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Original Article

Effects of stocking density on the growth, survival and production of endangered bata, *Labeo bata* (Hamilton, 1822) in primary nursing

Mohammad Rafiqur Rahman*[1], Sirajum Monira Shanta[1], Md. Abul Kalam Azad[2], Mohammad Kamruzzaman Hossain[2], Shabnam Mostary[2], Azhar Ali[3], MNS Mamun Siddiky[3], Md. Anamul Haque[4]

[1]Department of Fisheries Biology and Genetics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh.
[2]Department of Fisheries, Bangladesh.
[3]Bangladesh Fisheries Research Institute, Mymensing-2201, Bangladesh.
[4]Spectra Hexa Feeds Limited, Bangladesh.

Abstract: Effect of stocking densities on the growth, survival and production of bata, *Labeo bata* fry and fingerlings were tested in a primary nursery rearing system. The experiment was conducted for a period of 4 weeks in six earthen nursery ponds having an area of 0.032 ha each. Four-day-old fry stocked at 1.0 million/ha was designated as treatment-1 (T1), 1.5 million/ha as treatment-2 (T2) and 2.0 million/ ha as treatment-3 (T3). At stocking, all fry were of same age with a mean length and weight of 1.03±0.03 cm and 0.12±0.01 g, respectively. Fry in all the treatments were fed with Mega commercial fish feed. Physico-chemical parameters such as water temperature, transparency, dissolve oxygen, pH and total alkalinity in all the treatments were suitable ranges for fry and fingerling rearing. Plankton population (both phytoplankton and zooplankton) were found to be at optimum level for fish culture. Highest weight gain was observed in T1 (3.46±0.08) and lowest in T3 (1.98±0.03). Final length, final weight and survival of fingerlings also followed the same trends as weight gain. Fingerlings in T1 produced significantly higher specific growth rate (12.15±0.08) than T2 (11.31±0.03) and T2 (10.22±0.05). Feed conversion ratio was significantly lower in T1 (0.26±0.01) than T2 (0.42±0.02) and T3 (0.65±0.01). Significantly higher number of fingerlings was produced in T3 (1177700±4700) than T2 (963300±9900) and T1 (717850±7350), respectively. Despite of this, consistently higher net benefits were found from T1 than T2 and T3. Overall, highest growth (3.60±0.16 g), survival (71.79 ± 1.04%) and net benefits (TK. 127,087.00) of fingerlings were obtained at a density of 1.0 million hatchlings/ha. Therefore, out of three stocking densities, 1.0 million fry/ha appears to be most suitable stocking density for nursing and rearing of *L. bata* fry and fingerlings in primary nursing.

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Introduction

The bata, *Labeo bata* (Hamilton, 1822) is one of the most important species of minor carps under cyprinidae family. It has great demand as table fish due to its deliciousness, flavor and less spiny structure (Mahfuj et al., 2012). It is a freshwater subtropical species which is commonly known as 'Bangon Bata'. It is well-known as different name in different countries, Bata in Bangladesh (Rahman, 2005), Bhagan in India (Nath and Dey, 1989), and Bata labeo in Nepal (Shrestha, 2008). This fish contains about 15.42% of protein and 3.73% of lipid (Ahmed et al., 2012). It feeds on phytoplankton, algae and soft leaves of aquatic grasses. At the first sexual maturity attained 14.12 and 14.60 cm in total length for male and female *L. bata*, respectively (Hossen et al., 2014). Like tropical cyprinids, it normally breeds in streams, rivers and flood plains during monsoon months of April to July and fecundity of females is estimated around 23,000 to 81,000 per kg body weight (Hussain and Mazid, 2001).

Labeo bata is one of the major aquaculture species in Bangladesh. Earlier, the fish was widely available throughout the rivers, haors, baors, beels, jheels, canals and ponds of Bangladesh, but it has been seriously declining in the main streams (Rahman, 2005; Dahanukar et al., 2004). Loss of habitat and overexploitation, indiscriminate killing of fry and

*Corresponding author: Mohammad Rafiqur Rahman
E-mail address: mrafiqurrahamn@yahoo.com
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Table 1. Proximate composition (% dry matter) of the supplementary feeds supplied in experimental ponds.

Brand Name of feed	Type of feeds	Crude protein	Crude lipid	Crude fiber	Ash	NFE*
Mega Fish Feed	Pre-nursery	40.57	6.97	4.89	15.58	30.05
	Nursery	35.52	7.03	4.95	17.56	34.94

*Nitrogen free extract (NFE) was calculated as 100- % (moisture + crude protein + crude lipid + crude fiber + Ash)

fingerlings, pollution, siltation and other ecological changes are local threats to wild populations of *L. bata* (Hossain et al., 2009; Devi and Ali, 2013; Hossain, 2014). International Union of Conservation of Nature (IUCN), Bangladesh (2000) listed *L. bata* as one of the endangered minor carps. Many scientists have suggested that special attention is needed to protect this fish from extinction (Hussain and Hossain., 1999; Hussain and Mazid, 2001). Therefore, it is very much essential to protect this fish from extinction through development of appropriate nursing and rearing technique of fry and fingerlings.

The fry and fingerlings of *L. bata* rearing have not yet been well-developed due to its improper care and lack of appropriate rearing technology. So, a suitable culture technology for nursing and rearing of *L. bata* fry are very important to ensure reliable and regular supply of fingerlings. Stocking density is an important aspect to take into account when ranking families or progeny groups for growth performance. Fish density is a key factor affecting growth and maturation of wild and cultured fish besides food supply and its quality, genetics and

Materials and Methods

Study area and experimental design: The experiment was carried out for a period of 28 days from 01 June 2017 to 28 June 2017 in six earthen ponds at the private nursery ponds of Fish Seed Farm, Trishal, Mymensingh, Bangladesh. The area of each pond was 0.032 ha with an average water depth of 1 meter. All the ponds were of similar shape, size, basin conformation and bottom type. Three treatments differing in stocking densities of fry were employed with two replicates each. The designed treatments were 1.0 million fry/ha (treatment-1, T1), 1.5 million fry/ha (treatment-2, T2) and 2.0 million fry/ha (treatment-3, T3).

Proximate composition of feeds: There are two types of commercial mega fish feeds (pre-nursery and nursery) were purchased from local dealer of Mega feed seller. Proximate composition of the feeds (moisture, protein, lipid, ash and fiber) was analyzed according to AOAC (1984) method and nitrogen free extract (NFE) by subtraction (Castell and Tiews, 1980). Proximate composition of experimental feeds is shown in Table 1.

Pond preparation, stocking and management: At first, the ponds were dewatered, freed from aquatic vegetation, exposed to full sunlight and had a well-designed system of inlet and outlet. After drying, quicklime ($CaCO_3$, 247 kg/ha) was spread over the pond bottom. All the ponds were filled with ground water to a depth of about 1 m. Five days subsequent to liming, the ponds were fertilized with organic manure (cowdung) at the rate of 2470 kg/ha, Urea 25.0 kg/ha, and TSP 12.5 kg/ha to stimulate the primary productivity of the ponds. Seven days after manuring, the pond water was sprayed with Dipterex at the rate of 1 ppm to eradicate harmful insects and predatory zooplankton (Rahman et al., 2005). All the experimental ponds were stocked with four-day-old hatchlings of *L. bata* having an initial average length of 1.03±0.04 cm and weight of 0.12±0.01 g, respectively. The stocked hatchlings were fed four times in a day with commercially available mega pre-nursery and nursery feed commencing from the first day of stocking. The feeding rate was 24 kg/million fry/day for the first 1 week, 28 kg for the second 1 week, 32 kg for the third 1 week and 36 kg for the fourth 1 week. Fingerlings were collected weekly by a fine-meshed (hapa) net for growth studies. For proper feeding, the feed was broadcasted homogenously in each time.

Water quality parameters: The water quality parameters such as water temperature, transparency, dissolved oxygen (DO), pH and total alkalinity were monitored weekly throughout the experimental period

Table 2. Physico-chemical characters of water in the earthen nursery ponds during the experimental period.

Parameter	Treatments		
	T1	T2	T3
Water temperature (°C)	30.19±0.73[a] (27.00-32.50)	29.48±0.64[a] (27.00-32.00)	29.28±0.76[a] (26.00-32.00)
Transparency (cm)	28.75±1.35[c] (23.00-35.00)	35.50±1.77[b] (28.00-42.00)	45.38±2.69[a] (33.00-55.00)
Dissolved oxygen (mg/L)	5.74±0.13[a] (5.23-6.30)	4.77±0.17[b] (4.10-5.42)	3.86±0.0.10[c] (3.50-4.38)
pH	7.56±0.22[a] (6.80-8.30)	7.94±0.23[a] (7.20-8.60)	7.88±0.21[a] (7.10-8.60)
Total alkalinity (mg/L)	129.25±3.90[a] (115.00-145.00)	124.75±2.18[b] (112.00-133.00)	110.00±2.42[c] (102.00-121.00)

Values in the same row having the same superscript are not significantly different (P>0.05).
Values in the parenthesis indicate the range.

between 09.00 and 10.00 hr. Water temperature was recorded using a Celsius thermometer and transparency (cm) was measured by using a Secchi disc of 20 cm diameter. Dissolved oxygen were determined (mg/L) directly by a digital water quality analyzer Hanna DO meter (Model-HI 9146, Romania), pH by a digital pH-meter (Milwaukee pH meter, Model-PH55/PH56, USA), and total alkalinity was estimated following the standard method (Stirling, 1985; APHA, 1992).

Plankton monitoring: Quantitative and qualitative estimates of plankton in the nursery ponds were taken weekly. Ten liters of pond water were collected from different locations and depth of the pond and filtered through fine mesh (0.04 mm) plankton net. Filtered water was taken into a measuring cylinder and carefully made up to standard volume with distilled water. Using a plastic tubing, water was siphoned off from the measuring cylinder and water sample were concentrated into 50 ml and preserved using 5% buffered formalin in small plastic vials for subsequent studies. From each 10 ml preserved sample, 1 ml subsample was examined using a Sedgwick–Rafter (S–R) cell was used under a calibrated compound microscope for plankton counting. Plankton count (number of cells/L of water sample) was made using the formula proposed by Stirling (1985) and Rahman (1992).

Estimation of growth, survival, production and feed utilization study of fishes: Twenty individuals from each pond were sampled weekly during the experimental period. Growth in terms of length and weight, Specific Growth Rate (SGR) and Food conversion rate (FCR) was estimated. SGR and FCR were calculated according to Brown (1957), Castell and Tiews (1980) and Gangadhara et al. (1997), respectively. After 4 weeks, the fingerlings were harvested by repeated netting, followed by draining the ponds. The fingerlings were counted and weighed. Survival (%) and production (number/ha) of fingerlings were then calculated and compared among the treatments.

Analysis of experimental data: The collected data of growth, survival, production, water quality patrameters and plankton abundance under different treatments were analyzed through one way analysis of variance (ANOVA) followed by Duncan's New Multiple Range test to find out whether any significant difference existed among treatment means (Duncan, 1955; Zar, 1984). The statistical analysis was performed by SPSS software 19 (SPSS, USA). The level for significance was set at 0.05%. A simple cost-benefit analysis was done to estimate the net benefits from different treatments.

Results and Discussion

Water quality parameters: The ranges and mean values of various physic-chemical parameters, such as water temperature, transparency, dissolved oxygen (DO), pH and total alkalinity recorded during the experimental ponds are shown in Table 2. During the study period, the water temperature ranged from 26.00 to 32.50°C with a mean value of 30.19±0.73, 29.48±0.64 and 29.28±0.76°C in T1, T2 and T3,

Table 3. Mean values (±SE) and ranges of plankton abundance (cell/ml ×10^3) of pond water under different treatments during 4-week nursing period.

Plankton group	Treatments		
	T1	T2	T3
Plankton (cell/ml×10^3)			
Bacillariophyceae	135.24±3.34^a (125.48-150.08)	118.33±1.62^b (112.01-123.89)	100.27±1.94^c (92.87-107.24)
Chlorophyceae	102.34±1.22^a (98.12-107.54)	93.65±1.56^b (87.09-98.92)	77.57±1.20^c (74.02-82.98)
Cyanophyceae	67.35±1.30^a (62.05-71.55)	57.84±1.54^b (53.02-63.58)	45.02±1.33^c (38.59-49.01)
Euglenophyceae	6.64±0.86^a (4.95-8.99)	4.02±0.41^b (2.98-6.59)	3.93±0.32^b (2.74-5.23)
Total Phytoplankton	311.57±1.85^a	273.84±1.76^b	226.79±1.62^c
Zooplankton (organism/ml×10^3)			
Crustacea	48.47±1.27^a (44.12-53.42)	40.21±1.41^b (35.22-46.54)	34.52±0.84^c (31.59-37.84)
Rotifera	40.83±1.15^a (36.23-45.21)	35.64±0.86^b (32.06-39.01)	28.75±0.99^c (25.47-34.88)
Total Zooplankton	89.30±1.16^a	75.85±0.90^b	63.27±1.01^c

Values in the same row having the same superscript are not significantly different (P>0.05). Values in the parenthesis indicate the range.

respectively, which were not differed significantly (P>0.05). Similar results were observed by Haque et al. (1991, 1993), Kohinoor et al. (1994) and Samad et al. (2016). Mean transparency were 28.75±1.35, 35.50±1.77 and 45.38±2.69 cm in T1, T2 and T3, respectively which were differed significantly (P<0.05). Transparency was significantly higher (P<0.05) in T3, where stocking density was high, may be due to reduction of plankton population by the higher density of fish (Haque et al., 1993). The dissolved oxygen (DO) in the morning hours varied from 3.50 to 6.30 mg/L, with mean values of 5.74±0.13, 4.77±0.17 and 3.86±0.0.10 mg/L in T1, T2 and T3, respectively, the value of T1 was differed significantly (P>0.05) from T2 and T3. Comparatively low DO was recorded in the morning in ponds stocked with higher density of fish as compared with the ponds stocked with lower stocking density (Haque et al., 1993; Rahman and Rahman 2003; Ahmed, 2015). It seemed that the reason behind this was the high consumption of oxygen by the fishes as pointed out by Saha et al. (1988). The level of dissolved oxygen (DO) is within the acceptable range in all the experimental ponds. During the study, the pH values varied from 6.80 to 8.60 with the mean values of 7.56±0.22, 7.94±0.23 and 7.88±0.21 in T1, T2 and T3, respectively, which were the characteristics of good water quality and suitable for fish culture (Rahman and Rahman, 2003; Hossain et al., 2007; Ahmed, 2015; Samad et al., 2016). The mean values of total alkalinity were 129.25±3.90, 124.75±2.18 and 110.00±2.42 mg/L in T1, T2 and T3, respectively and the pH value of T1 was differed significantly (P>0.05) from T2 and T3. Significantly lower (P>0.05) alkalinity was observed in T3 than T1 and T2. Higher total alkalinity values might be due to higher amount of lime doses during pond preparation and frequent liming during the experimental period (Jhingran, 1991). Similar results were also recorded in the studies of Kohinoor et al. (1997), Chakraborty and Mirza (2007), Ahmed (2015) and Samad et al. (2016). Water quality was widely acknowledge to be one of the most important rearing conditions that could be managed to reduce diseases exposure and stress in intensive fish culture (Wedemeyer, 1996). In the present study, all of the water quality parameters were suitable ranges for rearing of fry and fingerlings (DOF, 2010).

Plankton enumeration: The mean number of phytoplankton and zooplankton under three stocking densities were 311.57±1.85 and 89.30±1.16, 273.84±1.76 and 75.85±0.90, 226.79±1.62 and 63.27±1.01 in T1, T2 and T3, respectively (Table 3).

Table 4. Growth performance, survival and production of *Labeo bata* fry or fingerlings after 4 weeks of rearing; mean ± SE with ranges in parentheses.

Parameters	Treatments		
	T1	T2	T3
Initial length (cm)	1.03±0.03[a] (0.90-1.10)	1.03±0.03[a] (0.90-1.10)	1.03±0.03[a] (0.90-1.10)
Final length (cm)	3.43±0.15[a] (3.61-3.25)	2.91±0.08[a] (2.93-2.89)	2.42±0.08[b] (2.40-2.44)
Initial weight (g)	0.12±0.01[a] (0.09-0.13)	0.12±0.01[a] (0.09-0.13)	0.12±0.01[a] (0.09-0.13)
Final weight (g)	3.60±0.16[a] (3.52-3.67)	2.85±0.09[b] (2.82-2.87)	2.09±0.09[c] (2.07-2.12)
Net Weight gain	3.46±0.08[a] (3.40-3.55)	2.73±0.03[b] (2.70-2.75)	1.98±0.03[c] (1.95-2.00)
Specific growth rate (SGR) (%/day)	12.15±0.08[a] (12.07-12.22)	11.31±0.03[b] (11.28-11.34)	10.22±0.05[c] (10.17-10.26)
Food conversion ratio (FCR)	0.26±0.01[c] (0.25-0.26)	0.42±0.02[b] (0.40-0.43)	0.65±0.01[a] (0.64-0.64)
Survival rate (%)	71.79±1.04[a] (71.05-72.52)	64.22±0.66[b] (63.56-64.88)	58.89±0.24[c] (58.65-59.12)
Production (number/ha)	717850±7350[c] (710500-725200)	963300±9900[b] (953400-973200)	1177700±4700[a] (1173000-1182400)

Values in the same row having the same superscript are not significantly different ($P>0.05$).
Values in the parenthesis indicate the range.

Twenty seven genera of phytoplankton were recorded in four groups viz. Chlorophyceae, Bacillariophyceae, Cyanophyceae and Euglenophyceae. The mean abundance of total phytoplankton in T1 was significantly higher ($P>0.05$) than those of T2 and T3. The zooplankton population consisted of 12 genera, including nauplii in two groups viz. Crustacean and Rotifera. Crustacea were dominant over the entire experimental periods in all treatments. The abundance of zooplankton differed significantly ($P<0.05$), decreasing from T1 to T3.

In the present study, the quantity of both phytoplankton and zooplankton was inversely related with the stocking density of fry. The quantity of phytoplankton and zooplankton was higher in T1 where stocking density of fry was low. It seems that in the ponds where the stocking density of high, consumption of plankton by the fishes also high. It was also found that in all the ponds that phytoplankton production was higher in comparison with zooplankton. Higher phytoplankton concentrations in pond water normally indicate higher productivity. The higher abundance of phytoplankton compared to zooplankton might be due to fertilization of ponds with Urea and TSP and excess uneaten feed (Keshavanath et al., 2002). More or less similar results have also been recorded in various food fish and fry or fingerling rearing ponds (Wahab et al., 1994; Haque et al., 1998; Kohinoor et al., 1999; Chakraborty et al., 2003, Rahman et al., 2005; Chakraborty and Mirza, 2007; Ahmed, 2015).

Growth, feed utilization and production of fish: Weekly growth of *L. bata* fry under different stocking densities at the end of the experimental period are summarized in Table 4. The growth in length and weight of fry are depicted in Figures 1 and 2, respectively. The initial length and weight of fry stocked in all the ponds were the same i.e. 1.03±0.03 cm and 0.12±0.01 g, respectively. It is evident the data that fry after 4 weeks of rearing attained a size of 3.25 to 3.61 cm (mean 3.43±0.15 cm) in length and 3.52 to 3.67 g (mean 3.60±0.16 g) in weight in ponds with lowest stocking density of 1.0 million/ha, while the fry attained a size of 2.89 to 2.93 cm (mean 2.91±0.08 cm) in length and 2.82 to 2.87 g (mean 2.85±0.09 g) in weight in ponds with 1.5 million/ha, and 2.40 to 2.44 cm (mean 2.42±0.08 cm) in length and 2.07 to 2.12 g (mean 2.09±0.09 g) in weight in ponds stocked with

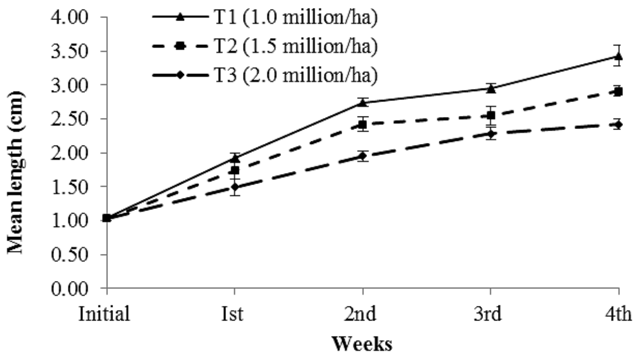

Figure 1. Weekly mean length (cm) gain of *Labeo bata* under different stocking densities.

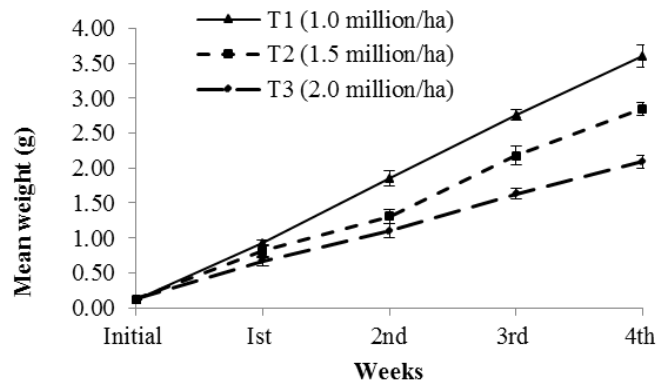

Figure 2. Weekly mean weight (g) gain of *Labeo bata* under different stocking densities.

2.0 million/ha (Table 4). From the present study, it is clearly indicated that the maximum growth in length and weight was attained at the lowest stocking density with 1.0 million/ha with the growth gradually decreasing with increase in density. Final average size in length and weight of fry attained in ponds with different stocking densities was observed to be significantly different (P<0.05). From Table 4, it clearly indicated that the T1 (3.46±0.08 g) showed the highest average gain in both length and weight followed by T2 (2.73±0.03 g) and T3 (1.98±0.03 g). Stocking density had previously been observed to have a direct effect on the growth of fish (Haque et al., 1993; Kohinoor et al., 1994; Rahman and Rahman, 2003: Ahmed, 2015; Samad et al., 2016). High density of fingerlings in combination with increased concentration of food in the rearing system might have produced a stressful situation and toxic substance which could be the probable cause for poor growth in T2 and T3 (Haque et al., 1994; Rahman and Rahman, 2003).

The range of specific growth rate (% per day) was found 10.22 to 12.22 with a mean value of 12.15±0.08, 11.31±0.03 and 10.22±0.05 in T1, T2, and T3, respectively. Specific growth rate (SGR) in T1 was significantly higher (P>0.05) than in T2 and T3 due to lower stocking density. Similar result was found by Chakraborty and Mirza (2007), Ahmed (2015) and Samad et al. (2016). Feed conversion ratio was significantly lower in T1 (0.26±0.01) than T2 (0.42±0.02) and T3 (0.65±01). Therefore, SGR and FCR were best for fish in T1 where lowest number of hatchlings (1.00 million/ha) was reared. However the lower FCR value in the present study indicates better food utilization efficiency, despite the values increased with increasing stocking densities. Fingerlings of *L. bata* had significantly higher survival in T1, where, the stocking density was lower than T2 and T3. The reason for reduced survival rate in these treatments was probably due to higher stocking density of fry as well as competition for food and space in the experimental ponds. The FCR values of present findings are lower than the values reported by Islam (2002) and Islam et al. (2002), Chakraborty and Mirza (2007), Ahmed (2015) and Samad et al. (2016). The highest survival rate was also observed in T1 (71.79±1.04) and the lowest in T3 (58.89±0.24). There was a significant variation (P>0.05) in the survival rate in *L. bata* fry and fingerlings among different treatments. The present findings compared with the values reported by Chakraborty and Mirza (2007), Ahmed (2015) and Samad et al. (2016) where they found similar survival rate of endangered *L. bata* at lower stocking density. In this experiment, crude protein levels (40.57% and 35.52% dry weight) in supplementary feeds are higher than the dietary protein of 31% for the optimal growth of *Labeo rohita* (De Silva and Gunasekera, 1991). However, growth in terms of length, weight, net weight gain, SGR and survival rate of fingerlings of *L. bata* was significantly higher in T1 where the stocking density was low compared to those of T2 and T3 although the same food was supplied in all the treatments at an equal ratio.

The productions of fingerlings (number/ha) were

Table 5. Cost and benefits from the nursing of bata, *Labeo bata* fingerlings in 1-ha earthen ponds for a nursing period of 4 weeks.

Item	Amount (TK)/ha/ 2 months			Remarks
	Treatments			
	T1 (TK)[a]	T2 (TK)	T3 (TK)	
A. Variable cost:				
1. Price of hatchlings (@ TK. 0.15/piece)	150,000	225,000	300,000	
2. Feeds				
a. Pre-nursery (@Tk. 80.00/kg)	23,360	34,960	46,640	
b. Nursery (@Tk. 55.00/kg)	20,955	31,405	41,855	
3. Human labour cost (@TK. 200.00/day)	12,000	12,000	12,000	02 labour/day
4. Fertilizer (Urea, TSP and Cowdung)	5,950	5,950	5,950	
5. Lime (247 kg/ha, @TK. 20.00/kg	4,950	4,950	4,950	
6. Miscellaneous	10,000	10,000	10,000	Dipterex, Oxy flow, carrying, netting etc
Total Variable Cost (TVC)	227,215	324,265	421,395	
B. Fixed Cost:				
1.Pond lease value	49,400	49,400	49,400	Tk. 200.00/decimal/year (Local rate, Mymensingh region)
2.Interest of operating capital	27,008	36,713	46,426	10% interest according to Bangladesh Krishi Bank, Bangladesh
Total Fixed Cost (TFC)	76,408	86,213	95,826	
Total Cost (TC= TVC+TFC)	303,623	410,378	517,221	
Total Return (TR)[b]	430,710	481,650	529,965	Price is related with size and weight
Gross Margin (GM= TR -TVC)	203,495	157,385	108,570	
Net return (TR-TC)	127,087	71,272	12,744	

[*a]TK 80.00 =1 US$

[b]Selling price of fingerlings Tk. 0.60/ piece (size 3.60 g, T1), Tk. 0.50/piece (size 2.85 g, T2) and Tk. 0.45/piece (size 2.09 g, T3).

710500 to 725200 (mean 717850±7350), 953400 to 973200 (mean 963300±9900) and 1173000 to 1182400 (mean 1177700±4700) in T1, T2 and T3, respectively (Table 5). Production of fingerlings differed significantly (P<0.05) among the three treatments. Significantly higher numbers of fingerlings were produced in ponds stocked with 2.0 million fry/ha than those from the ponds stocked with 1.0 and 1.5 million fry/ha, respectively. On the other hand, cost of production in T1 was consistently lower than those T2 and T3 (Table 5). Highest net benefit (in term of Bangladeshi Tk. /ha and one US$ = Bangladeshi TK. 80.00) was obtained in T1 (127,087.00) followed by T2 (71,272.00) and T3 (12,744.00), respectively. Despite this, consistently higher net benefits were obtained from ponds stocked with 1.0 million fry/ha than those from 1.5 and 2.0 million fry/ha. The higher market price of the larger fingerlings produced in ponds with 1.0 million fry/ha, substantially increased the net benefit compared to smaller fingerlings that produced in other ponds with higher stocking densities. Overall, highest growth, survival and benefits of fingerlings were obtained at a density of 1.0 million fry/ha. Water quality parameters of pond water during the study period were within the acceptable limits. Growth of fingerlings to be greater extent depended on the quality and quantity of food available. In the present investigation, the amount of supplementary feeds given in different treatments was based on the number of hatchlings stocked and amount of feed provided per fry was kept at the same level. Hence, the observed low growth at higher stocking densities could be due to less availability of natural food and some variations in environmental parameters (Kohinoor et al., 1997). The results in the present experiment are very similar to those of Saha et al. (1988), Kohinoor et al. (1994), Hossain (2001), Rahman and Rahman (2003), Chakraborty et al. (2003, 2006), Chakraborty and Mirza (2007).

From the present study, it can be concluded that the survival, growth and production of *L. bata* fingerlings were inversely related to the stocking densities of fry. Stocking density of 1.0 million fry/ha may be advisable for rearing of *L. bata* fingerlings for 4 weeks in primary nursing. Production of adequate quality seeds through application of our present findings might be extremely helpful towards the protection of *L. bata* from extinction as well as for its conservation and rehabilitation.

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