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Effect of stocking density on the growth and production of Thai Koi (*Anabas testudineus*) in Mymensingh region

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Abstract

The present study was conducted to optimize stocking density of Thai Koi (*Anabas testudineus*) in monoculture for a period of 98 days in 6 ponds of 0.2 ha each in a commercial farm under Mymensingh district. Three stocking densities of Thai Koi at 74,100, 86,450 and 98,800 ha^{-1} were assigned to treatments T_1, T_2 and T_3, respectively. Each treatment had two replicate ponds. The mean initial weight of Thai Koi was 0.2 g. A pelleted commercial diet containing 32-35% protein was fed twice daily at the rate of 20, 15, 12, 10, 8, 5 and 4% of the total body weight of the fish which was adjusted fortnightly. Feed conversion ratio (FCR) ranged from 1.73 to1.94 among the treatments. The water quality parameters were measured fortnightly and the ranges of temperature, pH, dissolved oxygen and total alkalinity were 27.5-29.6^{0}C, 7.8 - 8.7, 5.1-6.2 mgL^{-1} and 101-144 mgL^{-1}, respectively. Percent survival (%) of Thai Koi varied from 82.03 to 90.47. The weight gain of Thai Koi in T_1 (91.0g) was significantly higher (*P<0.05*) compared with that of T_2 (84.1g) and T_3 (76.5g). This result indicated higher growth in weight (g) at lower stocking densities and the growth rate gradually decreased with increasing density. The Specific Growth Rates (SGR %) were 6.73, 6.60, 6.54 in T_1, T2 and T_3 respectively and demonstrated no significant difference (*P>0.05*) among the treatments. The achieved production in weight were 6,584.84, 6,388.29 and 5,700.31 $kgha^{-1}$in T_3, T_2 and T_1, respectively. The production of Thai Koi was significantly higher (*P<0.05*) in T_3 than those the T_2 and T_1. But the highest net profit (Tk. 109.35 $kgfish^{-1}$) was derived in T_1 and lowest (Tk. 77.90 $kgfish^{-1}$) in T_3. The investment was rather highest in T_3 (Tk. 72.09 $kgfish^{-1}$) and lowest in T_1 (Tk 60.65 kgfish-1). That means the market value of per kg fish is decreasing in higher stocking density than the lower stocking density for its individual weight. Therefore, from the results of this study, it is concluded that for higher profit a total stocking density of 74100 ha^{-1} for Thai Koi (*Anabas testudineus*) monoculture in pond aquaculture system may be recommended.

Keywords: Specific growth rate, Stocking density, Production, Water quality, Survival rate

Introduction

It had been a common practice in most Asian countries to introduce suitable species of fish from one country to another having similar environmental conditions. Such introductions are usually done either to utilize a vacant niche, increase the overall production, improve standard of sport fishing, control insect pests by biological means or to decorate aquarium by ornamental species. In recent decade many exotic fish were introduced to the inland aquaculture system of Bangladesh (Rahman, 2005). As a consequence, exotic climbing perch (*Anabas testudineus*) or Koi was brought under aquaculture in Bangladesh. Koi is also commercially fished in other Asian countries as an important food fish (Sterba, 1983; Davenport and Matin, 1990, Jhingran, 1991).

Fish farmers in Bangladesh have cultured exotic climbing perch (*Anabas testudineus*) or Thai Koi. It is now considered as one of the most financially viable culture fish of Bangladesh for its high market demand, good nutritional value, delicious taste and availability of fry and fingerlings. In addition, it has high growth rate, high market price, short duration of culture period and easy marketing. In view of its culture potentials, a sharp increasing trend has been observed in some selected areas of Bangladesh, particularly, different Upazilas of Mymensingh district. Since it is newly introduced to Bangladesh, little information is available on its behavior, food habit, breeding and stocking density in monoculture and polyculture system.

Development of production technologies depends on many factors. Among them economic profitability and relative advantage of the production technology are the most important ones (Khaleque *et al.*, 1998). One the other, economic profitability of fish culture operation also depends on selection of species, time of stocking, stocking size of fingerlings, stocking densities and overall management practices (Rahaman *et al.* 2007).

Stocking density, however, is an important parameter in fish culture operation, since it has direct effects on the growth and survival as well as on the production. It is an established fact that growth rate progressively increase as the stocking densities decreases and vice-versa. Relatively less number of fish in a pond of similar size could get more space, food and dissolved oxygen at the same time. The growth of fishes is dependent on the population density (Le Cren, 1965). Generally direct relationship exists between food abundance and growth rate as well as between population density of the species and its growth rate, where as population density of the species and its growth rate tend to be inversely related (Le Cren, 1965). However, there may be no relationship between food abundance and growth rate, when a space-limiting effects operate on the population. Higher stocking density may cause crowding effects and reduction of growth rate. The present communication, however, intend to find out the effect of stocking density on growth and production of Thai Koi.

Materials and Methods

The experiment was carried out in 6 earthen ponds in a private commercial fish farm in Trishal Upazila under Mymensingh district, Bangladesh, for a period of 98 days, during July-October, 2006. The ponds were rectangular in shape with area ranging from 0.142 to 0.259 ha and water depth ranging from 1.0 to 1.5m. Ponds were well exposed to sunlight. The experiment consisted of three treatments with three stocking densities and each treatment had two replicate ponds (Table 1). All treatment ponds were stocked with similar size (0.2g) of fingerlings. The stocking density (no/ha) in T_1 T_2 and T_3 were 74,100, 86,450 and 98,800 respectively. Ponds were randomly assigned to the treatments.

Table 1. Experimental layout of Thai Koi culture

Treatment	Replication (Pond no.)	Pond size (ha)	Stocking density (no/ha)	Total Stocking	Stocking Size(g)
T_1	R-1 (1)	0.142	74,100	10,500	0.2
	R-2 (2)	0.162	74,100	12,000	0.2
T_2	R-3 (3)	0.202	86,450	17,500	0.2
	R-4 (4)	0.194	86,450	16,800	0.2
T_3	R-5 (5)	0.243	98,800	24,000	0.2
	R-6 (6)	0.259	98,800	25,600	0.2

The ponds were newly excavated for Thai Koi culture and the banks were planted with grass to prevent soil erosion. After one week lime was applied at the rate of 247 $kgha^{-1}$. Lime was dissolved by water overnight in an earthen pot and spread homogenously on the pond bottom prior to entering the water into the ponds. Urea (61.75 $kgha^{-1}$) and cow dung (123.5 $kgha^{-1}$) were also used as inorganic and organic fertilizers after 3 days of liming. After 7 days of fertilization, the ponds were filled in with underground water. The fingerlings of Thai Koi

(*Anabas testudineus*) were collected from a private hatchery in Mymensingh. At the beginning of the experiment, commercial pellet feed was applied at the rate of 20% of the body weight of reared Thai Koi and gradually it was readjusted fortnightly from 15%, 12%, 10%, 8%, 5%, and 4% of the total body weight of the fish.

Sampling was done weekly basis by using a cast net to observe the growth of Thai Koi and to adjust the feeding rate. During each sampling, 20 Thai Koi were collected from each pond. Weight of each Thai Koi was measured to assess the growth rate. Collected data were used to determine the following growth parameters as follows.

Weight gain (g) =Mean final weight – Mean initial growth

$$\text{Specific growth rate (SGR) (\%per day)} = \frac{\log_e W_2 - \log_e W_1}{T_2 - T_1} \times 100$$

Where, W_1 = Initial body weight of live Thai Koi at T_1 (time)
W_2 = Final body weight of live Thai Koi at T_2 (time)

The survival rate of Thai Koi for each treatment was examined on the basis of number of fish harvested at end of the experiment.

$$\text{Survival rate (\%)} = \frac{\text{No.of Thai Koi survived}}{\text{No.of Thai Koi stocked}} \times 100$$

The water quality parameters of ponds such as temperature, pH and dissolved oxygen and total alkalinity were measured using a Fish farming water quality test kits (Model FF-1A, HACH) fortnightly at 10:00 hours.

For statistical analysis, comparison of treatment mean was carried out using one-way analysis of variance (ANOVA) followed by Duncan's Multiple Range Test (DMRT) were performed to compare the different treatment means at 5% level of significance. Statistical analysis was performed using the SPSS (windows version 11.5) software package.

Results and Discussion

Growth, feed efficiency and feed consumption of fish and prawn are normally governed by few environmental factors (Fry, 1971). Environmental parameters exert an immense influence on the maintenance of a healthy aquatic environment and production of food organism. The values of water quality parameters such as temperature, pH and dissolved oxygen in all the treatments are shown in Table 2. The water temperature in different treatments ranged between 27.5 and 29.6^{0}C. The maximum temperature was recorded in T_3 in August, while the minimum of 27.5^{0}C was in T_2 in November. pH in different treatments ranged between 7.8 and 8.7. The highest pH value (8.7) was observed in T_3 in October, while the lowest (7.8) in T_1 was in August. Dissolved oxygen (DO) varied between 5.1 and 6.2 mgL^{-1}. The maximum dissolved oxygen (6.2 mgL^{-1}) was recorded in T_1 in August, while the minimum (5.1 mgL^{-1}) was in T_3 in October. Total alkalinity varied between 101 and 144 mgL^{-1}. The maximum total alkalinity (144 mgL^{-1}) was recorded in T_3 in August, while the minimum (101 mgL^{-1}) was in T_1 in October. There was no significant difference ($P>0.05$) between the temperature and total alkalinity among the treatments. But significant difference ($P<0.05$) was observed between pH and dissolved oxygen among the treatments.

Table 2. Water quality parameters in different ponds under three treatments (mean± S.E.)

Treatment	Temperature (^{0}C)	pH	Dissolved oxygen	Total alkalinity
T_1	28.29±0.249	8.17±0.084^b	5.91±0.080^a	115.43±4.423
T_2	28.29±0.257	8.30±0.062^b	5.67±0.109^{ab}	121.29±5.743
T_3	28.54±0.251	8.54±0.037^a	5.40±0.087^c	120.57±6.477
	NS	**	**	NS

Values in the same column with different superscripts are significantly different (P<0.05)

The growth performance in terms of weight gain (g), specific growth rate (SGR % day), food conversion ratio (FCR), survival (%) and production of Thai Koi in different treatments are shown in Table 3. The weight gain of Thai Koi in T_1 (91.0g) was significantly higher ($P<0.05$) compared with those of T_2 (84.13g) and T_3 (76.5g). This result indicates higher growth in weight (g) at lower stocking density and the growth rate gradually decreased with increasing densities. Pathak (1978) found average weight of individual *Anabas testudineus* around 33.83 g to 40.05g in six months. But in the present study, it was found that the average highest weight of individual Thai Koi was 91.0 g in 98 days and lowest 76.5 g in 98 days. The faster growth rate of Thai Koi might be due to improved variety of *Anabas testudineus* reared under improved semi intensive culture system.

The survival (%) and specific growth rate (SGR %) of Thai Koi demonstrated no significant difference ($P>0.05$) among the treatments (Table 3). In T_1, T_2, T_3, the survival (%) and SGR (%) were 90.47, 85.7 and 82.03, and 6.73, 6.60 and 6.54 respectively. Noor *et al.* (2006) conducted fifty days growth experiment in three earthen ponds in Bangladesh with supplemental feed treatments. They revealed that the gain in weight, SGR and survival rate were 55.83g, 7.92% and 81.67%, respectively.

Table 3. Growth performance of Thai Koi under different treatments (mean ± S. E.)

Growth parameters	Treatments		
	T_1	T_2	T_3
Mean initial weight (g)	0.2	0.2	0.2
Mean final weight (g)	91.2±0.22^a	84.33±0.01^b	76.7±0.06^c
Mean weight gain (g)	91.0±0.22^a	84.13±0.01^b	76.5±0.06^c
Specific growth gain (SGR) (% /day)	6.73±1.94	6.60±1.81	6.54±1.54
Food conversion ration (FCR)	1.73±0.01^c	1.86±0.01^b	1.94±0.01^a
Survival (%)	90.47±5.77	85.7±0.58	82.03±0.58
Yield (kgha^{-1}98 d^{-1})	5700.31±1.15^c	6388.29±57.74^b	6584.84±1.16^a

Values in the same column with different superscripts are significantly different (P<0.05)

At the end of 98 days culture period, there was a significant difference ($P<0.05$) in production (kgha^{-1} 98 days) of fish among the treatments. The production of Thai Koi was significantly higher ($P<0.05$) in T_3 than those of T_2 and T_1. The Thai Koi production was obtained 6,584.84, 6,388.29 and 5,700.31 kgha^{-1} in T_3, T_2 and T_1, respectively (Table 3). Thakur and Das (1986) and Akhteruzzaman (1988) obtained average yields of 1800 kgha^{-1} and 450-500 kgha^{-1}, respectively in 5-6 months culture period of *Anabas testudineus*. The higher yield acquired in present trial might be due to the stocking of Thai Koi. The food conversion ratio (FCR) were 1.94, 1.86 and 1.73 in T_3, T_2 and T_1, respectively (Table 3 and Fig. 1) and also showed significant difference ($P<0.05$) among the treatments.

A simple economic analysis was performed to estimate the net profit obtained from monoculture of Thai Koi at different densities in pond aquaculture system. The highest net profit (Tk. 109.35 kgfish^{-1}) was derived from T_1 and lowest (Tk. 77.90 kgfish^{-1}) from T_3 (Table 4 and Fig. 1). The highest investment was observed in T_3 (Tk. 72.09 kgfish-1) and lowest in T_1 (Tk 60.65 kgfish^{-1}). But the highest gross income (Tk 109.35 kgfish^{-1}) from fish was gained in T_1 and lowest (Tk 77.90 kgfish^{-1}) in T_3. That means the market value of per kg fish is decreasing in higher stocking density than the lower stocking density. Because, the individual fish weight decreased with the increasing of stocking density of fish (Table 3).

Table 4. A simple economic analysis of Thai Koi in pond monoculture aquaculture system (mean ± S. E.)

Investment & return (Tk)*	Treatments		
	T_1	T_2	T_3
Cost (kg fish^{-1})	60.65±0.06^c	67.20±1.15^b	72.09±1.15^a
Gross Income (kgfish-1)	169.99±01.03^a	160.01±1.29^b	149.99±0.73^c
Net profit (kgfish-1)	109.35±0.58^a	92.80±1.15^b	77.90±1.15^c
BCR[1]	1.80	1.38	1.08

[1]BCR- Benefit Cost Ratio. * Tk. 70 = 1 US$
Values in the same column with different superscripts are significantly different ($P<0.05$)

The benefit cost ratio (BCR) was observed to be highest in T_1 (1.80) and lowest in T_3 (1.08). The economic values in terms of cost, gross income and net profit (kgfish^{-1}) showed significant difference (*P<0.05*) among the treatments.

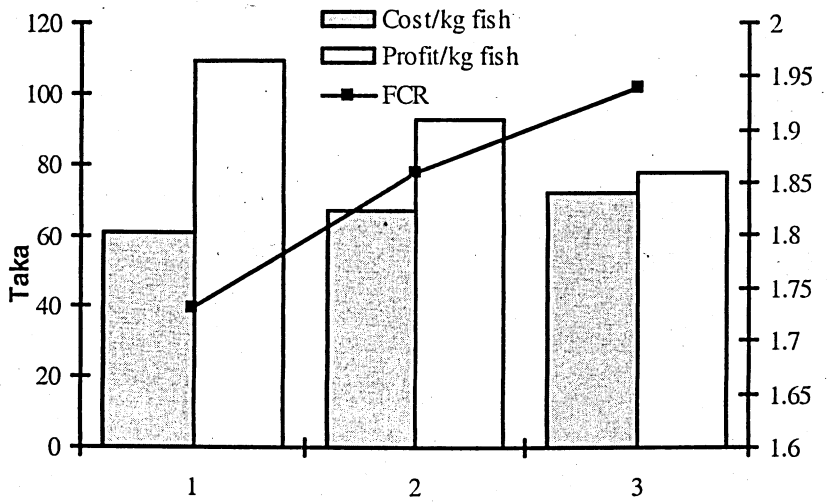

Fig. 1. Cost of production and profit (Tk kg fish^{-1}) with food conversion ratio (FCR)

Conclusion

The present experiment showed the highest growth rate in T_1 which was stocked at lower density although same food was supplied in all treatments at an equal ratio. This phenomenon indicated that there was a lower community feelings among the fishes which influenced them to take food properly and it might be absent in the treatments with higher

stocking densities. The lowest growth was obtained in the present experiment under the highest stocking rate of 98,800 ha^{-1}. During the economic analysis, it was found that gross profit was higher in T_3 than other treatments which might be due to higher stocking density but net profit was higher in T_1 where there was a lower stocking density. Therefore, from the results of this study, it is concluded that for higher profit a total stocking density of 74,100 ha^{-1} for Thai Koi (*Anabas testudineus*) monoculture in pond aquaculture system may be recommended.

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