Effect of stocking density on the growth and survival of monosex male tilapia (*Oreochromis niloticus)* fry (GIFTstrain) in hapa

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Abstract: An experiment was conducted for a period of 35 days to evaluate the effect of stocking density on the growth performances, survivability and water quality parameters of monosex male tilapia *(Oreochromis niloticus)* fry .There were five treatments with two replications. Stocking density (no./m^2)of 12 days old fry (0.0117g) were done at the rate of 702, 937,1250,1562,1952 per hapa in T_1, T_2, T_3, T_4 and T_5 treatments, respectively. They were fed with hormone (17α methyl testosterone) mixed feed (Saudi Bangla fish feed containing 35% protein) 5 times daily up to their satiation level. The water quality parameters such as water temperature, dissolved oxygen and P^H were measured weekly. The water temperature ranged from 26.9°C to 32.5°C; dissolved oxygen from 5.50 to 6.60 mg/l and P^H from 7.72 to 8.30 were recorded during the study period. There were no significant differences (P<0.01) of water quality parameters among the treatments. The highest mean cumulative weight (g) was 0.3465 in T_1 and the lowest was 0.1235 in T_5, the highest mean weight gain (g) was 0.3345 in T_1 and the lowest was 0.111 in T_5, the highest mean percent weight gain (%) was 2861.53 in T_1 and the lowest was 951.28 in T_5, the highest average daily weight gain (g) was 0.0095 in T_1 and the lowest was 0.0032 in T_5, the highest specific growth rate (%/day) was 0.0968 in T_1 and the lowest was 0.0672 in T_5, the highest survival rate (%) was 93.45% in T_1 and the lowest was 70.62% in T_5 and the highest production (g/m^2/35 days) was 219.62g in T_1 and the lowest production was 13.37 in T_5. There were significantly differences (P<0.01) in mean cumulative weight (g), mean weight gain (g), mean percent weight gain (%), average daily weight daily gain (g), specific growth rate (%/day), survival rate (%) and production(g/m^2/35days) of fish under different treatments.Considering the experiment, it could be suggested that lower stocking density (702/m^2) resulted the highest production of monosex male tilapia fry nursing with maximum utilization of artificial feeding without feed competition.

Key words: *Oreochromis niloticus*, monosex, 17α methyl testosterone, cumulative weight

Introduction

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 (Ballarin and Hallar, 1987).The species that are most important for aquaculture are in the genus *Oreochromis,* including the Nile tilapia *(O, niloticus)*, the Mozambique tilapia *(O. mossambicus)* and the blue tilapia (*O. aureus).* Tilapia has good resistance to poor water quality and disease, tolerance to a wide range of environmental conditions, ability to convert efficiently the organic and domestic waste into high quality protein, rapid growth rate and tasty flavor (Balarin and Hallar, 1987) Tilapia can tolerate dissolved oxygen concentration of 1 mg/l and can survive by using atmospheric oxygen when dawn DO concentration dropped to less than 1 mg/l. It has also the ability to survive under extremely low dissolved oxygen rich surface water layer by reducing activity (Chervinski, 1982).

Fish farms raise tilapia in ditches, ponds, cages, pens and concrete tanks, depending on the nature of their farmland and on their capacity to invest. The use of monosex fish is intrinsically desirable in a variety of fish species in a range of aquaculture production systems. The potential advantages sought from their use may include one or more of the following features: achievement of higher average growth rate, elimination of reproduction, reduction of sexual/territorial behavior, production of variation in harvest size, and reduction of risk of environmental impact resulting from escapes of exotic species. Fish as a group have systems of sex determination which are of considerable biological interest and significance for studies in evolutionary biology. However, they are very variable, relatively poorly understood and give rise to much variation in sex ratio between and within species. Enough is known, however, to enable us to say that these systems are often employed in ways which sharply distinguish the fishes from groups such as mammals, birds and reptiles. As a consequence, manipulations of sexual phenotype designed to produce monosex populations are not straightforward and the results are not necessarily predictable.

At this initial stage of monosex male tilapia farming, the farmers must have adequate information about a proper stocking density to serve their purpose. With this point of view, the present research has been designed primarily to understand some practical information on different stocking options including feeding on formulated diet. The main objectives are to determine the suitable stocking density for culture of monosex male tilapia fry in nursing system and to understand the effect of stocking density on the growth, survival and production of monosex male tilapia fed on a commercial feed.

Materials and Methods

The experiment was conducted in a private fish hatchery and farm "Agro-3" in Trishal Upazilla, Mymensingh. The size of research pond was 40 decimal. The experimental hapa (1m^2) were set at the corner of the pond and rest space of the pond was used by the hatchery owner for commercial purposes. The water depth was maintained at a maximum of 1.2m. Each experimental hapa was sunk under water about 2ft and just above the bottom and the rest of hapa were in surface of the water. There was well organized inlet and outlet system to maintain suitable water level in the pond. Water quality was maintained properly through routine exchange of water. The experiment was carried out for a period from 21 March to 5 May, 2009 to evaluate the effect of stocking density on the growth and survival of Tilapia fry in treatmented hapa. 12 days old fry was stocked in the hapa. Pond drying and remaining 7-10 days under sunlight until the bottom become hard. Liming was applied at the rate of 1 kg per decimal. After 3 days of liming underground water was entered in the pond. For this experiment 10 hapa each having an area of $1m^2$ hapa was used. A total of 5-treatments were used for this experiment. The treatments were T_1 (702fry/m^2), T_2 (937fry/m^2), T_3 (1250fry/m^2), T_4 (1562fry/m^2), and T_5 (1952fry/m^2) each with 2 replications. Company produced formulated nursery feed were used. Feed composition of Saudi Bangla nursery feed was Moisture-12 %(max), Protein-35 %(min), Fat-5 %(min), CHO-32 %(max) and Ash- 16% (max). During the rearing period feed was supplied at the rate of First week - 30%, Second week- 25%, Third week - 20%, Fourth week -15% and Fifth week - 10% of the body weight. The fry were fed 5 times daily during the nursing period (35 days). Sampling was done regularly at an interval of 7 days. Water temperature, p^H and dissolved oxygen were recorded daily and this data were collected between 1 PM to 2 PM of the day. Mean cumulative weight, mean weight gain (g), percent weight gain (%), average daily weight gain (g), specific growth rate (SGR) (%/ day), survival rate (%) and production (g/m^2/35days) data was collected during the growth trial.

Results

The result of the present experiment on growth and survival of Tilapia (GIFT strain) fry (*O. niloticus)* have been described bellow: The water quality parameters such as temperature, P^H and dissolved oxygen of all treatments were monitored weekly during the experimental period and values of these parameters are shown in Table 1. The experimental hapa (all treatments) were set in same pond. So the temperature fluctuation, dissolved oxygen and P^H was same for each of the 5 treatments. The temperature ranged from 26.9°C to 32.5°C. The average temperature was 29.6°C. The P^H ranged from 7.72 to 8.30. The average P^H was 7.87. The dissolved oxygen ranged from 5.5 to 6.5. The average dissolved oxygen was 6.06 during the experimental period.

Table 1. Weekly fluctuations of water quality parameters of the pond under different treatments during the experimental period

Parameters	Treatments	Sampling date						Average
		1st 21/03/09	2nd 28/03/09	3rd 04/04/09	4th 11/04/09	5th 18/04/09	6th 25/04/09	
Temp.(^{0}C)	$T_1 – T_5$	30.8	27.5	26.9	29.7	30.2	32.5	29.6
P^H	$T_1 – T_5$	7.72	7.54	7.60	8.30	8.18	7.90	7.87
Dissolved Oxygen(mg/l)	$T_1 – T_5$	6.50	5.50	6.50	6.30	5.60	6.00	6.06

Table 2. Mean cumulative weight, mean weight gain, mean percent weight gain, specific growth rate and average daily weight gain (g) of monosex male Tilapia (*O. niloticus*) fry under different treatments over a period of 35 days

Parameters	Initial wt. (g) 21/03/09	Treatments				
		Last sampling date (25/04/09)				
		T_1	T_2	T_3	T_4	T_5
Mean cumulative weight (g) (±SD)	0.0117	0.3465 ±0.0064	0.2885±0.0042	0.2015±0.0008	0.1605±0.0021	0.1235±0.0014
Mean weight gain (g) (±SD)		0.2123 ±0.1501	0.1503 ±0.1062	0.01303 ±0.0921	0.1158 ±0.0818	0.0798 ±0.0564
Mean percent weight gain (%) (±SD)		158.197 ±0.0552	127.698 ±0.0231	183.006 ±0.0417	259.06 ±0.0503	182.609 ±0.0255
Specific Growth Rate (SGR) (%/day) (±SD)		0.5699 ±0.0806	0.0450 ±0.0512	0.07523 ±0.0583	0.09080 ±0.0533	0.07413 ±0.0353
Average daily weight gain (g)		0.03032	0.0214	0.01861	0.01654	0.0114

Table 3. Survival rate (%) of monosex Tilapia (*O. niloticus*) fry under different treatments over a period of 35 days

Treatments	Stocking of fish (Initial No)	Total harvest (Final No)	Total Mortality (No)	Survival rate (%)
T_1	702	656	46	93.45
T_2	937	837	100	89.33
T_3	1250	1060	189	84.84
T_4	1562	1236	325	79.16
T_5	1952	1378	573	70.62

Table 4. Production (g /m^2 / 35 days) of monosex Tilapia (*O. niloticus*) fry under different treatments over a period of 35 days

Treatments	Initial weight (g)	Final weight (g)	No. at harvest	Production (g /m^2 / 35days)
T_1	0.0117	0.3465	656	219.63
T_2	0.0117	0.268	837	214.52
T_3	0.0117	0.2015	1060	201.18
T_4	0.0117	0.1605	1236	183.92
T_5	0.0117	0.1235	1378	154.06

Growth performances of monosex male Tilapia (O. niloticus) fry in relation to different stocking densities: The growth rate of monosex male Tilapia (*O. niloticus)* fry under different stocking densities were recorded weekly and the results of growth performances have been presented in Table 2. The result indicated higher growth in weight (g) at lower stocking densities and growth rate gradually decreased with increasing densities. The growth performances of Tilapia fry in terms of mean cumulative weight (g), mean weight gain (g), mean percent weight gain (%), average daily weight gain (g), specific growth rate (SGR) (%/day), survival rate (%) and production (g/m^2/35days) are summarized in Table 6. Mean cumulative weight of monosex Tilapia fry varied significantly among the treatments and ranged between 0.1235 ± 0.0014g and 0.3465 ± 0.0063g. The mean weight is 0.3465 ± 0.0063g in T_1 significantly higher (*P<0.01*) than the other treatments. Mean weight gain of Tilapia fry varied considerably among the treatments. Mean weight gain ranged between 0.111 ± 0.0014 and 0.3345 ± 0.0063g. Mean weight gain were 0.3345g in T_1 0.2765g in T_2, 0.1895g in T_3, 0.1485g in T_4 and 0.111g in T_5. Among the treatments the mean weight gain was significantly higher (*P<0.01)* in T_1 (0.3345 ± 0.0063g) than other treatments.

Table 5. Final measurement of length and weight of monosex Tilapia fry (*O. niloticus) under* different treatments over the period of 35 days

Treatments	Replications	Size group	Weight (gm)	Length range(cm)
T_1	R_1	Oversize	1.67	4-5.1
		Medium	0.68	3-3.9
		Small	0.23	2-2.9
		Very small	0.15	1.5-1.9
	R_2	Oversize	2.21	4-5.5
		Medium	0.63	3-3.9
		Small	0.23	2-2.9
		Very small	0.16	1.5-1.9
T_2	R_1	Oversize	2.17	4-5.5
		Medium	0.61	3-3.9
		Small	0.22	2-2.9
		Very small	0.15	1.5-1.9
	R_2	Exceptional	5.0	6-6.2
		Oversize	2.21	4-5.5
		Medium	0.61	3-3.9
		Small	0.21	2-2.9
		Very small	0.14	1.5-1.9
T_3	R_1	Exceptional	6.0	6.5-6.8
		Oversize	2.67	4-5.5
		Medium	0.51	3-3.9
		Small	0.21	2-2.9
		Very small	0.15	1.5-1.9
	R_2	Exceptional	5.5	6.2-6.4
		Oversize	2.54	4-5.5
		Medium	0.51	3-3.9
		Small	0.21	2-2.9
		Very small	0.15	1.5-1.9
T_4	R_1	Exceptional	5.0	6.1
		Oversize	2.40	4-5.5
		Medium	0.47	3-3.9
		Small	0.19	2-2.9
		Very small	0.15	1.5-1.9
	R_2	Oversize	2.67	4-5.5
		Medium	0.48	3-3.9
		Small	0.19	2-2.9
		Very small	0.14	1.5-1.9
T_5	R_1	Oversize	2.5	4-5.5
		Medium	0.36	3-3.9
		Small	0.16	2-2.9
		Very small	0.13	1.2-1.9
	R_2	Exceptional	5.7	6.4
		Oversize	2.57	4-5.5
		Medium	0.38	3-3.9
		Small	0.16	2-2.9
		Very small	0.13	1.2-1.9

Table 6. Comparison of mean (±SD) of growth parameters of monosex Tilapia (*O. niloticus*) fry in different treatments over a period of 35

Growth Performance measures	Treatments				
	T_1	T_2	T_3	T_4	T_5
Mean weight (g)	0.3465 ± 0.0063^a	0.2885 ± 0.0042^b	0.2015 ± 0.0007^c	0.1605 ± 0.0021^d	0.1235 ± 0.0014^e
Mean weight gain (g)	0.3345 ± 0.0063^a	0.2765 ± 0.0035^b	0.1895 ± 0.0007^c	0.1485 ± 0.0021^d	0.1110 ± 0.0014^e
Mean percent weight gain (%)	2861.53 ± 54.39^a	2365.81 ± 30.22^b	1622.22 ± 6.04^c	1271.79 ± 18.13^d	951.28 ± 12.08^e
Average daily weight gain (g)	0.0095 ± 0.0002^a	0.0079 ± 0.0001^b	0.0054 ± 0.0001^c	0.0042 ± 0.0001^d	0.0032 ± 0.0001^e
Specific growth rate (%/ day)	0.0968 ± 0.0005^a	0.0915 ± 0.0004^b	0.0813 ± 0.0001^c	0.0748 ± 0.0004^d	0.0672 ± 0.0003^e
Survival rate(%)	93.45^a	89.33^b	84.44^c	79.16^d	70.62^e
Production (g/m^2/ 35 days)	219.62 ± 4.17^a	214.68 ± 2.95^b	201.18 ± 0.74^c	183.91 ± 2.62^d	153.37 ± 1.94^e

***** Mean values with different superscript letters in the same row were significantly different (*P<0.01*).

The highest percent weight gain (%) of Tilapia fry was 2861.53% in T_1 and the lowest percent weight gain (%) was 951.28% in T_5. The percent weight gain (%) in different treatments were 2861.53% in T_1, 2365.81 in T_2, 1622.22% in T_3, 1271.795 in T_4 and 951.28% in T_5. The percent weight gain (%) in T_1 was significantly (*P<0.01)* higher than other treatments.

The highest mean values of SGR (%/day) of Tilapia fry was 0.0968 ± 0.0005%/day was in T_1 and the lowest specific growth rate was 0.0672 ± 0.0003% /day in T_5. The specific growth rate in T_1 was significantly (*P<0.01)* higher differences than other treatments. The average daily weight gain (ADG) (g) of Tilapia fry in different treatments were 0.0095±0.0002g for T_1, 0.0076 ± 0.0001g for T_2, 0.0054 ± 0.0001g for T_3, 0.0042±0.0001g for T_4 and 0.0032±0.0001g for T_5. The highest ADG (g) was 0.0095 in $T^1$and the lowest ADG (g) was 0.0095 in T_1.The significantly (*P<0.01)* highest average daily weight gain (g) was 0.0032 in T_5. The average daily gain (g) was significantly (*P<0.01)* higher than other treatments (Table 2). The survival rate (%) of mnosex Tilapia fry in different treatments was fairly high.

The survival rate ranged from 70.62% to 93.45%.The Survival rates were 93.45%, 89.33%, 84.44%, 79.16% and 70.62% in T_1, T_2, T_3, T_4 and T_5 respectively. The survival rate (%) was significantly (*P<0.01)* higher in T_1 than other treatments (Table 3). The production of Tilapia fry were 219.62g/m^2/35days, 214.68g/m^2/35days, 210.18 g/m^2/ 35 days, 183.91g/m^2/35days and 153.37g/m^2/35days for T_1, T_2, T_3, T_4 and T_5 respectively. The highest production was 219.62 g/m^2/35days in T_1 and the lowest production was 153.37 g/m^2/35days in T_5. The production in T_1 was significantly (*P<0.01)* higher than other treatments (Table 4). During the study period it was observed that, monsex Tilapia fry showed various size groups in each treatment. Very few fry became exceptionally large in size, some were medium in size, some were small in size and some were very small in size. Among the size groups of fry, the small size group was maximum in number in each treatment. The observed differences in size variations are shown in (Table 5).

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. Growth, reproduction and other biological activities of fish are largely depends on temperature. Therefore temperature has a marked effect on overall production of fish. For 1°C rise of temperature metabolic rate of fish increases by 10%. In warm water fish, maximal metabolic rate is observed at temperature range of 30^{0}C – 35°C. During the present study, the water temperatures were between 26.9^0 and 32.5°C. Haque (2005) found almost similar results. Chowdhury (2005) stated that the water temperature ranged from 25 to 35^{0}C is suitable for fish culture. Jhingran (1991) reported that the suitable temperature ranges for production of plankton in tropical ponds were between 18.3°C and 370C. Dissolved oxygen of a water body is very important factor for fish culture. Fishes living in a water body with insufficient dissolved oxygen become physiologically weak and for this physiological weakness fishes become vulnerable to diseases. Haque (2005) found more or less similar results. According to Rahman (2000) dissolved oxygen content of a productive pond should be 5mg/l or more. Kohinoor (2000) measured dissolved oxygen 2 to 7.4 mg/L, while Uddin (2002) recorded dissolved oxygen 2.2 to 8.8 mg/l in the ponds.

P^H is considered as an important factor in fish culture. It indicates the acidity-alkalinity condition of a water body. It is also called the productivity index of a water body. During the present study pH values were slightly alkaline which indicated good pH conditions for fry nursing and weekly fluctuations of the pH values. Chowdhury (2005) found almost similar results. Hussain *et al.* (2000) found pH 6.7 to 8.3 while Kohinoor *et al.* (1998) recorded pH 7.2 to 7.3 in the research ponds of BAU campus, Mymensingh. Water temperature, dissolved oxygen and P^H values were within the suitable range. Thus it may be concluded that all of water quality parameters were suitable for fish culture.

Growth performances: During the present study, growth performance of monsex Tilapia *(O. niloticus)* fry was investigated in this experiment. The highest weight gain was 0.3345g in T_1 with lowest stocking density of 702/m^3 compared to other treatments T_2 (937/m^2), T_3 (1250/m^2), T_4 (1562/m^2) and T_5 (1952/m^2), although same feed was supplied in all treatments. These phenomenon indicated that there was a lower stocking density reduces community feelings among the fishes which influenced them to take feed properly and it might be absent in the treatments with higher stocking densities. The present results agreed with the findings of Hossain *et al*. (2004) who achieved the best growth at lower stocking densities. Leboute *et al.* (1994) obtain highest weight gain in lower stocking densities compared to higher stocking densities. Cruz and Ridha (1989) observed that performance of *O. spilurus* in nursing phase for 68 days in cages. They found no significant differences in mean individual final weight, daily weight gain and survival rate among three stocking densities, but considerable higher yields were obtained when stocked with 400 and 600 fish/m^2 compared to that of 200 fry/ m^2.

During the present study it is observed that there were significant differences among the treatments. Mean cumulative weight (g), mean weight gain (g), average daily weight gain (g), percent weight gain (%), specific growth rate (%/ day), survival rate (%) and production (g/m^2/35 days) were significantly different at 1% level of significance. The mean cumulative weight 0.3465±0.0063g, mean weight gain 0.3345±0.0063g, average daily weight gain 0.0095±0.0002g, specific growth rate 0.0968±0.0005%/day and the percent weight gain 2861.53±54.39 were significantly higher in T_1 than other treatments (T_2, T_3, T_4, T_5) respectively.

From the experiment it was found that the growth and survivability were increased with the decreasing of density and the growth and survivability were decreased with the increasing of density. Based on the results of the present experiment, farmers could be suggested to rear tilapia *(O. niloticus)* fry at lower stocking density (702/1m^2) to get higher growth and survival in a short period of time. Further studies are necessary for a longer period to gain better knowledge before going for mass production.

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