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Growth and production of riverine *Catla catla* (Hamilton, 1822) fry in pond habitat based on stocking density

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Abstract

The research work was conducted for 60 days in earthen ponds of Fisheries Department under the University of Rajshahi to investigate fingerling production of riverine Catla, *Catla catla* (Hamilton, 1822) in pond habitat. The experiment was carried out under 3 treatments each with 3 replications. The stocked fries (*Catla catla*) were collected from Padma River, Rajshahi. The stocking density was maintained at 500/dec (T_1), 450/dec (T_2), and 400/dec (T_3) respectively. Fishes were fed same diet in three different treatments consisting of Fish meal (20%), rice bran (25%), wheat bran (25%) and mustard oil cake (30%) at the rate of 4-8% of body weight. The Physico-chemical characteristics of pond water were measured fortnightly. The mean values of some water quality parameters such as temperature (°C) were 31.30±1.29 (T_1), 31.24±1.46 (T_2), 31.36±1.29 (T_3); dissolved oxygen (mg/l) 6.74±0.49 (T_1), 6.97±0.63 (T_2), 7.25±0.38 (T_3); carbon dioxide (mg/l) 6.83±0.57 (T_1), 6.36±0.68 (T_2), 6.63±0.50 (T_3) and pH 7.07±0.22 (T_1), 7.11±0.23 (T_2), 7.46±0.08 (T_3); transparency (cm) 40.19±0.23 (T_1), 39.31±1.25 (T_2), 40.83±1.34 (T_3) respectively. The mean value of final fish weight (g) was 8.32±0.07 (T_1), 9.56±0.10 (T_2), 11.45±0.03 (T_3). The specific growth rates (SGR) at 60 days were ranged from 4.6(T_1) to 5.08(T_3) in different treatments during the experimental period. The survival rate ranged between 84 to 92%. Treatment T_2 and treatment T_3 showed significantly higher survival than Treatment T_1. The highest final weight gain, survival rate and cost benefit ratio were found in T_3 treatment. The production (kg/ha) of Catla was 758.29kg (T_1), 849.68kg (T_2), 958.36kg (T_3) respectively. The highest production was found in T_3. Among three treatments the production was very significant ($p<0.05$). The cost benefit ratio was for (T_1) 1:1.79, for (T_2) 1:1.88 and for (T_3) 1:2.19 respectively. The results of the present study indicate that treatment T_3 is better than treatment T_1 and T_2.

Keywords: Stocking density, fingerlings, production and *Catla catla*

Introduction

The spawn fishery in the different river system of Bangladesh plays a vital role in pond culture and is still considered as one of the important cash income of the fishermen. The Padma, the Brhamaputra and their tributaries and the Halda rivers are the main sources of spawn in Bangladesh (DOF, 2010) [1].

Previously seeds of catla used to be collected from the natural sources of river but because of large scale degradation of the breeding the natural supply of seeds has been drastically reduced and now about 90% of the total demand is being met from an estimated 800 hatcheries established under private and public sector in the country. Hatchery produced seeds do not grow as fast as the naturally collected seeds due to poor performance relating to inbreeding, negative selection, introgression etc. in the hatchery of Bangladesh (Shah, 2010) [2]

Development of suitable techniques of nursing and rearing of larvae is very important to ensure reliable and regular supply of fish fingerlings. Successful controlled method of fry nursing depends on a proper knowledge of nutritional and environmental requirement of the larvae in the aquatic ecosystem (Mollah, 1985) [3] Lack of proper care and understanding about the biotic and abiotic factors in the rearing system may result in mass mortality of young fry (Jhingran and Pullin, 1985) [4].

Selection of fish species plays an important role for any culture practice. Stocking density of different fish species in a poly culture system also plays a vital role on overall production of fish.

Higher density of a species may affect the growth of another species. Similarly lower density of a species may reduce the overall production. Among the fish species that make up the backbone of the carp farming system in Bangladesh is *Catla*. There should be a compatibility of species with diversified feeding habits that includes the whole range from omnivorous to macro-vegetation feeding fish species. The Indian major carp *Catla* have been characterized as surface plankton feeder (Agrawal and Mitul, 1992) [5].

A number of studies have been performed on the effect of fertilizers (Nandeesha *et al*., 1984; Dhawan and Toor, 1989; Varghese and Shankar and, 1981; Mitra *et al*., 1987) [6, 7, 8, 9] on growth and production of carps and some on the effects of stocking density (Backiel and Le Cren 1967: Davis *et al*., 1984; Haque *et al*., 1993) [10, 11, 12] on survival and growth of fry and fingerlings in different environmental conditions at different geographical locations, the results of which varied from one experiment to another.

Catla is one of native fresh water fish in Bangladesh for which the development of controlled larval rearing procedures are needed for stock enhancement. Therefore, a suitable culture method for rearing of riverine *Catla catla* fry are very important to ensure reliable and regular supply of fingerlings. Growth, survival and production of fingerlings in nursery ponds depend on quality fish fry and stocking density. The present experiment had been conducted to develop an optimum stocking density of *Catla catla* fry in nursery pond management system.

Materials and methods

Study location and pond facilities

The experiment was conducted in the experimental ponds situated on the north side of the department of Fisheries, University of Rajshahi for a period of 60days. The ponds were similar in shape, depth, basin configuration including water supply facilities. The average area of the ponds was 0.8 decimal (0.0032 hector).

Pond preparation

All unwanted fishes and other predatory species were completely removed through repeated netting from the ponds and finally applying rotenone at the rate 20mg/deci/feet water depth. After soaking overnight lime was applied at the rate of 1 kg/decimal. One week after liming, the pond was manured with cow dung minimum 0.5 kg/deci and maximum 11 kg/deci with a mean valve of 5.37 ± 4.74 kg/deci.

Collection and Stocking of fry

The hatchling of *Catla catla*mixed with some other species were collected from Padma river near the Rajshahi area and nursing 3 weeks in nursery pond. The rearing ponds were stocked with the separated fries of *Catla catla* after three weeks nursing for research purposes. The sizes of the stocked fires were 2.4±0.38 cm length and 0.60±0.04 g weight.

Use of supplementary feeds

Fries were fed three same type of supplemental feed for different treatment (T_1, T_2, and T_3), such as Fish meal, rice bran, wheat bran and Mustard oil cake at the rate of 4-8% body weight daily (Table-1 & 2).The proximate composition of each the feed were carried out in accordance with A.O.A.C method (1990) in table 3.

Table 1: Amount of supplementary feed

Days	Amount of feed
1-10	8% body weight of stocked fry
11-25	6% body weight of stocked fry
26-40	5% body weight of stocked fry
41-60	4% body weight of stocked fry.

Table 2: Inclusion rate of supplementary feed used during the study pond.

Supplementary feed	Percentage (%)
Fish meal	20
Rice bran	25
Wheat bran	25
Mustard oil cake	30

Table 3: Composition of feed used in the experiments

Components	Diets
Moisture	9.7%
Crude protein	24.5%
Crude lipid	12.6%
Crude fiber	15.5%
Ash	10.85%
NFE	28.85%

* Nitrogen free extract (NFE) calculated as
100-% (Moisture + Crudeprotein+ Crudelipid+ CrudeFiber+ Ash)

Design of the experiment

Evaluation of fingerling production of catla in ponds, three treatments were used each with three replications. The experimental layout has been given in the Table-4 below:

Table 04: Design of the experiment

Treatment	Species	Feed	Stocking density (piece/dec)
T_1	*Catlacatla*	24.5%	500 (123500 fry/ha)
T_2	*Catlacatla*	24.5%	450 (111150 fry/ha))
T_3	*Catlacatla*	24.5%	400 ((98800 fry/ha)

Water Quality parameters

Physico-chemical paremeters like water temperature (ºC), transparency (cm), dissolved oxygen (mg/l), Carbon dioxide (mg/l), NH_3-N (mg/l), pH, alkalinity (mg/l) of each experiment pond were measured at 15 days interval and data were recorded on sampling dates. Temperature was recorded using a Celsius thermometer, transparency by secchi disc and other chemical parameters were using Hack kit box (FF2, USA). Recording of water quality data were taken between 8:00 am and 9:00 am.

Growth parameters

The length gain (cm), weight gain (gm) and Survival rate was measured into the following formula used-

- **Length gain (cm)** = Average final length – Average initial length
- **Weight gain (gm)** = Average final weight – Average initial weight
- **Survival rate** = After completion of the experiment at 60th day the number of total live fingerlings in rearing pond was counted separately for calculation of survival rate.

$$\text{Survival rate (\%)} = \frac{\text{Number of fish at harvest}}{\text{Total number of fish stocked}} \times 100$$

- **Yield (kg/deci):** Yield was calculated by deducting biomass at stock from biomass at harvest and it was expressed as kg/deci.
- **Specific growth rate (SGR, % bwd^{-1})**

Specific growth rate (SGR, % bwd^{-1}) was calculated as-[Ln (final weight) – (initial weight)] / culture period (day) × 100 (Brown, 1957) [13].

Statistical Analysis

The length gain (cm), weight gain (g), Final length gain (cm), Final weight gain (g) and survival rate of fry during experimental period with same feeding & fertilization in different treatments were all tested using one way analysis of variance (ANOVA). Significant results (P<0.05) were further tested using Duncan's New Multiple Range Test (DMRT) to identify significant differences among means. This statistical analysis was performed with the support of the computer software SPSS (Statistical package for social sciences) program.

Results

Water quality parameters were monitored fortnightly. Water temperature, water transparency, dissolved oxygen, pH, Carbon dioxide of water varied from 31.24±1.46 to 31.30±1.29 ºC, 39.31±1.25 to 40.83±1.34 cm, 6.74±0.49 to 7.25±0.38 mg/l, 7.07±0.22 to7.46±0.08, 6.36±0.68 to 6.83±0.57 mg/l respectively. Among all the water quality parameters in three different treatments were not significant. Variation in the mean values of water quality parameters in three different treatments are shown in Table 5.

Table 5: Average water quality parameters under different treatments during the study period

Treatments / Parameters	T_1	T_2	T_3
Temperature (°C)	31.30±1.29^a	31.24±1.46^a	31.36±1.29^a
DO (mg/l)	6.74±0.49^a	6.97±0.63^a	7.25±0.38^a
CO_2 (mg/l)	6.83±0.57^a	6.36±0.68^a	6.63±0.50^a
pH	7.07±0.22^a	7.11±0.23^a	7.46±0.08^a
Transparency (cm)	40.19±0.23^a	39.31±1.25^a	40.83±1.34^a

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

Growth performance of fry in rearing pond during 60 days of rearing

For the evaluation of growth performance of fish in different treatments in terms of final weight, mean weight gain, specific growth rate (%,bwd-1), survival rate (%) and production (Kg/ha /60 days) were calculated and shown in table 06. In the present experiment there was no significant (P<0.05) difference in initial weight of fish under different treatments. The average final weights were 10.32±0.07, 11.56±0.10and 13.45±0.03in T_1, T_2 and T_3 respectively. Weight increments were statistically significant among the treatments. The highest weight gain were observed in T_3(12.85±0.06a)and lowest in T_1(9.72±0.03a). Similarly, The highest growths in length were noticed in T_3 (8.49±0.31cm) and the lowest in T_3 (7.93±0.45cm). The recorded mean specific growth rate after 60 days of experiment of treatments T_1, T_2 and T_3 were 3.57±0.06, 3.35±0.01 and 3.20±0.009 (Table 6) respectively, which were significantly (P<0.05) different among the treatments. The significantly (P<0.05) highest SGR (%, bwd^{-1}) value 5.08±0.09 was recorded treatment T_3 while the lowest 4.6±0.05 was obtained in T_3. The survival rate (%) in different treatments was fairly high. The survival rate (%) during the study period were 79.75±0.25%, 85.13±0.88 and 89.63±2.38% in the T_1, T_2 and T_3 respectively, which were significant different (P>0.005) among the treatments. The production of *Catla catla* ranged between 958.36kg (T_3) to 758.29kg (T_1) kg/ha/60days in different treatments (Table 6). Significant differences were found among three treatments when compared using ANOVA (P<0.05).

Table 06: Growth performance of *Catla catla* fries of three different treatments after 60 days.

Growth parameters	Treatments		
	T_1	T_2	T_3
Initial weight(g)	0.60±0.04^a	0.60±0.04^a	0.60±0.04^a
Weight gain (g)	9.72±0.03^c	10.96±0.06^b	12.85±0.06^a
Initial length(cm)	2.4±0.38^a	2.4±0.38^a	2.4±0.38^a
Length gain (cm)	7.93±0.45^b	7.84±0.36^b	8.49±0.31^a
SGR	4.6±0.05^b	4.8±0.1^b	5.08±0.09^a
Final weight (g)	10.32±0.07^c	11.56±0.10^b	13.45±0.03^a
Final length (cm)	10.34±0.03^b	10.24±0.02^b	10.89±0.07^a
Survival rate (%)	79.75±0.25^b	85.13±0.88^{ab}	89.63±2.38^a
Yield (kg/dec)	3550g/3.07kg	3796g/3.44kg	3741g/3.88kg
Yield (kg/ha)	758.29kg^c	849.68kg^b	958.36kg ^{a}

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

Cost Benefit Analysis

The cost of production was based on the local wholesale market price of the inputs. The cost of leasing ponds was not included in the total cost. The cost of different inputs and economic return from the sale of fishes in different treatments are summarized in the table 7. The total cost of inputs and profit hectare^{-1} were significantly different (P<0.05) among the treatments. The cost of input was lowest in$T_1$and highest in T_2. The net profit (TK/ha) was the highest in 182874.00±4.45 (T_3) and the lowest in 117779.00±8.65 (T_1), which was significantly different. Cost and benefit ratio were 1:1.79, 1:1.88 and 1:2.19 respectively.

Table 7: Cost-benefit analysis of *Catla catla* (during 60 days) in rearing system under different treatments

Treatments / Inputs	T_1	T_2	T_3
Pond preparation(TK/ha)	15, 000±0.00[a]	15,000±0.00[a]	15,000±0.00[a]
Fertilizer and lime(TK/ha)	10,167±0.00[a]	10,167±0.00[a]	10,167±0.00[a]
Price of feed(TK/ha)	58,345±0.00[a]	59,345±0.00[a]	60,625±0.00[a]
Price of fry(TK/ha)	61750.00±0.00[a]	55575.00±0.00[b]	49400.00±0.00[c]
Labour(TK/ha)	6510.00±0.00[a]	6510.00±0.00[a]	6510.00±0.00[a]
Harvesting(TK/ha)	10850.00±0.00[a]	10850.00±0.00[a]	10850.00±0.00[a]
Total cost(TK/ha)	147622.00±45.0[a]	157447.00±65.4[b]	152552.00±56.6[c]
Total income(TK/ha)	265401.00±8.65[b]	297388.00±5.33[b]	335426.00±4.45[a]
Net profit(TK/ha)	117779.00±8.65[b]	139941.00±5.33[b]	182874.00±4.45[a]
CBR	1.79±0.06[c]	1.88±0.04[b]	2.19±0.02[a]

Figure in the same row having same superscripts are not significantly different ($p>0.05$)

Discussion

Water quality parameters

Growth, feed efficiency and feed consumption of fishes are normally governed by a few environmental factors (Fry, 1971) [14]. Quality of experimental water remained favorable for fish growth throughout the experimental period. In the present study the average temperature recorded was 31.30±1.29 (T_1), 31.24±1.46 (T_2) and 31.36±1.29 (T_3) respectively. Ali *et al.,* (1982) [15] observed temperature range of 25-35.5°C in pond water. DoF (2008) [16] recorded suitable temperature ranges at 26-32.44°C in pond water for Carp fish culture in Bangladesh. These finding are also more or less similar from of the present study.

pH is considered as an important factor in fish culture. It indicates the acidity or alkalinity condition of a water body. The pH value of the experimental ponds were recorded as 7.07±0.22 (T_1), 7.11±0.23(T_2), 7.46±0.08 (T_3) respectively. According to Swingle (1957) [17] 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 optimum pH range for carp poly culture in pond is 6.5-9.0 (Dewan *et al.,* 1991; and Wahab *et al.,* 1994, DOF (2008) [18, 19, 16] recorded suitable pH ranges 5.66-7.44 in pond water. These findings are also more or less similar for catla fry in pond habitat.

Dissolved oxygen (DO, mg/l) is another important water quality parameter responsible for normal living of aquatic organisms. In the present study, the ranges of dissolved oxygen in different treatments varied from 6.75±0.49 (T_1), 6.97±0.63 (T_2), 7.25±0.38 (T_3) respectively. Nirod (1997) [21] recorded dissolved oxygen from 3.4 to 8.97 mg/l and Paul (1998) [22] found dissolved oxygen 0.8 to 7.85 mg/l, while Kohinoor (2000) [23] measured dissolved oxygen 2 to 7.4 mg/l in the research ponds of BAU campus, Mymensingh. So, the level of dissolved oxygen was within the acceptable range in all experimental ponds.

The recorded carbon dioxide among three treatments were 6.83±0.57 (T_1), 6.36±0.68 (T_2), 6.63±0.50 (T_3) respectively. DOF (2008) [16] recorded free $C0_2$ level of 1.04 - 29.49 mg/1. From the above findings, it is concluded that the carbon dioxide content of the experimental ponds was within the good productive range. Transparency ranged from 39.31 to 40.83 cm which was near the findings of Kohinoor (2000) [23] who recorded transparency values ranging from 15 to 58 cm. Wahab *et al*. (1994) [19] found transparency depth ranging from 5-75 cm in polyculture pond. The observed range of water transparency was more or less similar with the findings of Wahab *et al*. (1995) and Paul (1998) [20, 22].

Growth performance of Catla fry

Growth in terms of length gain and mean weight gain of *Catla* was significantly higher in T_3 where the stocking density was low compared to the treatments of T_2 andT_1.The present result coincide with the finding of Haque *et al.* (1993) [12] who carried out an experiment on the effect of stocking densities in six nursery ponds and achieved best growth at lower stocking densities in *Labeo rohita* and *Cirrhina mrigala*. DoF (2010) [1] observed the daily average weight gain of catla 0.391 g/day with mixture of rice bran and mustard oil cake (1:1) as supplemental feed fed at the rate 5% of total fish body weight daily. These findings are more or less similar from the present study. The highest SGR value was found at T_3 and lowest was observed at T_1.The lowest stocking densities provide more space, food and less competition, which were reported by various authors like Ahmed (1982) [24], Hasan *et al*. (1982) [25] and Haque *et al*. (1984) [26].

The survival rates of three different treatments of *Catla* were 79.75% (T_1), 85.13% (T_1), and 89.63% (T_3) respectively after 60 days of experimental period. A significantly ($p<0.05$) higher survivability observed in the treatments T_3. DoF (2005) [27] reported survival of carp fry in different ponds ranged from 52.1 to 73.3%. Best survival of 73.3% was obtained from the pond which was fertilized with urea and triple super phosphate at the rate of 112.5 and 37.5 kg/ha respectively. Haque *et al*. (1993) [12] reported survival carp spawn in different pond were 70.07%, 71.44%, 58.32% respectively. Wahab *et al* (1995) [20] found that the survival rate of all fish including Thai sarpunti was higher than 80.0% in polyculture with native major carps. Kohinoor *et al*. (1993) [28] reported the the survival rate of Thai sarpunti ranged from 86.0% to 94% in monoculture system. The findings of the previous studies indicate that survival rate of Catla was more or les similar to this study.

Among three treatments, the production of *Catla* 3.32±0.20 kg/dec (T_1), 3.66±0.04 kg/dec (T_2), 4.10±0.12 kg/dec (T_3) respectively. Among three treatments the highest production was observed in T_3 followed by T_2 and T_1. Lakshmanan *et al.* (1971) [29] presented that the fish were fed a mixture of mustard oilcake and rice bran. Fish production were in the range of 2230 to 4209 kg/ha/yr. Fry production from Hossain *et al.,* (1997) [30] obtained a yield of 3.64-9.91 kg/deci with 80 days from 3 seasonal nursery ponds with supplemented feeding. Boyd (1990) [31] suggested that feeding of carp with mixture of oilcake and rice bran 1:1 for better production. Uddin et al. (1994) [32] found a gross production of 3415 kg/ha/yr (ca. 2277 kg/ha/8 mo) from polyculture of carps with Thai sharpunti. The results in the present experiment are very close to those of Saha et al. (1988) [2] who 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. (2003) [33] also found 1663.48-2476.77 kg ha-1 productions after 8 weeks nursing of local sharpunti (*Puntius sarana*) hatchlings at stocking densities of 1.25 to 1.75 million ha-1. Similar to the present study, Rahman et al. (2003) [33] obtained a production of 1869.1 kg ha-1 by rearing of *Labeo calbasu* fingerlings for 8 weeks at a stocking density of 0.8 million hatchlings ha-1. Significantly higher numbers of fingerlings were produced in T3 where the stocking density was higher than those in T_2 and T_1.The total production of Catla obtained from this study were lower than those of the above studies. The reason behind this might be because of fry rearing of Catla in nursery rearing in ponds.

The cost benefit analysis indicated that the net profit and CBR was the highest in T_3 followed by T_2 and T_1, because weight gain, survival and production of fishes were higher in T_3 than those obtained in other treatments. Kohinoor *et al.* (1999) [34] reported a net benefit of Tk. 69750-73480/ha/6 month from polyculture of Thai sarpunti, Mirror carp and Silver carp fed with low cost feed. These findings are more or less similar vary from the present study.

Conclusion

From the study, it is clear that the higher growth and survival of *Catla* fingerling was found in lower stocking density (T_3). Finally it can be said that, to increase riverine carp fingerlings (*Catla*) production, the riverine fingerling production based research should be developed for inbreeding depression free indigenous catla stock and also for higher production of grow-out farmers.

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