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EFFECT OF STOCKING DENSITY OF FINGERLINGS PRODUCTION OF BLACKCARP *Mylopharyngodon piceus* (J. Richardson, 1846) IN POND CONDITION

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ABSTRACT

An experiment was conducted in pond condition under three treatments for a period of 60 days each with three replications to know the effect of stocking density on growth performance of fingerlings production of Black carp *Mylopharyngodon piceus*. Stocking density were used at the rate of 240 (T_1), 270 (T_2) and 300 (T_3) fingerlings/decimal, respectively. Initial average length and weight of *M. piceus* fry were 3±0.02 cm and 1.5±0.01g during stocking in the experimental ponds. The fish were initially fed with 25% protein content formulated feed at 8% of body weight and the rate was reduced to 6% gradually. The water quality variabilities were more or less similar in three treatments within the suitable ranges for aquaculture. The SGR value 3.57±0.006 was recorded in treatment T_1 while the lowest value was 3.20±0.009 in T_3. Survival rate (%) were significantly higher in T_1 (91.33±0.88) where the stocking density was low compared to those in T_2 (79.83±0.44) and T_3 (77.17±0.6), respectively. The net profit in treatment T_1 was (Tk. 475428.58±3.25) and lowest in T_3 (Tk. /ha 190138.5±6.15). The highest final weight gain, SGR%, production, net profit and cost benefit ratio were found in treatment T_1. In the present study production of *M. piceus* was found to be highest in lower stocking density. Therefore, it is evident that feeding with higher protein supplement with lower stocking density is effective for optimum growth of *M. piceus*.

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INTRODUCTION

Aquaculture is the cultivation of fish in captivity under controlled conditions. At present it is an important and rapidly expanding enterprise all over the world. In fish farming the management is directed towards the realization of maximum fish biomass within a certain time (Verreth, 1999; De-Franceso *et al.,* 2007; Schuchardt *et al.,* 2008). In Indian subcontinent, fisheries has always played a pivotal role in the food and nutritional security of the people (Sugunan, 2002). Black carp in Bangladesh is also called snail carp (Rahman, 2005) as it can reduce and control snail's biomass as well as increase the carrying capacity of the pond. Fingerling of Black carp is not available in Bangladesh for grow-out production. Therefore, a suitable culture method for rearing of *M. piceus* fry is very important to ensure reliable and regular supply of fingerlings.

Changes of population densities of fishes may lead to changes in growth and survival rate (Miao, 1992). Fish larvae grow slowly and have a low survival rate at high stocking density (Huang and Chiu, 1997). 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.

MATERIALS AND METHODS

Research area and time

The experiment was carried out for a period of 60 days from 17th July to 16th September, 2013 in Rajshahi University hatchery complex. Initial average length and weight of *M. piceus* fry 3.0$\pm$0.02 cm in length and 1.5$\pm$0.01g in weight were stocked in the experimental ponds. The experimental ponds were rectangular in shape with similar size, depth and bottom type including water supply facilities. The average area of the ponds was 0.60 decimal (0.0024 hector). The water depth was maintained around 1.0-1.25 m.

Experimental design

The experiment was conducted in the pond into three treatments viz. T_1, T_2 and T_3. Each experiment having three replications for evaluation of fingerlings production of *M. piceus*. In this experiment stocking density were 240/decimal (59280/ ha), 270/decimal (66690/ha) and 300/decimal (74100/ha) in the treatment T_1, T_2, T_3 respectively.

Pond preparation

Rotenone (19.76 kg/ha) was used for the removal of predatory and unwanted fish species. After 7 days, all ponds were treated with lime at the rate of 247 kg/ha to disinfect the water. The sources of water of experimental ponds were rainfall and deep tube-well. During the introduction of water in each experimental pond, fine mesh (2 mm) nylon net hapa was used in the mouth of the pumped water to prevent predatory fish egg, spawns, fry and adult or fry of aquatic harmful insects to inhabit their entrance.

Collection and stocking of Fry

Fry of black carp were collected from private hatchery of Jessore. Before releasing the fry to the experimental pond the initial length and weight of 10 fry were recorded with the help of measuring scale and a sensitive portable electric balance (KD300kc: 0.01g-300g).

Feed preparation and feeding

The supplemental feed was given to fry at the rate of 8%, 6% 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. Half of the ration was supplied at 9.00 am and remaining half was supplied at 4.00 pm. The proximate composition of feed has been presented in the table 1 and 2.

Table 1. Composition of feed used in the experiment

Ingredients	Inclusion rate (%)
Fish meal	20
Rice bran	30
Wheat flour	30
Mustard oil cake	20

Table 2. Proximate composition of feed used in the experiment

Components	Diets
Moisture	13.0
Crude protein	25.0
Crude lipid	10.98
Crude Fiber	11.34
Ash	10.2
NFE	29.48

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

Sampling procedure

Sampling was done on every fortnight interval by random sampling of 10% fry from each experimental pond by using a small net. Weight was taken with an electric balance and length was recorded with measuring board. All the collected data were recorded and finally calculated the average length and weight of fry according to treatment on each sampling day.

Water quality parameters

Physico-chemical parameters like water temperature (C), transparency (cm), Dissolved oxygen (mg/1), CO_2 (mg/l), NH_3-N (mg/1), pH, Alkalinity (mg/1) of each experimental pond were measured at 15 days interval and data were recorded. Temperature was recorded by using a Celsius thermometer, transparency was recorded by secchi disc and other chemical parameters were recorded by using Hack kit box (HACK kit, FF-2, USA).

Growth parameters

The growth, length in cm and weight in g was measured in every 15 days interval. To evaluate the fish growth the following parameters were measured.

i. Weight gain (g) = Average final weight - Average initial weight

ii. Length gain (cm) = Average final length - Average initial length

iii. Specific growth rate (SGR) = $\frac{LnW_2 - LnW_1}{T_2 - T_1} \times 100$

Where, W_2 = Final live body weight (mg) at time T_2

W_1 = Initial live body weight (mg) at time T_1

iv. Survival rate was calculated by the following formula =

$$\frac{\text{Initial number of fry} - \text{Final number of fry}}{\text{Initial number of fry}} \times 100 \text{ (Brown, 1957)}$$

v. Production of fishes = No. of fish harvested x final weight of fish.

Economics analysis

A simple economic analysis was done to estimate the economic return in each treatment for experiment. The total cost of inputs was calculated and the economic return was determined by the differences between the total return (from the current market prices) and the total input cost.

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).

RESULTS

Water quality parameters

Water quality parameters were monitored fortnightly. Water temperature, water transparency, dissolved oxygen, free carbon dioxide, pH, ammonia-nitrogen and total alkalinity of water varied from 29.12±0.02 to 32.02±0.0.04°C, 24.70±0.44 to 34.30±0.4 cm, 4.40±0.21 to 5.46±0.17 mg/1, 2.69±0.21 to 3.39±0.03 mg/1, 7.61±0.02 to 7.97±0.24, 0.09±0.0.01 to 0.14±0.003 mg/1and 89.78±0.89 to 107.0±5.19 mg/1respectively. Water temperature, water transparency, dissolved oxygen, free carbon dioxide, pH, ammonia-nitrogen and total alkalinity of water were not significantly ($p<0.05$) different among the parameters. Variation in the mean values of water quality parameters in three different treatments were showed in table 03.

Table 3. Variations in mean values of physico-chemical characteristics under different treatments during the study period

Parameters	Treatments T_1	T_2	T_3
Temperature (°C)	30.69±0.61^a	30.55±0.54^a	30.61±0.61^a
Transparency (cm)	29.38±1.67^a	28.86±1.41^a	30.22±0.69^a
DO (mg/l)	4.86±0.21^a	5.07±0.14^a	5.11±0.16^a
CO_2 (mg/l)	3.08±0.14^a	2.98±0.07^a	3.31±0.21^a
pH	7.76±0.03^a	7.82±0.07^a	7.72±0.04^a
Alkalinity	99.46±4.00^a	97.86±3.33^a	94.20±2.09^a
NH_3-N	0.11±0.02^a	0.13±0.01^a	0.13±0.01^a

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

Growth performance of fish

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 12.74±0.04g, 11.18±0.08g and 10.22 ±0.06g in T_1, T_2 and T_3 respectively. Weight increments were statistically significant among the treatments. The highest growths in weight were observed in T_1 (12.74±0.04) and lowest in T_3 (10.22±0.06). Similarly, the mean length gain in treatments T_1, T_2 and T_3 were 11.03±0.04, 9.34±0.04 and 8.23±0.05 cm respectively. The highest growths in length were noticed in T_1 (14.03±0.04cm) and the lowest in T_3 (11.23±0.05cm). 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 4) respectively, which were significantly ($P<0.05$) different among the treatments. The significantly ($P<0.05$) highest SGR (%, bwd^{-1}) value 3.57±0.006 was recorded treatment T_1 while the lowest 3.20±0.009 was obtained in T_3. The survival rate (%) in different treatments was fairly high. The survival ranged between 77.17±0.66 to 91.33±0.33. Significant ($P<0.05$) different survival rate were found among the treatments. The production of *M. piceus* ranged between 1286.6±100.19 (T_3) to 1690.8±106.5 (T_1) kg/ha/60days in different treatments.

Economic analysis

A simple economic analysis was performed to estimate the net profit from this culture operation. The cost of production was based on the local wholesale market price of the input used of the year 2013.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 table 05. The total cost of inputs and profit per hectare were significantly different (P<0.05) among the treatments. The cost input was lowest in T_1 treatment followed by T_2 and T_3. The net profit was highest in T_1 treatment and lowest in T_3 treatment which was significantly different among the treatments, cost and benefit ratio were calculated 1:1.41, 1:0.84, 1:0.48 among T_1, T_2 and T_3 respectively.

Table 4. Growth and production performance of *M. piceus* under different treatments during the study period

Growth parameters	Treatments		
	T_1	T_2	T_3
Weight gain (g)	11.24±0.04^a	9.68±0.08^b	8.1±0.06^c
Length gain (cm)	11.03±0.04^a	9.34±0.04^b	8.23±0.05^c
SGR(%,bwd^{-1})	3.57±0.006^a	3.35±0.01^b	3.20±0.009^c
Final weight (g)	12.74±0.04^a	11.18±0.08^b	10.22±0.06^c
Final length (cm)	14.03±0.04^a	12.34±0.04^b	11.23±0.05^c
Survival rate (%)	91.33±0.88^a	79.83±0.44^b	77.17±0.6^c
Yield (kg/ha/60 days)	1690.8±106.5^a	1413.7±181.84^b	1286.6±100.19^c

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

Table 5. Input cost and profit from *M. piceus* for 60 days in ponds of three different treatments

Components	Treatments		
	T_1	T_2	T_3
Initial pond preparation (Tk/ha)	32110.4±00^a	32110.4±00^a	32110.4±00^a
Fry cost (Tk/ha)	237112±00^c	266760±00^b	296400±00 ^{a}
Feed cost (Tk/ha)	56285.4±2.48^c	57422.4±1.03^b	58529.4±3.26 ^{b}
Operational cost (Tk/ha)	10150±00^a	10150±00^a	10150±00^a
Total cost (Tk/ha)	336155±32.04^c	366250±14.15^b	397387±8.45^a
Total income (Tk/ha)	811584±3.28^a	672075±3.32^b	587835.5±6.15 ^{a}
Net profit (Tk/ha)	475428.58±3.25^a	305819.8±3.32^b	190138.5±6.15^c
CBR	1.41±0.01^a	0.84±0.009^b	0.48±0.02^c

Figures in a row bearing common letter(s) do not differ significantly (p<0.05), *Leasing cost is not included

DISCUSSION

Water quality parameters

The mean values of secchi disk depth (cm) among the treatments were 28.86±1.41, 29.38±1.67 and 30.22±0.69 cm in treatments T_1, T_2 and T_3 respectively. Consistently higher transparency depth was recorded in T_3, which might be due to the reduction of the plankton population by higher density of fish (Haque *et al.*, 1993; 1994). Boyd (1990) recommended a transparency between 15 cm to 40 cm as appropriate for fish culture. Wahab *et al*. (1995) suggested that the transparency of productive water should be 40 cm or less. The mean values of water temperature in treatment T_1, T_2 and T_3 were 30.69±0.61°C, 30.55±0.54°C, 30.61±0.61°C respectively Quddus and Banerjee (1989) denoted that the water temperature between 29°C and 32°C is suitable for the faster growth of fish spawn and aquatic organisms under natural conditions. Rahman *et al.* (1992) also found water temperature ranged 25.5°C to 30.0°C, which is favorable for fish culture. The range of temperature (30.55–30.69°C) in the experimental ponds were within the acceptable range for nursing of fry and fingerlings of warm water fishes that agreed well with the findings of Haque *et al.* (1993; 1994), Kohinoor *et al.*

(2001), Rahman (2005) and Britz and Hecht (1987).In the present study the DO content in water was 4.86±0.21 to 5.11±0.16 mg/l. More or less similar results were reported by Hossain (2000) and Kohinoor *et al* (2001) study two ponds where they recorded DO values of fish ponds ranged from 3.8 to 6.9 mg/L and 2.04 to 7.5 mg/L respectively.

According to Rahman (1992) DO content of a productive pond should be 5 mg/l or more. The mean values of pH in treatments T_1, T_2 and T_3 were 7.76±0.03, 7.82±0.07 and 7.72±0.04 respectively. The pH values of the present study are also agreed with the findings of Hossain *et al.,* (2013), Chakraborty and Mirza (2007), Kohinoor *et al.* (1994)

In the present study mean values of total alkalinity were 99.46±4.00, 97.86±3.33 and 94.20±2.09 mg l^{-1} in treatment T_1, T_2 and T_3, respectively. The findings of the present study are in agreement with those of Islam (2002), Rahman and Rahman (2003), and Rahman *et al.* (2004, 2005). The mean values of ammonia-nitrogen were 0.11±0.02, 0.13±0.01 and 0.13±0.01 mg l^{-1} in T_1, T_2 and T_3 respectively. Kohinoor *et al.* (2001) recorded ammonia-nitrogen ranging from 0.01 to 1.55 mg/L in monoculture ponds. However, the present level of ammonia-nitrogen content in the experimental ponds is not lethal to the fish (Kohinoor *et al*., 2001). So, in the present study ammonia-nitrogen value was suitable for fingerling rearing. The mean value of CO_2 of water varied from 2.98±0.07 to 3.31±0.21 in T_1, T_2 and T_3 treatment respectively. DoF (2008) found that free CO_2 level of 1.04-29.49 mg/l which were more or less similar to the present study.

Growth and production performances

Growth in terms of final length, length gain, final weight gain and specific growth rate of fingerlings of *M. piceus* were significantly higher in T_1 where stocking density of fingerlings is 59280/ ha was low compared to these of T_2 66690/ha and T_3 (74100/ha) although the same food was applied at on equal ratio in all the treatment. Stocking density had previously been observed to have a direct effect on growth of fish (Islam 2002; Rahman *et al.,* 2004). High stocking density of larvae in combination with abundant food in the rearing system might produce a stressful situation if not from the build-up of metabolites than from competitive interaction (Haque *et al.,* 1994). Significantly higher survival rate of fingerlings was obtained in T_1 (91.33±0.88), where the stocking density was low compared to those in T_2 (79.83±0.44) and T_3 (77.17±0.6). The causes from decreasing survival rates in those treatments were well as competition for food and space in the experimental ponds. This agrees well in the findings of Kohinoor *et al.,* (1994) and Rahman *et al.,* (2005) during fry rearing experiments of various carp species.

In the present study, significantly higher net production of fingerling were obtained from ponds stocked with 59280 fingerlings/ha than those from the ponds stocked with 66690 fingerling/ha and 74100/ha, including 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 by 8 weeks rearing of Ruhu (*Labeo rohita*) fingerlings at 60000 to 80000/ ha stocking density. Similar production of 1869.1 kg/ha^{-1} by rearing of *Labeo calbasu* fingerlings for 8 weeks at a stocking density of 80000 fingerlings/ha. Significantly high numbers of fingerlings were produced in T_1 where the stocking density was lower than those in T_2 and T_3. The higher market price of larger fingerlings produced in ponds with 59280 fingerling/ha substantially increased the net benefit compared to those obtained from the smaller fingerlings produced at higher stocking density

Among the treatments, the highest production was also found in T_1 and consequently provides the highest net profit (Tk.475428.58±3.25) with $T_1$where fishes were stocked at 59280/ha. Similarly, the net profit in treatment T_2 was (Tk. 30581908±3.32) and lowest in T_3 (Tk./ha 190138.5±6.15).Cost benefit ratio(1.41±0.01) was also higher in T_1 which was significantly different among the treatment. . The finding is more or less similar to the finding with Bob Manuel and E.S, Erondu (2010) who found CBR of nile tilapia *O. niloticus*as 1.60-2.03 and Ali *et al.* (2011) found CBR as 2.60 Tk. Overall, the highest growth, survival, production and benefit of fingerlings were obtained in ponds with 59280 fingerlings/ha compared to the ponds with higher stocking densities.

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