carp production was not affected by the presence or absence of mola in carp-mola polyculture system. Survival of catla was higher (90.63%) in absence of silver carp. Wahab *et al.* (2004) reported reduced survival of catla in presence of silver carp. Wahab *et al.* (2004) also reported lower survival of catla in presence of silver carp due mainly to competition for food and space between these two species. Production of catla was significantly higher in carp-mola polyculture system in absence of silver carp (434.83 kg/ha/3 months). Roy (2004) reported that production of catla was higher in presence of grass carp and in absence of silver carp in his study on carp-SIS polyculture system.

Rohu production was lower in this study in presence of both higher stocking densities of silver carp and mola (163.29 kg/ha and 167.20 kg/ha, respectively). This might be due to interspecies competition between rohu and these two species. Roy (2004) reported lower growth of rohu in higher stocking densities of mola. Kohinoor *et al.* (1998) also stated that mola competed for food and space with rohu. Grass carp production and growth was highest at higher stocking densities of both silver carp and mola. Survival was highest where both silver carp and mola was stocked in the system. This species have antagonistic effect on more than one species in carp polyculture system. Roy (2004) found that grass carp production was not affected by the presence or absence of silver carp, but it performed better in presence of mola.

Highest Thai punti production was found in absence of mola. However, the increased stocking density of mola did not have much effect on production of Thai punti. Mrigal production was lower in absence of silver carp in carp-mola polyculture system (203.04 kg/ha). Presence of silver carp increased production of mrigal (Roy 2004). Milstein (1992) reported such synergistic effect between silver carp and common carp. However, the highest mrigal production in this study was also found in presence of mola (266.55 kg/ha). The performance of common carp both in terms of growth and production was higher in presence of mola in this experiment. Alim (2005) reported that presence of mola increased the performance of common carp. Production in this experiment was highest (155.82 kg/ha) where mola was stocked at a higher density, which also supports such relation. Mola production was three times higher where silver carp was absent (183.67 kg/ha) though the stocking density was double compared to the treatment where mola was stocked in presence of silver carp. Roy (2004) stated that mola production was better in presence of grass carp with other carps than silver carp plus other carps. Kohinoor *et al.* (1998) stated that the antagonisms between silver carp and mola was shown in their experiment.

The overall higher production of 2,035 kg/ha/3 months was obtained in that combination where only carps were stocked. The second best production (1,819 kg/ha/3 months) was observed where mola and silver carp were present in the system. But there were no significant difference in production between these two treatments. Roy (2004) recorded an overall production of 1,953 kg/ha/3 months in control pond, followed by 1,882 kg/ha/3 months in ponds where 100 mola were stocked per decimal with carps. In another experiment, he found 2,712 kg/ha highest production in 7 months of carp-mola polyculture. Roos *et al.* (1999) also recorded 2,500 kg/ha carp-mola polyculture during 7 months period in the Kishoreganj area, Bangladesh.

Economic analysis

The economic analysis of the proposed system was carried out to assess the economic return of carp-mola polyculture under low input management. The mean expenditures were higher for the carp-mola ponds with a higher mola density, than for the carp-mola ponds in presence of silver carp or only carp ponds because of the expenses for mola fry is included here. Mola is a self-recruiting species and once a mola stock is grown in pond, a regular natural stock of mola population can be created in farmers' pond by partial harvesting in every two to three months. This will reduce a major part of investment in such type of culture practices. The economics of three different combinations was analyzed on the basis of the expenditure incurred and total return from sale price of fish. The net benefits per hectare per 4 months for treatment SS, SM and MM were Tk. 102,709, 91,364 and 92,759, respectively. Roy (2004) reported Tk. 94,925, 88,330 and 68,270 as net benefits per hectare per 7 months for only carps, carps plus mola and carps plus chela polyculture systems, respectively. However, only carp polyculture system provided higher benefit, followed by carp-mola polyculture without silver carp. Roos (2001) reported that the net profit was Tk. 34,100/ha in carp-native SIS ponds and Tk. 28,100/ha per season in carp mola ponds, while Mymensingh Aquaculture Extension Project recorded the profit Tk. 32,000/ha for an 8 months production season in perennial ponds. Benefit-cost ratio (BCR) was obtained 3.16, 2.55 and 2.36 in treatment SS, SM and MM, respectively. Benefit-cost ratio was obtained higher in only carp polyculture. Roy (2004) reported higher benefit-cost ratio in only carp polyculture, followed by carp-mola and carp-chela polyculture systems.

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