International Journal of Natural and Social Sciences
ISSN: 2313-4461

Effects of stocking density on growth and production of monosex male tilapia in ponds

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ARTICLE INFO

Article history

Accepted 10 April 2018
Online release 16 April 2018

Keyword

Stocking density
Monosex tilapia
Male
Growth and production
Ponds

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ABSTRACT

To assess the effects of stocking density on growth and production of monosex male tilapia (*Oreochromis niloticus*) in ponds, an experiment was carried out during the period of two months from 14 March to 18 May 2013. Three stocking densities were used as 50, 100 and 150 fish /dec and designated the treatment as T_1, T_2 and T_3 respectively. Each treatment has three replications. Monosex male tilapia having a mean body weight of 0.117g was used in T_1, T_2 and T_3, respectively. A commercial feed fed at the rate of 30% body weight up to first 7 days and then gradually it was readjusted to 25%, 20%, 15%, 14%, 13%, 12% and 10%, respectively. The water quality parameters were monitored at 7 days interval and the ranges were: temperature 26.53 to 30.13°C, pH 6.68 to 8.71, dissolved oxygen 4.8 to 5.83mg/l and transparency 32.2 to 44.8 cm. At the end of the trial, the growth performance was evaluated by comparing mean final body weight and specific growth rate (SGR). The result of the present study showed that, the fish in T_1 stocked at the rate of 50 fish/dec resulted the best individual weight gain (35.97g) followed by T_2 (34.27g) and T_3 (32.13g) respectively. The SGR ranged between 8.77 and 8.95%. There was no significant variation ($P<0.01$) among the survival rate (%) which ranged from 74.56 to 78%. The production was 1.40, 2.58 and 3.59 kg/dec in T_1, T_2 and T_3, respectively. But the highest production of 3.59kg/dec was obtained in T_3 with stocking of 150 fish/dec due to higher stocking density. Although the highest production was obtained in T_3 but individually growth performance of monosex male tilapia was higher in T_1. Based on the result of present experiment, farmers could be suggested to rear tilapia (*O. niloticus*) at lower stocking density (50 fish/dec) to get higher growth and survival in a short period of time.

INTRODUCTION

The fisheries sector plays an important role in the agro-based economy of Bangladesh, through providing food and nutrition, alleviating poverty, creating employment opportunities and earning foreign exchange. Fisheries sector contributes 4.43% to the national GDP and 22.21% to the total agricultural GDP. The country's export earnings from this sector are 2.73% in 2010-11. Fish alone is supplementing about 60% of animal protein in our daily dietary requirement. The average growth rate of this sector during the last three years was 6.11%. About 10% of the total population is directly or indirectly employed in fisheries sector.

Tilapia is the common name applied to three genera of fish in the family Cichlidae, *Oreochromis*, *Sarotherodon* and Tilapia which are widely distributed in many countries of the world. Now it can be found in more than 100 countries. The species those are most important for aquaculture is in the genus *Oreochromis*, including the Nile tilapia (*O. niloticus*), the Mozambique tilapia (*O. mossambicus*) and the blue tilapia (*O. aureus*).

The introduction of tilapia in Bangladesh from Thailand was first initiated in 1954 with T. mossambicus and later in 1974, high yielding species of tilapia (*O. niloticus*) was introduced by UNICEF and Bangladesh Fisheries Research Institute (BFRI) in 1987 from Thailand and developed low input and low cost technologies. Tilapia has good resistance to poor water quality and disease, tolerance to a wide range of

How to cite this article: Alim A, Kamruzzaman, Rahman M and Amin MR (2018). Effects of stocking density on growth and production of monosex male tilapia in ponds. International Journal of Natural and Social Sciences, 5(2): 69-75.

environmental conditions, ability to convert efficiently the organic and domestic waste into high quality protein, rapid growth rate and tasty flavor.

Tilapia production is increasing rapidly in Asia, with an average annual growth rate of 10%, during 1989 to 1999. In 2002 the production was under 10,000 metric ton and by 2012 it had surpassed 100,000 metric ton in Bangladesh.

Manipulations of sexual phenotype designed to produce monosex populations are not straight forward and the results are not necessarily predictable. In the initial stage of monosex male tilapia farming the farmers must have adequate information about a proper stocking density to serve their purpose. For this, the present research has been conducted to determine some practical information on different stocking density including feeding with formulated diet. The main objectives of the research were to study the effect of stocking density on the growth and production performance of monosex male tilapia and to determine the suitable stocking density for culture of monosex male tilapia in ponds.

MATERIALS AND METHODS

Study area and period

The experiment was carried out for a period of two months from 14 March to 18 May 2013 to in nine experimental ponds situated in the Field Laboratory Complex, Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh.

Pond preparation

The area of each pond was 2 decimal with an average depth of 1.2 m all ponds were rectangular in shape, size and well exposed to sunlight. The ponds had facilities to provide water and water quality was maintained properly through routine exchange of water.

The ponds embankments were raised and repaired properly. Aquatic weeds were removed manually. Repeated netting was done for complete removal of unwanted fishes and other species. Liming was done at the rate of 1kg /decimal. After 3 days of liming ponds were filled with under ground water from deep tube-well. Cow dung was used 5 kg per decimal for plankton production.

Collection of fries

The monosex male tilapia fries (*O. niloticus*) were collected from the Reliance Hatchery, Mymensingh and transported to the farm in oxygen filled polythene bags covered by jute bags. After acclimatization the fries were transferred to culture pond.

Experimental design

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

Table 1
Experimental layout of monosex male tilapia culture in ponds.

Treatment	Replication (Pond no.)	Pond size (dec)	Stockig density/pond	Stocking size(g)
T_1	T_1R-1 (1)	2	100	0.117
	T_1R-2 (2)	2	100	0.117
	T_1R-3 (3)	2	100	0.117
T_2	T_2R-1 (4)	2	200	0.117
	T_2R-2 (5)	2	200	0.117
	T_2R-3 (6)	2	200	0.117
T_3	T_3R-1 (7)	2	300	0.117
	T_3R-2 (8)	2	300	0.117
	T_3R-3 (9)	2	300	0.117

Table 2
Average (Mean ±SE) values of water quality parameters under different treatments throughout the study period.

Treatments	Temperature (°C)	Dissolved Oxygen (mg/l)	pH	Transparency (cm)
T_1	28.08± 0.46	5.24±0.09	7.62±0.19	35.38±0.89
T_2	28.40±.42	5.39±0.13	7.36±0.15	38.58±1.27
T_3	28.38±0.41	5.3±0.09	7.40±0.12	39.38±1.33

Selection of feed

Commercial pellet feeds named "Saudi Bangla Fish Feed'' was selected for the present experiment. The proximate composition of different types of ''Saudi Bangla Fish Feed'' are protein (25.73%), lipid (8.60%), carbohydrate (25%), ash (21%) and average moisture (13.50%).

Feeding strategy

At the beginning of the experiment feed was supplied (1-7 days) at the rate of 30% of the body weight of reared monosex male tilapia and gradually it was readjusted to (8-14 days) 25%, to (15-22 days) 20%, to (23-29 days) 15%, (30-36 days) 14%, (37-43 days) 13%, (44-50 days) 12% and (51-64 days) 10% respectively. The fry were fed 2 times daily and sampling was done an interval of 7 days. Nursery feed were supplied until 29 days of rearing and then starter were provided until harvest.

Water quality parameters

Water temperature, dissolved oxygen, pH and transparency were recorded weekly during the study period and data were collected between 9.00 am to 11.00 am of the day.

Temperature of water was taken from each pond by using mercury Celsius thermometer (1 div: 0.l^{o}C). p^{H} was measured by an electric digital water proof pH meter (model: HANNA-211). Transparency was measured with a secchi disk of 15 cm diameter. To determine dissolve oxygen water samples were collected in black glass bottles with care to avoid any air bubble and immediately brought to the laboratory, and dissolved oxygen was measured by a portable DO meter (Lutron-5510).

Growth performance

Experimental data was collected during the growth trial to determine the cumulative weight, average daily weight gain, specific growth rate (SGR) and survival. At the end of the experiments, most of the fishes were caught by net and the rest by draining out the ponds for calculating rate and production (kg/dec/2 months).

Data analysis

The data obtained on the growth performance of fish, survival rate and production were statistically analyzed to see whether the influence of different treatments (stocking densities) on these parameters were significant or not. One way analysis of variance (ANOVA) was done with the help of SPSS (Statistical Package for the Social Sciences).

Economical analysis

A simple economical analysis was performed to estimate the net profit of rearing of monosex male tilapia (*Oreochromis niloticus*). The cost of nursery and starter-1 feed was BDT 40/kg and BDT 37.5/kg, respectively. From the experiment it was found that the average cost of three treatments BDT 1208.33. Production (kg/dec) was 8.4 kg in T_1, 15.48 kg in T_2 and 21.54 kg in T_3 and price of fish per kg was BDT 115 in T_1,BDT 110 in T_2, and BDT 110 in T_3.

RESULTS & DISCUSSION

Water quality parameters

The temperature varies for each of the 3 treatments. The temperature ranged from 26.53ºC to 30.13°C during the study period. The maximum water temperature was 30.13°C in T_1 in 6th week and the minimum water temperature was found 26.53°C in T_3 in 1st week. The means (±SE) values of water temperature were recorded (28.08±0.46), (28.40±.42) and (28.38±0.41) in T_1, T_2 and T_3, respectively and variation of temperature among the treatments. Dewan (1991), Nirod (1997), Rahman (2000), Kohinoor (2000), Sarker (2000), Hasan (2007), and Maghna (2012) who measured water temperature in ponds of BAU Campus, Mymensingh and found to vary from 29 to 32˚C, 21.8 to31.10˚C, 29.7 to 29.9˚C, 18.5 to 32.9˚C, 19.8 to 22.8˚C, 21 to 32.8˚C and 32 to 34.3˚C, respectively.

The pH ranged from 6.68 to 8.71. The highest value of pH 8.71 was recorded from T_1 in 3rd week and the lowest value 6.68 was recorded from T_2 in 2nd week. The means (±SE) values of pH were recorded (7.62±0.19), (7.36±0.15) and (7.40±0.12) in T_1, T_2 and T_3, respectively. In the present study pH values were slightly alkaline which indicated good pH conditions for fry nursing. Dewan (1991), Nirod (1997), Rahman (2000), Kohinoor (2000), Sarker (2000), Hasan (2007) and Maghna (2012)who measured pH in ponds of BAU Campus, Mymensingh and found to vary from 6.6 to 8.8, 6.5 to 8.5, 4.9 to 5.2, 6.5 to 8.0, 6.8 to 8.3, 6.5 to 7.9 and 7.6 to 8.3, respectively. The pH values were within the suitable ranges.

The dissolved oxygen ranged from 4.8 to 5.83mg/l. The maximum dissolved oxygen was 5.83mg/l in treatment T_2 in 2nd week and the minimum dissolved oxygen was found 4.8mg/l in treatment T_1 in 2nd week. The means (±SE) values of water temperature were recorded (5.24±0.09), (5.39±0.13) and (5.3±0.09) in T_1, T_2 and T_3 respectively. Dissolved oxygen of a water body is very important factor for fish culture. Dewan (1991), Nirod (1997), Rahman (2000), Kohinoor (2000), Sarker (2000), Hasan (2007), and Maghna (2012) who measured dissolved oxygen (mg/1)in ponds of BAU Campus, Mymensingh In the present study the mean dissolved oxygen values were within the suitable range.

The values of water transparency were noted to vary from 32.2 to 44.8 cm. Remarkable variation of water transparency were found in the ponds throughout the study period with the minimum values of 32.2 cm from T_1 in 9th week and the maximum values of 44.8 cm from T_3 in 1st week. Dewan (1991), Nirod(1997), Rahman (2000), Kohinoor (2000), Sarker (2000) and Maghna (2012) who measured water transparency (cm) in ponds of BAU Campus, Mymensingh.

Growth performance

The growth rate of monosex male tilapia (*O. niloticus*) under different stocking densities were recorded weekly. The result indicated higher growth in weight (g) at lower stocking densities and growth rate gradually decreased with increasing densities.

Mean weight gain (g)

Significantly ($p<0.01$) highest mean weight gain (g) was 35.85g in T_1 and lowest mean weight gain (g) was 32.02g in T_3 (Table 3, Figure 1). The highest mean weight gain in T_1 with lowest stocking density of 50/dec compared to other T_2 (100/dec) and T_3 (150/dec) although same feed was supplied in all treatments. These results stated that lower stocking density reduces competition among the fishes which influenced them to take feed properly and it might be absent in the treatments with higher stocking densities. The results agreed with the findings of Kawamoto et al. (1957) and Roy (2009) who achieved the best growth at lower stocking densities. Rahim (2010) obtained highest weight gain (10.64g) in lower stocking densities compared to higher stocking densities.

Percent weight gain (%)

There was significant difference ($p<0.01$) among the different treatments. The highest mean value (30640.74±496.74) of percent weight gain was found in T_1 whereas the lowest mean value (27364.39±543.55) of percent weight gain was found in T_3. The results indicated that the percent weight gain varied in different stocking densities which coincides with the findings of Rahim (2010). He found percent weight gain ranged from 3971 to 5415%.

Table 3
Average (Mean ± SE) values of growth parameters of monosex male tilapia (*O. niloticus*) under different treatments during the study period.

Weight (g)	Treatments			LSD	Level of significance.
	T_1	T_2	T_3		
Initial weight (g)	0.117	0.117	0.117	-	NS
Final weight (g)	35.97±0.58a	34.27±0.16a	32.13±0.67b	1.51	**
Weight gain (g)	35.85±0.58a	34.15±0.16a	32.02±0.67b	1.51	**
(%) Weight gain	30640.74±496.74a	29187.75±124.18a	27364.39±543.55b	1292.04	**
Average daily wt gain (g)	0.560±0.009a	0.534±0.002a	0.500±0.01b	0.017	**
SGR (%/day)	8.95±0.025a	8.87±0.007a	8.77±0.01b	0.08	**
Survival rate (%)	78.00±2.31b	75.17±1.74b	74.56±0.99b	5.29	NS
Production (kg/dec)	1.40±0.064c	2.58±0.07b	3.59±0.11a	0.25	**

**= significant at 1% level of probability (P≤0.01); NS= Not significant
In column figures with same or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT)

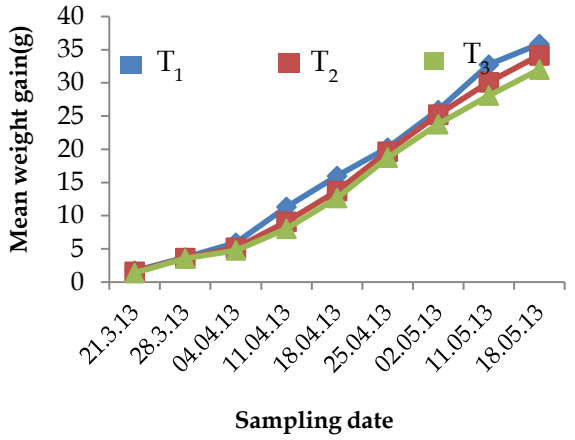

Figure 1
Weekly mean weight gain (g) (±SD) of monosex male tilapia (*O. niloticus*) under different treatments during the study period.

Specific growth rate (SGR) (%/day)

The values of specific growth rate of monosex male tilapia were observed 8.95%, 8.87% and 8.77% in treatments T_1, T_2 and T_3, respectively (Table 3). There was significant difference (P<0.01) among the different treatments. Islam (2007), Begum (2009) and Rahim (2010) who recorded specific growth rate ranged 2.363 to 2.655%, 3.65 to 3.79% and 3.09 to 3.34%. They obtained the highest values of specific growth rate at lowest stocking densities.

Average daily weight gain (g)

Highest average daily weight gain (g) was 0.56g in T_1 and lowest average daily weight gain (g) was 0.50g in T_3 (Table 3). There was a significant difference among the highest values of 0.56g in T_1 followed by T_2 and T_3.

Survival rate (%)

The highest survivability was recorded in T_1 (78%) and the lowest survivability was in T_3 (74.56%) (Table 3). There was no significant difference (P<0.01) among the different treatments. A similar survival rate was observed by Hasan (2007), Begum (2009) and Rahim (2010) who recorded survival rate ranged from 79.44 to 89.83%, 84 to 92% and 78.67% to 85.67%. Survival rate was found to be negatively influenced by different stocking densities such as the lowest stocking density showed the highest survivability.

Production (kg / decimal / 2 months)

The highest production was observed 21.54 Kg/dec/2 months in T_3 and the lowest production was observed to be 8.4 Kg/dec/2 months in T_1 (Table 3). Although the mean weight gain (g) in T_1 was highest but total production was highest in T_3 which might be due to higher number of fishes.

The present result supports the findings of Begum (2009) and Rahim (2010) who achieved the best production from higher stocking densities compared to that achieved with the lower ones.

Cost benefit ratio

From the experiment it was found that the highest net profit was BDT 587.8 in T_2. That time the market price was BDT 115/kg fish. Culture of monosex male tilapia (*O. niloticus*) at stocking density (100 fish/dec) showed higher benefit in short period of time. 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 is 1.40. So it can be said that the cost benefit ratio in T_2 was more beneficial than T_1 and T_3.

Under the experimental condition, different treatments showed different growth rates. It was found that the total production was increased with the increase of stocking density. But the individual fish growth rate was decreased with the increase of stocking density. Although the individual weight gain in T_1 was highest but total production was highest in T_3 (21.54 Kg/dec/2 months) which might be due to higher number of fishes. Based on the this experimental condition, it can be recommended that the optimum stocking density for monosex male tilapia was 200 fish/pond with respect to growth, as the size of the fish influences the market price.

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