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Density based sustainable fingerling production techniques of indigenous major carp, *Labeo rohita* (Hamilton, 1822) in ponds of Bangladesh

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ABSTRACT

Density based fingerling production technique of indigenous major carp (Labeo rohita) was conducted in ponds from 14^{th} August to 14^{th} October, 2013. Experiment was carried out under rearing pond with three treatments group each having three replicates. Size of the stocked fries was 1.5±0.12 cm length and 0.43±0.13 g weight. Stocked fries (Labeo rohita) were collected from Rajshahi City Hatchery, Rajshahi. Stocking density was maintained at 400000/ha (T_1), 500000/ha (T_2), 600000/ha (T_3) respectively. Fishes were fed same diet in three different treatments consisting of 25.5% protein at the rate of 8- 10% of body weight. Also same type of fertilizers was used in three different treatments consisting of Cowdung, Urea, and T.S.P. Physico-chemical characteristics of pond water were measured fortnightly. Mean values of some water quality parameters such as temperature (°C) were 31.18±1.33 (T_1), 31.21±1.37 (T_2), 31.12±1.25 (T_3); dissolved oxygen (mg/l) 6.65±0.54 (T_1), 6.61±0.48 (T_2), 7.05±0.28 (T_3); carbon dioxide (mg/l) 6.75±0.53 (T_1), 6.49±0.56 (T_2), 6.70±0.50 (T_3) and pH 6.08±0.21 (T_1), 7.04±0.22 (T_2), 7.18±0.17 (T_3); transparency (cm) 39.92±0.60 (T_1), 39.91±0.58 (T_2), 89.87±0.74 (T_3) respectively. Sampling was also done fortnightly. Mean value of final length (cm) 7.76±0.12 (T_1) 7.74±0.12 (T_2) 7.70±0.14 (T_3) and the mean value of final weight (g) was 4.98±0.25 (T_1), 4.61±0.32 (T_2), 4.37±0.32 (T_3). Survival rate of Labeo rohita was 74.96% (T_1), 66.50% (T_2), and 62.50% (T_3) respectively. Highest survivability was found in T_1. The production (kg/ha) of Labeo rohita fry was 1392.02±64.83 (T_1), 1419.77±96.26 (T_2), 1511.05±96.70 (T_3) respectively. The highest production was found in T_3. Higher CBR was found from treatment T_1 (1:2.71) than from treatment T_2 (1:2.40) and T_3 (1:2.47). From the study it is evident that lower stocking density effective for optimum result in the growth of Labeo rohita fry.

Key Words: *Fingerling, Indigenous, Labeo rohita, Major carp and Stocking density*

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I. Introduction

Fingerling (fish), a young fish that has developed to about the size of a finger. Availability of carp fingerlings are the most important factor in determining the success of closed water aquaculture. 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. 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 *Labeo rohita*. 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 *Labeo rohita* have been characterized as mid feeder (Agrawal and Mitul, 1992). Development of suitable techniques of nursing and rearing of larvae is very important to ensure reliable and regular supply of fish fingerlings to reduced fry mortality. 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). 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). The density at which a fish species can be stocked is an important factor in determining the economic viability of a production system in intensive aquaculture (Papst *et al.*, 1992).The high stocking density, however, may exert adverse effects on growth and survival. Therefore, it is necessary to predetermine and standardize the optimum stocking density for each species in order to obtain the best possible output. Normally the quantity of feed consumed increases with increase in size of the fry in the ponds and consequently the quantity of plankton will be increased when the fry have grown to a large size. Growth, survival and production of fingerlings in nursery ponds depend on quality of supplementary feeds and stocking density. The present experiment has been conducted to develop a suitable stocking density of *Labeo rohita* fry in nursery pond management system.

II. Materials and Methods

The experiment was carried out for a period of 60 days from 14th August, 2013 to 14th October, 2013 in the south side of Maherchandi village, Matihar thana, Rajshahi.

Experimental design: Experiment was conducted with 3 different treatments of stocking densities of Rui (*Labeo rohita)* namely T_1, T_2, T_3. Treatments assignment were T_1: 400000/ha**,** T_2: 500000/ha and T_3: 600000/ha.

Pond preparation: Before start of the experiment, to repair dyke and bottom of the study pond, all the aquatic weeds and insects were removed. The quantity of rotenone was used 19.76 kg/ha for the removal of predatory and unwanted fish species. 227.24 kg/ha lime was used for the pond preparation by the farmer. The pond was prepared by using cow dung 1326.39 kg/ha, by using urea 242.06 kg/ha, by using TSP 192.66 kg/ha. Sources of water were deep tube-well and rain. The water was supplied by the pump machine.

Collection of fry: Fry were collected from the "Rajshahi Fish Feed Hatchery", Rajshahi, Bangladesh. Fry were transported to the experimental site through plastic bag with proper aeration.

Stocking of fry: Rearing ponds were stocked with the separated fries of *Labeo rohita* after three weeks nursing for research purposes. The size of the stocked fires was 1.5±0.12 cm length and 0.43±.13 g weight. The length and weight of around 10% of all fry of each pond was measured and recorded for estimating initial stocking biomass and to adjust initial feeding rate for fishes.

Feeding of fishes: Fries were fed three same type of supplemental feed for different treatments (T_1, T_2, and T_3), such as fish meal, mustard oil cake, rice bran, wheat flour and maize bran at the rate of 8-10% of body weight daily. The supplemental feed was given to fry at the rate of 10%, 8% in 1st and 2nd month respectively. The quantities of feed were adjusted every 15 days interval on the basis of increase in the average body weight of the stocked biomass. The proximate composition of each, the feed were carried out in accordance with A. O. A. C method (1990). The proximate composition of feed has been presented in the Table 01 and Table 02.

Table 01. Composition of feed used in the experiment

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

Table 02. Proximate composition of feed used in the experiment

Components	Diets
Moisture	9.6 %
Crude protein	25.5%
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)

Growth sampling of fish: Fries were sampled from each rearing ponds by using small meshes seine net at fortnightly interval to determine the change in their growth in terms of length and weight gain. At least 10% fish from each pond was taken to make assessment of growth trends and to readjust feeding rate. Length and weight of sampled fish were measured using a measuring scale and digital electric balance (OHAUS, MODEL No.CT-1200-S). Fishes were handled carefully to avoid stress during sampling.

Monitoring of water quality parameters: Different water quality parameters such as temperature (ºC), transparency (cm), pH, dissolved oxygen (mg/l), alkalinity, ammonia-nitrogen (mg/l) of the ponds were monitored at 8.00 am in each fortnight to assess the physico-chemical condition of the pond and analyzed by using HACH water quality analytical kit (FF_2, USA).

Growth parameters: Several parameters (Mean weight gain, Total weight gain, Specific growth rate, and Survival rate) were used to evaluate the growth performance of fishes under different treatments. Growth data collected from different treatments during the trials were calculated and analyzed using following equations:

Mean weight gain (g) = Mean final weight (g) - Mean initial weight (g)
Total weight gain (g) = Mean weight gain (g) × Number of fish (g)
Length gain (cm) = final length (cm) – initial length (cm)

SGR (%, bwd^{-1}) = **Error!**× 100 (Brown, 1957: Ricker, 1975)

Survival rate (%) = **Error!**× 100 (De Silva, 1989)

Production of fish: At the end of the experiment, the ponds were drained and the fishes were enumerated and measured. Production was calculated based on average final weight of the harvested fishes and was expressed as kg/ha. The formula is Production = No. of harvested fishes x final weight of fish.

Input cost and profit analysis: Simple cost-benefit analysis was followed to study the economics of fingerling production of *Labeo rohita* under different treatments for the present study. Data on both fixed and variable costs were recorded to determine the total cost (BDT/ha/60 days). Total return

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determined from the market price of fish was expressed as BDT/ha/60 days. Net benefit calculated by deducting the total return from total cost was expressed as BDT/ ha/60days.
CBR was calculated, CBR=Net benefit/total cost.

Statistical analysis: For the analysis of collected data, one-way analysis of variance (ANOVA) was performed by using the SPSS (Statistical Package for Social Science, evaluation version-16.0) program and significance was assigned at the 0.05% level and tested Duncan's New Multiple Range Test (DMRT) to identify significant differences among the mean values (Zar, 1984).

III. Results and Discussion

Water quality parameter: Growth, feed efficiency and feed consumption of fishes are normally governed by a few environmental factors (Fry, 1971; Brett, 1979). The mean values of different water quality parameters under different treatments by the total of all fortnights are presented in Table 03 and Figure 01. The ranges of water temperature (°C) in the study pond during the study period were more or lese similar which was 31.18±1.33 (T_1), 31.21±1.37 (T_2), 31.12±1.25 (T_3) respectively. The finding is also more or less similar with the findings of Ali *et al.* (1982), they observed temperature range of 25-35.5°C in pond water and Boyd (1998) reported the suitable water temperature of 25-32°C for warm water aquaculture species. Transparency ranged from 39.87±0.74 cm (T_3) to 39.92±0.60 cm (T_1) which was near the findings of Kohinoor (2000) who recorded transparency values ranging from 15 to 58 cm. The observed range of water transparency was more or less similar with the findings of Wahab *et al.* (1995), Boyd (1998) and Paul (1998). Ranges of dissolved oxygen in the study pond during the study period were 6.65±0.54 mg/l (T_1), 6.61±0.48 mg/l (T_2), 7.05±0.28 mg/l (T_3) respectively which was similar to the findings of Wahab *et al.* (1995), they found that dissolved oxygen ranging from 2.2 to 7.1 mg/l in nine ponds at BAU campus. The recorded dissolved oxygen range was more or less similar with the findings of Nirod (1997), Paul (1998) and Kohinoor (2000). Ranges of pH values in the study pond during the study period were 7.08±0.21 (T_1), 7.04±0.22 (T_2), 7.18±0.17 (T_3) respectively. The optimum pH range for carp culture in pond is 6.5-9.0 (Swingle, 1957; Dewan *et al.,* 1991; and Wahab *et al.,* 1994) which are more or less similar from the present study. Ranges of carbon dioxide (mg/l) in the study pond during the study period were 6.75±0.53 (T_1), 6.49±0.56 (T_2), 6.70±0.50 (T_3) respectively. DoF (2008) found that free $C0_2$ level of 1.04 - 29.49 mg/1 which was similar to the present study. From the above findings, it is concluded that all water quality parameters of the experimental ponds was within the good productive range.

Table 03. Average water quality parameters under different treatments

Treatments / Parameters	T_1	T_2	T_3
Water temperature (°C)	31.18±1.33 [a]	31.21±1.37 [a]	31.12±1.25 [a]
Transparency (cm)	39.92±0.60 [a]	39.91±0.58 [a]	39.87±0.74 [a]
DO (mg/l)	6.65±0.54 [a]	6.61±0.48 [a]	7.05±0.28 [a]
pH	7.08±0.21 [a]	7.04±0.22 [a]	7.18±0.17 [a]
CO_2 (mg/l)	6.75±0.53 [a]	6.49±0.56 [a]	6.70±0.50 [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: Growth parameters initial length and weight, final length & weight, length gain, weight gains are presented in Table 04.

The length gain (cm), weight gain (g) was found to be highest in T_1 although the same food was applied at an equal ratio in all the treatments. The causes might include competition for food and habitat due to higher number of fish. Stocking density had previously been observed to have a direct effect on the growth of fish (Haque *et al.*, 1993; Kohinoor *et al.*, 1994; Islam, 2002; Islam *et al.*, 2002; Rahman *et al.*, 2004; Rahman *et al.*, 2005).

SGR (%) were found 3.40±0.24 (T_1), 4.34±0.54 (T_2) and 4.25±0.28 (T_3). Apu *et al.* (2012) carried out an experiment on carp fishes under three treatments each with two replications. They found specific growth rates in treatments 1, 2 and 3 were 2.94%, 3.07% and 3.02% respectively. The findings of the present study were more or less similar with their findings. Kohinoor *et al.* (1999) obtained the SGR

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values of 1.33-1.35% in thai barb when they were with carps. Rahman *et al.* (2011) estimated SGR values of rahu, catla and olive barb were 1.55-1.63%, 1.56-1.58% and 0.87-0.97% respectively. These values were lower from the present study, which might be because of higher stocking density of fishes in their study.

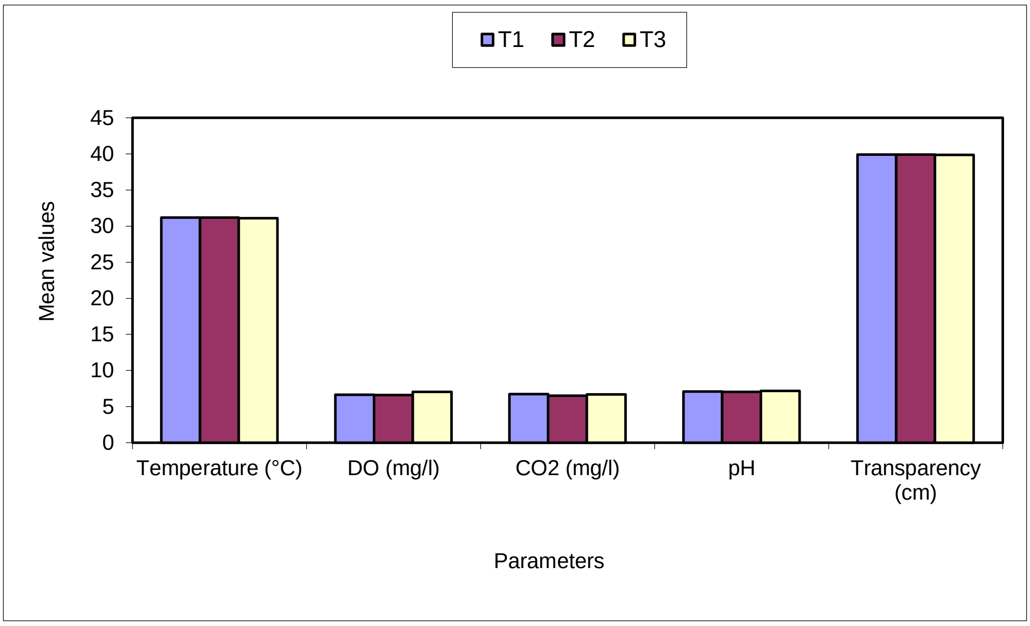

Figure 01. Different parameters under three treatments during study period.

Table 04. Mean growth performance of fries of three different treatments after 60 days

Treatments / Parameters	T_1	T_2	T_3
Initial length (cm)	1.5±0.12^a	1.5±0.12^a	1.5±0.12^a
Inital weight (g)	o.340.13 ^{a}	o.340.13 ^{a}	o.340.13 ^{a}
Final length (cm)	7.76±0.12 ^{a}	7.74±0.12^a	7.70±0.14^a
Length gain (cm)	5.85±1.24 ^{a}	5.76±1.21^a	5.75±1.19^a
Final weight (g)	4.98±0.21 ^{a}	4.61±0.12^a	4.37±0.22 ^{b}
Weight gain	4.55±0.11 ^{a}	4.18±0.31 ^{a}	3.94±0.21 ^{a}
SGR (%)	3.40±.24 ^{a}	4.34±0.54 ^{a}	4.25±0.28 ^{a}
Survival rate (%)	74.96±0.62 ^{a}	66.54±0.35 ^{b}	62.50±0.42 ^{c}
Yield/Production (kg/ha)	1392.02±64.83^c	1419.77±96.26 ^{b}	1511.05±96.70^a

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

Survival rates of three different treatments of *Labeo rohita* were 74.96% (T_1), 66.5% (T_1), and 62.50% (T_3) respectively after 60 days of experimental period. A significantly ($p<0.05$) higher survivability observed in the treatments T_1. Haque *et al.* (1993) reported survival rate of carp spawn in different ponds were 70.07%, 71.44%, 58.32% respectively. Samad *et al.* (2014a) 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.* The author works with advanced fry and get survival rate higher than the referred findings.

Significantly higher gross and net productions of fingerlings were obtained from ponds stocked with 400000/ha than those from the ponds stocked with 500000/ha and 600000/ha, indicating that the growth and percentage of survival decreased with increasing stocking density. The results in the present experiment are very close to those of Saha *et al.*(1988) 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. Fry production from Hossain *et al.* (1997) was 3.64-9.91 kg/deci with 80 days from 3 seasonal nursery ponds with supplemented feeding. Rahman et al. (2003) 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} which was more or less similar to the present study.

Rahman *et al.* (2004) 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 T_3 where the stocking density was higher than those in T_2 and T_1.

Table 05. Cost benefit analysis of *Labeo rohita* fry (during 60 days) in rearing system

Parameters (BDT)	Treatments		
	T_1	T_2	T_3
Pond operational cost (tk/ha)	10258.74±0.00^a	10258.74±0.00^a	10258.74±0.00^a
Price of fry (Tk/ha)	16000.00±0.25^c	20000.00±0.35^b	23000.00±1.35^a
Cost of feed (Tk/ha)	16219.67±0.67^c	17270.67±0.67^b	18150.67±0.67^a
Others cost (Tk/ha)	2470±0.00^a	2470±0.00^a	2470±0.00^a
Total cost (Tk/ha)	44947.07±0.23^c	49998.07±0.32^b	54878.07±0.35^a
Total cost of fingerling (sale)	166800±5.23^b	170372±8.23^b	187440±6.23^a
Benefit (Tk/ha)	121853.23±0.25^a	120374.93±0.12^b	132562.43±0.32^c
CBR	2.71±0.06^a	2.40±0.03^b	2.47±0.05^b

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

Total cost, net profit and CBR significantly varied from 44947.07±0.23 tk/ha (T_1) to 54878.07±0.35 tk/ha (T_3), 120374.93±0.12 (T_2) to 132562.43±0.32 tk/ha (T_3) and 2.40±0.03 (T_2) to 2.71±0.06 (T_1) respectively (Table 05). Significant difference was found among the treatments in case of CBR. Both total cost and net profits were found higher with treatment T_3 but CBR was higher in T_1. Fish production, survival rate, total cost, net profit and CBR were found moderate with treatment T_2 and T_3. Samad *et al.* (2014b) recorded that the CBR of *Clarias batrachus* culture was higher (1:1.24) when 30% protein containing feed were used. Findings indicated that fish production with highest survival rate and lowest total cost were obtained with treatment T_1. However overall findings indicated that low cost and maximum benefit can be achieved using lower stocking densities in ponds for *Labeo rohita* fry.

IV. Conclusion

In terms of water quality, production and economics; it is evident from the study that lower stocking density (i.e., 400000/ha) effective for optimum result in the growth of *Labeo rohita* fingerlings. However, further studies can be carried out with higher stocking density and different protein supplement to see the effect of that higher stocking density and protein supplement on the growth and production of *Labeo rohita* for longer period of time to evolve a definite pond culture technology of advanced fingerlings of *Labeo rohita* for grow out culture of commercial farmers in Bangladesh.

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