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# Effects of Stocking Density on Survival, Growth and Production of Thai Climbing Perch (*Anabas testudineus*) under Fed Ponds

(Kesan Ketumpatan Penstokan kepada Kemandirian, Pertumbuhan dan Penghasilan Ikan Puyu Thailand (*Anabas testudineus*) di Bawah Kolam Ternakan)

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ABSTRACT

*An experiment was carried out in 6 earthen ponds to investigate the effects of stocking density on growth, survival and production of Thai climbing perch (*Anabas testudineus*). Three stocking densities (treatments) were compared: ponds with 350, 400 and 550 individuals per decimal (0.01 acre). All treatments were randomly assigned and in duplicate. Artificial feed containing 34% crude protein was applied initially 20% of total fish weight per day. Gradually the feeding rate was reduced to 15, 12, 10, 8 and 5% of total fish weight per day. Feeding rates per pond were adjusted fortnightly after weighing minimum 20% of the fish stocked. The duration of the experiment was 90 days. Results showed that all growth parameters were higher in ponds with lower stocking density than the ponds with higher stocking density, while total fish yield was higher in ponds with higher stocking density than in the ponds with lower stocking density. Cost-benefit analysis revealed that all three systems were economically profitable. However, the ponds with a stocking density of 550 individuals per decimal were the most profitable system. More research is still needed to further optimize stocking density of Thai climbing perch in aquaculture ponds. Until then, stocking 550 individuals of Thai climbing perch per decimal will yield a good production to fish farmers in the South and South-East Asian regions.*

*Keywords: Aquaculture; artificial feed; specific growth rate; survival*

ABSTRAK

*Satu uji kaji telah dijalankan dalam kolam bertanah untuk menentukan kesan ketumpatan penstokan ke atas pertumbuhan, kemandirian dan penghasilan ikan puyu Thailand (*Anabas testudineus*). Tiga ketumpatan penstokan (rawatan) telah dibandingkan: kolam dengan 350, 400 dan 550 individu per perpuluhan (0.01 ekar). Semua rawatan dibuat secara rawak dengan duplikasi. Makanan tiruan yang mengandungi 34% protein kasar sebanyak 20% berat ikan diberikan pada peringkat awal setiap hari. Kadar pemberian makanan dikurang beransur-ansur kepada 15, 12, 10, 8 dan 5% berat ikan setiap hari. Kadar pemberian makanan bagi setiap kolam diselaraskan setiap dua minggu selepas pencatatan berat minimum 20% stok ikan. Jangka masa uji kaji adalah 90 hari. Hasil menunjukkan bahawa semua parameter pertumbuhan lebih tinggi dalam kolam yang mempunyai ketumpatan penstokan yang rendah berbanding dengan kolam yang mempunyai ketumpatan penstokan yang tinggi. Sebaliknya, hasil ikan adalah lebih tinggi dalam kolam yang mempunyai ketumpatan penstokan yang tinggi daripada kolam yang mempunyai ketumpatan penstokan yang rendah. Analisis kos-manfaat menunjukkan bahawa ketiga-tiga sistem menunjukkan keuntungan secara ekonomi. Namun, kolam yang mempunyai ketumpatan penstokan 550 individu per perpuluhan adalah sistem yang paling menguntungkan. Kajian lanjutan diperlukan untuk mengoptimumkan ketumpatan penstokan ikan puyu Thailand dalam kolam akuakultur. Sehingga itu, penstokan 550 individu ikan puyu Thailand per perpuluhan didapati memberikan hasil yang baik kepada penternak ikan di kawasan Asia Selatan dan Asia Tenggara.*

*Kata kunci: Akuakultur; kadar pertumbuhan spesifik; kemandirian; makanan tiruan*

## INTRODUCTION

In 2008, Bangladesh was the ninth largest aquaculture producing country in the world, supplying 12% of global aquaculture production excluding China (FAO 2010). The aquaculture species mainly includes large carp namely rohu *Labeo rohita* (Hamilton 1822), mrigal *Cirrhinus mrigala* (Bloch 1795), catla *Catla catla* (Hamilton 1822), grass carp *Ctenopharyngodon idella* (Valenciennes 1844), silver carp *Hypophthalmichthys molitrix* (Valenciennes 1844) (Hossain et al. 2008; Rahman et al. 2008a; Rahman et al. 2008b). However, aquaculture of small indigenous species (SIS) is increasing rapidly in Bangladesh (DoF 2002). SIS is generally considered to be those fishes which grow to a maximum length of about 25 cm (Felts et al. 1996; Hossain & Afroze 1991). In terms of nutritional value, SIS has higher protein, vitamins and minerals than other fishes. Previously SIS was not considered as aquaculture species. Fisherman used to collect SIS from different inland water bodies like ponds, natural depressions, rivers and canals. However, this situation was changing rapidly with declining capture production and increasing consumer demand. A decade ago, SIS was cultured in the pond as an additional crop while various large carp species were cultured as cash crop. Nevertheless, production systems are continuously changing (Rahman et al. 2006; 2008c). Nowadays, fish farmers culture SIS as a main cash crop.

In Bangladesh, a wide variety of SIS is available. Among these climbing perch *Anabas testudineus* (Bloch 1792), Taki *Channa punctata* (Bloch 1793), Veda *Nandus nandus* (Hamilton 1822), Pabda *Ompok pabda* (Hamilton 1822), Tengra *Mystus vittatus* (Bloch 1794), Mola *Amblypharyngodon mola* (Hamilton 1822), Puti (*Puntius sophore*), Shing *Heteropneustes fossilis* (Bloch 1794), Magur *Clarias batrachus* (Linnaeus 1758), Chapila *Gudusia Chapra* (Hamilton 1822), Chela *Salmophasia bacaila* (Hamilton 1822), Chanda *Chanda nama* (Hamilton 1822) are important. Nowadays, among SIS climbing perch is the most popular aquaculture species and its aquaculture production is increasing very rapidly (Belton et al. 2011). There are two types of climbing perch, local and Thai types. The local type has no body spots whereas Thai type has body spots on the body surface (Biswas & Shah 2009). However, hatchery technology of local strain is not developed yet. Fry collection of local climbing perch strain is difficult, therefore farmer stock Thai climbing perch strain in their aquaculture ponds. Farmers also prefer to stock Thai climbing perch because it enjoys a higher consumer preference and market value. In addition, farmers prefer to stock Thai climbing perch because (1) it grows very fast (marketable size: within 3-4 months), (2) culture technology is very easy, (3) it can be cultured both in deep or shallow water, (4) it can survive in low oxygen concentrated water, (5) it is very resistant against disease, and (6) it can be marketed in live condition (Mahmood et al. 2004). Unfortunately, aquaculture technology of Thai climbing perch is not well developed yet. Study on aquaculture of climbing perch is very limited.

Mondal et al. (2010) compared the aquaculture of Thai climbing perch between cage and pond under three management systems in Bangladesh. Phuong et al. (2006) studied integrated cage-cum-pond culture systems with climbing perch in cages suspended in Nile tilapia *Oreochromis niloticus* (Linnaeus 1758) ponds in Vietnam. However, study for optimization of climbing perch density in pond aquaculture is lacking. Such information is necessary for maximum utilization of resource (aquaculture ponds). Considering the above issue, the present study was conducted to understand the production performance of Thai climbing perch in ponds under different stocking densities. The objective of this study was to understand the effects of different stocking density of Thai climbing perch on its growth, survival and production under artificially fed ponds.

## MATERIAL AND METHODS

### STUDY AREA AND EXPERIMENTAL DESIGN

A 90-day experiment was carried out from 1 June to 30 August, 2009 in six earthen ponds at a private farm in Tarakanda upazila, Mymensingh, Bangladesh. All ponds were rectangular in shape with a maximum depth of 1.2 m. The sizes of the ponds were 60, 60, 35, 60, 50 and 50 decimals. All ponds had well organized inlet and outlet systems. They were also fully exposed to prevailing sunlight. Three stocking densities were compared in the present study: 350 (treatment $T_1$), 400 ($T_2$) and 550 ($T_3$) individuals per decimal (Table 1). Two replicates of each treatment were assigned randomly to the ponds.

### POND PREPARATION, FISH STOCKING AND MANAGEMENT

Prior to the experiment, ponds were drained, renovated, aquatic vegetation was removed and all fishes and macrofauna were eradicated. All ponds were treated with agricultural lime ($CaCO_3$) at a rate of 0.5 kg decimal$^{-1}$ and filled with water 7 days prior to fish stocking. The ponds were individually supplied by ground water with an adjacent shallow tube-well.

Thai climbing perch fries were collected from a nearby nursery called Matsha Projonon Kendra located at Tarakanda Upazila of Mymensingh district, Bangladesh. All fries were resealed in the experimental ponds in the afternoon. Afternoon was chosen to release fries in the ponds as the water temperature is more stable and the oxygen concentration in the pond water is generally higher in the afternoon than any other time of the day. Individual stocking weight of Thai climbing perch fry per pond

TABLE 1. Replication, pond size and stocking density of Thai climbing perch in treatment with 350 individuals per decimal, treatment with 400 individuals per decimal and treatment with 550 individuals per decimal

| Treatment | Replication | Pond size (dec) | Stocking density (dec) | Total no. of fish stocked |
|---|---|---|---|---|
| 350 ind. dec$^{-1}$ ($T_1$) | 1 | 60 | 350 | 21, 000 |
| | 2 | 60 | 350 | 21, 000 |
| 400 ind. dec$^{-1}$ ($T_2$) | 1 | 35 | 400 | 14,000 |
| | 2 | 60 | 400 | 24, 000 |
| 550 ind. dec$^{-1}$ ($T_3$) | 1 | 50 | 550 | 27,500 |
| | 2 | 50 | 550 | 27,500 |

ind, individuals; dec, decimal

ranged between 4.8 and 5.2 g. The diet containing 34% protein, 12.5% lipid, 21% carbohydrate and 15% ash was applied initially 20% of total fish weight per day. Gradually the feeding rate was reduced to 15, 12, 10, 8 and 5% of total fish weight per day. Feeding rates per pond were adjusted fortnightly after weighing minimum 20% of the fish stocked. The artificial feed was collected from Saudi Bangla feed company, Mymensingh, Bangladesh.

### FISH HARVESTING

At the end of the experiment, the ponds were drained and all fish were harvested and weighed. Specific growth rate (% body weight day$^{-1}$) was calculated using the formula of Day and Fleming (1992), $SGR = [\ln WT_f - \ln WT_i] \times 100/T$, where $WT_f$ is the average final fish weight (g), $WT_i$ is the average initial fish weight (g) and $T$ is the duration of the experiment (days).

### DATA ANALYSIS

All data were analyzed statistically using SPSS (Version 12.5) statistical software (SPSS. Inc., Chicago, USA) after they were checked for normal distribution and homogeneity of variance. Only percent data had to be arcsine transformed before analysis; however, non-transformed data are presented in tables. A one-way ANOVA was used to examine treatment effects (stocking density) on weight gain, survival, growth and production. If the effects were significant, difference between the means was analyzed by a post-hoc (Tukey test) for unplanned multiple comparison of mean ($p$<0.05 level of significance).

## RESULTS

### FISH YIELD PARAMETERS

The mean individual harvesting weight and length, weight and length gain, survival, specific growth rate of Thai climbing perch in different treatments are presented in Table 2. Stocking density (treatment) had significant effects ($p$<0.01) on all growth parameters, which were higher in ponds with lower stocking density than the ponds with higher stocking density. Harvesting weight and length, weight and length gain, survival, specific growth rate of Thai climbing perch decreased with increasing stocking density. Changes of average individual weight and length over time showed almost similar trend (i.e., $T_1$ was higher than $T_2$, followed by $T_3$) (Figure 1). However, the effects of stocking density was opposite on the average total yield of Thai climbing perch (i.e. average total yield was higher in $T_3$ than $T_2$, followed by $T_1$) (Figure 2). The average total yield in $T_3$ was 4,037 kg acre$^{-1}$, which was 1.4 and 1.3 times higher than the $T_1$ (2,872 kg acre$^{-1}$) and $T_2$ (3,132 kg acre$^{-1}$), respectively.

### COST-BENEFIT ANALYSIS

The cost-benefit analysis of Thai climbing perch culture under different treatments is given in Table 3. The analysis revealed that both total cost and total income were higher in $T_3$ than $T_2$, followed by $T_1$. When compared net profit with total cost, the net profit was 22.4% of the total cost in the $T_1$, 24.4% in $T_2$ and 35.3% in the $T_3$. When compared the net profit among three treatments, the net profit was highest in the $T_3$ (152,865.00 BDT acre$^{-1}$ 90 days$^{-1}$), which was 2 and 1.7 times higher than the net profit of $T_1$ (76,230.00 BDT acre$^{-1}$ 90 days$^{-1}$) and $T_2$ (89,140.00 BDT acre$^{-1}$ 90 days$^{-1}$), respectively.

## DISCUSSION

In intensive aquaculture, stocking density is an important indicator that determines the economic viability of the production system. Although a positive effect of stocking density on growth is reported in some species, it is well accepted that the stocking density is critical factor for many aquatic animal for their growth and survival (Rahman & Verdegem 2010; Weatherley 1976). Stocking density is related to the volume of water or surface area per fish. Increase in stocking density results in increasing stress,

TABLE 2. Effects of treatment on harvesting weight, weight gain, survival, specific growth rate, harvesting length and length gain of Thai climbing perch in treatment with 350 individuals per decimal, treatment with 400 individuals per decimal and treatment with 550 individuals per decimal based on one-way ANOVA

| Parameters | Significance ($p$ value) | Treatment mean ± standard deviation | | |
|---|---|---|---|---|
| | | 350 ind. dec$^{-1}$ | 400 ind. dec$^{-1}$ | 550 ind. dec$^{-1}$ |
| Harvesting weight (g) | ** | 90.03±0.04$^a$ | 87.73±0.95$^b$ | 84.15±0.49$^c$ |
| Weight gain (g) | ** | 85.03±0.04$^a$ | 82.73±0.95$^b$ | 79.15±0.49$^c$ |
| Survival (%) | ** | 96.57±0.03$^a$ | 94.75±0.07$^b$ | 92.72±0.49$^c$ |
| SGR (%/day) | ** | 3.21±0.001$^a$ | 3.18±0.01$^{ab}$ | 3.14±0.01$^b$ |
| Harvesting length (cm) | ** | 14.95±0.07$^a$ | 14.30±0.28$^{ab}$ | 13.55±0.07$^b$ |
| Length gain (cm) | ** | 11.14±0.07$^a$ | 10.49±0.28$^{ab}$ | 9.74±0.07$^b$ |

** $p$<0.01; NS, not significant; ind. dec$^{-1}$, indivduals per decimal; SGR, Specific growth rate

Mean values in the same row with no superscript in common differ significantly ($p$<0.05)

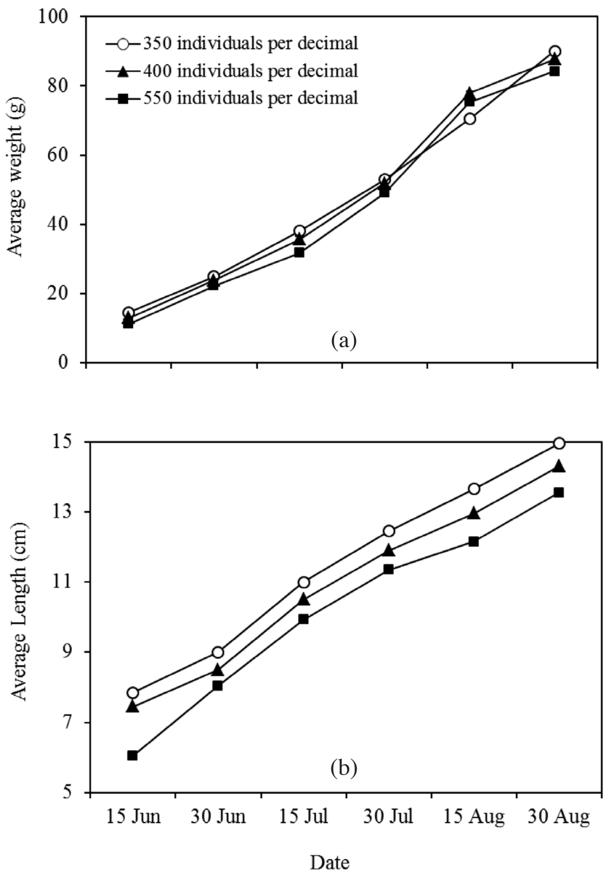


FIGURE 1. (a) Changes of average individual weight and (b) length in treatment with 350 individuals per decimal, treatment with 400 individuals per decimal and treatment with 550 individuals per decimal

which leads to higher energy requirements, causing a reduction in growth rate and food utilization. It is directly related with the competition for food and space (Rahman et al. 2008d, 2010; Rahman & Verdegem 2010). Generally, fish needs to compete less for food and space in lower stocking density than the higher stocking density. The present study provides an empirical evidence on the effects of Thai climbing perch stocking density on its growth and survival, where they (growth and survival) were higher in ponds with lower stocking density than the ponds with higher stocking density. There are no previous studies comparing the effects of Thai climbing perch density on its growth and survival in aquaculture ponds. However, Suresh & Lin (1992) reported decreasing growth of tilapia *Oreochromis niloticus* (Linnaeus 1758) with increasing stocking density. Similar effects of stocking density on survival and growth observed in a wide variety of fish species (Huang & Chiu 1997; Imsland et al. 2003; Irwin et al. 1999; Rahman 2006; Rahman & Verdegem 2007; Rahman et al. 2008a).

In the present study, the average individual fish weights were from 84 to 90 g after a three months culture period. This result was much better than the result of Mandal et al. (2010), who observed that the average individual harvesting weight of Thai climbing perch 27 ± 0.3 g in tilapia ponds after a 120 days culture period supplying with 35% protein content diet. The most plausible reason of lower average individual harvesting weight in their study might be high stocking density (2000 Thai climbing perch plus 2000 tilapia per decimal) and mix-culture with tilapia (a fish of same family). However, both stocking density and mix-culture might increase competition for food and space, which resulted in lower growth and harvesting weight of fish (Rahman et al. 2007;2008b;2010). However, the survival rate of Thai climbing perch in our study concurs with the results of Mandal et al. (2010), who also observed a high survival (96%) rate of Thai climbing perch.

In the present study, higher yield was observed at higher fish density while higher growth was observed at lower fish density. However, the relation between fish growth and fish yield was not linear. The plausible reason might be the average individual growth difference between treatments was very small compared to the difference of stocking density between treatments. The similar non-linear relation between fish growth and fish yield was

TABLE 3. Cost-benefits analysis (BDT/acre/90 days) of Thai climbing perch in treatment with 350 individuals per decimal, treatment with 400 individuals per decimal and treatment with 550 individuals per decimal

| Item | 350 ind. dec$^{-1}$ | 400 ind. dec$^{-1}$ | 550 ind. dec$^{-1}$ |
|---|---|---|---|
| Expenditure | | | |
| Pond preparation (Lime, labour, embankment repair) | 20,000.00 | 20,000.00 | 20,000.00 |
| Price of fry | 87,500.00 | 10,0000.00 | 137,500.00 |
| Feed cost | 183,000.00 | 195,000.00 | 225,000.00 |
| Manpower | 30,000.00 | 30,000.00 | 30,000.00 |
| Others (including leasing cost) | 20,000.00 | 20,000.00 | 20,000.00 |
| Gross cost (total) | 340,500.00 | 36,5000.00 | 432,500.00 |
| Income | | | |
| Gross income (total) | 416,730.00 | 454,140.00 | 585,365.00 |
| Net profit | 76,230.00 | 89,140.00 | 152,865.00 |

BDT, Bangladesh Taka; ind. dec$^{-1}$, indivuduals per decimal.
Selling price of fish: 145.00 BDT/kg fish (1 USD = 70.00 BDT)

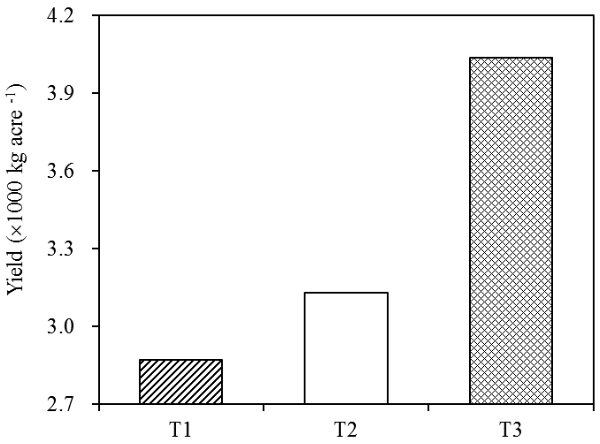


FIGURE 2. Total yield (kg acre-1) of fish in treatment with 350 individuals per decimal (T1), treatment with 400 individuals per decimal (T2) and treatment with 550 individuals per decimal (T3) over a 90-day culture period

also observed by Al-Harbi and Siddiqui (2000) in tilapia cultured in fiberglass tanks. The yield of Thai climbing perch in the present study was high (2900- 4,000 kg acre$^{-1}$ 90 days$^{-1}$), which was greater than the yield obtained by Thakur & Das (1986). They reported that the average yield of Thai climbing perch as 1800 kg ha$^{-1}$ after a 5-6 months culture period. The higher production in the present study might be due to supply of sufficient (5-20% of fish body weight) protein rich (34% crude protein) artificial feed. This resulted in low food competition between individuals, high survival and high fish growth.

Thai climbing perch has accessory respiratory organs. They could be farmed at high stocking density. More research is still needed to elucidate the effects of higher stocking density than 550 individuals per decimal on growth, survival and yield of Thai climbing perch in aquaculture ponds.

According to the cost-benefit analysis, all three systems in the present study were economically profitable. However, ponds with the stocking density of 550 individuals per decimal were the most profitable system. In the cost-benefit analysis, all input costs were strictly considered despite the fact that, in reality, most of the small-scale fish farmers use their own resources like lands and labors etc. In this case, cash input costs would be lower, and net profit would be higher than the present analysis.

In conclusion, the ponds with a stocking density of 550 individuals per decimal were the most profitable system. More research is still needed to further optimize stocking density of this fish in aquaculture ponds. Until then, stocking 550 individuals of Thai climbing perch per decimal will yield a good production to fish farmers in the South and South-East Asian regions.

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