Bangladesh J. Fish. Res., 14(1-2), 2010: 45-53

Effects of stocking density on growth and production of GIFT (*Oreochromis niloticus*)

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Abstract
The study was carried out to assess the effects of stocking density on growth and production of GIFT for a period of 100 days. Three stocking densities were used 150, 200 and 250 fish/decimal; designated as treatment T_1, T_2 and T_3 respectively having two replicates for each. Commercial pellet feeds were fed at the rate of 30% body weight up to first 10 days and then gradually it was readjusted to 22%, 18%, 15%, 12% 10%, 8%, 6%, 5% and 4% respectively after every 10 days interval. The result showed that the fish in the treatment T_1 stocked with the lowest stocking density (150 fish/dec) resulted in best individual weight gain (148.65g) followed by those in treatment T_2 and T_3 respectively. The specific growth rates (SGR) at every 10 days were ranged from 6.59 to 1.11 in different treatments during the experimental period. The food conversion ratio (FCR) values ranged between 1.82 to 2.03 with treatment T_1 showing the lowest FCR. The survival rate ranged between 84 to 92 %. Treatment T_1 and treatment T_2 showed significantly higher survival than Treatment T_3. The fish production rate in treatment T_1, T2 and T_3 were 18.58, 23.87 and 26.78 kg/decimal respectively.

Key words: GIFT, Stocking density

Introduction

The GIFT strain was developed by the International Center for Living Aquatic Resources Management (ICLARM) through several generations of selection from a base population involving eight different strains of Nile tilapia, *Oreochromis niloticus* (Eknath *et. al.* 1993). GIFT tilapia is a hardy fish, which can survive in shallow and turbid water conditions and is a good converter of organic matter into high quality protein. Its rapid growth rate and tasty flavour (Balarin and Haller 1982, Pullin and Lowe-McConnel 1982) has been identified as one potential species. It also indicates that tilapia has made a significant contribution to food production, poverty alleviation and livelihoods support in the Asia and the Pacific. To optimize utilization of small water bodies for productive fish culture, researches have undertaken to identify suitable species for short

cycle aquaculture and developed low-cost management systems for optimizing production.

Stocking density is an important parameter in fish culture operations, since it has direct effects on the growth and survival and hence on production. It is an established fact that growth rate of fishes progressively increase as the stocking densities decreases and vice-versa. This was because of relatively less number of fish in a pond of similar size could get more space, food and dissolved oxygen at the same time. Stocking densities and management measures practiced by pond operators in Bangladesh are not based on scientific knowledge, thus resulting in poor growth and survival of fry. To obtain maximum economic returns it would be necessary to stock the ponds at optimum stocking densities for optimum growth in relation to inputs and productivity of the water body. The study was undertaken to study the effect of stocking density of GIFT tilapia culture under the same feed and management conditions.

Materials and methods

The experiment was carried out for a period of 100 days during February to May, 2007 in six selected experimental ponds of "*Nagla Fisheries Ltd.*", Haluaghat, Mymensingh. The size of each pond was 80 decimal and the ponds were indicated by the numbers 1, 4, 2, 5, 3, 6 respectively. The ponds were similar in respect of depth, basin configuration and pattern including water supply facilities. The water depth was maintained at a maximum of 1.2 m. There was well organized inlet and outlet system to maintain suitable water level. The ponds were surrounded by fine meshed nylon nets to prevent entering of frogs and fish eating animals. Water quality was maintained properly through exchange of water during the experimental period.

Experimental design

The ponds were selected randomly. The experimental layout is shown in Table 1.

Table 1. Experimental layout of GIFT tilapia culture

Treatment	Replication (Pond No.)	Pond Size (decimal)	Stocking density (nos./dec)	Total no. of stocking	Average wt. at stocking (g)
T-1	R-1 (1)	80	150	12000	3.0
	R-2 (4)	80	150	12000	3.0
T-2	R-1 (2)	80	200	16000	3.0
	R-2 (5)	80	200	16000	3.0
T-3	R-1 (3)	80	250	20000	3.0
	R-2 (6)	80	250	20000	3.0

After draining out of water, the ponds were fully dried and subsequently crushed limestone was spread on the pond bottom @250 kg ha^{-1}. After 3 days ponds were filled with water from deep tube-well and then cow-dung was applied @1000 kg/ha for phytoplankton production. The water depth was maintained at around 1.2 meter throughout the experiment. Fish were stocked after one week of fertilization.

The GIFT tilapia fries were collected from the Reliance Hatchery, Trishal, Mymensingh and transported to the farm in oxygenated polythene bags covered by jute bags. The fries were released to the culture ponds after sufficient acclimatization. Locally available commercial pellet feeds named "Quality feeds" was selected for the experiment. This pellet feed was examined and used due to having appreciable stability in water and nutritive value within the normal range. The proximate compositions of different types of "Quality feeds" are given in Table 2.

Table 2. Proximate composition of different types of tilapia feeds of "Quality Feeds Ltd" used for this experiment

Constituent	Amount (%)			
	Nursery-1	Nursery-2	Starter	Grower
Moisture	11	10	9	9
Protein	36	34	32	30
Lipid	8	7	7	7
Ash	6	5	5	5

At the beginning of the experiment feed was supplied at the rate of 30% of the body weight of reared GIFT and gradually it was readjusted to 22%, 18%, 15%, 12% 10%, 8%, 6%, 5% and 4% respectively after every 10 days interval. They were fed four times daily up to 30 days, then three times daily up to 70 days and then twice daily up to the end of the experiment. The feeding strategy is shown in Table 3.

Table 3. Feeding strategy for different types of feeds

Culture period	Types of supplied feed	Feeding frequency	Feeding rate (% of body weight)
1-10 days	Nursery-1	4 times	30%
11-20 days	Nursery-2	4 times	22%
21-30 days	Nursery-2	4 times	18%
31-40 days	Starter	3 times	15%
41-50 days	Starter	3 times	12%
51-60 days	Starter	3 times	10%
61-70 days	Starter	3 times	8%
71-80 days	Grower	2 times	6%
81-90 days	Grower	2 times	5%
91-100 days	Grower	2 times	4%

Analysis of water quality parameters

Water temperature (°C), pH, dissolved oxygen (DO), transparency (cm) and total alkalinity were recorded at 10 days interval between 9.00 A.M. and 11.30 A.M. using a digital meter (YSI model 58). Secchi disc was used to measure the transparency (cm) of the water. Total alkalinity was measured by Acid titration method.

GIFT tilapia sampling procedure

Sampling of tilapia was done at every 10 days interval using a cast net to observe the growth for adjustment of feeding rate was. Twenty fish were sampled from each pond. Weight of each fish was measured to assess the differential growth. The sampled fish were handled very carefully to avoid the handling stress.

Statistical analysis of data had been done to see whether the influence of different treatments (stocking densities) on the growth (weight) and production of fishes were significant or not. One way analysis of variance (ANOVA) was done to test the significance of difference among different treatment means. Significant differences among different treatment means were identified by Duncan's New Multiple Range Test (DMRT).

A simple economic analysis was done to estimate the net profit from different treatments. The cost of leasing of the ponds was not included in total cost. An additional 7.5% on total cost was included as operational cost according to ADCP (ADCP, 1983).

Results

Water quality parameters

The overall mean values of each water quality parameter of all treatments during the study period have been presented in Table 4.

Table 4. Water quality parameters (mean value ± S.E.) as recorded in different treatments during study period

Treatments	Parameters			Calculated
	T_1	T_2	T_3	F-Ratio
Temperature (°C)	28.66±0.33 (21.0-32.3)	28.90±0.06 (21.4-32.5)	29.21±0.04 (21.8-32.9)	4.17
Dissolved oxygen (mg l^{-1})	5.20±0.06 (4.88- 5.75)	5.08±0.04 (4.73-5.45)	4.96±0.04 (4.55-5.20)	13.19
pH	7.57±0.01 (6.4-8.5)	8.00±0.04 (6.9-8.9)	8.20±0.04 (6.9-9.0)	167.46
Total alkalinity (mg l^{-1})	101.18±0.00 (82-116)	101.23±0.06 (87-122)	96.82±1.29 (84-107)	23.13
Transparency (cm)	19.57±0.68 (17-23)	22.59±0.71 (18.5-28)	24.61±1.06 (19.5-29)	18.50

Growth in relation to stocking density

The growth rate of GIFT tilapia under different stocking densities were recorded 10 days interval and the results have been presented in the Table 5. This result indicates higher growth in weight (g) at lower stocking densities and the growth rate gradually decreased with increasing densities. For the evaluation of growth performance of fish in different treatments in terms of weight gain, average daily gain, specific growth rate (SGR % per day), food conversion ratio (FCR), survival (%) and production (kg/decimal/100 days) were calculated and are shown in Table 5.

Table 5. Growth parameters of GIFT tilapia observed in different treatments.

Growth parameters	Treatments		
	T_1	T_2	T_3
Mean initial weight (g)	3.0±0.25	3.0±0.25	3.0±0.025
Mean final weight (g)	151.65±4.74	141.2±3.96	130.85±2.19
Weight gain (g)	148.65±4.74	138.2±3.96	127.85±2.19
Average daily gain (g)	1.48±0.05	1.38±0.04	1.27±0.02
SGR (% per day)	3.92±0.03	3.85±0.03	3.78±0.02
FCR	1.82±0.02	1.92±0.03	2.03±0.01
Survival rate (%)	92.31±0.26	87.46± 0.08	84.52±0.38
Production (kg/decimal)	18.58±0.03	23.87±0.06	26.78±0.07

There was no significant ($p \leq 0.05$) difference in initial weight of fish under different treatments. In the study period the significantly higher mean weight gained by GIFT tilapia was 155.0 g in Treatment T_1. There were highly significant differences among treatment T_1, treatment T_2 and treatment T_3 in terms of weight gain when compared using ANOVA ($p \leq 0.05$). From the Table 5 the significantly highest average daily gain (1.48 g) found in treatment T_1. Significant differences were found among three treatments when compared using ANOVA ($p \leq 0.05$). The mean specific growth rate of GIFT tilapia in different treatments ranged between 1.11 and 6.59. The significantly ($p \leq 0.05$) highest SGR values (6.59) was recorded in treatment T_3 while the lowest (1.11) was obtained also in treatment T_3. Significant differences were found among three treatments when compared using ANOVA ($p \leq 0.05$).

The survival (%) in different treatments was fairly high. The survival ranged between 84 to 92 %. Treatment T_1 and treatment T_2 showed significantly higher survival than Treatment T_3. The mean values of survival (%) were 92.31±0.26, 87.46± 0.08 and 84.52±0.38 for treatments T_1, T_2 and T_3 respectively. There were significant differences among the three treatments when compared using ANOVA ($p \leq 0.05$).

The food conversion ratio (FCR) values among the treatments were ranged between 1.82 to 2.03. The significantly lowest i.e. the best FCR (1.82) was obtained with treatment T_1 while the highest (2.03) FCR i.e. the worst was obtained with treatment T_3.The mean values of FCR were 1.82±0.02, 1.92±0.03 and 2.03±0.01for treatments T_1,

T_2 and T_3 respectively. There were significant differences among the three treatments when compared using ANOVA ($p \leq 0.05$).

Fish production

The production of GIFT tilapia ranged between 18.58 to 26.78 kg/decimal/100 days in different treatments. The total production of fish in treatment T_1, T_2 and T_3 were 2,972 kg, 3,820 kg and 4,285 kg. In present study the highest production was 4285 kg and it was found in the treatment T_3 which was higher than treatment T_1 and T_2.

Economic analysis

A simple economic analysis was performed to estimate the net profit from this culture operation. The cost of production was based on the Mymensingh whole sale market price of the year 2007 in consideration of the inputs used. The prepared feed costs were calculated as Tk. 23.00/kg, 22.00/kg, 20.00/kg and 19.00/kg for nursery-1, nursery-2, starter and grower. The selling prices of GIFT tilapia were of Tk. 70.00/kg, 68.00/kg and 66.00/kg for treatment T_1, T_2 and T_3 fish. The cost of leasing ponds was not included in the total cost. An additional 7.5% on total cost was included in operational cost according to ADCP (1983). It was observed that the highest net profit (Tk. 246.88/decimal/100 days) was obtained with stocking density of 150 fish/decimal (T_1) while the lowest profit (Tk. 118.26/decimal/100 days) was obtained with stocking density of 250 fish/decimal (T_3).

Table 6. Economic analysis of GIFT tilapia production of the end at the study period

Investment (Tk.)	Treatments		
	T_1	T_2	T_3
Lime + Cowdung	1500	1500	1500
Cost of fry	24000	32000	40000
Feed cost	131280	168800	206600
Operational cost	11758.5	15172.5	18607.5
Total cost	168538.5	217472.5	266707.5
Cost of production/kg fish	56.71	56.93	62.24
Selling price/kg fish	70.00	68.00	66.00
Gross income (Tk.)from fish sale	208040	248304.2	278533.9
Net profit	39501.5	30831.73	11826.41
Net profit/dec./100 days	246.8844	192.6983	118.2641

Discussion

Water quality parameters

The results of the water quality parameters were found within the acceptable range of fish culture and all of them were more or less similar without any abrupt changes in

any parameters of the ponds. Murty *et al.* (1978) reported negligible monthly fluctuations in the values of physico-chemical properties of water in the fertilized and unfertilized ponds. During the present study, the highest temperature recorded in the month of May was 32.9°C in T_3 and the lowest 21.0°C in T_1 were found in February. The mean values of water temperature of the ponds under treatment T_1, treatment T_2 and treatment T_3 were 28.66±0.33, 28.90±0.06 and 29.21±0.04 respectively. Kabir (2004), Chowdhury (1998) found almost similar results. The observed value of pH (6.4 t0 9.0) recorded in present study indicate that pH in all treatments were within the range and suitable for fish culture. The concentration of dissolved oxygen (DO) in the present experiment was found 4.62 to 5.75 mg l^{-1}. The mean values of dissolved oxygen content obtained with treatments T_1, T_2 and T_3 were 5.20±0.06, 5.08±0.04 and 4.96±0.04 respectively. The lowest concentration of oxygen was observed in ponds (T_3); this might be due to over population that rapidly consumed the dissolved oxygen. The observed alkalinity levels (82 to 122 mg l^{-1}) of water of the experimental ponds indicate that the productivity of the ponds was medium to high. The observed secchi disc value ranged from 17.00 to 29.00 cm in different treatments. The mean values of transparency were 19.57±0.68, 22.59±0.71 and 24.61±1.06 for treatments T_1, T_2 and T_3 respectively.

Growth performances of GIFT

The effects of stocking density on growth and production of GIFT tilapia was investigated in this experiment. It was found that the growth rates varied in different stocking densities. The highest growth rate was found in treatment T_1 which was stocked with lower densities (150/dec) although same food was supplied in all treatments at an equal ratio. The lowest growth rate was obtained in the present experiment under the highest stocking rate. Leboute *et al.* (1994) obtained highest weight gain in lower stocking densities compared to high stocking densities, in case of tilapia culture in cages. Cruz and Ridha (1989) found no significant differences in mean individual final weight, daily growth rate and survival rate among three stocking densities, in case of (*O. spilurus*) in nursing phase for 68 days in cages. The average daily weight gain and specific growth rate in the treatment T_1 was significantly higher than that of T_2 and T_3 which might be due to less competition for feed in lower stocking density.

The percent survival as recorded in the present study varied between 84 to 92 %. The survival rate recorded in present study is higher than that the survival rate recorded by Hussain *et al.* (1987), which might be attributed to the relatively larger size of fingerlings (15g). The mean values of survival (%) were 92.31±0.26, 87.46± 0.08 and 84.52±0.38 for treatments T_1, T_2 and T_3 respectively. Treatment T_1 and treatment T_2 showed significantly higher survival than Treatment T_3. Survival rate was found to be negatively influenced by different stocking densities. It might be due to high competition of food and space among the fishes.

The total production of fish in treatment T_1, T_2 and T_3 were 1858 kg/acre/100 days, 2388 kg/acre/100 days and 2678 kg/acre/100 days. Although the mean weight gain in

treatment T_1 was highest but total production was highest in treatment T_3 which might be due to higher number of fishes. The present result supports the findings of Dimitrov (1976) who achieved the best production from higher stocking densities when compared to that achieved with the lower ones.

A simple economic analysis was performed to estimate the net profit from this culture operation. During the economic analysis it was found that gross profit was highest (Tk. 278,534) in treatment-T_3 where (Tk. 208,040) in treatment-T_1 and (Tk. 248304) in treatment-T_2 respectively, which might be due to higher stocking density but net profit was higher in case of lower stocking density. It was observed that the highest net profit (Tk. 246.88/decimal/100 days) was obtained with stocking density of 150 fish/decimal (T_1) while the lowest profit (Tk. 118.26/decimal/100 days) was obtained with stocking density of 250 fish/decimal (T_3). Thus, the results of the present study indicated that a stocking density of 150 fish/decimal is optimum for GIFT tilapia culture with formulated feed.

References

ADCP, 1983. Fish feeds and feeding in developing countries. Aquaculture Development and Coordination Programme. ACDP/PEP/83/18. UNDP/FAO: 97 p.

Ali, S., A.K.A. Rahman, A.R. Palwary and K.H.R. Islam, 1982. Studies on the diurnal variations in physico-chemical factors and zooplankton in a freshwater pond. *Bangladesh J. Fish.*, 2-5(1-2): 15-23.

Alikhunhi, K.H., 1957. Fish culture in India. Farm, Bull. No. 20, India Counc. Agric. Res. New Delhi, 144 p.

Aminul, M.I., 1996. Qualities of water and soil in Aquaculture. Fish Week Compendium, 96. Dept. Of Fisheries, Dhaka-1000.

Balarin, J.D. and R.D. Haller, 1982. The intensive culture of Tilapia in tanks, raceways and cage. *In:* J.F. Muir and R.J. Roberts (eds.). Recent Advances in Aquaculture. Westview Press, Boulder, Colorado, USA. 265-355.

Bhuiyan, B.R., 1970. Physico-chemical qualities of water of some ancient tanks in Sibsagar, Asam. *Environmental Health*, 12: 129-134.

Boyd, C.E., 1979. Water quality in warm water fish ponds. Agricultural Experiment Station. Auburn University, Auburn, Alabama, USA: 359-364.

Boyd, C.E., 1982. Water quality management for pond fish culture. Elsevier Sci. Publ. Co. Amsterdam-Oxford- New York. 318 p.

Boyd, C.E., 1990. Water quality management for pond fish culture. Birmingham Publishing Co., Birmingham, Alabama: 482-486.

Chowdhury, M.B.R., 1998. Involvement of aeromonad and pseudomonands in diseases of farmed fish in Bangladesh. *Fish Pathol.*, 33: 247-254.

Cruz, E.M. and M. Ridha, 1989. Preliminary study on the production of the Tilapia, *O. spilurus* (Gunther), cultured in seawater cages. *Aquacult. Fish, Managt.*, 20: 381-388.

Dimitrev, M., 1976. Carp culture in net cages. *FAO Aquaculture Bull.*, 8(1): 8-16.

Eknath, A.E., M.M. Tayamen, M.S. Palada-de Vera, J.C. Danting, R.A. Reves, E.E. Dionisio, J.B. Capili, H.L. Bolivar, T.A. Abella, A.V. Circa, H.B. Bentsen, T. Gjedrem and R.S.V. Pullin,

1993. Genetic Improvement of Farmed Tilapia: the growth performances of eight strains of *Oreochromis niloticus* tested in different farm environments. *Aquaculture*, 111: 171-188.

Haque, M.S., M.A. Wahab, M.I. Wahid and M.S. Haq, 1998. Impacts of Thai silver barb (*Puntius gonionotus* Bleeker) inclusion in the polyculture of carps. *Bangladesh J. Fish. Res.*, 2(1): 15-22.

Hossain, M.A., S.M. Rahmatullah, M.S. Islam, A.K.M.A. Kabir, M.S. Islam and S. Dewan, 1997. Impact of chapila (*Gudusia chapra*) on growth of carps in polyculture. *Bangladesh J. Fish. Res.*, 1(2): 19-23.

Hussain, M.G., M.A. Rahman and M. Akteruzzaman, 1987. A study on the production of *O. niloticus* (Linnaeus) under semi-intensive system in Bangladesh. *Bangladesh J. Fish. Res.*, 1(2): 19-23.

Jhingran, V.G., 1991. Fish and Fishes of India (3rd ed.) Hindustan Pub. Co., New Delhi: 727 p.

Johnson, W.E., 1965. On mechanism of self regulation of population abundance in *Onrhynchus merka. Mitt. Int. Verin. Theor. Angew. Limnol.*, 13: 66-87.

Kabir, M.S., M.A. Wahab, M. Karim, M.C.J. Verdegem, and D.C. Little, 2004. Comparison between existing low input and high input integrated pond-dike aquaculture systems in some villages of Muktagacha, Mymensingh. *J. Bangladesh Agril. Univ.*, 2(1): 103-112.

Le Cren, E.D., 1965. Some factors regulating the size of population of Freshwater. *Mitt. Int. Verein. Theoro Agew. Limnol*, 13: 88-105.

Leboute, E.M., S.M.G. Souza, L.O.S. Afonso, S.O. Zrmmermann, 1994. Preliminary study on the cage culture of all male Nile tilapia (*O. Niloticus*). *Aquaculture*, 8(4): 151-155.

Murty, D.S., G.N. Saha, C. Seevaraj, P.V.G.K. Reddy and R.K. Reddy, 1978. Studies on increased fish production in composite fish culture through nitrogenous fertilization with and without supplementary feeding. *J. Inland Fish Soc. India*, 10: 39-45.

Pullin, R.S.V. and R.H. Lowe-McConnel (eds.), 1982. The biology and culture of Tilapias. ICLARM Conference Proceedings 7: 360 p.

Rahman, M.S., 1992. Water quality management in aquaculture. BRAC Prokashana, Dhaka, 84 p.

Reid, G.K., 1964. Ecology of inland water and estuaries. Reinhold Publ. Corp., New York, 373 p.

Saha, S.N. and S. Dewan, 1979. Food and feeding habits of *Tilapia nilotica* (Linnaeus) (Perciformes: Ciclidae) I. Types and amount of feed taken by the fish and its size and patterns of feeding. *Bangladesh J. Zool.*, 7(1): 53-60.

Sultana, R., A.H.M. Kohinoor, M.S. Islam and M.G. Hussain. 1997. Comparative studies on growth of fry of GIFT and existing strain of Nile Tilapia (*O. niloticus* L.). *Bangladesh J. Fish. Res.*, 1(1): 25-30.

Swingle, H.S., 1967. Standardization of chemical analyses for waters pond mud. FAO Fish Rep., 4(44): 397-421.

Verani, J.R., C.S.R.M. Pinto, P.D. Paiva and Y.A. Tarata, 1983. Experimental studies on intensive fish culture of the all-male hybrid of *Sarotherodon niloticus* X *Sarotherodon hornorum* stocked various levels. *In:* Proceedings of the International symposium on tilapia in aquaculture, Nazareth, Israel, 8-13 May, Tel. Aviv Uni. Tel Aviv, Israel, 499-505.

Weatherley, A.H., 1976. Factors affecting maximization of fish growth. *J. Fish. Res .Bol. Can*, 22: 1046 –1048.

(Manuscript received 21 March 2010)