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Monoculture of climbing perch, Thai koi, *Anabas testudineus* (Bloch) under different stocking densities at on-farm

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Abstract
An on-farm trial was undertaken in nine earthen ponds (400 to 640 m^2) to evaluate the growth and production potentials of climbing perch, Thai koi (*Anabas testudineus*) for the period of four months from March through June 2006. Three stocking densities such as 75,000 (T1), 100,500 (T2) and 125,000/ha (T3) were tested with three replications. Fish were fed with commercial (SABINCO) pelleted feed (35% crude protein). Fish productions obtained in three treatments such as T1, T2 and T3 were 6,480±217, 6,384±154, 6,617±187 $kg^{-1}ha$, respectively. The results demonstrated higher mean growth in T1 than in T2 and T3. However, the net benefit was achieved Tk. 7,26,975 from T1, where the stocking density was 75,000/ha.

Key words: *Anabas testudineus*, Monoculture, Stocking density

Introduction

The climbing perch, *Anabas testudineus*, locally known as Koi, is an favorite small indigenous fish of Bangladesh. It inhabits in paddy fields, ditches, ponds, water reservoirs, canals and haors. It can withstand harsh environmental conditions such as low oxygen due to presence of accessory air breathing organ, wide range of temperature and other poor water conditions. The species is considered as a valuable item of diet for sick and convalescents. It contains high amount of physiologically available iron and copper, which are essentially needed for haemoglobin synthesis. In addition, it also contains easily digestible fat of very low melting point and many essential amino acids (Saha 1971).

In late 1980s, the catches of the fish have drastically declined from open waters due to various ecological changes in inland water bodies. The fish is now sold at an exorbitant price in the market. Keeping these in view, seed production technology through artificial propagation was developed in captive condition by the Bangladesh Fisheries Research Institute. But in culture aspects, the growth rate of native strain is very slow in ponds ecosystem (Kohinoor *et al.* 1991).

To overcome this situation, another fast growing climbing perch known as Thai koi (*Anabas testudineus*) has been introduced from Thailand in 2002. This strain has some special characteristics such as faster growth rate, shorter culture period, higher survival rate etc. Seed production of this species through artificial propagation technique has been developed (Kohinoor and Zaher 2006). But proper culture technology has not yet been optimized and evaluated. Therefore, research needs to evaluate its culture potentials in pond ecology. The present study, attempted to evaluate the production potentials of Thai koi at on farm management under different stocking densities.

Materials and methods

The experiment was carried in nine farmer's ponds of 400 to 640 m^2 with depth of 1.2 to 1.5 m in Boilor village under Trishal upa-zilla in Mymensingh district, Bangladesh for a culture period of four months during March to June 2006. Before beginning of the experiment, ponds were drained, renovated and cleaned of aquatic vegetation and all small fish and other larger aquatic organisms. Later all ponds were limed (CaO) at the rate of 250 kg/ha. Then after three days, ponds were filled up with underground water and fertilized with cattle dung at the rate of 2,000 kg/ha.

The ponds were allocated into three treatments groups and each having three replicates. Fingerlings of Thai Koi (*Anabas testudineus*) were stocked at the rate of 75,000, 1,00,500 and 1,25,000/ha under treatment-1 (T1), treatment-2 (T2) and treatment-3 (T3) on 01 March 2006. Before stocking, the initial mean weights of the fry were measured using sensitive balance (OHAUS Model CS-2000).

After stocking, in all the treatments, a 35% protein containing pelleted feed (SABINCO feed) were applied at the rate of 16-4% of estimated fish biomass twice daily at 10.00 hr in the morning and at 15.00 hr in the afternoon. The fingerlings were fed at the rate of 16% of their body weight for the first two weeks and it was reduced to 4% on the subsequent weeks. During the culture trial, in every month all the ponds were lime at the rate of 125 kg/ha.

Fish sampling was done at fortnightly interval through seine netting and weighing 50 fish to measure the growth to assess the health status and for feed adjustment.

Water quality parameters such as water temperature (°C), DO (mg/l), p^H, alkalinity (mg/l) were monitored weekly from 0930 to 1000 hrs. Water temperature was recorded using a Celsius thermometer and transparency was measured by using a Seechi disc of 20 cm diameter. Dissolve oxygen and pH were measured directly using a digital portable oxygen meter (OAKTON) and portable pH meter (HANNA 8424), respectively. Alkalinity was determined following the titrimetric method according to the standard procedure and methods (Clesceri *et al.* 1992).

Plankton sample was collected fortnightly using 25 μm mesh plankton net and later analysed numerically with the help of a Sedgewick-Rafter counting cell (SR-cell) under a compound microscope. Calculation of the abundance of plankton was done using the following formula (Stirling 1985):

$$N = \frac{A \times 1000 \times C}{V \times F \times L}$$

Where,

N = No. of plankton cells or units per litre of original water;
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 = Number of fields counted; and
L = Volume of original water in litre.

After a grow out period of four months, ponds were drained by pump and all the fishes were harvested. Total bulk weight and number of fish from each pond were recorded. Specific growth rate was estimated as:

SGR (% bw/d) = [In (final weight)-In (initial weight]/culture period (days) × 100.

For statistical analysis of data, a one-way ANOVA was carried out using STATGRAPHICS version 7 statistical package using the PC. Significance was assigned at the 0.05% level.

Results and discussion

The physico-chemical factors of the pond water under three treatments are presented in Table 1. The water temperature in T1, T2 and T3 ranged from: 21.80-31.5°C, 22.10-32.5°C and 22.00-32.9°C, respectively with the mean values 26.24±0.58, 26.36±0.81 and 26.22 ±0.76°C. The variations in temperature among the treatments were found similar ($p<0.05$) and were within the suitable range for growth of fish in tropical ponds (Rahman *et al.* 1982, Roy *et al.* 2002 and Begum *et al.* 2003).

Table 1. Mean values of water quality parameters in different treatments

Water quality parameter	T1	T2	T3
Temperature (°C)	26.24±0.58	26.36±0.81	26.22 ±0.76
Transparency (cm)	32.24±1.14	28.22±1.45	25.65±1.12
pH	7.33 - 7.89	7.11 - 8.20	7.05 - 7.69
Dissolved oxygen (mg/l)	4.70 - 6.80	4.52 - 6.20	4.12 - 5.80
Total alkalinity (mg/l)	135.0±11.20	124.0±7.54	120.0±6.1

The water transparency did not show any significant ($p<0.05$) difference among the treatments. The mean values were 32.24±1.14, 28.22±1.45 and 25.65±1.12cm in T1, T2 and T3, respectively. The values of transparency some times varied with sampling dates

which could be due to differences in abundance of plankton. Boyd (1990) recommended a transparency between 15-40 cm as appropriate for fish culture. Normally, the transparency value was low in this experiment because usually koi did not consume plankton during juvenile and adult stage.

The level of pH varied from 7.33 to 7.89, 7.11 to 8.20 and 7.05 to 7.69 in T1, T2 and T3, respectively. The pH in all the pond water was alkaline throughout the experimental period which might be due to regular application of lime in all the ponds at monthly interval. Different authors have reported a wide variations in pH from 7.50 to 8.20 (Chakraborty *et al.* 2005), 6.8 to 8.20 (Begum *et al.* 2003), 7.03 to 9.03 (Roy *et al.* 2002) and 7.18 to 7.24 (Kohinoor *et al.* 1998) in fertilized fish pond and found the ranges productive.

The dissolved oxygen content in the experimental ponds ranged from 4.7 to 6.8, 4.52 to 6.2 and 4.12 to 5.8 in T1, T2 and T3, respectively, with the mean values of 5.12±0.14, 5.06±0.17 and 4.94±0.23 mg/l. Comparatively lower level of dissolved oxygen as observed in the experimental ponds appeared to be related to sampling time where the dissolved oxygen was monitored at about 9.00-10.00 am. At this time, dissolved oxygen remains lower in concentration. Rahman *et al.* (1982) reported that dissolved oxygen content of a productive pond should be 5.0 mg/l or more. The values found in present experiment were around 5.0.

Total alkalinity ranged from 126 to 156, 120 to 142 and 118 to 140 mg/l with mean values of 135±11.20, 124±7.54 and 120±6.1 mg/l in T1, T2 and T3, respectively. These values did not show any significant difference among the treatments. The variations in total alkalinity in all the treatments were within the productive range for aquaculture ponds (Wahab *et al.* 1995 and Kohinoor *et al.* 1998).

Plankton population

The different groups of plankton with their mean abundance are shown in Table 2. Phytoplankton population mainly comprised of Bacillariophyceae, Chlorophyceae, Cyanophyceae and Euglenophyceae, and zooplankton consisted of Crustacea and Rotifeara. The numerical abundance in different groups of phytoplankton were recorded in various treatments. Chlorophyceae was the most dominant phytoplankton group followed by Cyanophyceae, Bacillariophyceae and Euglenophyceae. Mean total phytoplankton abundance ranged from 47.14 to 64.14x10^4 cells/l and the values were not significantly different among the treatments means. The mean abundance of zooplankton varied from 16.36 to 23.80x10^4 units/l and showed no significant differences among the treatments means. Islam *et al.* (1997) recorded 10.2 to 34.0x10^3 cells/l plankton population in farmer's pond and Kohinoor *et al.* (1998) mentioned 22.50 to 27.83x10^3 cells/l of phytoplankton population. In another study, Roy *et al.* (2002) investigated plankton population in carp-SIS Polyculture management in farmer's pond and found 24.98 to 29.24x10^3 cells/l plankton population. The plankton population which observed in the present study was higher than the above mentioned results. This might be due to the fact that in the ponds 35% protein enriched feed was applied and

the left over feed enhanced the production of plankton in the ponds. Moreover, usually *Anabas testudineus* did not consume plankton. This species is plankton feeder in its larval and fry stage but soon becomes insectivorous and voracious feeder (Singh and Samuel 1981).

Table 2. Mean abundance of plankton ($x10^4$ cells/l) in pond waters under three treatments

Phytoplankton group	T1	T2	T3
Bacillariophyceae	12.25±0.72	13.77±0.48	15.25±0.60
Chlorophyceae	22.31±3.10	25.20±2.17	26.88±2.23
Cyanophyceae	6.91±1.23	11.70±2.02	13.92±1.54
Euglenophyceae	5.67±0.62	6.89±1.12	8.09±1.42
Total Phytoplankton	47.14±6.48	57.56±8.22	64.14±5.96
Crustacea	7.21±2.42	9.25±2.45	10.55±2.42
Rotifeara	9.15±1.64	10.68±1.10	13.25±2.48
Total zooplankton	16.36±1.89	19.93±1.45	23.80±1.75

Growth and production

The growth rates of *A. testudineus* under different stocking densities are shown in Table 3. The weight increments of different treatments over the culture period are graphically shown in Fig. 1. For about one month, the rate of growth was almost similar in all the treatments. It was also observed that the growth rate was always higher in T1 followed by T2 and T3. The mean final weight in T1, T2 and T3 were 96±8.68, 78±10.72, and 71±14.96 g, respectively (Fig. 1). The average weight (g) gain of *A. testudineus* was significantly ($p<0.05$) different from one treatment to another and was recorded to be 88.89, 74.92, and 67.83g in T1, T2 and T3, respectively over the experimental period. The mean weight of T1 showed significant differences ($p<0.05$) from that of T2 and T3, whereas significant differences was also observed between mean weight of fish in T2 and T3. The results indicated that higher growth rate attained at lower stocking density and vice versa which has the similarity with the findings of some authors (Islam *et al.* 1978, Haque *et al.* 1984, Kohinoor *et al.* 2004).

Table 3. Monthly growth performances of Thai *A. testudineus* under three different treatments

Treatment No.	Mean initial wt. (g)	Harvesting wt. (g)	SGR (% per day)	Survival (%)	Production (kg/ha)
T1	3.11±0.40	96±8.68	2.86^a	92	$6,480±217^b$
T2	3.08±0.42	78±10.72	2.68^b	84	$6,384±154^b$
T3	3.17±0.64	71±14.96	2.54^c	79	$6,617±187^a$

*Figures in the same column with different superscripts are significantly different ($p<0.05$)

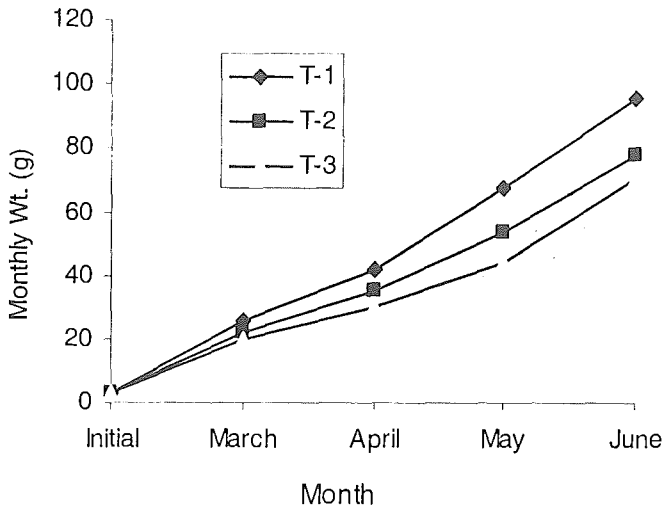


Fig.1: Monthly growth rate of Thai Koi at different stocking densities

The specific growth rate (SGR) (% per day) of Thai *A. testudineus* at different stocking densities was observed to be 2.86, 2.68 and 2.54 in T1, T2 and T3, respectively. The ANOVA showed SGR was significantly different ($p<0.05$) among the treatments.

The mean survival rate of Thai *A. testudineus* was found to vary with the stocking densities. The highest survival rate (93%) was observed in T1, where stocking density was 75,000/ha and the lowest (84%) was obtained in T3, where stocking density was 1,25,000/ha. The differences among the treatments were found to be significant ($p<0.05$). The mean FCR value of T1, T2 and T3 were 1.89, 2.32 and 2.47, respectively. T1 resulted in the lowest FCR value of fish, while the highest FCR value was found in T3.

The calculated production of Thai *A. testudineus* in T1, T2 and T3 were 6,480±217, 6,384±154 and 6,617±187 kg/ha, respectively. The fish production was higher in T1 than other treatments but lowest production was found in T3. The production level of T1 was found to be significantly higher than that of T2 and T3. Treatment 3 appeared to give the lowest production and differed significantly ($p<0.05$) from T1 and T2. Thakur and Das (1986) reported that *A. testudineus* production was 1,800 kg/ha/170 days in India by applying supplementary feed (rice bran, mustard oil cake and fish meal) with the stocking density of 60,000/ha. They also stated that by applying the above feed, they achieved 702 kg/ha over a period of 11 months, where the stocking density was 1,25,000/ha. Earlier study conducted by Akhteruzzaman (1988) evaluated the production potentials of *A. testudineus* in monoculture management at the density of 16,000/ha and obtained a production of 450 kg/ha in five months rearing with supplementary feed consisted of rice bran (50%), mustard oil cake (30%) and fish meal (20%).

The gross production of *A. testudineus* in mono-culture condition was 425 kg/ha at the stocking density of 20,000/ha, where rice bran (50%), mustard oil cake (30%) and

fish meal (20%) was used as supplementary feed over a period of five months (BFRI 1998). The production obtained in all the treatments in this experiment was higher than these mentioned results of different authors. In the present experiment, Thai strain of *A. testudineus* was used which might be genetically superior than the native strain of Bangladesh. In all aspects, the stocking of 75,000 fry/ha may be advisable for rearing of Thai *A. testudineus* in pond ecology which might give high production.

Cost and benefit

A simple cost-benefit analysis was performed to estimate the amount of profit that has been generated from these types of culture (Table 4). Cost and benefit analysis showed that T1 generated the highest return over a period of four months Tk. 7,26,975/ ha where Thai koi fry were stocked in 75,000/ha (T1) and lowest net return was found Tk. 3,87,550/ha where stocking density was 1,25,000/ha (T3). Hussain *et al.* (1989) analyzed the cost and benefit of Nile tilapia (*Oreochromis niloticus*) in monoculture condition and got net benefit of Tk.72,827/ha/6 months, where fish were fed with rice bran and mustard oil cake. In the case of net benefit of Silver barb (*Puntius gonionutus*), Akhteruzzaman *et al.* (1993) found that Tk. 68,135 to 75,028/ha/6 months could be achieved by applying supplementary feed and fertilization. Whereas, Kohinoor (2001) got the net profit of Tk.32,910/ha/6 months in monoculture of small indigenous fish, punti (*Puntius sophore*). In another study, Kohinoor *et al.* (2006) reported that monoculture of endangered fish, gulsha (*Mystus cavasius*) gave a net benefit of Tk. 42,291/ha over a period of six months. In the present study, the net return was higher than the above findings. The production as well as economic return obtained was very encouraging and the Thai Koi fish culture would add an extra in such a way that farmer may get a chance to consume them readily than sale them to the market.

Table 4. Cost and return analyses of fish production in different densities in one hectare area

Inputs	T1		T2		T3	
	Quantity (Kg)	Cost (Tk.)	Quantity (Kg)	Cost (Tk.)	Quantity (Kg)	Cost (Tk.)
Lease value	-	25,000	-	25,000	-	25,000
Pond preparation		4,000		4,000		4,000
Fingerling	75,000	75,000	1,00,000	1,00,000	1,25,000	1,25,000
Feed	12,577	3,14,425	14,683	3,67,075	17,204	4,30,100
Harvesting cost		5,000		5,000		5,000
Labour		16,000		16,000		16,000
Total cost		4,39,425		5,17,075		6,05,000
Benefits						
Sell price of koi T-1: Tk.180/kg) T-2: Tk. 170/ kg T-3: TK. 150/kg)	6,480	11,66,400	6,384	10,21,440	6,617	9,92,550
Net benefit/ha		7,26,975		5,04,365		3,87,550

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