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Stocking density for profitable farming of Thai *Koi* in Mymensingh region

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ABSTRACT

A study was conducted to analysis of appropriate stocking density for profitable farming of of Thai *Koi* (*Anabas testudineus)* over a period of 165 days from 29 September 2010 to 13 March 2011 in nine earthen ponds located in the northern side of the Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh. Three stocking densities such as 500/decimal (T_1), 750/decimal (T_2) and 1000/decimal (T_3) were tested with the three replications. The water quality parameters were monitored at fortnightly interval. The mean value of water temperature in T_1, T_2 and T_3 was 23.25 ± 1.95°C, dissolved oxygen content were 5.0 ± 1.33 mg/L, 4.95 ± 1.32 mglL and 5.05 ± 1.11, pH were 7.50 ± 0.20, 7.62 ± 0.28 and 7.70 ± 0.36 and alkalinity were 171.00 ± 19.12, 168.00 ± 18.14 and 164.00 ± 25.47 respectively. At the end of the study the mean specific growth rates of Thai *Koi* were 0.89%, 0.85%, and 0.84%, the average weight gain (g) were 43.69 ± 0.11, 36.69 ± 1.90 and 36.36 ± 0.29 in T_1, T_2 and T_3 respectively. The survival rates were 95.08%, 95.49% and 88.00% in T_1, T_2 and T_3 respectively. Fish productions were 5155.50 kg/ha, 8543.62 kg/ha and 10558.55 Kg/ha in 165 days and the cost benefit ratio were found 1.39, 1.41 and 1.51in T_1, T_2 and T_3 respectively. The results demonstrated significantly higher mean production and net benefit in T_3 than in T_1 and T_2 ($P<0.05$). The highest production was found in T_3 in which stocking density was 1000/decimal and the lowest production was found in T_1 which stocking density was 500/decimal. The highest net profit was also obtained from T_3 followed by T_1, and T_2.

INTRODUCTION

The climbing perch locally known as *Koi*, *Anabas testudineus* (Bloch 1792) is a teleost belonging to the family Anabantidae and order Perciformes. This species is naturally distributed in Bangladesh, India, Pakistan, Ceylon, Burma, Sri Lanka, Thailand, Southern China, The Philippines, Polynesia, and Malaysia. Anabas testudineus contains high amount of iron and copper, which are essentially needed for hemoglobin synthesis. It also contains easily digestible fat of very low melting point and many essential amino acids (Saha, 1971). The species is considered as a valuable item because of its special nutritive and medicinal qualities, ailing patients use it as diet for recovering from illness (Chandi, 1970).

In 2002, a private entrepreneur, Aqua Farm Ltd., Dhanmondi, Dhaka, Bangladesh imported Thai *Koi* strain from Thailand. Presently this strain is getting more popular than our native *Koi* (strain) due to its higher growth rate and about 90 to 180 days require to obtained marketable size.

Stocking density is the major factor to obtained optimum production. Fish farmers of Mymensingh region used 800-1200 fry/decimal of thai *Koi* that was reported from Atiqul Tarakandi (personal communication, (Raihan, 2010).

Economically productive aquaculture systems depend upon an adequate supply of low cost feeds with high nutritional quality. The major cost in the fish industry is feed; it contributes about 40% to 60% of total cost (Akiyama et al., 1992) in fish culture. The feed must be nutritionally adequate and commercial for the sound operation of a fish farm (Akiyama et al., 1992).

The present study was attempted to evaluate the production potentials and profitable condition of Thai *Koi* at on farm management under different stocking densities. The main objectives of this

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study were to analysis the suitable water quality perameters of culture potentials of the Thai *Koi* in mini pond culture system and to estimate the the appropriate stocking density of Thai *Koi* culture on the basis of cost benefit ratio for profitable culture system and recommend to the farmers.

MATERIALS AND METHODS

Description of study area

The study was conducted for a period of 165 days from 29 September-2010 to 13 March 2011 in nine experimental ponds each of 0.60 decimal, located in the northern side of the Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh. Water depth was maintained to a maximum level 1.5 m and all the ponds were similar in size, depth and configuration.

Pond preparation

To eradicate all undesirable fish, insect and other aquatic organism ponds were drained out completely. Aquatic weeds were removed and embankments were repaired manually. Lime was applied at the rate of 1 Kg/decimal. After one week of lime application, the ponds were filled with water from a deep tube-well supply.

Experimental design

The ponds were selected randomly to accommodate the relevant treatments. The experimental layout is shown in Table 1.

Table 1
Experimental layout of Thai *Koi* culture.

Treatment	Replication (pond no)	Pond size (d)	Stocking Density	Total stocked	Stocking size (g)
T_1	R-1 (1)	0.60	500	325	1.53
	R-2 (2)	0.60	500	325	1.53
	R-3 (3)	0.60	500	325	1.53
T_2	R-1 (4)	0.60	750	488	1.53
	R-2 (5)	0.60	750	488	1.53
	R-3 (6)	0.60	750	488	1.53
T_3	R-1 (7)	0.60	1000	650	1.53
	R-2 (8)	0.60	1000	650	1.53
	R-3 (9)	0.60	1000	650	1.53

Collection and release of fry

The fry of Thai *Koi* were collected from the Brahmaputra Hatchery, Shambhugonj, Mymensingh and transported to the experimental ponds with polythene bag having oxygen. Then the fry were acclimatized with experimental pond water in polythene bag and then stocked at 5 pm.

Selection of feed

Commercial pellet feed named "Mega feed" was selected for the present study. This pellet feed was examined and used due to having appreciable water stability, high nutrient value and quick water grown promoting qualities. The proximate compositions of different types of "Mega feed" are given in the Table 2.

Feeding Strategy

During the whole experiment careful attention was given in regular feeding of fishes. Fish were fed at a rate of 40% of their body weight for the first two weeks then was gradually reduced to 30% for the next two weeks, 15% for the next two weeks, 6% for the following two weeks, 3% for the next two weeks, 2% for the next two weeks, 2% for the next two weeks, No feeding was applied in last two weeks of December and first two weeks of January then 0.5% for the next two weeks and 1% till the termination of the experiment. Feeding was

adjusted on the basis of fish weight taken at fortnightly intervals. The feed was supplied manually twice a day.

Table 2
Proximate composition of "Mega feed".

Constituent	Amount (%)
Protein	33.63
Lipid / Oil	7.82
Crude fiber	6.20
Moisture	12.65
Carbohydrate	19.62
Ash	20.08

Water quality

The water quality parameters were recorded throughout the experimental period. The physico-chemical parameters like temperature (°C), dissolved oxygen (mg/l), alkalinity (mg/l), Nitrate (mg/l) and pH were measured fortnightly on the day of sampling. Water quality measurements and sample collection were made between 9.00 am to 10.00 am on each sampling day.

Sampling of fish

Sampling of fish was done at 15 days intervals in the morning at around 7am to 8 am. During each sampling fish were caught by cast net and weight was taken by correctness weighing balance (Accuracy up to 0.1 g).

Growth performance

The following parameters were used to evaluate the growth of fish such as weight gain (g), percent weight gain, specific growth rate (SGR), survival rate (%) and production (Kg/ha/165days) according the standard procedure described by Mondal et al. (2016).

Weight gain (g)

Weight gain was calculated as: Weight gain (g) = Mean final weight (g) –Mean initial weight (g)

Percent weight gain

This is a straight forward measure of the overall increase in the mean body weight over a time. At the end of the experiment all the fish were harvested by drying the ponds. Then the final weight gained by each species in each treatment were recorded by weighing (g) them with the help of balance.

Survival rate

The survival rate of each treatment was calculated by counting each species survived at the end of the experiment.

Production

The production of each treatment was determined by multiplying the average gained weight (g) of each species of fish by the total number of fish survived at the end of the experiment.

RESULTS AND DISCUSSION

Physicochemical parameters of the pond water

Water temperature (°C)

The mean values of water temperature in treatments T_1, T_2 and T_3 were 23.25±1.95 °C and 23.25±1.95°C and 23.25±1.95 respectively (Table 3). Alim (2005) measured water temperature to range from 17.30 to 33.50°C that was more or less similar. Masud et al. (1996) were measured water temperature to range (24.7 to 30°C). The temperature as observed in this study appeared to be suitable for fish culture.

Dissolved oxygen (mg/L)

During the study period, the dissolved oxygen content of the water were varying from 3.50 to 8.50 mg/L in T_1, 3.0 to 8.0 mg/L in T_2 and 4.0 to 7.5 mg in T_3. The mean values of dissolved oxygen content of the water in T_1, T_2 and T_3 were 5.0 ± 1.33 mg/L, 4.95 ± 1.32 mg/L and 5.05 ± 1.11 respectively (Table 3). Alim (2005) measured dissolved oxygen ranged from 1.2 to 8.5 mg/L and Banerjee (1967) considered 5 to 7 mg/L of dissolved oxygen content of water is fair in respect of productivity.

pH

During the study period, the range of pH values recorded in T_1, T_2 and T_3 were varying between 7.4 to 8.0, 7.4 to 8.3 and 7.4 to 8.3 respectively. The mean values of pH were 7.50 ± 0.20, 7.62 ± 0.28 and 7.70 ± 0.36 recorded in T_1, T_2 and T_3 respectively (Table 3). There was no significant variation of pH values under different treatments. Most natural water has pH values of 6.5 to 9 (Boyd, 1982). The present finding was within acceptable range required for fish culture 6.5 to 8.5 (DOF, 1996).

Alkalinity (mg/L)

Alkalinity (mg/l) of the experimental ponds was varied from 120 to 180 mg/L, 120 to 190 mg/L and 100 to 190 mg/L in T_1, T_2 and T_3 respectively (Table 3). The mean values of alkalinity were 171.00±19.12, 168.00±18.14 and 164.00± 25.47 recorded in T_1, T_2 and T_3 respectively. There was no significant variation of alkalinity among different treatments.

Raihan (2010) funded alkalinity on his experiment was 114 to 180 that was more or less similar. Rahman (2000) found alkalinity varied from 37 to 151 mg/l. Uddin (2002) conducted an experiment in earthen ponds Field Laboratory of Bangladesh Agricultural University, Mymensingh observed that alkalinity varied from 45 to 180 mg/l.

Nitrite (mg/L)

During the experiment there was a little amount nitrite (<0.03mg/L) found in experimental ponds which is negligible. Nitrite is the least toxic of the major inorganic nitrogen compounds (Table 3).

Ammonium (mg/L)

A little amount of ammonium (0 to 0.02,0 to 0.03 and 0 to 0.03 mg/L in respectively T_1, T_2 and T_3) was found in experimental ponds and there was not significant variation among the values (Table 3).

Table 3
Average (Mean ± SD) values of water quality parameters under different treatments during the study period

Treatment	Temperature (˚C)	Dissolved oxygen (mg/L)	Alkalinity (mg/L)	pH	Nitrite (mg/L)	Ammonium (mg/L)
T1	23.25±6.17	5.0±1.33	171.00±19.12	7.50±0.20	<0.03	0 to 0.02
T2	23.25±6.17	4.95±1.32	168.00±18.14	7.62±0.28	<0.03	0 to 0.03
T3	23.25±6.17	5.05± 1.11	164.00± 25.47	7.70±0.36	<0.03	0 to 0.3

Growth performance of fish

The weight (g) gain, percent weight (g) gain, specific growth rate (SGR% per day), survival (%) and production (Kg/0.6dec/165days) were calculated and presented in Table 4 for the evaluation of growth performance of fish in different treatments.

The stocking density of 500/d, 750/d and 1000/d were used in the experiment. Kohinoor et al. (2007) tested 300/d, 400/d and 500/d in three treatments which is lower than present experiment. Farmers of Mymensingh region practiced stock densities of 1000/d (2011) and 3500-4000/d (2011, personal communication) which was higher than the present experiment. Rahman and Marimuthu (2010) carried out in three different stocking densities were 1.0 million/ha in T_1, 1.2 million/ha in T_2 and 1.4 million/ha in T_3, respectively for 56 days. Stocking density of different treatments (T_1, T_2, T_3 and T_4) were 200/d, 400/d, 600/d and 800/d tested in experiment by Raihan (2010).

The results of the present experiment showed that, the highest growth rate was achieved in T_1 which had lower density. This phenomenon indicated that there was a lower community feeding among the fishes which influenced

them to take food properly and it might be absent in the treatments with higher stocking density. The lowest growth was obtained under the highest stocking density (1000/d). This does not agree with Weatherley (1976) who stated that there was no general certainty that fish would grow more rapidly in lower density. The only probable explanation is that the fishes could take feed, space and environment properly without competition.

Weight gain

There were no significant ($P<0.05$) difference in initial weight of fish under different treatments. The mean weight gains of fish at the end of the experiment were followed by 45.22 g, 38.22 gm and 37.89g in T_1, T_2 and T_3 respectively (Table 4, Figure 1) . Weight gains in all the treatments were significantly different with each other.

Mustafa et al. (2010) observed the initial average weight of *Anabas testudineus* fry increased from 0.9g to 3.5g, 1.0g to 7.3g, 0.95g to 5.82g and 0.92g to 5.4g in the treatments T_1, T_2, T_3 and T_4 respectively. The highest and lowest average final length was found in T_2 and T_1 respectively. But the present study is closely related to Khan (2008) who observed that the average highest weight of individual Thai *Koi* was 91.0g and lowest 68.5g after four months culture and Kohinoor et al. (2007) observed highest weight gain was 88.89g and lowest weight gain was 67.83g in four months culture operation.

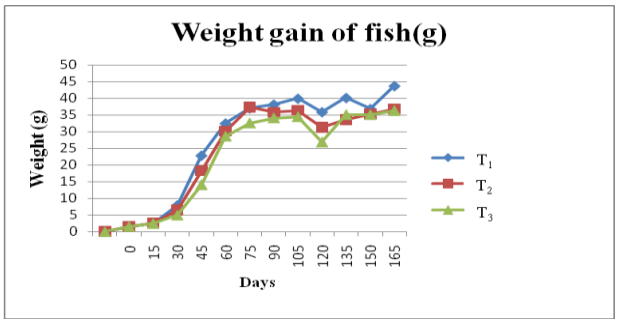

Figure 1
During the study period weight gain of fishes at different treatments.

Table 4
Growth parameters of Thai *Koi* (*Anabas testudineus*) observed in different treatments during the study period.

Growth parameters	Treatments		
	T_1	T_2	T_3
Initial weight(g)	1.53±0.05	1.53±0.05	1.53 ±0.05
Final weight(g)	45.22 ±4.14^a	38.22±3.81^b	37.89±3.82^b
Weight gain (g)	43.69±0.11^a	36.69±1.90^b	36.36±0.29 ^{b}
% Weight gain	2855.56±7.19^a	2398.26±124.07^b	2376.25±19.23^b
SGR (%/day)	0.89±0.23^a	0.85±0.05^b	0.84±0.45^b
Survival %	95.08±.64^a	95.49±1.14^a	88.00±1.69^b
Fish production (Kg/0.6 dec/165days	13.50±0.07^a	17.11±1.04^b	20.79±0.23^c

Percent weight gain

The % weight gains of Thai *Koi* in different treatments were 2855.56 %, 2398.26 %, 2376.25 % in respectively T_1, T_2 and T_3. The significantly ($P<0.05$) highest % weight gain values (2855.56) was recorded in T_1 while the lowest (2376.25) was obtained in T_3 (Table 4).

SGR (% per day)

In different treatments the mean specific growth rates of Thai *Koi* were 0.89%, 0.85%, and 0.84%

in respectively T_1, T_2 and, T_3. The significantly ($P<0.05$) highest SGR value (0.89) was recorded in T_1 while the lowest (0.85) was obtained in T_3 (Table 4).

Survival (%)

The survivals (%) in different treatments were 95.08%, 95.49%, and 88.00% in T_1, T_2 and T_3 respectively. The survival rates were significantly different among the treatments. The highest survival was obtained in T_2 (95.49%) and the lowest was in T_3 (88%) due to higher stocking density (Table 4).

This result does not agree with Akhteruzzaman (1988) who reported that the survival rate of *Anabas testudineus* varied from 60 to 80. But these results were closed to the present study with Kohinoor et al. (2007), who observed that the survival rate of Thai *Koi* varied from 79% to 92%. Mustafa *et al.* (2010) also observed the survival rates were recorded 74, 85, 81 & 79 % in the treatments T_1, T_2, T_3 and T_4 respectively. However, these differences were not significant ($P>0.05$) among treatments of each experiment. Mookerjee and Mazumdar (1946) in a study with climbing perch observed survival rate ranging from75%-89%. This observation is within our observed value of survival rate of *A. testudineus*. Hasan et al. (2010) reported that the survival rate of Thai *Koi* were 73%, 76% and 83% in T_1, T_2 and T_3 respectively during the period of experiment.

Fish production

The productions of Thai *Koi* were ranged between 13.50 to 20.79 Kg/0.6 dec/165 days in different treatments (Table 4). T_1 resulted in significantly ($P<0.05$) higher production compared to T_1 and T_3.

Higher production was obtained from T_3 which might be due to higher number of fishes than T_1 and T_2. T_3 had highest stocking density but obtained less production than T_3 due to produced stress in fish, which lead to reduced growth and production. In the present study, the production were 5155.5 kg/ha, 8,543.62 kg/ha and 10,558.55 kg/ha in T_1, T_2 and T_3 respectively (in 165 days). Thakur and Das (1986) and Akhteruzzaman (1988) mentioned that the average yield was 1800 kg/ha and 350-500 kg/ha respectively in 5-6 months. These results are much lower than the findings of the present experiment. Raihan (2010) found that the production of Thai *Koi* (*Anabas testudineus*) was ranged between 4620.38 to 6401.44 kg/ha/75days in different treatments.

Economic analysis

To estimate the net profit from the Thai *Koi* culture operation a simple economic analysis was performed. The cost of production was based on the Mymensingh whole sale market price of the input used in the year 2011. The commercial feed cost was Tk. 30.00/Kg. The sell price of Thai *Koi* was Tk. 140/Kg. It was observed that, the highest net profit was obtained from T_3 and lowest profit was obtained from T_1 (Table 5).

Cost benefit ratio

From the experiment it was found that the highest net profit was BDT 5,33,422.00 in T_3 (Table 5). That time the market price was BDT 140/kg fish. Culture of Thai *Koi* at stocking density (1000 fish/dec) showed higher benefit. The similar result was found by Karim (2006), who stated that the highest benefit was found at lower stocking density in 98 days. The average cost benefit ratio of the present study is 1.45. So it can be concluded that the cost benefit ratio in T_3 was more beneficial than T_1 and T_2.

Table 5
Economic analysis of fish production at the end of the experimental period.

Inputs	T_1		T_2		T_3	
	Quantity	Cost (Tk.)	Quantity	Cost (Tk.)	Quantity	Cost (Tk.)
Pond preparation		100		100		100
Lime and fertilization		30		30		30
Fingerling	500/d	250	750/d	375	1000/d	500
Feed	34.143Kg	1025	46.69 Kg	1400	50.51 Kg	1515
Harvesting cost		50		50		50
Labour		100		100		100
Total cost/0.6 dec		1555		2055		2295
Total cost/1 dec		2092		3425		3825
Cost per ha		5,16,724.00		8,45,975.00		9,44,775.00
Production/ha	5155.5Kg		8,543.62Kg		10,558.55Kg	
Benefits						
Sell price (140Tk/Kg)		7,21,770.00		11,96,106.80		14,78,197.00
Net benefit/ha(Tk.)		2,05,046.00		3,50,131.8		5,33,422.00
Cost benefit ratio (CBR)		1.39		1.41		1.56
Average of CBR			1.45			

CONCLUSION

The present study revealed that the stocking density had significant effects on growth, survival and production of Thai *Koi*. Considering increase in growth rate, survival, net production and profit of Thai *Koi*, the stocking density (1000 individuals/ decimal) of the treatment T_3 produced better result when compared to the other densities. Thus a stocking density of 1000 individuals/ decimal could be recommended to culture in earthen ponds in Mymensingh region. Thai *Koi* is an important fish species which will definitely play an important role for livelihood upliftment of the rural fish farmers. So, the farmers may come forward for adapting Thai *Koi* culture techniques from which they will be able to make more profit than other fish species. So, it could be concluded that the stocking density of 1000 fish per decimal is suitable and advisable in monoculture system of Thai *Koi*.

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