GROWTH AND PRODUCTION PERFORMANCES OF CROSSBRED CLIMBING PERCH KOI, *Anabas testudineus* IN BANGLADESH

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Abstract

The study was performed for evaluating the growth and production performances of crossbred climbing perch (*Anabas testudineus*) during August to October 2009. The crossbred groups of fish were produced by crossing between native climbing perch and Thai climbing perch (*A. testudineus*). Growth and production performances was compared at grow out condition between crossbred groups in the two reciprocal crosses of treatments viz. T_1: Native climbing perch (♀) × Thai climbing perch (♂) and T_2: Thai climbing perch (♀)×Native climbing perch (♂. At the same time, they were compared also with their respective control F_1 pure line groups i.e. T_3: Native climbing perch (♀) × Native climbing perch (♂) and T_4: Thai climbing perch (♀) × Thai climbing perch (♂). It was evident from the results that among the treatments in grow out system, the highest mean harvesting weight was 69.25±9.01 g found in T_4 (Thai climbing perch), which was significantly different (P<0.05) from all other treatments. Whereas, T_3 (native climbing perch) also showed the lowest mean harvesting weight 33.38±8.74 g and showed significant differences (P<0.05) among all the treatments. The mean harvesting weight of both the crossbred groups i.e. T_1 and T_2 were 50.83±6.65 and 59.94±7.83 g, respectively and these results were statistically insignificant (P>0.05) between them but significant among all other treatments. The highest (93.60%) and lowest (83.06%) survival rates were observed in Thai koi (T_4) and native Koi (T_3) parental stocks, respectively. Wider variations in terms of productions performances were observed among the treatments, where the gross production of T_1, T_2, T_3 and T_4 were 2,753±96.67, 3,401±73.26, 1,733±168.47 and 4,051±185 kg/ha, respectively. The productions obtained from crossbred groups were at intermediate compared to their control pure line groups. Higher FCR mean value was observed in native control line (T_3), while, lower FCR mean value was observed in Thai control line (T_4).

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Introduction

Climbing perch Koi (*Anabas testudineus*) is an important indigenous fish species of Bangladesh. The fish is very popular for its delicious taste and flavour. This species considered as a valuable item of diet for sick and convalescent. According to Saha (1971), the fish contain high values of physiologically available iron and copper essentially needed for hemoglobin synthesis. Once climbing perch was abundantly available in almost all freshwater systems of Bangladesh, however, recently population of this fish has been declining very rapidly. The reasons for such decline are many, such as ecological degradation, indiscriminate fishing, use of pesticides and fertilizers, destruction of habitats, obstruction to breeding migration, management failure, etc. In the face of diminishing natural population of climbing perch-planners, policy makers, aquaculturists, and fisheries biologists are thinking of its cultivation through intensive farming (DOF, 2002).

A substantial number of seasonal water bodies like ponds, ditches, canals etc. are presently lying fallow and not suitable for carp culture. In this context, our endemic koi fish is the promising species for culture in such waters bodies due to the presence of their accessory respiratory organs, which allow them to thrive in waters with low oxygen levels. During the past few years, natural population of these fishes is rapidly decreasing due to lack of scientific management

and draining out of beels, marshes and similar natural habitat to meet up the excessive market demand and also for the production of paddy and other agricultural crops. Moreover, natural breeding grounds are under continuous destruction due to use of excessive fertilizer, insecticides and pesticides. If this situation continues, these endemic local koi will be endangered in near future. In our country, culture of these species has not yet been flourished. Among various reasons, lack of appropriate technology, paucity of fry and fingerlings, and determination of appropriate stocking density are the major setbacks for its culture in the country. The breeding technology of native Koi (*A. testudineus*) had successfully been developed in freshwater Station of the Institute (Kohinoor, 1991). But the growth rate is very slow in comparison to Thai Koi *A. testudineus*. Its slow growth and small size does not favour sustainable production per unit area in a culture system (Kohinoor *et al.,* 2009).

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). Introduced Thai *A. testudineus* is fast growing, however, it does not taste like Native *A. testudineus*. Although the Thai *A. testudineus* is presently used for production purposes by large number of farmers but it is not widely accepted by consumers owing to its lack of taste in comparison to native *A. testudineus*. The proposed research activities have been addressed with an objective to develop cross bred Koi through crossing between native and Thai Koi (*A. testudineus)*.

Materials and Methods

Crossbred koi fry were produced through crossing between native Koi and Thai koi. Prior to breeding, 400 native Koi having mean weight 48.24±3.26 g were collected from natural sources and reared in a pond (400 m^2). While, 500 Thai Koi (68.20±4.29 g) were collected from Thailand and reared also in same size pond. Supplementary feed containing 30% crude proteins were supplied at 4-8% of estimated body weight in both native and Thai koi. During breeding season (March-May, 2009), four groups of fry were produced through induced breeding. The groups- 1, 2, 3 and 4 were assigned as tretaments- 1, 2 3 and 4, respectively. These treatments are as follows:

T_1 (Group I): Female native koi (♀) × Male Thai koi (♂)
T_1 (Group II): Female Thai koi (♀) × Male native koi (♂)
T_1 (Group III): Female native koi (♀) × Male native koi (♂)
T_1 (Group IV): Female Thai koi (♀) × Male Thai koi (♂)

Production of pure line Thai and native koi fry

Pure line Thai and native koi fry were produced in the hatchery of Freshwater Station, Bangladesh Fisheries Research Institute (BFRI) through induced breeding propagation.

Grow out system

Design of experiment

In this experiment, there were four treatments with three replications. In all the treatment groups, the stocking density was maintained at 62,500 ha^{-1}. In this experiment, four earthen ponds were used. Each pond was equally partitioned by bamboo split into three chambers (100m^2). The details of design of experiment are shown in Table 1.

Table 1. Stocking density in the four treatments

Treatment groups	Stocking density ha^{-1}
T_1: Female native koi (♀) × Male Thai koi (♂)	62,500
T_2: Female Thai koi (♀) × Male native koi (♂)	62,500
T_3: Female native koi (♀) × Male native koi (♂)	62,500
T_4: Female Thai koi (♀) × Male Thai koi (♂)	62,500

Pond preparation

The ponds were dried and cleaned for weed and unwanted animals. The dried ponds were left exposed to sunlight for seven days and then limed at the rate of 250 kg ha^{-1}. Five days after liming, underground water was supplied from a deep tube well to the ponds and filled up to the depth of 1 meter. After three days, the ponds were fertilized with cow dung at the rate of 2,000 kg ha^{-1}.

Fish stocking and management

The ponds were stocked with fish after five days of fertilization. The initial weights of fry were 1.06±0.24, 1.04±0.26, 1.09±0.30 and 1.13±0.28 g, respectively. After stocking, Feeding was done with floating pelted feed containing 30% crude protein @ 4-10 % of body weight twice daily.

Fish sampling

Sampling was done at 15 days interval and random samples of 50 *A. testudineus* fry were caught by seine net from all the treatments to assess the growth and health condition for feed adjustment.

Analyses of water quality parameters

Water samples were collected between 09:00 to 10:00 am at three days intervals of each pond surface to a depth of 20 cm (Azim *et al.*, 2001). 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 (HANNA, model HI 9142) 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). Ammonia-nitrogen was measured using a high precision HACH Kit (DR 2000).

Harvesting of fish

After 120 days of rearing, the fish were harvested from all the ponds. Primarily the harvesting of fish was performed by repeated netting using a seine net and final harvesting was done by dewatering the ponds with a submerged low lift pump. During harvest, all fishes were counted and weighed from each pond to assess the survival rate and production

Analysis of experimental data

Data were analyzed using the statistical package, Statgraphics Version 7. ANOVA was performed on all the dependent variables to find out whether treatments had any significant effect on growth. Duncan's New Multiple Range Test (DMRT) was performed to identify any significant difference among treatment means.

Results

Detailed results of the study on growth performances, survival rate, fish biomass, water quality parameters and all other aspects as recorded during the period of study are presented.

Water quality parameter

Mean levels of physicochemical parameters over 120 days of rearing of crossbred and control groups of koi are presented in Table 2.

Temperature is one of the most important physical factors, which influences the physico-chemical and biological environment of a water body. The mean values of water temperature of T_1, T_2, T_3 and T_4 were 27.70±1.32, 27.94±1.67, 27.98±1.46 and 28.19±1.59°C. The variations in temperature among the treatment means were found similar ($P<0.05$).

Water transparency varied between 26 and 34 cm when all ponds and sampling times were considered. It varied a little among the treatments with an average of 25.75±4.75, 24.83±4.12, 28.58±3.84 and 22.91±4.80 cm in T_1, T_2, T_3 and T_4, respectively. These readings were not significantly different when compared using ANOVA. Water transparency varied between 18 and 36 cm when all ponds and sampling times were considered. The water transparency did not show any significant ($P<0.05$) difference among the treatment means. The values of transparency some times varied with sampling dates which could be due to differences in abundances of plankton.

The level of pH varied from 6.89 to 8.11, 6.92 to 8.84, 7.04 to 8.2.3 and 6.86 to 8.25 in T_1, T_2, T_3 and T_4, respectively. The pH in all pond water was alkaline throughout the experimental period which might be due to regular application of lime in all the ponds at monthly interval.

The dissolved oxygen contents in the experimental ponds ranged from 4.24 to 6.80, 4.1 to 6.6, 4.11 to 7.40 and 4.20 to 9.90 mg L^{-1} in T_1, T_2, T_3 and T_4, respectively, with the mean values of 5.30±0.69, 5.36±0.65, 5.57±0.95 and 4.2±0.69 mg L^{-1}. Comparatively higher 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.

Total alkalinity ranged from 85 to 145, 92 to 142, 104 to 162 and 94 to 152 mg L^{-1} with mean values of 108.83±13.34, 113.25±14.15, 124.95±13.41 and 116.54±15.58 mg L^{-1} in T_1, T_2, T_3 and T_4, respectively. When the results of all ponds collected over the entire experimental periods were compared, there was no significant difference.

Ammonia-nitrogen is toxic to fish and above a certain level it can cause fish mortality. The range of ammonia-nitrogen was 0.021-0.80, 0.011- 0.79, 0.015-0.64 and 0.01-0.99mg L^{-1} in treatments-1, 2, 3 and 4, respectively. The highest ammonia-nitrogen value was 0.99 in the month of October in treatment-4 and the lowest value was 0.011 in the month of August in treatment-3. The differences among treatments were not significant ($P>0.05$) when compared using ANOVA.

Table 2. Mean values of water quality parameters in different treatments

Water quality parameters	Treatment			
	T_1	T_2	T_3	T_4
Temperature (°C)	27.70±1.32	27.94±1.67	27.98±1.96	28.19±1.82
Transparency (cm)	25.75±4.75	24.83±4.12	28.58±3.84	22.91±4.80
pH	6.89 to 8.11	6.92 to 8.84	7.04 to 8.23	6.86 to 8.25
Dissolved oxygen (mg L^{-1})	5.30±0.69	5.36±0.65	5.57±0.95	4.2±0.69
Total alkalinity (mg L^{-1})	108.83±13.34	113.25±14.15	124.95±13.41	116.54±15.58
NH_3-N (mg L^{-1})	0.29 ± 0.15	0.26 ± 0.13	0.19±0.11	0.34±0.17

Growth and production

Details of stocking, growth, survival, harvesting and production of koi under four treatments are presented in Table 3. It was evident from the results that among the treatment groups in grow-out system, the highest harvesting mean weight 69.25±11.35 g was found in T_4 (Thai climbing perch) which was significantly different (P<0.05) from all other treatments. Whereas, T_3 (native climbing perch) also showed the lowest harvesting mean weight (33.38±8.7 g), which was significantly different (P<0.05) from all other treatments. The harvesting mean weight of both the crossbred groups i.e. T_1: Native koi (♀) × Thai koi (♂) and T_2: Thai koi (♀) × Native koi (♂) were 50.83±6.65 and 59.94±7.83 g, respectively and these results were not statistically significant (P>0.05) between them. The growth of crossbred was at intermediate between the pure line Thai koi and native koi. It is remarkable that, the growth rate of both crossbred groups were significantly higher (P<0.05) than that of pure line native koi, while growth rate of both crossbred group of koi showed significantly lower (P<0.05) than that of pure line Thai stock. The growth patterns of koi in different months of different treatments are shown in Figure 1, where a clear distinguishable difference in weight was observed in every month among the treatments.
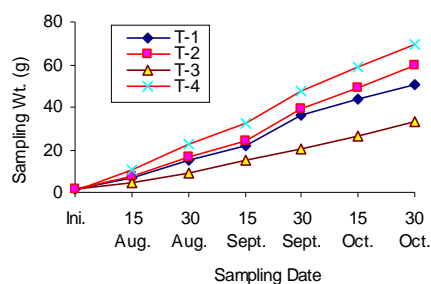

Fig. 1: Sampling Wt. (g) Koi in different treatments

The mean survival rate of koi was found to vary in different treatments. The highest (93.6%) and lowest (83.06%) survivals were observed in Thai koi (T_4) and native Koi (T_3) parental stocks, respectively. The differences among the treatment means of survivals were found to be insignificant (P>0.05). The survival of cross bred group i.e. T_1 and T_2 were 86.67 and 90.80%, respectively, where the difference between the treatments are apparent but were not statistically significant. The survival rate of Thai Koi (T_4) showed significant differences with cross bred groups and native koi i.e. T_1, T_2 and T_3.

The specific growth rate (SGR) of koi at different treatments was observed to be 3.23, 3.40, 2.90 and 3.52 for T_1, T_2, T_3 and T_4, respectively. The SGR of native koi in T_3 was significantly (P<0.05) different from T_1, T_2 and T_4, whereas, T_1 and T_2 did not show any significant difference (P>0.05) between them.

However, the gross production of T_1, T_2, T_3 and T_4 were 2,753±96.67, 3,401±73.26, 1,733±168.47 and 4,051±185 kg/ha, respectively. Wider variations in terms of production performances were observed among the treatments. These results when tested statistically, showed significant differences among the treatments. The highest and lowest production was observed in T_4 (Thai koi) and T_3 (native koi), respectively. The production obtained from cross bred groups of koi showed higher values over native koi, but Thai koi showed higher production over crossbred koi. The production variation between crossbred groups was not significant (P>0.05). Production of cross bred groups showed 58-96% higher than that of native koi while 16-33% less than Thai koi.

Table 3. Mean weight, survival and production of Koi under different treatments

Treatment	Stocking Density ha^{-1}	Mean initial Wt. (g)	Mean Harvesting Wt. (g)	Mean survival (%)	Mean FCR	Mean SGR (%)	Mean Production (kg ha^{-1})
T_1	62,500	1.06±0.24	50.83±6.65[b]	86.67[b]	3.35[c]	3.23[b]	2,753±96.67[b]
T_2	62,500	1.04±0.26	59.94±7.83[b]	90.80[b]	3.20[c]	3.40[b]	3,401±73.26[b]
T_3	62,500	1.09±0.30	33.38±8.74[d]	83.06[c]	4. 25[a]	2.90[c]	1,733±168.47[c]
T_4	62,500	1.13±0.28	69.25±9.01[a]	93.60[a]	2.90[b]	3.52[a]	4,051±185[a]

* Dissimilar superscript indicates significant difference at 5% level of probability

Discussion

All the water quality parameters of the experimental ponds were found to be within the acceptable ranges for aquaculture and there was no abrupt change in any parameter of the pond water. In this experiment, the variations in water temperature among the treatment means were found similar and were within the suitable range of growth of fish in tropical ponds (Rahman et al., 1982; Roy et al., 2002; Begum et al., 2003, Kohinoor et al., 2007; Mondol et al., 2010). Boyd (1982) reported that the range of water temperature from 26.06 to 31.97°C is suitable for fish culture. Normally, the transparency value was low in this experiment because usually koi did not effectively consume plankton (Nargis and Hossain, 1987; Singh and Samual, 1981). Boyd (1982) also recommended a transparency between 15-40 cm as appropriate for fish culture. The pH in all pond water was alkaline throughout the experimental period which might be due to regular application of lime in all the ponds at monthly interval. According to Swingle (1967), pH from 6.5 to 9.0 is suitable for pond fish culture and pH more than 9.5 is unsuitable. Different authors have reported a wide variations in pH from 7.18 to 7.24 (Kohinoor et al., 1998), 7.03 to 9.03 (Roy et al., 2002), 6.8 to 8.20 (Begum et al., 2003) and 7.50 to 8.20 (Chakraborty et al., 2005) in fertilized fish ponds and found the ranges to be productive.

Rahman et al. (1982) measured dissolved oxygen range of 3.8 to 10.7 mg L^{-1} from a lake situated at Mymensingh. Wahab et al. (1994) recorded dissolved oxygen values ranging from 5.10 to 7.15 mg L^{-1}, while Kohinoor et al. (2007) recorded dissolved oxygen values ranging from 4.12 to 6.80 mg L^{-1}. In another study, Mondol et al. (2010) also recorded dissolved oxygen ranging from 6.51 to 6.65 mg L^{-1} during their experiment in the pond of Bangladesh Agricultural University Campus, Mymensingh. The variations in total alkalinity in all the treatments were found in productive range for aquaculture ponds (Boyd, 1982; Wahab et al., 1995; Kohinoor et al., 1998 and Kohinoor, 2009). Dewan et al. (1991) recorded total ammonia-nitrogen (NH_3-N) values of 0.50 to 6.20 mg L^{-1}, which was less than the present study. Ahmed (1993) found NH_3-N values 0.03 to 0.04 mg L^{-1}, while Azim et al. (1995) recorded mean total ammonia-nitrogen of 0.10 mg L^{-1}. Mondol et al. (2010) recorded total ammonia- nitrogen range from 0.098 to 0.167 mg L^{-1} in the research ponds of Bangladesh Agricultural University Mymensingh.

The productivity of Thai koi was much more higher than native and cross bred groups. While, the production of crossbred groups were higher than native koi. The mean harvesting weight and survival rate of Thai Koi was higher than all other treatments. For this reason, Thai Koi showed highest production among the treatments. While the mean harvesting weight and survival of crossbred groups exhibited higher values than native koi. Therefore, the production of crossbred groups also higher than native koi but lower than that of Thai koi. The survival rate of all treatments was fairly high. Among the treatments, the lowest survival was observed in native koi (T_3).The main factors that might have attributed to the high survival were the proper stocking of healthy seed, freedom from predation, favourable ecological conditions (physicochemical factors) and also proper feeding etc. High survival rate of climbing perch was reported by many authors (Rao, 1971, Kohinoor et al., 2007, 2009 and Kim Van Van and Vo Qui Hean, 2009). These indicated that climbing perch is an excellent candidate for aquaculture perhaps more so than other culture species.

Thakur and Das (1986) reported that Koi (Anabas testudineus) production was 1,800 kg ha^{-1} in India by applying supplementary feed (rice bran, mustard oil cake and fish meal) with the stocking density of 60,000 ha^{-1} in 170 days. They also stated that by applying the above feed, achieved 702 kg ha^{-1} over a period of 330 days, where the stocking density was 1,25,000 ha^{-1}. Earlier study conducted by Akhteruzzaman (1988) evaluated the production potentials of native koi (Anabas testudineus) in monoculture

management at the density of 16,000 ha^{-1} and obtained a production of 450 kg ha^{-1} in five months rearing with supplementary feed consisted of rice bran (50%), mustard oil cake (30%) and fish meal (20%).

In a trial conducted by Kohinoor *et al.* (2007) investigated on the effects of stocking density on the growth and production of Thai Koi (*Anabas testudineus*) in Freshwater Station, Bangladesh Fisheries Research Institute at three stocking densities (50,000 to 1,25,000 ha^{-1}) by applying supplementary feed (35% crude protein). They observed growth was increased in the treatment with lower stocking density and obtained production 6480 to 6617 kg ha^{-1} in 150 days culture period.

Kohinoor *et al.* (2009) assessed the production potentials of native koi (*Anabas testudineus*) at different stocking densities (50,000 to 62,250 ha^{-1}) in Freshwater Station, Bangladesh Fisheries Research Institute, Mymensingh. They found the highest total net yield of 1,916 ha^{-1} over a period of 5 months culture period by applying supplementary feed containing 35% crude protein. The production obtained in the cross bred group was lower than these mentioned results of Thai koi by different authors. Whereas, the production of native Koi was lower over cross bred groups these also mentioned by different authors (Akhteruzzaman, 1988; Thakur and Das, 1986; Kohinoor *et al.,* 2009).

Conclusion

In native koi, yellowish colour found in the abdomen region, which also observed to some extent in the crossbred group (T$_1$). Body shapes of cross bred koi (T$_1$) was more or less same as native koi, while the production of both the two groups of crossbred Koi were comparatively higher over native koi. Organoleptic testing of the four groups of koi revealed that the crossbred koi showed superior taste performances compared to Thai koi. Therefore, in terms of taste in associated with production values, crossbred koi can be a good culture species in Aquaculture Avenue.

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