

Polyculture of carp with small indigenous fish, bata, *Labeo bata* (Ham.) at different stocking densities

A.H.M. Kohinoor*, S. Sultana and M.G. Hussain
Freshwater Station, Bangladesh Fisheries Research Institute
Mymensingh 2201, Bangladesh
*Corresponding author

Abstract
Small indigenous fish species (SIS) play very important role in the diet of the people of Bangladesh. Until recently, the possibilities of culture them in consideration with the Indian major carp yet to be explored. In view of the above, an experiment on the polyculture of carps with SIS, bata (*Labeo bata*) was carried out to evaluate their production performance in the on-farm condition during 15 March to 15 September 2003. Three different stocking densities of bata with carp species were given. After six months of rearing, the productions obtained were 2,466±98 kg/ha, 2,395±88 kg/ha and 2,074±94 kg/ha from treatments-1, 2 and 3, respectively. The highest production was obtained from treatment-1, when compared with treatments-1 and 2. The contribution of bata in terms of production was 10.31% in treatment-1, while it was 13.36% and 14.38% in treatments-2 and 3, respectively.

Key words: Polyculture, *Labeo bata*, Stocking density

Introduction

The production potentials of small indigenous fish of Bangladesh through aquaculture have remained unexplored. Only a small number of Indian major and Chinese carps have been used for polyculture throughout the country, but the culture of small fish has received little attention with due importance. There are many small fish in Bangladesh *viz.* punti (*Puntius* sp.), chapila (*Gudusia* chapra), mola (*Amblypharyngodon mola*), bata (*Labeo bata*), dhela (*Osteobramcotio cotio cotio*), colisa (*Colisa fasciata*), kacki (*Corica soborna*) etc., which are potential for freshwater aquaculture (Thilsted *et al.* 1997). These were abundantly available in rivers, streams, ponds, beels, ditches and flood plains in the past. Now-a-days, these species have gradually been disappearing from the natural systems, which in turn severely affecting the bio-diversity.

Therefore, special attention is needed to culture the small indigenous fish species as they are rich source of vitamin-A, iron, calcium, and minerals those are usually less available in large carps (Thilsted *et al.* 1997). Besides, it is affordable by the poor people due to its low market price compared to carps. Ahmed and Hassan (1983) reported that

75% of the rural children in Bangladesh suffer from malnutrition and 25% of them below 5 years of age die due to malnutrition. Considering the many folds benefits of small indigenous fishes, an attempt was made to assess the production potentials of carps and bata (*Labeo bata*) in the polyculture management under on-farm condition.

Materials and methods

The experiment was conducted for a period of six months from March to September 2003 in nine farmer's ponds of 400-600 m^2 area with a depth of 1.0-1.5m at Boilor, Trishal, Mymensingh. Prior to the trial, all the ponds were cleaned and limed at the rate of 250 kg/ha. After three days of liming, ponds were fertilized with cowdung at the rate of 1,000 kg/ha.

Three stocking densities of bata (*Labeo bata*) were tested keeping the large carp species combination and stocking density similar. Each stocking density of bata was considered as treatment and replicated thrice. Fingerlings of bata have been stocked at the rate of 5,000, 7,500 and 10,000/ha in treatments-1, 2 and 3, respectively. In all the treatments, catla (*Catla catla*), rohu (*labeo rohita*) and mrigal (*Cirrhcious mrigala*) were stocked at the rate of 5,000/ha at the ratio of 1:1:1 and an addition, a species grass carp (*Ctenopharyngodon idella*) was also stocked at the rate of 250/ha.

After stocking, all the ponds were fertilized with organic fertilizer (Cowdung) at the rate of 1,000 kg/ha/15 days interval. Besides, the fishes were fed with rice bran and mustard oil cake (3:1) at the rate of 4% of body weight. Fishes under all treatments were sampled regularly at monthly intervals to determine the growth rate as well as feed adjustment.

Water samples were collected between 10:00 to 11:00 am at ten-day interval of each pond surface to a depth of 20cm. A number of clean 500 ml black bottles marked with pond number and sampling date were used for collection of water samples. The bottles were then brought to the Water Quality and Pond Dynamics Laboratory of Freshwater Station, Bangladesh Fisheries Research Institute. Water temperature (°C) from each pond was recorded at least three spots by using a Celsius thermometer. Water transparency was determined by using a standard Seechi disc of 20 cm. diameter. Dissolved oxygen (mg/l) and pH were measured using a digital DO meter (WPA, model OX20) and a direct reading digital pH meter (HANNA, model HI 9025), respectively. Total alkalinity (mg/l) was determined titrimetrically according to the standard procedure and methods (APHA 1992). Collection of plankton was made at monthly interval. Quantitative and qualitative analyses of plankton were determined as per APHA (1992) and the estimation was based on following formula:

$$N = (P X C X 100)/L$$

Where, N = the number of plankton cells per litre of original water;
P = the number of plankton counted in ten fields;
C = the volume of final concentration of the sample (ml);
L = the volume (litre) of the pond water sample

After a grow out period of six months, fish were harvested by repeated seine netting. Total weight and number of fish from each pond were recorded. Survival and gross production of fish under each treatment was estimated. For statistical analysis of data, a one-way ANOVA was carried out using the statistical package, Stat graphics Version 7.

Results and discussion

Water quality parameters

The physico-chemical factors of the pond water under three treatments were recorded regularly. Overall mean values of six months data of each of the parameter are presented in Table 1.

Table 1. Water quality parameter (mean ±SE) under different treatments

Parameters	Treatment-1	Treatment-2	Treatment-3
Temperature (°C)	27.90±1.12^{a}	27.86±1.09^{a}	27.49±1.11^{a}
Transparency (cm)	37.65±2.11^{a}	38.40±1.92^{a}	30.14±2.00^{a}
Dissolved oxygen (mg/l)	4.19±0.20^{a}	3.89±0.35^{b}	3.82±0.41^{b}
pH	7.3-8.6	7.5 -8.2	7.5- 8.5
Total Alkalinity (mg/l)	170.10±6.96^{a}	161.15±9.58^{a}	166.40±10.29^{a}

Figures in the same row having the different superscripts are significantly different ($P<0.05$)

The water temperature recorded during the study period was more or less similar in different ponds under three treatments. The values of water temperature ranged from 19.1 to 32.2 °C, 19.7 to 33.1 °C and 19.9 to 33.1°C in treatments-1, 2 and 3, respectively. There was no significant difference among the treatments when ANOVA was performed ($p>0.05$). Wahab *et al.* (1995) recorded water temperature to vary from 27.2 to 32.4°C in the ponds used for polyculture experiment. Roy *et al.* (2002) observed the water temperature ranging from 20.8 to 30.1°C in the pond water of Trishal, Mymensingh.

Water transparency values of different ponds under three treatments showed variations on different sampling dates. The transparency values ranged from 30 to 53 cm, from 24 to 44 cm and from 20 to 43 cm in treatments-1, 2 and 3, respectively. There was no significant difference among the treatments when ANOVA was performed ($p>0.05$). The values of transparency varied with sampling date, which could be due to the abundance of plankton and turbidity of water. Boyd (1990) recommended a transparency between 15 to 40 cm as appropriate for fish culture. The dissolved oxygen values were found to be relatively low in all treatments because the experimental rural ponds are surrounded by many trees. Most of the times, leaves of trees fall in the pond water and cause oxygen depletion. The values of dissolved oxygen in different pond waters ranged from 3.5 to 5.9 mg/l, 3.3 to 6.6 mg/l and 3.96 to 5.4 mg/l in treatments-1, 2 and 3, respectively. The data showed significant variation ($p<0.05$) between treatment-1 other two treatments, whereas there was no significant variation observed between treatments-2 and 3. Dissolved oxygen concentrations more than 3.5 mg/l in pond waters were reported by several authors (Ali *et al.* 1982, Martyshev 1983, Wahab *et al.* 1996, Kohinoor *et al.* 1998 and Roy *et al.* 2002) which was similar to that of the present study.

pH of pond water under different treatments was found to be alkaline. The values ranged from 7.3 to 8.6 in treatment-1, 7.5 to 9.0 in treatment-2 and from 7.5 to 8.5 in treatment-3. Kohinoor *et al.* (1998) observed that pH range from 7.18 to 7.24 in the research ponds of the Field laboratory of Bangladesh Agricultural University. Roy *et al.* (2002) obtained a pH range from 7.03 to 9.03 in fish ponds located in Trishal, Mymensingh. The observed values of pH in the water ranging from 7.3 to 8.6 indicated that the experimental ponds were suitable for fish culture (Boyd 1982). The total alkalinity values of the pond water under different treatments were found to be at the productive level. The values ranged from 138 to 212 mg/l, 126 to 198 mg/l and from 149 to 196 mg/l in treatments-1, 2 and 3, respectively. No significant variation ($p>0.05$) was observed among the treatments. Total alkalinity levels for natural waters may range from less than 5 mg/l to more than 500 mg/l (Boyd 1990). Kohinoor (1998) and Roy (2002) found the average total alkalinity above 100 mg/l in their study. Total alkalinity values found in the present study were within the suitable range (Alikunhi 1957).

Variation in plankton abundance

The overall mean values of each of the planktonic groups found in different treatments are presented in Table 2. One way analysis of variance showed significant variations ($p<0.05$) among the treatments.

Table 2. Mean (±SE) number ($x10^3$/l) of different plankton groups under three treatments

Plankton group	Treatment-1	Treatment-2	Treatment-3
Bacillariophyceae	6.92 ± 1.34^{a}	5.76 ± 1.31^{a}	4.60 ± 1.60^{b}
Chlorophyceae	120.33 ± 40.83^{a}	107.40 ± 35.76^{a}	95.11 ± 13.21^{b}
Euglenophyceae	0.46 ± 0.12^{a}	0.40 ± 0.15^{a}	0.37 ± 0.22^{b}
Cyanophyceae	6.88 ± 1.20^{a}	7.00 ± 2.5^{a}	5.22 ± 2.41^{b}
Total phytoplankton	134.59 ± 28.61^{a}	120.56 ± 24.42^{a}	105.30 ± 19.82^{bc}
Crustacea	3.83 ± 1.00^{a}	2.21 ± 0.38^{a}	2.00 ± 0.42^{a}
Rotifera	5.41 ± 1.70^{a}	5.86 ± 1.40^{a}	3.91 ± 0.79^{b}
Total zooplankton	9.24 ± 1.90^{a}	8.07 ± 1.20^{a}	5.91 ± 0.53^{b}
Total plankton	143.83 ± 43.98^{a}	128.63 ± 40.91^{a}	111.21 ± 19.60^{b}

*Figures in the same row having the different superscripts are significantly different ($p>0.05$)

Thirty genera of phytoplankton belonging to Bacillariophyceae, Chlorophyceae, Euglenophyceae and Cyanophyceae were identified during the study period in different treatments. The mean values of total phytoplankton were 134.59±28.61ĺ 10^3, 120.56± 24.42 103 and 105.30±19.82ĺ 10^3/l in treatments-1, 2 and 3, respectively (Table 2). The values of treatments-1 and 2 showed significant difference ($p<0.05$) from treatment-3. Among the phytoplankton groups, Chlorophyceae was the most dominant group and the least was Euglenophyceae in all treatments.

Fifteen genera of zooplankton belonging to Crustacea and Rotifera were identified during the entire period of study in different treatments. The mean abundance of total zooplankton was $9.24\pm1.90x10^3/l$ in treatmrnt-1, $8.07\pm1.20x10^3/l$ in treatmrnt-2 and $5.91\pm0.53x10^3/l$ in treatment-3, respectively. The values of treatments-1 and 2 were not significantly different ($p>0.05$) but showed significant variation ($p<0.05$) from treatment-3. Wahab and Ahmed (1992) reported the mean phytoplankton population to be $17.22x10^4$, $9.26x10^4$ and $13.87x0^4/l$, and zooplankton was $1.19x10^4$, $1.90x10^4$ and $1.07x10^4/l$ from three sets ponds, respectively. While, Kohinoor *et al.* (1998) recorded 22.50 to $27.83x10^3/l$ phytoplankton and 5.20 to $6.34x10^4/l$ zooplankton from their polyculture ponds. In a study, Roy *et al.* (2002) observed the phytoplankton abundance ranged from 20.60 ± 1.33 to $24.60\pm2.23x10^3/l$ in farmer's pond. The higher abundance of plankton (phytoplankton and zooplankton) in the present study might be due to regular application of supplementary feed and fertilization. The highest abundance of total plankton population in treatment-1 might be due to the fact that fish in treatment-1 consumed lesser amount of plankton than other two treatments because of comparatively lesser density of fish was stocked in treatment-1.

Growth and production of fish

Details of fish stocking, growth and production performance in different treatments are presented in Table 3. It was observed that among the endemic carp species under three treatments, the highest weight was attained by catla (*C. catla*) in treatment-1. Catla (*C. catla*) reached an average weight of 616±54g in treatment-1, 590±48g in treatment-2 and 524±38 in treatment-3, respectively. When compared, the sampling weight of catla (*C. catla*) was significantly higher ($p<0.05$) in treatment-1 than those of treatments-2 and 3.

The average weight attained by rohu (*L. rohita*) were 412±22g, 388±31g and 334±41g in treatments-1, treatment-2 and treatment-3, respectively. The poor growth was recorded in treatment-3 with an average daily increment of 1.80g. However, it was significantly better in treatments-1 and 2 than that of treatment-3. The weights of mrigal (*C. mrigala*) were 390 ± 46g, 310 ± 30g and 274 ± 29g, in treatments-1, 2 and 3, respectively. The weight gained by mrigal (*C. mrigala*) in treatment-1 was significantly ($p<0.05$) higher than treatments-2 and 3. In contrast to the other species, grass carp showed similar growth patterns in all treatments, which vary from 806 to 876g in different treatments with no significant ($p>0.05$) difference.

Table 3. Growth and production of fish under three treatments during the period of experiment

Treatment	Fish spp.	At stocking		At harvesting wt. (g)	Survival (%)	Total production (kg/ha/6 months)
		Initial wt. (g)	Stocking density/ha			
T-1	Catla	10.33±1.41	5,000	616±54[a]	89	2,466.13±98[a]
	Rohu	9.33±1.18		412±22[a]	84	
	Mrigal	7.68±1.53		390±46[a]	81	
	Bata	3.41±0.71	5,000	62±3.83[a]	82	
	Grass carp	8.25±2.14	250	852±50.12[a]	92	
T-2	Catla	10.05±1.28	5,000	590±48[b]	90	2,395.54±88[a]
	Rohu	9.86±1.21		388±31[a]	86	
	Mrigal	7.59±1.66		310±30[b]	83	
	Bata	3.29±0.65	7,500	54±3.88 [b]	79	
	Grass carp	8.77±2.94	250	876±38.05 [a]	94	
T-3	Catla	10.28±1.55	5,000	524±38[b]	87	2,074.24±94[b]
	Rohu	9.49±1.09		334±41[b]	81	
	Mrigal	7.29±1.07		274±29[c]	80	
	Bata	3.59±0.54	10,000	42±3. [bc]	71	
	Grass carp	8.00±1.95	250	606±30.89[ab]	92	

Figures in the same column having the different superscripts for each species are significantly different ($p<0.05$)

The average final weights of *L. bata* were 62±3.83g, 54±3.88g and 42±3.0g in treatments-1, 2 and 3, respectively. The growth performance of fish in treatment-3 was poor, whereas it performed well in treatment-1. The weight of *L. bata* showed significant difference ($p<0.05$) among the treatments.

The total fish production obtained was 2,466±98g in treatment-1, 2,395±88g in treatment-2 and 2,074±91 kg/ha in treatment-3 (Table 3). The highest production was obtained from treatment-1, where *L. bata* was stocked at low stocking density (5,000/ha). The lowest production was obtained in treatment-3, where *L. bata* were stocked at high density (10,000/ha). The production was found to be almost same in treatment-1 and treatment-2 and showed no significant difference ($p>0.05$), but treatment-3 appeared to give the lowest production and differed significantly ($p<0.05$) from treatments-1 and 2.

The percentage contribution of *L. bata* in terms of production was 10.31% in treatment-1, while in treatments-2 and 3, their percentage were 13.36% and 14.38%, respectively. The relative contribution of fish in different treatments has been illustrated in Fig.1.

It has been found that the average weight of all species was higher in treatment-1. The probable reason behind the maximum weight gained by all the stocked large carps in treatment-1 might be that *L. bata* stocked in lesser density in this treatment than other two treatments. This is also reflected in treatment-3, where lowest weight gain was recorded of the stocked major craps, where *L. bata* was stocked in highest density. It was observed that in all treatments the growth of mrigal (*C. mrigala*) was more affected than other carps, because *L. bata* was bottom feeder, which may have more competed for food and space with mrigal. The growth of *L. bata* was lesser in treatment -3 than others because of highest stocking density of bata in this treatment.

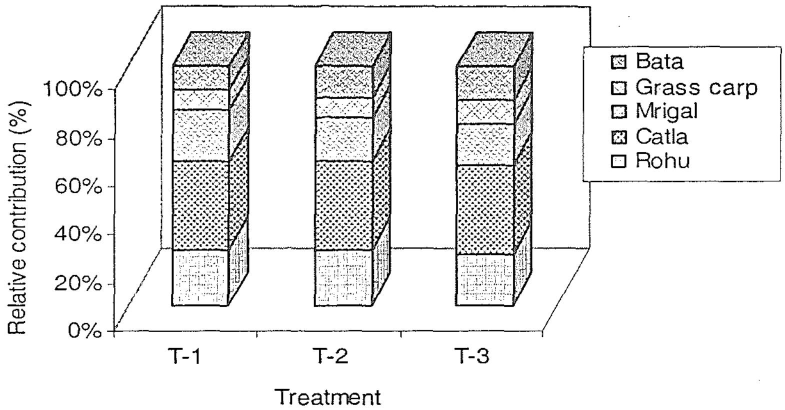

Fig. 1. Relative contribution of different fish species in the three treatments

Earlier study conducted by Akhteruzzaman *et al.* (1997) obtained a production of 3,323 kg/ha/8 months from the polyculture of bata (*L. bata*), rajpunti (*B. gonionotus*) and catla (*C. catla*) with the stocking density of 42,000/ha. In another study, Kohinoor *et al.* (1997) observed that a gross production of 2,552 kg/ha/6 months in polyculture of pabda (*O. pabda*) with rajpunti (*B. gonionotus*) and common carp (*C. carpio*). The total productions of fish in the present experiment were in conformity with Kohinoor (2000), who obtained a total production with a range of 1,863 to 2,128 kg/ha/6 months from polyculture of carps with three SIS viz. mola (*A. mola*), punti (*P. sophore*) and chela (*C. cachius*). Whereas, Roy *et al.* (2002) cultured the SIS with major carps in farmers ponds in Mymensingh region and obtained a production of 2,176 to 2,560 kg/ha in seven months culture period.

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