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# Evaluation of growth, survival and production of stinging catfish shing (*Heteropneustes fossilis*) at different stocking densities in primary nursing

**Mohammad Rafiqur Rahman, Mohammad Kamruzzaman Hossain, Golam Mohammad Moshiur Rahman, Sirajum Monira Shanta, Naznin Sultana, Al-Minan Noor and Rafiul Islam**

**Abstract**
An experiment was carried out in six nursery ponds of 5.0 decimal each with 4 days old stinging catfish shing (*Heteropneustes fossilis*) spawn at three stocking densities *viz.* 2, 3 and 4 million $ha^{-1}$ for the period of 4 weeks from 01 June to 28 June 2017. MEGA pre-nursery and nursery feeds were provided three times daily at the rate of 15% for the first one week and were decreased by 1% every week thereafter. Growth of fry was inversely related to stocking densities. Similar inverse relation was also observed in case of survivals, which were 55.74, 50.20 and 34.41% at 2, 3 and 4 million spawn $ha^{-1}$ stocking densities, respectively. The final length, final weight and survival rate of *H. fossilis* fry were significantly ($P<0.05$) higher in T1 than those obtained from T2 and T3, respectively. Considering the highest gross and net production the stocking density applied in 3 million spawn $ha^{-1}$ found best in primary nursing which a better production to fish farmers but more research still needed to further optimize stocking density of *H. fossils.*

**Keywords:** Stinging catfish, primary nursing, stocking densities, growth, survival, production

## 1. Introduction
The Asian stinging catfish, *Heteropneustes fossilis* (Bloch), is a species of airsac catfish. It is locally known as shingi or Shing. *H. fossilis* is native to Bangladesh, Pakistan, India (including the Andaman Islands), Nepal, Sri Lanka, Barma, Thailand and Lous [1]. It can tolerate slightly brackish water. It is omnivorous. This species breeds in confined waters during the monsoon months, but can breed in ponds, derelict ponds, and ditches when sufficient rain water accumulates. It is always marketed in live condition. It contains high amount of iron (226 mg100 $g^{-1}$) and fairly high content of calcium compared to many other freshwater fishes [2]. *H. fossilis* is of high economic importance and of great demand because of its medicinal value [3]. 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 [4]. 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 [5]. However, the fish is recommended for patients after recovery from malaria for its invigorating qualities [6].

*H. fossilis* 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 [7]. Presently, *H. fossilis* is one of the threatened fish in Bangladesh [8]. Considering its status of threatened, high market value and high consumer demand it is essential to develop an appropriate breeding, nursing and fry rearing technology of *H. fossilis*.

To develop any aquaculture operation, one of the obstacles to overcome is the availability of the fry and fingerlings [9]. Survival of the fry and its rearing up to a size suitable for stocking is a great problem. Therefore, the present experiment has been carried out to standardize appropriate stocking densities in respect to the growth, survival and production of *H. fossilis* spawn under Bangladesh context.

## 2. Materials and Methods

The experiment was carried out for 4 weeks from 1 June to 28 June, 2017 in six earthen nursery ponds of farmer near to Bangladesh Agricultural University Campus, Mymensingh, Bangladesh. The ponds were rectangular in shape and the surface area of each pond was 5.0 decimal (0.02 ha) with an average depth of 0.8 meter. Water of the experimental ponds was drained out and all fish species and aquatic vegetations were removed. After drying, pond bottoms were treated with quicklime (CaO) at the rate of 250 kg $ha^{-1}$ to kill harmful animals and pathogens. All the ponds were then filled with ground water at a depth of about 0.8 meter. Five days subsequent to liming, the ponds were fertilized with organic manure (cattle dung) at the rate of 2,500 kg $ha^{-1}$. Seven days after manuring, the pond water was sprayed with dipterex (1.0 ppm) to eradicate harmful insects and predatory zooplankton. One day after the application of dipterex, 4-day-old fry having an average length of 1.34±0.03 cm and weight of 0.0008±0.0002 g were stocked in the experimental ponds. Three treatments differing in stocking densities of fry viz., 2 million $ha^{-1}$ (T1), 3 million $ha^{-1}$ (T2) and 4 million $ha^{-1}$ (T3) were tested with two replicates each.

In order to acclimatize them to the new environment, the fry were not fed for the first day. From the second day of stocking, fry were fed three times (8:30am BDT, 1:00pm BDT and 5:00pm BDT) daily with MEGA pre nursery feed which containing 40% crude protein for the first one week. The rest of three weeks have been used MEGA nursery feed which containing 38% protein. The rate of feeding was 15% of the estimated body weight of fry for the first week, 14% for the second week, 13% for the third week and 12% for the fourth week. Subsequent to stocking, the ponds were manured with organic fertilizer (1, 00 kg $ha^{-1}$) at weekly interval. Fingerlings were sampled weekly by seining with a fine-meshed net for the assessment of growth, health condition and feed adjustment. The feeding strategy is shown in Table 1.

**Table 1:** Feeding strategy for different types of feed

| Nursing period | Types of supplied feed | Feed rate (% of body weight) |
|---|---|---|
| 1-7 days | Pre Nursery | 15% |
| 8-14 days | Nursery | 14% |
| 15-22 days | Pre Starter | 13% |
| 23-28 days | Pre Starter | 12% |

Physico-chemical parameters of pond water were monitored weekly between 09.00 and 10.00 hr. Temperature ($^0$C) and dissolved oxygen (mg/l) were determined directly by a digital water quality analyzer Hanna DO meter (Model-HI 9146, Romania), pH by a digital pH-meter (Milwaukee pH meter, Model-PH55/PH56, USA), and transparency (cm) by a secchi disc and ammonia nitrogen by a UV VIS Spectrophotometer water analysis kit (DR 6000TM, USA). Total alkalinity was estimated following the standard method of Stirling and APHA [10, 11].

Quantitative and qualitative estimates of plankton in the experimental ponds were also taken weekly. Ten liters of water, collected from different locations and depths of each pond were filtered through fine-meshed plankton net (25 µm) to obtain a 50 ml sample. The samples were preserved immediately with 5% buffered formalin in plastic bottles. Plankton density was estimated by using a sub-sampling technique. A Sedgwick-Rafter (S-R) cell was used under a calibrated compound microscope for plankton counting. Plankton cells in 10 randomly chosen squares were counted for quantitative estimation using the formula proposed by Rahman [12].

Biological parameters such as plankton samples were also collected from all the experimental ponds at seven days intervals by filtering 20 liters of water through No. 55 bolting silk plankton net. The samples were immediately preserved in 5% formalin solution and later analyzed in laboratory for qualitative and quantitative estimation of phytoplankton and zooplankton. Planktons were identified up to generic level following the method of Ward and Whipple, Prescott, Needham and Needham and Hossain *et al.*, [13, 14, 15, 16].

After 8 weeks of nursing, the fry were harvested by repeated netting, followed by drying the ponds. The live fingerlings were counted and weighed individually. Survival (%) and production (kg $ha^{-1}$) of fry were then estimated and compared among the treatments.

The mean values for growth, survival, production, water quality parameters and plankton abundance of different treatments were tested using one-way analysis of variance (ANOVA) followed by Duncan's Multiple Range Test [17]. The level for statistical significance was set at 0.05%.

## 3. Results

The mean values of physic-chemical parameters recorded during the experimental ponds were recorded and presented in Table 2. The mean air temperature was 35.00±0.82$^0$C which was similar in three treatments and the mean water temperature were 30.69±1.15, 30.50±1.00 and 30.57±0.97 ºC in T1, T2 and T3, respectively but did not differ significantly ($P$>0.05) among the treatments. The mean values of Dissolved Oxygen (DO) ranged was 5.98±0.72 (T1), 4.28±0.30 (T2) and, 3.43±0.66 mgl-1 (T3) and showed significant difference ($P$<0.05) among the treatments. The mean values of pH were 7.60±0.86, 7.87±0.58 and 7.81±0.61 recorded in T1, T2 and T3, respectively but did not differ significantly ($P$>0.05). The transparency of water were significantly ($P$<0.05) higher in T1 (33.38±4.24 cm) than those obtained in T2 (42.25±6.22 cm) and T3 (52.13±7.27 cm). The highest mean value of total alkalinity was recorded in T1 (149.25±18.00 mgl-1) and the lowest was in T3 (130.50±15.70 mgl-1) but the variations among the treatments were not statistically significant ($P$>0.05). The mean values of ammonium-nitrogen (NH4-N) in T1 (0.03±0.01 mgl-1) was significantly ($P$<0.05) lower than other treatments. However, there was no significant ($P$>0.05) variation between the T2 (0.05 ± 0.03) and T3 (0.06 ± 0.03 mgl-1)

**Table 2:** The ranges of water quality parameters of weekly samples under the three treatments during 4-week nursing period

| Parameter | Treatments | | |
|---|---|---|---|
| | **T1 (2 million ha-1)** | **T2 (3 million ha-1)** | **T3 (4 million ha-1)** |
| Air temperature (°C | 35.00±0.82[a] (34.00-36.00) | 35.00±0.82[a] (34.00-36.00) | 35.00±0.82[a] (34.00-36.00) |
| Water temperature (°C) | 30.69±1.15[a] (29.50-32.00) | 30.50±1.00[a] (29.00-31.50) | 30.57±0.97[a] (29.50-31.00) |
| Dissolved oxygen (mg-l) | 5.98±0.72[a] (4.90-6.80) | 4.28±0.30[b] (3.90-4.70) | 3.43±0.66[c] (2.60-4.10) |
| pH | 7.60±0.86[a] (6.40-8.70) | 7.87±0.58[a] (7.20-8.60) | 7.81±0.61[a] (6.90-8.60) |
| Transparency (cm) | 33.38±4.24[c] (28.00-38.00) | 42.25±6.22[b] (35.00-51.00) | 52.13±7.27[a] (43.00-60.00) |
| Total alkalinity (mg-l) | 149.25±18.00[a] (123.00-167.00) | 140.13±15.76[ab] (117.00-155.00) | 130.50±15.70[b] (105.00-146.00) |
| Total Ammonia-nitrogen (mgl-1) | 0.03±0.01[a] (0.01-0.05) | 0.05±0.03[b] (0.02-0.08) | 0.06±0.03[a] (0.02-0.09) |

Mean± SD (Standard deviation) and range in parentheses; Figures in the same column having different superscript are differed significantly (*P*>0.05).

Mean abundances of plankton populations over the 4 weeks are summarized in Table 3: The phytoplankton population in the experimental nursery ponds was mainly found four groups- Bacillariophyceae, Chlorophyceae, Cyanophyceae and Euglenophyceae whereas the zooplankton population were composed only two groups-Crustacea and Rotifera. Phytoplankton of Chlorophyceae group was the most dominant and Euglenophyceae group was the least abundant as observed during the study period. Zooplankton of Rotifera group was the most dominant in terms of both numbers and genera compared to Crustacean group among the treatments. The total phytoplankton ranged from (7797 to 12997) cellsl-1 with mean abundance were 12738±183 (T1), 9726±82 (T2) and 7841±52 cellsl-1 (T3), respectively and showed significant (*P*<0.05) difference among the treatments. The mean abundance of total zooplankton were 6270±197, 4852±214 and 4025±154 cellsl-1 in T1, T2 and T3, respectively and also showed statistically significant (*P*<0.05) among the treatments.

**Table 3:** The ranges of plankton abundance (cellsl$^{-1}$) of pond water of weekly samples under the three treatments during 4-week nursing period

| Plankton group | Treatment-1 | Treatment-2 | Treatment-3 |
|---|---|---|---|
| **Phytoplankton** | | | |
| Bacillariophyceae | 3294±632[a] (2351-3811) | 2643±805[b] (1341-3199) | 2314±404[c] (1203-2743) |
| Cyanophyceae | 2804±406[a] (2168-3145) | 2341±398[b] (1788-2788) | 1907±228[c] (1287-2148) |
| Chlorophyceae | 4835±1394[a] (2658-5749) | 3237±624[b] (2226-3874) | 2519±174[c] (2014-2814) |
| Euglenophyceae | 1935±316[a] (1452-2242) | 1505±194[b] (1178-1656) | 1102±110[c] (1002-1283) |
| Total | 12868±183[a] (12738-12997) | 9726±82[b] (9668-9784) | 7841±52[c] (7797-9884) |
| Zooplankton | | | |
| Crustacea | 3274±774[a] (2018-3889) | 2660±587[b] (1748-3321) | 2334±410[c] (1602-2759) |
| Rotifera | 2996±362[a] (2451-3475) | 2192±433[b] (1657-2841) | 1691±299[c] (1494-2269) |
| Total | 6270±197[a] (6131-6409) | 4852±214[b] (4700-5003) | 4025±154[c] (3916-4134) |

Mean± SD (Standard deviation) and range in parentheses; Figures in the same column having different superscript are differed significantly (*P*>0.05).

The growth in length and weight and survival rate of *H. fossilis* in different treatments recorded during this study is given in Table 4. The initial length and weight of spawn stocked in all the ponds were same i.e. 1.43±0.03 cm and 0.0008±0 g. The mean final length and weight attained under T1, T2 and T3 were 4.46±0.27 cm and 3.59±0.18g, 3.87±0.15 cm and 3.02±0.10g and 3.52±0.14 cm and 2.66±0.09g, respectively. The highest mean final weight was also obtained in T1 and lowest in T3. However, the mean final length and weight were showed significant difference (*P*<0.05) in T1 followed by T2 and T3, when ANOVA was performed. The highest survival rate (55.74±1.20%) was also observed in T1, where the stocking density was 2 million spawn/ha whereas the lowest was 34.41±0.77% in T3, where the stocking density was 4 million spawn ha$^{-1}$ and there were significantly differences among the treatments.

**Table 4:** Growth performance and percentage of survival of Shing fry after 4 weeks of nursing under different stocking densities

| Treatments/stocking densities | Initial length (cm) | Initial weight (g) | Final length (cm) | Final weight (g) | Survival rate (%) |
|---|---|---|---|---|---|
| $T_1$ (2 million ha$^{-1}$) | 1.43±0.03[a] (1.30-1.50) | 0.0008±0.0002[a] (0.0007-0.0010) | 4.46±0.27[a] (2.82-3.23) | 3.59±0.18[a] (3.52-3.66) | 55.74 ±1.20[a] (54.53-56.94) |
| $T_2$ (3 million ha$^{-1}$) | 1.43±0.03[a] (1.30-1.50) | 0.0008±0.0002[a] (0.0007-0.0010) | 3.87±0.15[ab] (2.37-2.50) | 3.02±0.10[b] (3.00-3.04) | 50.20 ±0.44[b] (49.76-50.63) |
| $T_3$ (4 million ha$^{-1}$) | 1.43±0.03[a] (1.30-1.50) | 0.0008±0.0002[a] (0.0007-0.0010) | 3.52±0.14[b] (2.00-2.18) | 2.66±0.09[b] (2.54-2.78) | 34.41 ±0.77[c] (33.64-35.17) |

Mean± SE (Standard Error) and range in parentheses; Figures in the same row having different superscript are significantly different (*P*>0.05).

The gross and net production of *H. fossilis* fry obtained from the present study has been shown in Table 5. As could be seen in Table 5, the initial weight at stocking (kgha$^{-1}$) different significantly (*P*<0.05) among the treatments, while the total production (kg pond$^{-1}$) at harvesting under treatment 2 was significantly different (*P*<0.05) from treatment 3 and 1 but no differed significantly (*p*>0.05) between treatment 3 and 1. The mean gross and net production of the fry after 4 weeks of nursing period recorded 4005.1±162.91 and 4003.50±162.92, 4547.46±15.17 and 4545.06±15.32 and 3661.18±82.28 and 3657.98±82.28 kg ha$^{-1}$ at 2, 3 and 4 million fry ha$^{-1}$ stocking densities, respectively, indicating that as growth and percentage of survival decreased with increase in stocking density, the total production of fish did not maintain the same trends (compare Table 4 and 5).

**Table 5:** The gross and net productions of shing fry at different stocking densities after 4 weeks of nursing

| Treatments/ stocking densities | Initial stocking wt. (kg ha$^{-1}$) | Total production (kg pond$^{-1}$) | Production (kg ha$^{-1}$) | |
|---|---|---|---|---|
| | | | Gross | Net |
| $T_1$ (2 million ha$^{-1}$) | 1.6$^a$ | 81.07±3.30$^b$ (77.78-84.37) | 4005.1±162.91$^b$ (3842.18-4168.01) | 4003.50±162.92$^b$ (3840.58-4166.41) |
| $T_2$ (3 million ha$^{-1}$) | 2.4$^b$ | 92.05±0.31$^a$ (91.74-92.36) | 4547.46±15.17$^a$ (4532.14-4562.78) | 4545.06±15.32$^a$ (4529.74-4560.38) |
| $T_3$ (4 million ha$^{-1}$) | 3.2$^c$ | 74.11±1.67$^b$ (72.45-75.78) | 3661.18±82.28$^b$ (3578.90-3743.46) | 3657.98±82.28$^b$ (3575.70-3740.26) |

Mean± SE (Standard Error) and range in parentheses; Figures in the same row having different superscript are significantly different ($P$>0.05).

## 4. Discussion

The water quality parameters greatly 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 [18, 19]. The mean range of water temperature (29 to 32 $^0$C) in the nursery ponds is within suitable range for nursing of Shing (*H. fossilis*). Monir and Rahman [20] observed almost similar types of temperature variation in nursery ponds of *H. fossilis* fingerlings in northern region of Bangladesh. The dissolved oxygen (DO) in the morning was low in during the study period of nursery ponds where stocked with a high density of fish compared to low stocking density ponds. This might be due to the higher consumption rate of oxygen by the higher density of fish and other aquatic organisms that agree with Boyd [21]. However, the DO level is within the acceptable ranges in all nursery ponds during the study period. The recorded pH values of water of experimental nursery ponds ranging from 6.4 to 8.7 which indicates slightly alkaline. However, the pH was found to be suitable for fish culture that agrees well with the findings of Monir and Rahman [20]. The mean transparency level was significantly ($P$<0.05) higher in T3 and consistently lower in T1, which might be due to the reduction of the plankton population by higher density of fish [22, 23]. The mean transparency level was significantly ($P$<0.05) higher in T3 and consistently lower in T1, which might be due to the reduction of the plankton population by higher density of fish [22, 23]. The mean values of total alkalinity was significantly ($P$<0.05) higher in T1 followed by T2 and T3 but no significant differences ($P$>0.05) were recognized between the values of treatments 2 and 3. Similar results were also found in the studies of Monir and Rahman [20]. Boyd [21] reported that the suitable range of ammonia-nitrogen in fish culture less than 0.1 mgl$^{-1}$. However, in the present study the level of ammonia-nitrogen content in the experimental nursery ponds is not lethal to the *H. fossilis* fry [23].

The plankton abundance in the present experiment was significantly higher in T1 which might be due to the lower density fry than those in T2 and T3. It seems likely that in the nursery ponds where stocking density was high, consumption of plankton by the fry was also high. The phytoplankton abundance was consistently higher than that of zooplankton. However, the plankton population in the study showed to be more or less similar with the findings of Monir and Rahman [20].

Growth performances in final length and weight and survival rate of Shing (*H. fossilis*) in nursery ponds revealed that T1 was significantly higher ($P$<0.05) where the stocking density of fry (2 million spawn ha$^{-1}$) was low compared to those of T2 (3 million spawn ha-1) and T3 (4 million spawn ha-1) although the same fish feed with equal ratio was applied among all the treatments. The lower growth performances were in T2 and T3 than T1 that might be due to competition for food and habitat for higher number of spawn. Stocking density is known to be one of the important parameters in fish culture, since it directly effects growth and survival, and hence production [24]. Haylor [25] revealed that the growth and survival rate of African catfish (*Clarias gariepinus*) larvae was significantly influenced by the density at which they were stocked. More or less similar results also were obtained by Rahman [22], Kohinoor [26] and Kohinoor [27] from their fry/fingerlings rearing experiments with various carp, barb and catfish species. However, higher stocking density with abundance with sufficient feed might produce a stressful situation if the feed is not used for growth [28, 29]. The above results were more or less in agreement with those of the present study.

The highest gross and net production were obtained in ponds stocked with 3 million spawn ha$^{-1}$, which were significantly different ($P$<0.05) from production obtained in ponds stocked with 2 million ha$^{-1}$ and 4 million ha$^{-1}$ but no differed significantly ($P$>0.05) in ponds stocked with 2 million ha$^{-1}$ and 4 million ha$^{-1}$. Survival and growth of fry were inversely related to the stocking densities. However, the medium stocking densities of 3 million ha$^{-1}$ showed the highest production, while the lowest production was obtained in ponds stocked with 4 million ha$^{-1}$ (Table 5). The physic-chemical parameters of pond water during the experimental period were within acceptable limits. However, Khan *et al.* [30] observed the effect of different stocking densities on production of catfish (*H. fossilis*) in earthen ponds and got the production 2080 to 3364 kg ha$^{-1}$. A study conducted by Kohinoor *et al.* [31] obtained production 7549 to 8786 kg ha$^{-1}$ in six month culture from *H. fossilis* at different stocking densities. This production is higher than that the present study due to its longer period of culture and less stocking densities. Another study conducted by Monir and Rahman [20] found gross production of 3170 kg ha$^{-1}$ to 7525.86 3170 kg ha$^{-1}$ in 8 weeks rearing from *H. fossilis* at different stocking densities.

## 5. Conclusion

The present study revealed that the survival and growth of the fry were inversely related to the stocking densities of spawn. But in relation to the production, the stocking density of 3 million spawn ha$^{-1}$ showed better results than both the higher (4 million spawn ha$^{-1}$) and lower (2 million spawn ha$^{-1}$) stocking rates. So, the stocking density of 2 million spawn ha$^{-1}$ may be suggested for nursing of Shing (*H. fossilis*) spawn for 4 weeks in primary nursing.

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