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EFFECTS OF STOCKING DENSITY ON GROWTH AND PRODUCTION PERFORMANCE OF INDIGENOUS STINGING CATFISH, *Heteropneustes fossilis* (Bloch)

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Abstract

An on-farm experiment was undertaken in nine earthen ponds to evaluate the growth and production potentials of stinging catfish shing, *Heteropneustes fossilis* for the period of six months from March to August 2010. Three stocking densities such as 1,25,000 (T_1), 1,87,500 (T_2) and 2,50,000 ha^{-1} (T_3) were tested with three replications each. Fish were fed with commercial pelleted feed containing 35% crude protein. After six months rearing, the mean harvesting weights of shing were 69.42±6.20, 58.74±3.85 and 49.50±4.52g in T_1, T_2 and T_3, respectively. Significant ($P<0.05$) highest mean harvesting weight was found in T_1. The best survival was found in T_1 (87%) among the treatments. The calculated mean production of shing (*H. fossilis*) in three treatments such as T_1, T_2 and T_3 were 7549±52, 9031±71 and 8786±60 kg ha^{-1}, respectively, which were significantly different ($p<0.05$) from each other.

Keywords: Growth, Stinging Cat fish, Stocking Densities, Earthen Pond

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Introduction

Among the air-breathing catfishes, stinging catfish (*Heteropneustes fossilis*) is very popular and high valued fish in Bangladesh. This fish is locally known as Shingi or Shing. It is considered to be highly nourishing, palatable and tasty and well preferred because of its less spine, less fat and high digestibility in many parts of Indian subcontinent (Khan *et al.,* 2003). The species is very high content of iron (226 mg 100g^{-1}) and fairly high content of calcium compared to many other freshwater fishes. Due to high nutritive value the fish is recommended in the diet of sick and convalescents. Being a lean fish it is very suitable for people for whom animal fats are undesirable (Rahman *et al.,* 1982). It is a very hardy fish and can survive for quite a few hours outside the water due to presence of accessory respiratory organs. It can tolerate slightly brackish water. The fish adapts well to hypoxic water bodies and to high stocking densities (Dehadrai *et al.,* 1985). This fish was abundantly available in open water system of floodplains, canals, beel and haors of Bangladesh. But due to over exploitation and ecological changes in its natural habitats; this species have become threatened. Indiscriminate destructive practices have caused havoc to aquatic bio-diversity in Bangladesh (Hussain and Mazid, 2001). Presently, *H. fossilis* is one of the threatened fish in Bangladesh (IUCN Bangladesh, 2000). This fish has enormous aquaculture potential and it could be easily grown in ponds and small ditches. Culture of *H. fossilis* has yet been well flourished in Bangladesh due to lack of appropriate culture technique. Considering its status of threatened status, high market value and high consumer demand it is essential to develop suitable culture technique. The culture technique will helpful to prevent the fish from being extinct and at the same time this delicious tasty fish will be available for the rural and urban people.

Although the air breathing fish Shing is in high market demand, hither to very little attention has been paid to develop culture techniques. Earlier accounts on this species include seasonal morphology of gonads in relation to the biology (Azadi and Siddique, 1986; Kuddus *et al*., 1995), induced breeding for fry production (Thakur *et al*., 1977; Saha, 1998), food and feeding habits (Kuddus *et al*., 1995) and nutrition (Hossain *et al*., 1993; Anwar and Jafri, 1995). But few published literature are available on growth and production of *H. fossilis* in pond, cistern and net cages (Lipton, 1983; Haque *et al*., 1988; Narejo *et al*., 2005; and Khan *et al*., 2003). Considering the lack of information on these lines, the present investigation was carried out to ascertain the optimum stocking density of *H. fossilis* in pond ecology for sustainable production.

Materials and Methods

Pond selection and preparation

The experiment was conducted for a period of six months from March to August 2010 in nine farmer's ponds of 400-600 m^2 area with a depth of 1.0-1.5m at Modhupur, Tarakanda, Mymensingh. Prior to stocking, ponds were dried and cleaned for weeds and unwanted aquatic animals. The dried ponds were left exposed to sunlight for several days and then limed at the rate of 250 kg ha^{-1}. Five days after liming, ponds were filled-up with deep tube well water up to the depth of 1 meter. After three days, ponds were fertilized with cowdung at the rate of 1,000 kg ha^{-1}.

Experimental design

Three different stocking densities of shing (*H. fossilis*) were tested in the experiment. Stocking density was maintained as treatment and which replicated thrice. Fingerlings of shing were stocked at the rate of 1,25,000, 1,87,500 and 2,50,000 ha^{-1} in T_1, T_2 and T_3, respectively.

Source of fingerlings

The fingerlings of *H. fossilis* were used in this experiment were collected from a private hatchery of Mymensingh, Bangladesh. The sizes of fingerlings were 3.26±0.55, 3.44±0.46 and 3.24±0.39g in T_1, T_2 and T_3, respectively.

Fish stocking

Fingerlings of *H. fossillis* were stocked in 01 March 2010 according to the experimental design. All ponds of various sizes were divided randomly into three treatment groups viz. group-1 (T1), group-2 (T2) and group-3 (T3). The ponds belong to Treatment-1 (T_1), Treatment-2 (T_2) and Treatment-3 (T_3) were stocked with *H. fossillis* fingerlings at the stocking density of 1,25,000 (T_1), 1,87,500 (T_2) and 2,50,000 ha^{-1} (T_3), respectively.

Post stocking management

After stocking, in order to meet up the increasing dietary demand, commercial fish feed named Saudi Bangla Fish feed (starter-2) containing 35% crude protein were applied as supplementary feed at the rate of 4-10% of standing biomass of fish twice daily at 0500 hrs and 1900 hrs daily. Proximate composition of the feed was determined following the standard methods given by Association of Official Analytical Chemists (AOAC) (1984) in the Feed and Nutrition Laboratory of Freshwater Station, Bangladesh Fisheries Research institute, Mymensingh. The amount of feed was adjusted fortnightly on the basis of sampling of experimental fish. The proximate composition of the feed is shown in Table 1. Besides this, lime was applied in all the ponds at the rate of 125 kg ha^{-1} at monthly interval.

Table 1. Proximate analyses of the feed used (% dry mater basis)

Dry mater	Protein	Lipid	Ash	Crude fiber
81.10±2.0	35.00±1.0	3.11±0.09	18.20±0.2	10.10±0.68

Fish sampling

Random samples of 50 fish from each pond were sampled fortnightly by using a seine net. The total weight was measured by using a portable balance (Tanita, Japan).

Water sampling and analysis

Water quality parameters such as water temperature, transparency, pH, dissolved oxygen (DO) and total alkalinity were determined at weekly interval between 0900 to 1000 hrs. Temperature was recorded using a Celsius Thermometer, dissolve oxygen and pH meter (Hanna pH 300) and a portable digital DO meter (MI 605, MARTINI).

Harvesting of fish

At the end of the experiment, the fishes were harvested, first by seine netting and then by draining out of the ponds. The harvested fishes were counted and weight was recorded to find out the survival rate and production, respectively. Specific growth rate (SGR) was estimated as:

SGR (% bw d^{-1}) = [In (final weight) – In (initial weight)]/culture period (days) × 100

Data analysis

Data were analysed using the statistical package, Statgraphics Version 7. ANOVA was performed on all the dependent variables to see whether the treatment had any significant effect or not.

Results

Water quality parameter

Mean values of physico-chemical parameters over the period of shing farming are presented in Table 2. The water temperature in T_1, T_2 and T_3 ranged from: 24.60- 30.7°C, 23.88-29.84°C and 24.50-30.30°C, respectively with the mean values 27.90±1.12, 27.86±1.09 and 27.49±1.11 The mean water temperature in T_1, T_2 and T_3

were not statistically significant (P<0.05). The water transparency showed significant (p<0.05) difference among the treatments. The mean values were 24.65±3.11, 26.00±3.92 and 2014±2.40 cm in T_1, T_2 and T_3, respectively. Mean transparency values differed significantly (P<0.05), increasing from T_3 to T_1. The level of pH varied from 7.10-8.20, 7.15-8.70 and 7.08- 8.60 in T1, T2 and T3, respectively.

The dissolved oxygen content in the experimental ponds ranged from 4.70 to 6.80, 4.27 to 6.70 and 3.31 to 6.90 in T_1, T_2 and T_3, respectively, with the mean values 5.32±0.14, 4.79±0.32 and 4.23±0.47 mg L^{-1}. Comparatively lower level of dissolved oxygen as observed in the treatment-3. Dissolved oxygen values (mg L^{-1}) did not differ significantly (P<0.05). Total alkalinity ranged from 85 to 128, 87 to 138 and 84 to 140 mg L-1 with mean values of 109±6.96, 113±9.58 and 117±10.29 mg L^{-1} in T_1, T_2 and T_3, respectively. These values did not show any significant difference (P<0.05) among the treatments.

The range of mean values of ammonia-nitrogen (unionized) was 0.033±0.012, 0.042±0.021 and 0.055±0.031 in T_1, T_2 and T_3, respectively. The highest ammonia-nitrogen value was 0.97 in the month of August in T_3 and the lowest value was 0.017 in the month of March in T_1. The differences among treatments were significant (P>0.05) when compared using ANOVA.

Table 2. Water quality parameter (mean ±SE) of the ponds under different treatments

Parameter	Treatment-1	Treatment-2	Treatment-3
Temperature (°C)	27.90±1.12 (24.60-30.70)	27.86±1.09 (23.88-29.84)	27.49±1.11 (24.50-30.30)
Transparency (cm)	24.65±3.11 ^{b}	26.00±3.92 ^{b}	20.14±2.40 ^{a}
Dissolved oxygen (mg/L)	5.32±0.14 ^{a}	4.79±0.32 ^{b}	4.23±0.47 ^{b}
pH	7.10-8.20	7.15 -8.70	7.08- 8.60
Total Alkalinity (mg/L)	102.00±6.96	113.00±9.58	123.00±10.29
Total ammonia (mg/l)	0.033±0.012	0.042±0.021	0.055±0.031

Figures in the same row having the same superscripts are not significantly different (P>0.05)

Growth and production

Details of stocking, harvesting, growth, FCR, SGR and production of shing (*H. fossilis*) in the three treatments during the study period are shown in Table 3. Growth of shing in ponds was investigated and the results obtained from the experiment indicated that the growth rate varied in different stocking densities. On the basis of final growth attained at harvest under T_1, T_2 and T_3 were 69.42±6.20, 58.74±3.85 and 49.50±4.52, respectively. The highest harvesting weight was obtained in T_1 and lowest in T_3. The harvesting mean weight showed significant differences (P<0.05) in T_1 followed by T_2 and T_3 when ANOVA was performed. The monthly sampling weights of fish under different stocking densities are shown in Fig. 1.

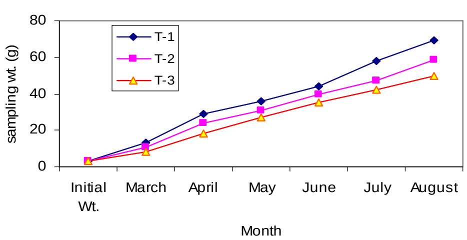

Fig. 1: Monthly growth rate (g) of Shing (*H. fossilis*) in different stocking densities

The Figure indicates that the growth rate was always higher in T_1 then followed by T_2 and T_3. The results showed that higher growth rate was observed at against lower stocking densities. The specific growth rate (% per day) of fish in different treatments varied among the treatments. Highest value was obtained in T_1 and lowest in T_3. SGR in T_1 was significantly higher than T_3, while T_2 was not significantly different from T_1, but was significantly different from T_3. FCR was significantly lower in T_1 than in T_2 and T_3. Therefore, SGR and FCR were best for fish in T_1 where lowest number of fingerlings was reared (1,25,000 ha^{-1}).

The percentage of survival as recorded in the present study was 87±3.6, 82±4.58 and 71±2.64 for T_1, T_2 and T_3, respectively. The highest survival rate was observed in T_1 and the lowest in T_3. Differences in survival rates among the treatments were found to be significant (P<0.05). The mean production of shing was 7,549±52, 9,031±71 and 8,786±60 Kg ha^{-1} in T_1, T_2 and T_3, respectively. The highest fish production was obtained in T_2 followed by T_3 and the lowest in T_1. However, production of fish differed significantly (P<0.05) among the three treatments.

Table 3. Growth, survival and production of shing (*H. fossilis*) under the three treatments

Treatment	Initial weight (g)	Harvesting mean weight (g)	Survival (%)	FCR	Production (kg ha^{-1})	SGR (%)
Treatment-1	3.26±1.11^{a}	69.42±6.20^{a}	87±3.6^{a}	2.78	7,549±52^{b}	2.33^{a}
Treatment-2	3.34±0.96^{a}	58.74±3.85^{b}	82±4.58^{a}	3.12	9,031±71^{a}	2.22^{a}
Treatment-3	3.24±1.0^{a}	49.50±4.52^{c}	71±2.64^{b}	3.59	8,786±60^{c}	2.13^{a}

* Figures in the same column with different superscripts are significantly different (P>0.05)

Correlation matrix among stocking density, harvesting weight, survival, FCR, SGR (%) and production of shing is shown in Table 3 and gave a clear picture of the relationships among the parameters (Table 4). Stocking density showed a negative correlation with harvesting weight, survival and SGR. It means that if stocking density increased, then mean values of harvesting weight, survival and SGR decreased. While, harvesting weight showed positive correlation with survival but negative correlation with FCR and production. Survival rate indicated the negative correlation with FCR and production.

Table 4. Correlation matrix among stocking density, harvesting weight, survival, FCR, SGR and production of shing under grow-out system

Parameter	Stocking density	Harvesting Wt. (g)	Survival (%)	FCR	SGR	Production (Kg)
Stocking density	1.000	-	-	-	-	-
Harvesting Wt. (g)	-0.999*	1.000	-	-	-	-
Survival (%)	-0.978	0.968	1.000	-	-	-
FCR	0.996*	-0.961	-0.993*	1.000	-	-
SGR (%)	-0.998*	1.000	0.964	-0.989*	1.000	-
Production (Kg ha^{-1})	0.776	-0.804	-0.628	0.717	-0.813	1.000

* Significant difference at 5% level of probability

Discussion

Environmental parameters exert an immense influence on the maintenance of a healthy aquatic environment and production of food organisms. Growth, feed efficiency and feed consumption of fish are normally governed by a few environmental factors (Brett, 1979). The mean range of temperature (27.49-27.93°C) in the experimental ponds is within the acceptable range for farming of shing that agrees well with the findings of Haque *et al*. (1984) and Kohinoor *et al*. (1994, 2007). Boyd (1982) reported that the range of water temperature from 26.06 to 31.97°C is suitable for fish culture. Transparency was consistently higher in all the treatments, because shing did not consume plankton in adult stage. For this reason plankton abundance was found in all the ponds of treatments. The Dissolved oxygen in the morning was low in ponds stocked with high density of fish compared to ponds stocked with a low density. Similar results were observed by Saha *et al*. (1988) for rohu (*L. rohita*) and Rahman and Rahman (2003) for calash (*L. calbasu*). Fluctuation of dissolved oxygen might be attributed to photosynthetic activity and variation in the rate of oxygen consumption by fish and other aquatic organisms (Boyd, 1982). However, the level of dissolved oxygen is within the acceptable ranges in all the experiment ponds.

Roy *et al*. (2002) obtained a pH range 7.03 to 9.03 in fish ponds located in Trishal, Mymensingh. The observed pH values of water ranging from 7.3 to 9.0 indicated that the experimental ponds were suitable for fish culture (Boyd, 1982). During the study period, the pH values of pond water under different treatments were found to be alkaline. Roy *et al*. (2002) obtained a pH range 7.03 to 9.03 in fish ponds located in Trishal, Mymensingh. The observed pH values of water ranging from 7.1 to 8.6 indicated that the experimental ponds were suitable for fish culture (Boyd, 1982). The total alkalinity values of the pond water under different treatments were found to be productive level. Total alkalinity levels for natural waters may range from less than 5 mg L^{-1} to more than 500 mg L^{-1} (Boyd, 1982). Kohinoor *et al.* (1998) and Roy *et al.* (2002) found the average total alkalinity above 100 mg L^{-1} in their studies. Total alkalinity values found in the present study were within the suitable range (102 to 123). Total ammonia (including unionized fraction) was found in all the treatments because, high density if fish was stocked. The droppings of the fish might be produced more ammonia in the ponds. New (1987) reported that excessive use of feed or fertilizer caused sediments in the pond bottom which may produce ammonia in the ponds and other gases. In this experiment, this may be happened. The suitable range of Ammonia (NH_3) below 0.1 mg L^{-1} (Boyd, 1982).

Growths of fish in ponds were investigated and the results obtained from the experiment indicated that the growth rate varied in different stocking densities. Growth in terms of mean harvesting weight and SGR of *H. fossilis* was significantly higher in T_1 where the stocking density was low compared to the treatments of T_2 and T_3 although same feed was supplied in all the treatments at an equal ratio. The low growth rate of *H. fossilis* in T_2 and T_3 appeared to be related with higher densities and increased competition for food and space and an inverse relationship with the stocking density provided that space had limiting effects operate on the population (Johnson, 1965). The present results coincide with the findings of Narejo *et al*. (2005) who achieved best growth at lower stocking densities in shing farming. While Mollah (1985) reported that the lower density gave higher size and higher survival rate in *Clarias macrocephalus*. They also reported that the lower density gave larger size and higher survival rate in *H. fossilis* in cemented cistern fed on formulated feed. In the present experiment, highest harvesting mean weight and highest survival rate has been observed in lowest stocking density. The lowest stocking densities provide more space, food and less competition, which were reported by various authors like Ahmed (1982), Hasan *et al.* (1982) and Haque *et al*. (1984). The percentage of survival as recorded in the present study was 87, 82 and 81 for T_1, T_2 and T_3, respectively. Survival was found to be negatively influenced by stocking densities. It might be due to high competition and space among the fishes. The mean growth increase in this experiment was found to be comparable to the gain achieved in rice fields where *H. fossilis* was shown to grow about 25 g during 60 days culture period (Dehadrai, 1981). Lipton (1983) observed that the shing attained 30.35 g over 112 days with gross production 1242.35 g/m^2 in cage culture management. In a study, Thakur and Das, (1986) reported production range was 1642 to 7,300 kg ha^{-1} in four to eleven months culture period of *H. fossilis*. In a study, Mustafa (1991) who has reported to achieve an estimated production of 1592, 2373 and 1764 kg ha^{-1} yr^{-1}. from monoculture of mola (*A. mola*), chola punti (*P. sophore*) and colisha (*C. fasciata*), respectively. While Akhteruzzaman *et al*. (1991) reported that in monoculture condition the production of *Puntius sarana* was 1,200 kg ha^{-1} in six months. However, Khan *et al*. (2003) observed the effect of different stocking densities on production of catfish (*H. fossilis*) in earthen ponds and got the production range 2080 to 3364 kg ha^{-1}. A study conducted by Kohinoor *et al*. (2006) obtained production of 1370 to 1535 kg ha^{-1} in six months from *Mystus cavasius* in monoculture management. While in the present experiment, higher production was noticed. The reason might be due to longer culture period and higher stocking density and better management.

Therefore, the stocking density of 1,87,500 ha^{-1} for culture of shing, *H. fossilis* is advisable for farmers in commercial basis.

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