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MONOCULTURE OF SILVER BARB (*BARBODES GONIONOTUS*) VS. MIXED CULTURE WITH GIFT (*OREOCHROMIS NILOTICUS*) IN SEASONAL MINI PONDS UNDER FARMING SYSTEM IN BANGLADESH

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The comparative production performance and the feasibility of production of fish in unutilized seasonal mini ponds under farmer's condition through culturing silver barb (*Barbodes gonionotus* Bleeker) in mono and mixed culture with Genetically Improved Farmed Tilapia (GIFT) (*Oreochromis niloticus*.L) was investigated in six seasonal mini ponds of 0.02 ha each for five months. Silver barb mono culture (Treatment-1) and mixed culture (Treatment-2) with GIFT were tested with stocking density of 16,000/ha of fish for both treatments. There was no significant variation on either water quality parameters or abundance of planktonic organisms due to different culture systems of silver barb. In mixed culture (T2) system, GIFT ranked 1st position in the production (1442.90 kg/ha) and the individual production of silver barb was 856.36 kg/ha. A significantly ($P < 0.05$) higher total production (2299.26 kg/ha) of fish and net benefit (58, 383.12 TK/ha or US$ 1004/ha) was recorded in the mixed culture (T2) than that of the total production (1606.53 kg/ha) and net benefit (31, 774.26 TK/ha or US$ 546.42/ha) of monoculture system (T1).

Key words**:** *Barbodes gonionotus*, *Oreochromis niloticus* L. Mono and mixed culture, Mini ponds, Farming system.

Introduction

Most farmers of rural areas of Bangladesh have access to utilized or unutilized water bodies such as seasonal mini ponds, ditches, canals etc, which retain water for 4 to 6 months. Rapid growing fish species like silver barb and Genetically Improved Farmed Tilapia (GIFT) having high market price can easily be grown in these types of water bodies. The production potentiality of silver barb and GIFT for culture in seasonal mini ponds and ditches has already been proven in Bangladesh.

Synergistic interactions among fish species are manifested by higher growth and yielding mixed culture than monoculture (Yashouv 1971). The basis for these interactions are two interrelated processes namely the increase of available food resources and the improvement environmental condition (Milstein 1992). Mixed culture can even show symbiotic effects, when one specie improve the environmental condition and food supply for others (Hossain *et al* 1997). Silver barb or Thai sharpunti (*Barbodes gonionotus*) was introduced into Bangladesh from Thailand in 1977 and now it has become a popular fish in our country, (Anon 1992). This herbivore species, fed mainly on aquatic plants, grasses and algae, (Phaohorom 1970; Srisuwantach 1981). Nile tilapia is preferred by the farmers because of its faster growth rate compared with any other short cycled fish species including other commonly used tilapia strains. Another promising Genetically Improved Farmed Tilapia known as GIFT, resistant to many diseases, reproduce easily, survive and grow in poor water quality, eat a variety of foods and grow on a diet of relatively low quality has been introduced in Bangladesh on July 1994 which was developed by the ICLARM through several generations of selection from a base population involving eight different strains of *Oreochromis niloticus*, (Eknath *et al* 1973). Hussain *et al* (2000) conducted comparative study in freshwater station of Bangladesh Fisheries Research Institute on culture of GIFT and existing Nile tilapia under different culture conditions and observed that the growth performance of GIFT was 40-57% higher than existing Nile tilapia. Mazid (2002) reported that monoculture of both silver barb and GIFT in seasonal ponds can produce 1800-2000 kg/ha and 2500-3000 kg/ha within 5-6 months in Bangladesh. Sarker *et al* (2002) observed total production of Silver barb of 1556.86 kg/ha in monoculture and 806.60 kg/ha in mixed culture with common carp in the yard ditches within 5 months in Bangladesh.

Fish selection is a key factor in the optimal management of mixed culture. It is an important phenomenon to know silver barb (*B. gonionotus*) mono and mixed culture with GIFT (*O. niloticus*) both of which can depend on natural food resources and may play significant management technique to efficiently utilize the production potential of the seasonal mini ponds. Fishery is an important aspect of farming system in Bangladesh and there is an urgent need to improve the efficiency of utilization of limited resources which is the

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base of these small farmers. Considering the above facts, the study was undertaken to compare the production performance and determine the feasibility of production of fish under farmer's condition using unutilized seasonal mini ponds through culturing silver barb in mono and mixed culture with GIFT.

Materials and Methods

Experimental ponds and their preparation. The experiment was carried out in Bangladesh Fisheries Research Institute under Farming System Research and Development site, Goyeshpur, Pabna for a period of 5 months (May 15-October 15, 2000) in selected farmer's six mini seasonal ponds of 0.02 ha each with an average depth of 1.2m. 7 days before the stocking of fish, ponds were prepared with liming @ 250 kg/ha and then fertilized with cow dung, urea and triple super phosphate (TSP) @ 750 kg/ha, 40 kg/ha and 60 kg/ha, respectively.

Stocking of fish and pond management. The ponds were randomly divided into two treatment groups. After seven days of fertilization three mini ponds under the treatment-1 (monoculture) were stocked with only silver barb (*B. gonionotus*) at a density of 16,000 /ha and rest three mini ponds under treatment-2 (mixed culture) were stocked with silver barb (*B. gonionotus*) and GIFT (*O. niloticus*) with same density in the ratio of 50:50. Feeding began immediately after stocking. Fish were fed with only rice bran @ 3-4% body weight and quantity of feed application was adjusted fortnightly on the basis of total biomass for both treatments. Subsequent to stocking, all the ponds were fertilized with cow dung regularly at monthly intervals @ 1050 kg/ha.

Limnological parameters. The important Physico-chemical parameters viz. water temperature (°C), transparency (cm), dissolve oxygen (mg/l), pH were monitored fortnightly following standard methods (APHA 1992). Quantitative and qualitative analysis of phytoplankton and zooplankton were also made fortnightly. Plankton samples were collected from each of the mini ponds. Ten liters of water were passed through plankton net of 25 micron-mesh size. Filtered samples were transferred into a measuring cylinder and carefully made up to a standard volume of 50 ml. Samples were examined under a binocular microscope using a Sedgewick-rafter cell (S-R cell). Plankton cells in 10 randomly chosen squares were counted and used for quantitative estimation using the following formula described by Stirling (1967)

$$N = \frac{A \times 100 \times C}{V \times F \times L}$$

where, N=No. of plankton cells, A=Total No. of plankton counted, C=Volume of final concentrate of the sample in ml, V=Volume of a field in cubic mm, F=No. of fields counted, L=Volume of original water in liter.

Growth of fish. The ponds were sampled fortnightly intervals to assess the growth in length (cm) and weight (g) and feeding was adjusted on the basis of estimated fish biomass and to check up the health condition of fish. At the end of the experiment, all the fishes were harvested by cast netting and following de-watering the ponds. During harvest, the fishes were individually counted and weighed to assess survival, growth and production.

Statistical analysis. For statistical analysis of data, a one way ANOVA and Duncan's Multiple Range Test (DMRT) were applied using the statistical package, STATAGRAPHICS version 7.

Results and Discussion

Water quality parameters. The water quality parameters measured throughout the culture period were found to be more or less similar and all of them were within the acceptable ranges (Table 1). During the culture period the water temperature varied from 27-32.2°C. There was no significant difference (P>0.05) between two treatments. Highest temperature was

Table 1
Mean (±SD) values of water quality parameters of different seasonal mini ponds

Parameters	T1				T2			
	Pond-1	Pond-2	Pond-3	Mean	Pond-1	Pond-2	Pond-3	Mean
Water temperature (°C)	29.23±0.14	29.36±0.41	29.85±0.43	29.48±0.09	30.12±0.02	29.87±0.37	29.91±0.28	29.96±0.17
Transparency (cm)	27.70±1.84	29.80±0.76	28.26±1.12	28.58±1.48	29.62±4.29	30.12±2.24	28.23±0.88	28.42±2.26
pH	7.75±0.42	7.27±0.82	8.21±0.26	7.74±0.33	8.32±0.61	7.62±0.07	7.50±0.86	7.81±0.49
Dissolve oxygen (mg/l)	7.12±0.13	6.64±0.41	6.45±0.65	6.73±0.33	6.85±0.18	7.42±0.69	6.69±0.72	6.98±0.40
Total alkalinity (mg/l)	64.12±1.83	69.17±2.27	58.25±3.00	63.84±3.57	72.50±2.29	76.23±1.28	82.45±2.32	77.06±9.70
Total ammonia (mg/l)	0.09±0.04	0.11±0.02	0.10±0.06	0.10±0.01	0.08±0.02	0.10±0.01	0.09±0.04	0.09±0.01

recorded 32.2°C in the month of July. Dewan *et al* (1991) reported temperature ranges from 30.2-34°C (June-August) while Wahab *et al* (1996) recorded temperature ranges from 28.5-31.3°C (August-November) in their experiment with carps. Water transparency of the ponds varied from 25-32.5 cm. Boyd (1982) suggested a transparency between 15-45 cm to be good for fish culture. The level of dissolve oxygen (DO) was within the range of 5.3-7.45 ppm in all the ponds. There was no significant (P>0.05) difference between treatments**.** Boyd (1982) stated that DO content of 5 to 7 ppm is good for fish culture. The range of total alkalinity values in the present study varied between 58.25 and 82.45 mg/l. Moyle (1946) reported that ponds and lakes with a range of total alkalinity of 40.0-90.0 mg/l are of medium to highly productive. Hence, the ponds are said to be medium to highly productive. The range of total ammonia over the study period was 0.09 to 0.11 mg/l and were within the limit (0.05-0.17 mg/l) suitable for fish culture, reported by Boyd (1982), pH of the ponds in the present study was observed from 7.25-8.4. Shah *et al* (1998) recorded the range of pH from 6.46-7.04 in pond fish culture which was lower than the present study.

Plankton. The group wise mean abundance of plankton observed in two treatments is shown in Table 2. Phytoplanktonic population mainly composed of Bacillariophyceae, Chlorophyceae, Cyanophyceae and Euglenophyceae reflected usual composition in the tropical fish pond (Dewan *et al* 1991; Wahab *et al* 1995). In T1, the mean value of phytoplankton was 29.03±4.82x10^3 cells/l, while in T2 the abundance was slightly higher at 31.81±5.92x10^3 cells/l. Chlorophyceae was observed to be the most dominant phytoplankton group in both treatments. Wahab and Ahmed (1992) found that Cyonophytes dominated in the ponds containing Indian major carps. Bacillariophyceae abundance was least in the two treatments with mean 3.94±0.10x10^3 cells/l in T1 and 4.13±0.14x10^3 cells/l in T2. There was no significant (P>0.05) variation bet-ween treatments with regard to phytoplankton population. The zooplankton only comprised of Crustacea and Rotifera. The mean values of zooplankton in T1 and T2 were 7.09±0.51x10^3 cells/l and 6.32±0.58x10^3 cells/l, respectively and the difference was not significant (P>0.05). Rotifera was the dominant group in terms of abundance in both the treatments. Wahab *et al* (1995) recorded phytoplankton numbers ranging from 2x10^5 to 8x10^5 cells/l and zooplankton of 2x10^4 to 2x10^5 cells/l in their study. Haque *et al* (1998) recorded phytoplankton and zooplankton abundance of 3.78±0.15x10^4 cells/l to 50.64±1.29x10^4 cells/l and 4.91±0.8 to 6.16±0.8x10^4 cells/l respectively in their study. Compared to the observation, the plankton abundance was lower in the present study and this might be due to the lower quantity of fertilizer used.

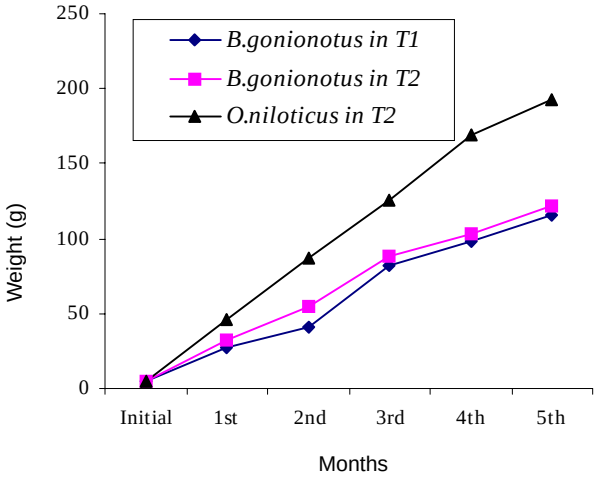

Fig 1. Growth performances of fishes under two treatments.

Growth and yield of fish. Monthly growth performance of silver barb and GIFT under two treatments during the experiment are shown in Fig 1. Silver barb reached an average final

Table 2

Mean (±SD) abundance of plankton (cells x 10^3/l) of different seasonal mini ponds under two treatments

Parameters	T1				T2			
	Pond-1	Pond-2	Pond-3	Mean	Pond-1	Pond-2	Pond-3	Mean
A. Phytoplankton								
Bacillariophyceae	3.71±2.40	3.86±0.30	4.25±2.67	3.94±0.10	4.15±0.90	3.95±2.10	4.30±2.20	4.13±0.14
Chlorophyceae	13.94±2.16	11.19±4.24	14.77±5.26	13.30±1.94	15.27±5.24	14.85±2.31	14.72±2.24	14.95±0.29
Cyanophyceae	4.96±1.80	6.71±1.20	8.25±2.98	6.64±1.23	4.25±2.26	5.52±0.08	6.35±1.28	5.37±0.90
Euglenophyceae	3.45±1.69	4.86±5.60	7.16±2.28	5.15±4.82	6.28±2.10	8.13±4.70	7.67±1.08	7.36±1.31
Total (A)				29.03±4.82				31.81±5.92
B.Zooplankton								
Crustacean	1.90±2.19	2.25±1.12	2.85±2.42	3.11±0.52	3.10±0.50	2.36±2.45	3.87±0.80	2.33±0.26
Rotifera	3.19±1.85	4.24±2.50	4.56±4.20	3.98±0.65	4.86±2.42	3.95±4.31	3.15±3.28	3.99±0.74
Total (B)				7.09±0.51				6.32±0.58

Table 3
Growth parameters of silver barb (*B.gonionotus*) in mono (T1) and mixed culture (T2) with GIFT (*O. niloticus*)

Treatments	Fish species	Stocking density (no/ha)	Av. initial wt (g)	Av. final wt (g)	Av. wt. gain (g)	SGR (% day)	Survival (%)	Production (kg/ha)	
								Species wise	Total
T1	*B. gonionotus*	16,000	4.85	116.05	111.21	2.11	85.14	1606.53	1606.53[b]
	B. gonionotus	8,000	4.85	122.25	117.40	2.14	87.57	856.36	
T2	*O. niloticus*	8,000	5.13	192.85	187.72	2.41	93.52	1442.90	2299.26[a]

*Dissimilar superscript denotes significant difference (P<0.05)

Table 4
Cost - benefit (per hectare) from monoculture of silver barb, (*B. gonionotus*) (T1) and mixed culture (T2) with GIFT (*O. niloticus*)

Inputs	T1(Monoculture)		T2(Mixed culture)	
	Quantity	Cost (Tk.)	Quantity	Cost (Tk.)
A. Cost				
Lime (kg)	250.00	1,000.00	250.00	1,000.00
Cow dung (kg)	6,000.00	3,000.00	6,000.00	3,000.00
Urea(kg)	50.00	300.00	50.00	300.00
TSP(kg)	50.00	600.00	50.00	600.00
Ricebran (kg)	11,000.00	22,000.00	11,000.00	22,000.00
Fingerlings (Nos.)	16,000.00	8,800.00	16,000.00	8,400.00
Total (Tk.)		35,700.00		35,300.00
	(US$ 613.92)		(US$ 607.05)	
B. Benefit				
Silver barb (Tk. 42/kg)	1,606.53	67,474.26	856.36	35,967.12
GIFT (Tk. 40/kg)			1442.90	57,716.00
Gross benefit		67,474.26		93,683.12
Net benefit (B-A)		31,774.26[b]		58,383.12[a]
	(US$ 546.41)		(US$ 1004.00)	

*Dissimilar superscript denotes significant difference (P<0.05); 1 US$ = 58.15 TKs

weight 116.05 g in monoculture (T1) and 122.25 g in mixed culture (T2). There was no significant difference (P>0.05) between the treatments. The highest weight gain (117.40 g) of silver barb was attained in mixed culture but when a one way ANOVA was run, the difference was not significant (P>0.05) statistically. In mixed culture system the average final weight of GIFT was 192.85 g and the weight gain was 187.72 g (Table 3). Hossain *et al* (1997) recorded average weight gain of *O. niloticus* 78.8 g in mixed culture system with mirror carp, silver carp and silver barb for 105 days. In monoculture system, silver barb showed lower growth compared to the mixed culture with GIFT. The specific growth rate (SGR) of silver barb was 2.11(% day) and 2.14 (% day) in mono and mixed culture, respectively (Table 3). There was no significant difference (P>0.05) between the two treatments. In mixed culture system SGR of GIFT was comparatively higher (2.41% day) than the silver barb.

Based on the number of fish harvested at the end of the culture period, the mean survival rate of two different species in two treatments were fairly high (Table 3). The survival rate of silver barb was 85.14% in monoculture (T1) and 87.57% in mixed culture (T2). There was no significant difference (P>0.05) between the survival rates of silver barb in two treatments. Kohinoor *et al* (1993) obtained a survival rate of 86 to 94% in monoculture of silver barb. In mixed culture (T2) system, GIFT showed the highest survival rate (93.52%) between the two species. Hossain *et al* (1997) observed 87.5 to 100% survival of GIFT when studied mixed culture with silver barb, mirror carp and silver carp in seasonal ponds.

Total yield of fish was significantly (P<0.05) higher in mixed culture system (Table 3). In mixed culture (T2) system GIFT ranked 1st position in the production (1442.90 kg/ha) and the highest total production was observed 2299.26 kg/ha due to an increase yield of GIFT and additional yield of silver barb.

The lowest total net production was obtained 1606.53 kg/ha in silver barb monoculture system (T1). Kohinoor *et al* (1993) reported a silver barb production of 1952 kg/ha/5 months in mono culture with rice bran feeding which is higher than the present study. Wahab *et al* (1996) also observed 5294-5670 kg/ha/yr production of silver barb in the polyculture with carps. Hossain *et al* (1997) recorded lowest production of 900 kg/ha/105 days without feed and fertilizer and highest total production of 2233 kg/ha/105 days in mixed culture of silver barb with Nile tilapia, mirror carp and silver carp in seasonal ponds. The overall increase of fish production in mixed culture system may have due to the synergistic interaction from fecal input of silver barb. The excreta have essential food materials edible for GIFT, which helped to increase the growth and production of GIFT. On the contrary, being a bottom feeding fish GIFT caused an "upwelling" of nutrients and helped to increase the phytoplankton productivity of the ponds and ultimate growth of silver barb as well.

Cost-benefit analysis. The cost benefit feature from silver barb monoculture and silver barb mixed culture with GIFT is presented in Table 4. Cost of production amounted to TK 35,700/ha or US$ 613.92/ha and TK 35,300/ha or US$ 607.05/ha in monoculture (T1) and mixed culture (T2), respectively. All variable costs were remained same in both treatments except GIFT fingerling cost for T2. The gross benefit in monoculture (T1) amounted to TK 67,474.26/ha or US$ 1160.35/ha, leaving a net benefit of TK 31, 774.26/ha or US$ 546.42/ha, while gross benefit from mixed culture (T2) amounted to TK 93683.12 or US$ 1611.05/ha with a net benefit of TK 58, 383.12/ha or US$ 1004/ha showing a higher profit per hectare than that of monoculture (T1). Kohinoor *et al* (1993) reported that the net income of silver barb semi-intensive culture was 75, 098 TK or US$ 1291.45/ha/6 month which was higher than the profit obtained with the present study.

The present study revealed that the individual production of silver barb was lower in mixed culture system than in monoculture but there was overall increase in total production of fish including GIFT. It may be concluded that the mixed culture of silver barb and GIFT can be performed in the seasonal mini ponds under farmer's condition to maximize the utilization and production of fishes as well as the net benefit throughout the rural areas of Bangladesh.

References

American Public Health Association (APHA) 1992 *Standard Methods for the Examination of Water and Wastewater*. American Public Health Association, Washington DC, USA, pp 1193.

Anon 1992 Fisheries Research Institute (FRI) *Pokorey Rajputir Chash*. Extension Bulletin No.6. Fisheries Research Institute, Mymensingh, Bangladesh.

Boyd C E 1982 *Water Quality Management for Pond Fish Culture*. Elsvier Science Publishers, Amsterdam, The Netherlands, pp 318.

Dewan S, Wahab M A, Beveridge M C M, Rahman M H, Sarker B K 1991 Food selection, electivity and dietary overlap among planktivorous Chinese and Indian major carps fry and fingerlings grown in extensively managed, rain-fed ponds in Bangladesh. *Aquaculture and Fisheries Management* **22** 277.

Eknath A E, Ayamen M M, Patada-de vera M S, Danting E E, Capili J B, Boliver H L, Abella T A, Circa A V, Bentsen H B, Gjerdrem T, Pulli R V S 1993 Genetic improvement of farmed tilapias: the growth performance of eight strains of *Oreochromis niloticus* tested in different farm environments. *Aquaculture* **11** 171-188.

Haque S M, Wahab M A, Wahid M I, Haq M S 1998 Impacts of Thai silver barb (*Puntious gonionotus* Bleeker) inclusion in the polyculture of carps. *Bangladesh J Fish Res* **2**(1) 15-22.

Hossain M A, Ahmed M, Kamal M, Islam M N 1997 Mixed culture of fishes in seasonal ponds through fertilization and feeding. *Bangladesh J Fisheries* **1** (2) 9-18.

Hussain M G, Kohinoor A H M, Islam M S, Hossain M A, Dey M M 2000 Culture of GIFT in seasonal ponds. *Bangladesh J Aqua Trop* **15**(3) 273-280.

Kohinoor A H M, Akhteruzzaman M, Shah M S 1993 Production of (*Puntious gonionotus* Bleeker). *Bangladesh J Zool* **21**(2) 77-83.

Mazid M A 2002 *A Guide Book on Fish Production Technology*. A special report on Fish fortnight, Bangladesh Fisheries Research Institute, Mymensingh, Bangladesh.

Milstein A 1992 Ecological aspect of fish species interaction in polyculture ponds. *Hydrobiologia* **231** 177-186.

Moyle J B 1946 Some indices of lake productivity. *Trans Am Fish Soc* **76** 322-334.

Phaohorom S 1970 *The study of biology, feeding and growth of Puntious gonionotus (Bleeker)*. Annual Report, Dept Fish, Bangkok, Thailand.

Sarker P K, Chowdhury B B P, Khan M S A, Pal H K, Mondol S 2002 A Study on Silver Barb (*Puntious gonionotus*) monoculture Vs. mixed culture with Carp (*Cyprinus carpio*) in the yard ditches of Bangladesh. *On Line Journal of Biological Science* **2**(4) 230-231.

Shah A K M A, Hossain M A, Afsana K 1998 Effect of different rice bran on the growth of Thai silver barb (*Puntious gonionotus*, Bleeker) in seasonal ponds. *Bangladesh J Fish Res* **2** 159-169.

Srisuwantach V 1981 *Induced Breeding of Thai Silver Barb*

(*Puntious gonionotus* Bleeker) SAFIS manual No.10. Eng. Transl. The secretariat, South-East Asain Fish. Dev. Center, Thailand.

Stirling H S 1967 Standardization of chemical analysis for waters and pond mud. *FAO Fish Rep* **4**(44) 397-421.

Wahab M A, Ahmed Z F 1992 Effects of planktivorous carp species combination on food organism and electivity indices in fish pond. *Progress Agric* **5**(2) 21-30.

Wahab M A, Ahmed Z F, Islam M A, Rahmatullah S M 1995 Effect of introduction of common carp, *Cyprinus carpio* (L) on the pond ecology and growth of fish in polyculture. *Aquaculture Research* **26** 619-628.

Wahab M A, Azim M E, Haq M M, Ahmed Z F 1996 Effects of frequency of fertilization on water quality and fish yields. *Progress Agric* **7**(2) 33-39.

Yashouv A 1971 Interaction between the common carp (*Cyprinus carpio*) and the silver carp (*Hypopthalmichthys molitrix*) in fish ponds. *Mamidges* **23** 85-92.