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Article

Effects of stocking density on growth, survival and production of mirror carp (*Cyprinus carpio var. specularis*) spawn in nursery pond

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Abstract: The research work was conducted to evaluate the effects of stocking density on growth, survival and production of mirror carp (*Cyprinus carpio* var. *specularis*) spawn in nursery pond for a period of 35 days. Three treatments differing in stocking density of hatchling viz., T_1:172900 individuals/ha, T_2:148200 individuals/ha and T_3:123500 individuals/ha were employed each having three replicates. Fries were fed same diet in three different treatments consisting of (28.5%) at the rate of 6-10% of body weight. The Physico-chemical characteristics of pond water were measured weekly. The mean values of some water quality parameters such as temperature (°C) were 30.41 ±1.15 (T_1), 30.38±1.08 (T_2), 30.45±1.10 (T_3); transparency (cm) 40.00±0.90 (T_1), 39.74±0.51 (T_2), 39.93±0.70 (T_3); dissolved oxygen (mg/l) 6.79±0.45 (T_1), 6.71±0.38 (T_2), 7.02±0.29 (T_3); pH 7.55±0.18 (T_1), 7.67±0.16 (T_2), 7.62±0.20 (T_3) and alkalinity (mg/l) 116.20±0.64 (T_1), 99.36±0.45 (T_2), 96.47±0.93 (T_3) from 35 days respectively. Except alkalinity no significant value were found for parameters. Sampling was also done weekly. The mean value of final weight (g) was 0.35±0.004 (T_1), 0.42±0.008 (T_2), 0.59±0.006 (T_3). The survival rate of *Cyprinus carpio* var. *specularis* was 54.20% (T_1), 62.90% (T_2) and 74.56% (T_3) respectively. The highest survivability was found in T_3. The production (kg/ha) of *Cyprinus carpio* var. *specularis* was 76.32±4.96 (T_1), 77.60±5.19 (T_2), 91.04±6.02 (T_3) respectively. Significantly ($p < 0.05$) highest production was found in T_3.

Keywords: mirror carp; spawn; stocking density; growth; survival and production.

1. Introduction

Freshwater fish production has always been dominated by carps (71.9 percent, 24.2 million tones, in 2010) (FAO, 2012). Aquaculture in Bangladesh has rapidly progressed in recent years with a contribution of 44% to the annual fish production (Talukdar *et al*., 2012). In 2010-11 fiscal year carp species comprises 34.61% of the total fish production (DoF, 2012). The main carp species cultivated in the world are primarily seven in number and are often grouped on the basis of their natural geographical occurrence: the so-called Chinese carps which include the grass carp (*Ctenopharyngodon idella)*, the silver carp (*Hypophthalmichthys molitrix)* and the bighead carp (*Aristichthys nobilis)*, and the so-called Indian major carps which include catla (*Catla catla)*, rohu (*Labeo rohita)* and mrigal (*Cirrhinus mrigala)*. The seventh species is the common carp (*Cyprinus carpio)*. Taxonomically, carps belong to the family of *Cyprinidae* (order: Cypriniformes) (Azad *et al*., 2004). *Cyprinus carpio* is an important freshwater fish cultured in Asia, particularly in India Pakistan and Bangladesh. For intensive and extensive fish culture it is necessary to ensure the supply of suitable sized good quality fish seed in sufficient quantities. From the beginning the rivers were the major source of carp seed production in Bangladesh. Millions of eggs and spawns were collected from the rivers during monsoon (May-August). But the due to the destruction of natural availability of carp seed the aquaculture venture has become dependent on the hatchery produced fry. Induced spawning has opened the door of new era in the production of fish throughout the world. The main source of fish seeds in Bangladesh are spawn produced in government and private hatcheries and some collected from rivers. For a successful fish culture it is essential to cultivate fish in three stages of their life history. The three stages are i) fry rearing in nursery ponds ii) fingerlings in rearing ponds and iii) older fingerlings in stocking pond. The ultimate fish crop from the stocking ponds therefore, will largely depend upon the success achieved in rearing the fish in the two preceding stages. A number of studies have been performed on the effects of stocking density (Backiel and Le Cren 1967; Davis *et al*., 1984; Haque *et al*., 1993) on survival and growth of fry and fingerlings in different environmental conditions at different geographical locations, but the results of which varied from one experiment to another. The specific objectives in this study were to monitor water quality parameters, to evaluate the growth and production performance system under different levels of fish stocking densities and thereby to recommend the suitable density of *C. carpio* var. *specularis* in nursery pond.

2. Materials and Methods

2.1. Study area and experimental design

The experiment was carried out for a period of 35 days from 6th October to 13th November-2011in nine earthen nursery ponds of the Department of Fisheries, University of Rajshahi, Bangladesh. The ponds were rectangular in shape and the surface area of each pond was 0.004 ha with an average depth of 1.0 meter. The ponds had similar rectangular size, depth, basin conformation and bottom type. Three triplicate treatments differing in stocking density of hatchling viz., T_1:172900 individuals/ha, T_2:148200 individuals/ha and T_3:123500 individuals/ha were employed.

2.2. Pond preparation, stocking and fertilization

The ponds were drained, freed from aquatic vegetation and well exposed to sunlight. After drying, quicklime (CaO, 250 kg ha^{-1}) was spread over the pond bottom to eradicate harmful insects and pathogens. Three days after liming, all the ponds were filled with ground water to a depth of about 1.0 meter. Then all the experimental ponds were fertilized with organic manure (cow dung-1326.39 kg/ha) and inorganic fertilizer (urea-242.06 kg ha^{-1}, TSP-192.66 kg ha^{-1}) as basal dose after 5 days. Seven days after manuring, the pond water was sprayed with sumithion (2470 ml/ha) to eradicate harmful insects and predatory zooplankton such as copepods and cladocerans. All the nursery ponds were surrounded by fine-meshed nylon nets fixed with locally available bamboo poles to prevent predators (such as frogs, snakes etc) to enter the ponds. Fry of *C. carpio* were collected from Banga Bihary Hatchery, Balihar union under Naogoan district and stocked in the experimental ponds. Before releasing the larvae to the experimental pond the initial length and weight of 10% larvae were recorded with the help of a scale and a sensitive portable electric balance (OHAUS, MODEL no. CT-1200-5). Initial length and weight of spawn were 1.00±0.02 cm and 0.013±0.008 g respectively.

2.3. Fertilization

After stocking, all the ponds were fertilized with cowdung at the rate of 247 kg ha−1, Urea 25.0 kg ha^{-1} and TSP 12.5 kg ha^{-1} at weekly intervals to stimulate the primary productivity of the ponds throughout the experimental period.

2.4. Supplementary feeding

Inclusion rate (%) of different feed and Proximate composition of feed used in the experiment is shown in Tables 1 and 2. Fries in all the treatments were fed with same type of supplemental feed consisting of 28.5% protein in a mixture of fish meal, rice bran, wheat flour, maize bran and mustard oil cake at the rate of 6%, 7%, 8%, 9% and 10% body weight per daily at 1st, 2nd, 3rd, 4th, 5th, 6th and 7th week respectively. The quantities of feed were adjusted every seven days interval on the basis of increase in the average body weight of the stocked biomass. The feed was broadcast on the pond water surface.

Table 1. Inclusion rate (%) of different feed used in the experiment.

Ingredients	Inclusion rate (%)
Fish meal	25
Mustard oil cake	20
Rice bran	15
Wheat flour	20
Maize bran	20

Table 2. Proximate composition of feed used in the experiment.

Components	Diets
Moisture	9.8 %
Crude protein	28.5%
Crude lipid	13.6%
Crude fiber	14.5%
Ash	7.55%
NFE	26.25%

* Nitrogen free extract (NFE) calculated as
100-% (Moisture + Crude protein+ Crude lipid+ Crude Fiber+ Ash

2.5. Water quality parameters

Water samples from each pond were collected during 9:00–10:00 a.m. at 15 day's interval for analysis of important Physico-chemical parameters such as temperature, transparency; dissolved oxygen, pH, total alkalinity and ammonia-nitrogen were recorded. Secchi disc was used for the measurement of water transparency and water temperature was recorded by an ordinary Celsius thermometer (O ^{o}C to 120^{o} C). The dissolved oxygen, pH and total alkalinity of water were measured by using a HACH Kit (DR/2010 model, HACH, Loveland, CO, USA, a direct reading spectrophotometer) at the pond site.

2.6. Estimation of growth, survival, production

Fries were sampled weekly by a fine-meshed nursery net for the assessment of growth, health condition and feed adjustment. 10% stocked from each experimental pond were sampled weekly for weight measurement. Growth in terms of weight and Specific Growth Rate (SGR) was estimated. SGR calculated according to Brown (1957). After 90days of rearing, the fingerlings were harvested by repeated netting, followed by draining the ponds. The fingerlings were counted and weighed individually. Survival (%) and production (kg ha–1) of fingerlings were then calculated and compared among the treatments.

2.7. Calculations and statistical analysis

The following formulae were applied to the data:

- Mean weight gain (g) =Mean final weight- Mean initial weight
- $$\text{SGR } (\%, \text{bwd}^{-1}) = \frac{L_n \text{ final weight - } L_n \text{ initial weight}}{\text{Culture period}} \times 100$$

(Brown, 1957)

- Survival rate (%) =No. of fish harvested/ No. of fish stocked x 100
- Production= No. of fish harvested x final weight of fish.

2.8. Statistical analysis

For the statistical analysis of data collected, one-way analysis of variance (ANOVA) was performed using the SPSS (Statistical Package for Social Science, evaluation version-15.0). Significance was assigned at the 0.05% level. The mean values were also compared to see the significant difference through DMRT (Duncan Multiple Range Test) after Zar (1984). A simple cost–benefit analysis was done to estimate the net benefits from different treatments.

3. Results

3.1. Water quality parameters

Mean levels of physico-chemical parameters over the 35 days nursing of spawn are presented in Table 3 and Figure 1. The mean water temperature (°C), transparency (cm), dissolved oxygen (mg/1) and pH in treatment T_1, T_2 and T_3 were not statistically significant ($P>0.05$). Total alkalinity was statistically significant ($P<0.05$) with the treatments. Despite these variations, water quality parameters in all the experimental ponds were within the normal range for fish culture (Table 3).

Table 3. Mean physico-chemical characters of water in the earthen nursery ponds during the experimental period.

Parameters \ Treatments	T_1	T_2	T_3
Water temperature (°C)	30.41±1.15 ^{a}	30.38±1.08 ^{a}	30.45±1.10 ^{a}
Transparency (cm)	40.00±0.90 ^{a}	39.74±0.51 ^{a}	39.93±0.70 ^{a}
DO (mg/l)	6.79±0.45 ^{a}	6.71±0.38 ^{a}	7.02±0.29 ^{a}
pH	7.55±0.18 ^{a}	7.67±0.16 ^{a}	7.62±0.20 ^{a}
Total alkalinity (mg/l)	116.20±0.64^{a}	99.36±0.45^{b}	96.47±0.93^{c}

Figures in a row bearing common letter do not differ significantly (P<0.05).

3.2. Growth, survival rate and production of fish

Growth and production parameters of fingerlings are shown in Table 4. The increase in weight was the highest in T_3 followed by T_2 and T_1. The initial length and weight of hatchings, stocked in all the ponds were same. The fish in T_3 treatment showed the highest gain in weight (0.58±0.04g) compared to the T_2 and T_1 treatments, where stocking density of spawn was 123500 individuals ha^{-1}. However, the mean final weight and SGR(%, bwd^{-1}) of fingerlings among the treatments was significantly different (P<0.05). SGR in T_3 was significantly higher (P<0.05) than in T_2 and T_1.

Therefore, mean final weight and SGR were best for fish in T_3 where lowest number of hatchlings (123500 individuals ha^{-1}) was reared. The highest survival rate (74.56%) was also observed in T_3 and the lowest (54.20%) in T_1. There was a significant variation (P<0.05) in the survival rate was observed among different treatments. The mean production (kg ha−1) of fry was 76.32±4.9, 77.60±5.1and 91.04±6.02 in treatment T_1, T_2 and T_3, respectively. Production was highest in treatment T_3 and lowest in treatment T_1. However, production of fries differ significantly (P<0.05) among the three treatments (Table 4).

Table 4. Growth performance, survival and production of *C. carpio* var. *specularis* fry after 35 days of rearing.

Parameters \ Treatments	T_1	T_2	T_3
Initial weight (g)	0.013±0.008 ^{a}	0.013±0.008 ^{a}	0.013±0.008 ^{a}
Weight gain (g)	0.34±0.03^{b}	0.41±0.04^{b}	0.58±0.04^{a}
Final weight (g)	0.35±0.004^{c}	0.42±0.008^{b}	0.59±0.006^{a}
SGR(%, bwd^{-1})	8.86±2.12^{c}	9.34±3.52^{b}	10.32±3.16^{a}
Survival rate (%)	54.20±0.76^{c}	62.90±0.74^{b}	74.56±0.73^{a}
Yield**(**kg/ha/35 days)	76.32±4.96^{b}	77.60±5.19^{b}	91.04±6.02^{a}

Figures in a row bearing common letter do not differ significantly (P<0.05).

4. Discussion

4.1. Water quality parameters

Growth, feed efficiency and feed consumption of fishes are normally governed by a few environmental factors (Brett, 1979). Fish culturists are more conscious about the maintenance of optimum condition of water quality. Water temperature plays an important role in the physiology of fish, the relative quality of food intake and standardization of feeding levels might also be affected to a great extent with a marked effect on overall production of fish. In the present study the average temperature of the experimental ponds was within the acceptable range for nursery ponds that agrees well with the findings of Haque *et al.* (1993, 1994) ; Kohinoor *et al.* (1994); Hossain *et al.* (2013); Chakraborty and Mirza (2007) and Priyadarshini *et al.* (2011).

Transparency is an important physical factor, which indicates the productivity of a water body. In this study, transparency ranged from 39.74±0.51 to 40.00±0.90 cm which is within the range found by Kohinoor (2000) who recorded transparency values ranging from 15 to 58 cm. Hossain *et al.* (2013); Wahab *et al*. (1995) and Chakraborty and Mirza (2007) recorded almost similar transparency values of pond water in nursery pond.

Dissolved oxygen (DO, mg/l) is another important water quality parameter responsible for normal living of aquatic organisms. Wahab *et al.* (1995) recorded dissolved oxygen ranging from 2.2 to 7.1 mg/l. Chakraborty and Mirza (2007) recorded DO 3.88 to 5.22 mg/l while Kohinoor (2000) measured dissolved oxygen 2 to 7.4

mg/l in nursery pond. So, the level of dissolved oxygen (DO) was within the acceptable range in all the experimental ponds.

According to Swingle (1957) pH 6.5 to 9.0 is suitable for pond fish culture and pH more than 9.5 is unsuitable because free CO_2 is not available in this situation. The pH values of the present study are also agree with the findings of Hossain *et al.* (2013), Chakraborty and Mirza (2007), Kohinoor *et al.* (1994), Chakraborty *et al.* (2003) and Rahman and Rahman (2003).

In alkaline waters essential nutrients are found in higher quantities and this is the most important reason for higher biological productivity in alkaline waters than in acidic waters. But highly alkaline condition is not favorable for biological production (Rahman, 1992). The findings of the present study of alkalinity are in agreement with those of Islam (2002), Rahman and Rahman (2003). Boyd (1998) stated that the natural fertility of pond water increases with increase in total alkalinity more than 100 mg/l should be present in high productive water bodies. Kohinoor (2000) found the average total alkalinity values above 100 mg/l in his experiments. The mean values of alkalinity in the present study are more or less agreed with the above scientists.

4.2. Growth, survival rate and production of fish

Growth in terms of weight, weight gain and SGR of fries of *C. carpio* var. *specularis* was significantly higher in T_3 where the stocking density was low compared to those of T_1 and T_2 although the same food was supplied in all the treatments at an equal ratio. The low specific growth rate of fry in treatment T_1 and T_2 appeared to be related with higher densities and increased competition for food and space (Haque *et al*., 1994; Islam *et al*., 2002; Islam, 2002; Rahman and Rahman, 2003; Chakraborty *et al*., 2006; Rahman & Verdegem, 2010). High density of fries in combination with increased concentration of food particularly mustard oil cake in the rearing system might have produced a stressful situation and toxic substance which could be the probable cause for poor growth in treatment T_1 and T_2 (Haque *et al*., 1994; Rahman and Rahman, 2003).

Significantly higher survival rate was recorded in T_3, where, the stocking density was lower than T_1 and T_2. 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. Priyadarshini *et al. (*2011) found survival rate of *Cyprinus carpio* fry and fingerlings 61.67 and 68.89 % in manure+feed and feed fed ponds at a stocking density of 4 individual/m^2. Hossain *et al.* (2013) found the survival rate of silver carp and bata 55.05 to 63.11 and 51.10 to 55.18 % in nursery pond. Samad *et al*. (2014) also found highest survival rate (75.17±0.48) and lowest survival rate (65.77±0.28) in nursery ponds for fry rearing of *L. bata.* Similar results also were obtained by Tripathi *et al*. (1979), Uddin *et al.* (1988), Haque *et al.* (1994), Kohinoor *et al*. (1994), Hossain (2001), Rahman and Rahman (2003) , Chakraborty *et al.* (2003) and Chakraborty & Mirza (2007) for fry and fingerlings of various carp and barb species.

In the present study, significantly higher production was observed in T_3 at lower fish density compared to those of T_1 and $T_{2.}$ Priyadarshini *et al.* (2011) obtained gross production of *Cyprinus carpio* fry 2309.01 g/tanks/months fed with feed and manure a stocking density of 4 individuals/m^2. Saha *et al.* (1988) obtained a gross production of 1385.15 to 1995.60 kg ha^{-1} by 8 weeks rearing of rohu (*Labeo rohita*) fingerlings at 0.6 to 0.8 million ha^{-1} stocking densities. Rahman *et al.* (2009) obtained a gross production of 1075.12 to 1576.08 kg ha^{-1} of reba carp (*Cirrhinus ariza*) fingerlings at 0.8 to 1.2 million ha^{-1} stocking densities in 8 weeks. Rahman *et al.* (2004) obtained a production of 1869.10 kg ha^{-1} by rearing *Labeo calbasu* at a stocking density of 0.8 million hatchling ha^{-1}.

Overall, highest growth, survival and production of fries were obtained at a density of 123500 hatchlings ha^{-1}. 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. Incorporation of mustard oil cake at a higher proportion (60%) in the supplementary feed may have produced obnoxious gases and stressful situation in the pond environment which might be accounted for poor growth in *L. bata* fingerlings (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) and Chakraborty *et al*. (2003, 2006).

5. Conclusions

Finally, it can be concluded that the survival, growth, and production of *C. carpio* var. *specularis* fries were inversely related to the stocking densities of spawn. Stocking density of 123500 million hatchlings ha^{-1} may be advisable for rearing of *C. carpio* var. *specularis* fries for 35 days in single-stage nursing. Therefore such research work will generate information to help subsistence and commercial farmers to increase more production in polyculture.

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Conflict of interest
None to declare.

References

Azad MA K, M R Rahman, Z Rahman, MA Kader, MM Haque, and MJ Alam, 2004. Polyculture of carp, tilapia and pangas using low cost inputs. Pak. J. Biol. Sci., **7**: 1918-1926.

Backiel T and ED Le Cren , 1967. Some density relationship for fish population parameters. In: S.D. Gerkings (Editor). The Biological Basic, of Fresheater Fish Populations. Blackwell Scientific Publication's. Oxford. 261-293.

Boyd CE., 1998. Water quality for fish pond. Aquaculture Research and Development series no. 43. Auburn University, Alabama, USA. 37.

Brett JR and TDD Groves, 1979. Physiological energetics In: W.S. Hoar, D.J.Randall and J.R. Brett (Editors). Fish physiology, Vol. III. Bioenergetics and Growth. Academic Press. New York, NY, 279-352.

Brown ME, 1957. Experimental studies on growth. In: Brown, M.E. (Ed.), The Physiology of Fishes, Vol. I. Academic Press, New York, 361–400.

Chakraborty B K and M J A Mirza, 2007. Effect of stocking density on survival and growth of endangered bata, *Labeo bata* (Hamilton–Buchanan) in nursery ponds. Aquaculture, 265:156-162.

Chakraborty B, Miah MI, Mirza MJA and MAB Habib, 2003. Rearing and nursing of local sarpunti, *Puntius sarana* (Hamilton) at different stocking densities. Pak. J. Biol. Sci., 6: 797–800.

Chakraborty BK, Miah MI, Mirza MJA and MAB Habib, 2006. Rearing and nursing of endangered sarpunti, *Puntius sarana* (Ham.) with tree supplementary feeds. J. Asiat. Soc. Bangladesh Sci., 32: 33–41.

Davis GH, Bhuiyan AR and M Ammen, 1984. Fish production in managed farmers ponds with different feeding and stocking regimes. Proceedings of the 7th seminar on maximum livestock production from minimum land. Department of Animal Science, BAU, Mymensingh. 111-129.

DoF (Department of Fisheries), 2012. Sharonika, Jatio Matshya Saptaha-2012 (in Bengali), Department of Fisheries, Ministry of Fisheries and Livestock, Government of Peoples Republic of Bangladesh, 144.

FAO, 2012. The State of World Aquaculture and Fisheries. Rome. 209.

Haque MZ, MA Rahman and MM Hossain, 1993. Studies on the effect of stocking densities on the growth and survival of migral (*Cirrhinus mrigala*) fry in rearing ponds. Bangladesh J. Zool., 21: 51–58.

Haque Z, MA Rahman, MM Hossain and MA Rahman, 1994. Effect of stocking densities on the growth and survival of mirror carp, *Cyprinus carpio* var. *specularis* in rearing ponds. Bangladesh J. Zool., 22: 109–116.

Hossain MI, S Ahmed, S Reza, MY Hossain, MN Islam, J Ara and R Islam, 2013. Effects of organic fertilizer and supplementary feeds on growth performance of silver carp (*Hypophthalmichthys molitrix*) and bata (*Cirrhinus reba*) fry in nursery ponds. International Journal of Research in Applied, Natural and Social Sciences, 1: 117-124.

Hossain QZ, 2001. Induced breeding of the fish Cirrhinus reba by pituitary gland extract and survival of spawn in nursery ponds. J. Asiat. Soc. Bangladesh Sci., 27:205–213.

Islam MS, 2002. Evaluation of supplementary feeds for semi intensive pond culture of Mahaseer, *Tor putitora* (Hamilton). Aquaculture, 212: 263–276.

Islam MS, S Dewan, MG Hussain, MA Hossain and MA Mazid, 2002. Feed utilization and wastage in semi-intensive pond culture of mahseer, *Tor putitora* (Ham.). Bangladesh J. Fish. Res., 6: 1–9.

Kohinoor AHM, M Haque, MG Hussain and MV Gupta, 2000. Growth and survival of *Labeo rohita*, *Labeo bata* spawn in nursery ponds at different stocking densities. J. Asiat. Soc. Bangladesh Sci., 20: 65-72.

Kohinoor AHM, MZ Haque, MG Hussain and MV Gupta, 1994. Growth and survival of Thai punti, *Puntius gonionotus* (Bleeker) spawn in nursery ponds at different stocking densities. J. Asiat. Soc. Bangladesh Sci., 20: 65–72.

Kohinoor AHM, MA Hossain and MG Hussain, 1997. Semi intensive culture and production cost of pabda (*Ompok pabda*) with rajputi (*Puntius gonionotus*) and mirror carp (Cyprinus carpio var. specularis) in mini ponds. Bangladesh J. Zool., 25: 129–133.

Priyadarshini M, JK Manissery, B Gangadhar and P Keshavanath, 2011. Influence of feed, manure and their combination on the growth of *Cyprinus carpio* (L.) fry and fingerlings. Turk. J. Fish. Aquat. Sci., 11:577-586.

Rahman MS, 1992. Water quality management in aquaculture. BRAC prakashana. 66, Mohakhali, Dhaka – 1212, Bangladesh, 75 p.

Rahman MM and MCJ Verdegem, 2010. Effects of intra- and interspecific competition on diet, growth and behaviour of *Labeo calbasu* (Hamilton) and *Cirrhinus cirrhosus* (Bloch). Applied Animal Behavioural Science, 128: 103-108.

Rahman MA, M Zaher and KM Azimuddin, 2009. Development of fingerling production techniques in nursery ponds for the critically endangered reba carp, *Cirrhinus ariza* (Hamilton, 1807). Turk. J. Fish. Aquat. Sci., 9:165-172.

Rahman MR and MA Rahman, 2003. Studies on the growth, survival and production of calbasu (*Labeo calbasu* Ham.) at different stocking densities in primary nursing. Bull. Fac. Sci., Unv. Ryuyus, Jpn. 76: 245–255.

Rahman MR, MA Rahman and MG Hossain, 2004. Effects of stocking densities on growth, survival and production of calbasu (*Labeo calbasu* Ham.) in secondary nursing. The Bangladesh Veterinarian, 21:58–65.

Samad MA , S Jasmine, MR Mosaddequr, S Jahan, RM Selim, MH Istiaque and MH Yeamin, 2014. Effect of Feeds and Fertilizers on Growth and Survival Rate of Threatened *Labeo bata* Fry in Earthen Nursery Ponds. World Journal of Zoology, 9: 244-249.

Saha SB, M Gupta, MG Hossain and MS Shah, 1988. Growth and survival of Rohu (*Labeo rohita*) fry in rearing ponds at different stocking densities. Bangladesh J. Fish., 16:119–126.

Swingle HS, 1957. Standardization of chemical analysis for waters and pond muds. FAO Fish Report, 4: 397-421.

Talukdar MZH, M Shahjahan and MS Rahman, 2012. Suitability of duck weed (*Lemna minor*) as feed for fish in polyculture system. Int. J. Agril. Res. Innov. & Tech., 2: 42-46.

Tripathi SD, A Dutta, KK Sen Gupta and S Pattra, 1979. High density rearing of Rohu spawns in village ponds. Symosium of Inland Aquaculture. (Abstracts) February 12–13, 1979, CIFRI. Barrack Pore. 14.

Uddin MS, MV Gupta and G Barua, 1988. Effect of fertilizers on the growth and survival of Rohu, (*Labeo rohita*) spawn in nursery ponds. Bangladesh J. Fish., 11: 83–88.

Wang Ji-Qiao, SA Flickinger, Be Keming, Yao Liu and Hengwen Xu, 1995. Daily food consumption and feeding rhythm of silver carp (*Hypophthalmichthys molitrix*) during fry to fingerling period. Aquaculture, 83: 73-79.

Zar JH, 1984. Biostatistics. Prentice-Hall, Inc., Englewood Clitts, New Jersey, USA. 718.