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WATER QUALITY, GROWTH AND PRODUCTION PERFORMANCE OF STINGING CATFISH, *HETEROPNEUSTES FOSSILIS* (BLOCH) IN CEMENTED TANKS WITH TWO DIFFERENT STOCKING DENSITIES

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Abstract: Attempt has been taken to develop intensive tank culture technique providing natural environment for Stinging catfish (*Heteropneustes fossilis*) inside tank to increase survival rate as well as production. The experiment was conducted for a period of 150 days in two tanks (T1 and T2) of 300 m^2. Fish fries with a mean weight and length ranged from 1.02 to 2.2 g and 2.7 to 3.5 cm were stocked in T1 and T2, respectively. Stocking density of fingerlings were 1, 25,000 and 1, 50,000 per Ha in T1 and T2, respectively. Commercial pelleted feed was supplied to tank reared fish twice daily at a rate of 3-10% of body weight per day and later feeding rate was adjusted based on body weight by sampling. Important water quality parameters (temperature, DO, pH, transparency, ammonia and nitrate) were recorded weekly throughout the culture period. Survival rate was 87% and 84% in T1 and T2, respectively. Mean final weight were 41.73 ± 2.09g and 40.6 ± 0.90 g in T1 and T2, respectively. Length-weight relationship indicates that the growth rate was always higher in T1 followed by T2. Results showed that net yield was relatively higher in T2 (5115.35 ± 113.13 Kg/ha) than T1 (4537.12 ± 227.4 Kg/ha). In case of production, there was significant difference ($p < 0.05$) between two treatments. This experiment demonstrated the potential of *H. fossilis* production through new technique of tank culture system. However, more research is needed using local feed ingredients with higher stocking density.

Key words: Stinging catfish, stocking density, tank, production

INTRODUCTION

Bangladesh is ranked fourth position in Inland fishery production just after China, India and Myanmar and fifth position in closed waters (FAO 2014). 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). It can survive for a very long time when kept in captivity even in a small quantity of water, because it has massive paired sac-like pharyngeal lungs as accessory respiratory organs (Das 1927). Due to accessory respiratory organs it can thrive well in water in low

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oxygen levels. The stinging catfish belongs to the phylum Chordata, class Actinopterygii, order Siluriformes, family Heteropneustidae, genus *Heteropneustes*, species *H. fossilis* (Bloch 1794). The species is not only recognized for its delicious taste and market value but is also highly esteemed from nutritional and medicinal properties of view (Chakraborty and Nur 2012). It remains high amount of iron (226 mg/100 g) and fairly high content of calcium compared to many other freshwater fishes (Saha and Guha 1939). Being a lean fish it is very suitable for people for whom animal fats are undesirable (*Rahman et al*. 1982). 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. Due to over exploitation and ecological changes in its natural habitats; this species have become threatened (IUCN Bangladesh 2000). But in recent years, the fish has become gradually been endangered as the natural habitats and breeding grounds of this fish has been severely degraded due to over exploitation, ecological changes, reduction of water bodies, application of pesticides in rice cultivation, release of chemical effluents from industrial plants and hydrological changes due to construction of flood control infrastructure (Khan *et al.* 2003 and Kohinoor *et al.* 2012). 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.

The present attempt is aimed at studying comparative production performances of stinging catfish in cemented tank environment with low water circulation. However, the specific objectives of the work are - to compare growth and production in rectangular tanks; to determine appropriate stocking density of the fish in tank and to identify the problem in tank culture of stinging catfish for further improvement of culture technology using tanks.

MATERIAL AND METHODS

The work was carried out at the private rearing tanks “Puspita Raceway Aquafarm” of Kendua Upazilla of Netrakona district, Bangladesh. The experiment was conducted for a period of 150 days from March to July. Two tanks were constructed to conduct this experiment. The tanks were rectangular shape with an area of 300 m^2 (0.003 ha) and an average depth of 1.10 m. The growth performance of *H. fossilis* was evaluated under double treatment.

Two different stocking densities of shing *(H. fossilis*) were tested in the experiment. Fingerlings of shing stocked at the rate of 1,25,000 and 1,50,000 per hector in T1 and T2, respectively.

Tank 1(T1) Tank 2(T2)

Fig. 1. Design of experimental cemented tanks.

Source of fingerlings: The fingerlings of *H. fossilis* used in this experiment collected from a private hatchery of Mymensingh, Bangladesh. The sizes of fingerlings were 3.07 ± 0.21 and 3.09 ± 0.25 cm in T1 and T2, respectively.

Supplementary feeding: After stocking, 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 3-10% of body weight daily. From the first day of stocking, the fingerlings were fed twice daily in the morning and afternoon. 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 proximate composition of the feed is shown in Table 1.

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

Dry matter	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

Water quality parameters: Physico-chemical parameters of tank water were monitored fortnightly between 9.00 a.m. and 10.00 a.m. Water temperature was recorded using a Celsius thermometer and transparency (cm) was measured by using a Secchi disc of 20 cm diameter. Dissolved oxygen and pH was measured directly using a digital electronic oxygen meter (YSI, Model 58, USA) and an electronic pH meter (Jenway, Model 3020, UK). Nitrate-Nitrogen (mg/l) was determined by nitrate measuring kit (HANNA instrument Test Kit). Ammonia-Nitrogen (mg/l) was determined by ammonia measuring kit (HANNA instrument Test Kit).

Water recycling: Low-lift-pump was used to recycle surface water and shallow tube-well was used for adding underground water in the tank. These methods mitigated pollution from excretory product of individuals and maintained water quality suitable for the experimental fish and primary productivity.

Fish sampling, estimation of growth, survival, production: Random samples of 50 fish from each tank were sampled fortnightly by using a seine net. The length (cm) and weight (g) of individual fish was recorded separately with the help of a measuring scale and a portable sensitive electronic balance. Weight of fishes was measured separately to assess the health condition of fish and their growth. Growth in terms of weight, average daily growth (ADG), specific growth rate (SGR) and percentage of survival and mean values (±SD) for each parameter were computed. ADG and survival rate were followed according to De Silva (1989). SGR calculated according to Brown (1957) and Ricker (1979). At the end of the experiment, the fishes were harvested by draining out of the tanks. The number of individuals counted and weight was measured. Survival rate and production (individual's ha-1) of then calculated and compared between the treatments.

Estimation of growth performance and production: The total length (cm) and weight (g) of individual fish were recorded separately during the stocking period and final harvesting period due to estimation of the growth performance and production of these fish species.

Weight gain = Final body weight − Initial body weight

$$\text{\% of weight gain} = \frac{\text{Mean final body weight (W2)} - \text{Mean initial body weight (W1)}}{\text{Mean initial body weight}} \times 100$$

$$\text{Average daily weight gain} = \frac{\text{Final body weight (W2)} - \text{Initial body weight (W1)}}{\text{Days}}$$

$$\text{Specific growth rate = (SGR) per day (\%)} = \frac{\text{In W2} - \text{In W1}}{\text{Days}}$$

where, W_1= Initial body weight (g) at time T_1 (day), W_2= Final body weight (g) at time T_2 (day)

$$\text{Survival rate} = \frac{\text{No. of fishes harvested}}{\text{No. of fishes stocked}} \times 100$$

Yield of fishes

Gross Yield = No. of fish caught × Average final weight

Simple arithmetical tools like average, range, percentage etc. were used to tabulate the results. For analysis of treatment effects of fish production and separation of treatments mean by DMRT were perform as per methods outlined in Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Water quality parameters: The optimum fish production depends on the physico-chemical qualities of water. The water quality parameters that were recorded during the study period provided in Table 2 and Figs 2-7.

Table 2. Physico-chemical parameters of two different tanks -Tank1 (T1), Tank 2 (T2)

Physico-chemical parameters	No. of estimation	Treatments		Level of significance
		T1	T2	
Temperature (ºC)	20	29.3 ± 1.30	29.0 ±1.26	NS
pH	20	7.26 ± 0.31	7.30 ± 0.28	NS
Dissolved oxygen (mg/l)	20	7.67 ± 0.58	7.55 ± 0.66	NS
Transparency (cm)	20	40.0 ± 1.84	39.6 ± 1.73	NS
Nitrate-nitrogen (mg/l)	20	0.15 ± 0.08	0.16 ± 0.09	*
Ammonia-nitrogen (mg/l)	20	0.76 ± 0.41	0.87 ± 0.32	NS

NS = Not significant ($p > 0.05$), *significant ($p < 0.05$).

The values of water quality parameters were within the acceptable range that regulates this intensive culture system strongly. The water temperature was almost same and the mean values of temperature were 29.3 ± 1.30ºC and 29.0 ± 1.26ºC in T1 and T2, respectively. There was no significant difference ($p > 0.05$) of mean values water temperature between two treatments.

The pH values of different treatments were found to be slightly alkaline ranging from 7 to 7.8. The mean values of pH were 7.26 ± 0.31 and 7.30 ± 0.28 in T1 and T2 respectively. There was no significant difference (p <0 05) between the two treatments.

Growth and production performance: The mean initial weight, final weight, weight gain, specific growth rate (SGR%/day), survival rate and production of fishes were recorded during the study period and summarized in Tables 3, 4 and 5.

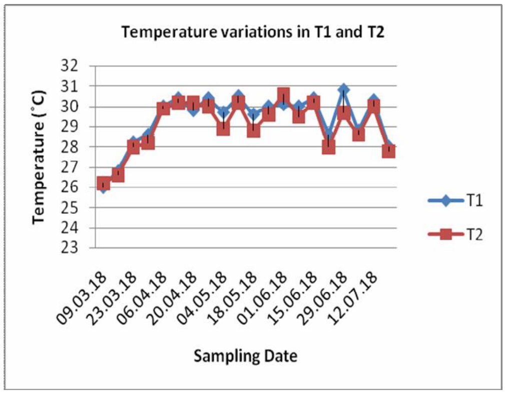

Fig. 2. Temperature variations in T1 and T2.

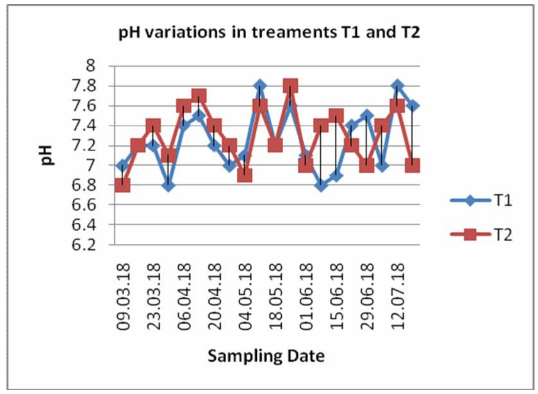

Fig. 3. pH variations in T1 and T2.

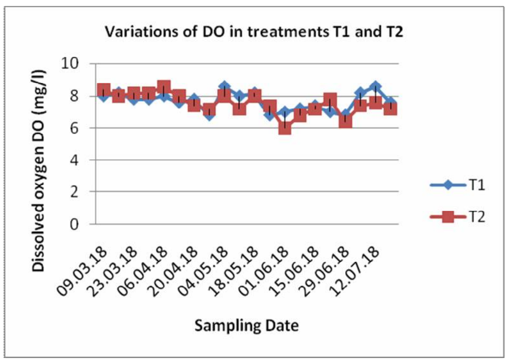

Fig. 4. Dissolved oxygen (DO) variations in T1 and T2.

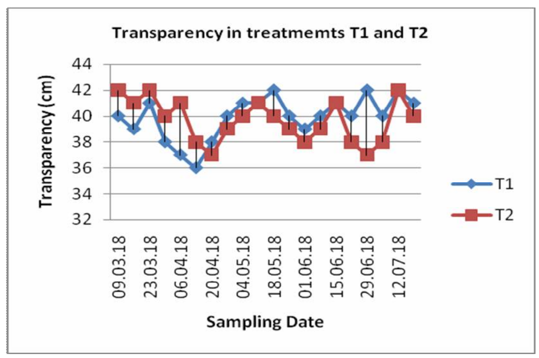

Fig. 5. Transparency variations in T1 and T2.

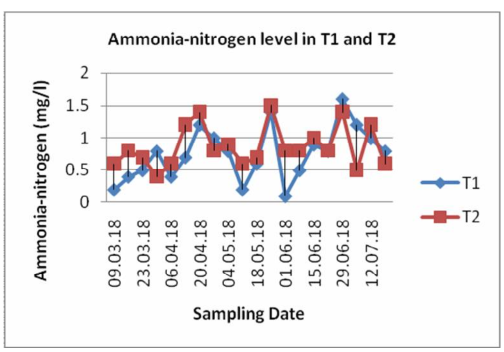

Fig. 6. Variations in nitrate-nitrogen levels in T1 and T2.

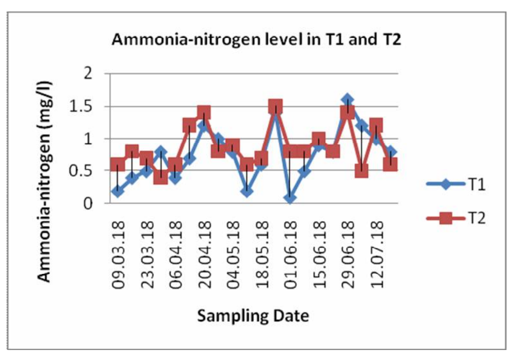

Fig. 7. Variations in Ammonia-nitrogen levels in T1 and T2.

The range of dissolved oxygen was recorded from 6.8 to 8.6 mg/l. The mean values of dissolved oxygen concentration were 7.67 ± 0.58 and 7.55 ± 0.66 mg/l. There was no significant difference ($p > 0.05$) of mean values of dissolved oxygen concentration between two treatments.

Table 3. Average cumulative growth increment of *Heteropneustes fossilis* in different months in T1

Species name	March		April		May		June		July	
	L (cm)	W (gm)	L (cm)	W (gm)	L (cm)	W (gm)	L (cm)	W (gm)	L (cm)	W (gm)
	3	1.08	12.6	10.11	13.9	16.6	16.1	30.5	17.5	42.25
	3.2	1.12	12	11.25	14.3	18.75	16	27.5	19.5	40.12
	2.9	1.08	11.9	12	14.5	17.2	16.3	28.7	19	43.75
H. fossilis	3.3	1.16	12.1	12.5	14.8	17.6	17.2	25.5	20	45
	3.1	1.02	11.9	10.6	13.5	18	15.5	30.8	18.2	39.5
	3	2.2	10.8	13.5	14.2	15.8	16	28.2	19.5	41.9
	3.5	1.5	12	10.5	14.1	18.2	16.5	25.6	18.5	40.15
	2.9	1.15	11.5	12.7	14.9	17.25	16.5	24.5	17.8	40.9
	2.8	1.02	11.2	10.8	13.8	16.8	17.5	28.8	19.6	44.45
	3	1.15	10.8	11.8	14.2	16.5	17.2	26.15	17.9	39.25
Mean	3.07	1.25	11.68	11.58	14.22	17.27	16.48	27.63	18.75	41.73
SD (±)	0.21	0.36	0.59	1.11	0.43	0.89	0.64	2.15	0.88	2.09

Table 4. Average cumulative growth increment of *Heteropneustes fossilis* in different months in T2

Species name	March		April		May		June		July	
	L (cm)	W (gm)	L (cm)	W (gm)	L (cm)	W (gm)	L (cm)	W (gm)	L (cm)	W (gm)
H. fossilis	3.1	1.3	11.7	11.25	13.8	16.4	17	25.35	18.2	40.25
	3.2	1.5	11.9	12.1	14.6	17.1	16.3	26.6	19.4	40.9
	3.5	1.7	12.6	11.78	13.4	15.95	16.9	27.5	17.4	39.87
	2.9	1.5	11.1	10.65	13.8	16.57	17.2	26.26	19.7	41.35
	3.4	1.8	11.9	11.3	13.9	16.98	17.5	25.9	20	40.6
	2.8	1.46	12.5	12.25	14.5	17.4	15.8	26.45	18.6	40.87
	3	1.45	11.8	11.67	13.9	16.75	15.5	24.8	17.8	41.35
	2.7	1.3	10.9	10.85	14.9	17.25	16.6	25.45	18	41.99
	3.1	1.6	11.5	11.26	13.8	16.58	15.8	26.75	19.7	38.9
	3.2	1.4	11.5	10.24	15.5	17.25	16.2	25.75	18.9	39.9
Mean	3.09	1.50	11.74	11.34	14.21	16.82	16.48	26.08	18.77	40.60
SD (±)	0.25	0.16	0.54	0.64	0.64	0.46	0.67	0.79	0.91	0.90

The mean value of water transparency was 40.0 ± 1.84 cm and 39.6 ±1.73cm. The highest value of water transparency was recorded 44cm in T1 during the month of May. There was no significant difference ($p > 0.05$) of mean values of transparency between two treatments. Some variations of the overall mean values of nitrate-nitrogen were found in treatments. The range of nitrate-nitrogen was recorded from 0.05 to 0.3 mg/l and 0.06 to 0.28 mg/l in T1 and T2, respectively. There was significant difference ($p < 0.05$) of mean values of nitrate-nitrogen between two treatments.

Table 5. Growth and production parameters (Mean± SD) of stinging catfish in different treatments of rectangular tanks

Growth and production performance parameters	Treatments		Level of significance
	T1	T2	
Initial length (cm)	3.07 ± 0.21	3.09 ± 0.25	NS
Final length (cm)	18.75 ± 0.88	18.77 ± 0.91	NS
Length gained (cm)	15.68 ± 0.88	15.68 ± 0.92	NS
Initial body weight (gm)	1.25 ± 0.36	1.50 ± 0.16	NS
Final body weight (gm)	41.73 ± 2.09	40.6 ± 0.90	*
Weight gained (gm)	40.48 ± 2.15	39.1 ± 0.97	NS
Specific growth Rate (SGR)	2.36 ± 0.16	2.20 ± 0.08	NS
Survival rate (%)	87	84	*
Total yields (kg/ha)	4537.12 ± 227.4	5115.35±113.13	*

NS –= Not significant ($p > 0.05$), * significant ($p < 0.05$).

The range of the value ammonia-nitrogen was recorded from 0.20 to 1.6 mg/l and 0.5 to 1.5 mg/l in T1 and T2, respectively. There was no significant difference ($p < 0.05$) between two treatments.

Growth of shing in tanks was investigated and the results obtained from the experiment indicated that there was no significant variation in initial weight of this species between the treatments but in case of final weight, weight gain, SGR and production of *H. fossilis* in different tanks varied on different stocking densities. The mean final weight of *H. fossilis* in T1 (41.73 ± 2.09 g) was significantly higher ($p > 0.05$) than T2 (40.6 ± 0.90 g). The highest harvesting weight was obtained in T1 and lowest in T2. The harvesting mean weight showed significant differences ($p < 0.05$) in T1 followed by T2. The mean final weight gain of *H. fossilis* in different treatment was 40.48 ± 2.15 g and 39.1 ± 0.97 g in T1 and T2, respectively. The monthly sampling weights of fish under different stocking densities are shown in Fig. 8. The Figure indicates that the growth rate was higher in T1 then followed by T2. 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. Specific growth rate in T1 (2.36±0.16) was significantly higher ($p < 0.05$) than T2 (2.20 ± 0.08). 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.

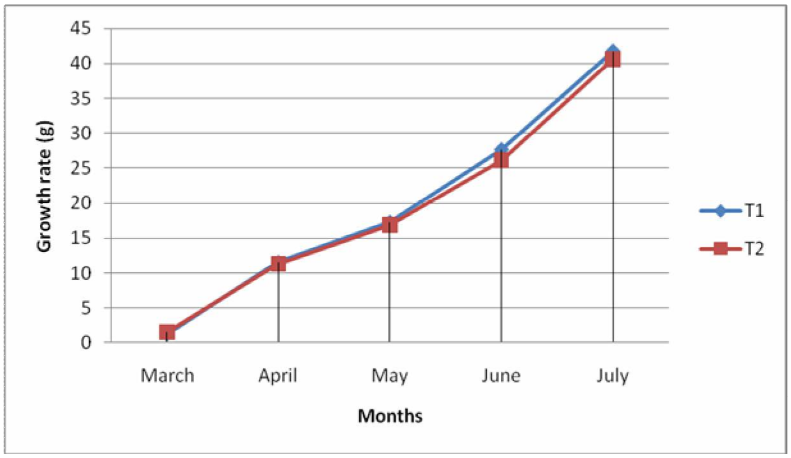

Fig. 8. Monthly growth rate (g) of Shing (*H. fossilis*) in different stocking densities.

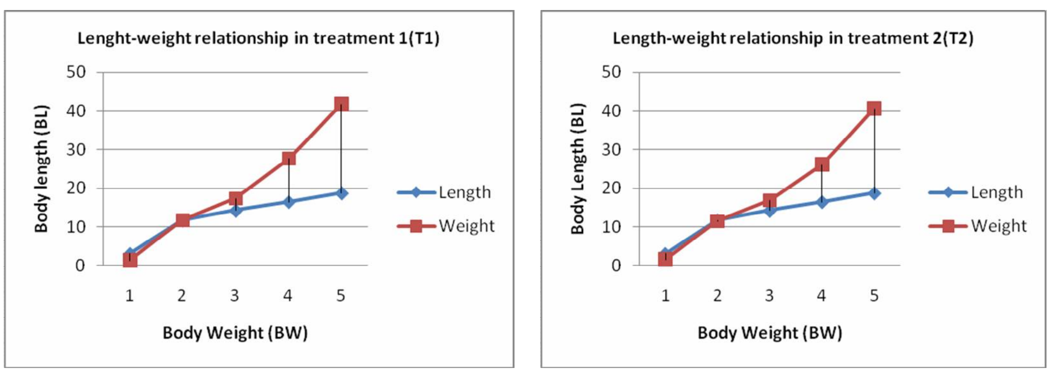

Fig. 9. Length-weight relationship of *H. fossilis* in two different treatments.

The percentage of survival as recorded in the present study was 87% and 84% for T1 and T2, respectively. The highest survival rate was observed in T1 and the lowest in T2. Differences in survival rates among the treatments were found to be significant ($p < 0.05$). The mean production of shing was 4537.12 ± 227.4 and 5115.35±113.13 kg/ha in T1 and T2, respectively. The highest fish production was obtained in T2 followed by T1. However, production of fish differed significantly ($p < 0.05$) between the two treatments.

Length-weight relationship which was measured for more than 500 fishes (Fig. 9) shows that at the beginning of culture length and weight increased at same rate. But after a certain period they increased opposite directionally.

CONCLUSION

Growth, feed efficiency and feed consumption of fish are normally governed by a few environmental factors (Brett 1979). The mean range of temperature (27.4 - 29.8°C) in the experimental tanks is within the acceptable range for farming of shing that agrees well with the findings of Haque *et al.* (1984) and Kohinoor *et al.* (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. The dissolved oxygen was low in tank stocked with high density of fish compared to tank stocked with a low density. Similar results were observed by Saha *et al.* (1988) for rohu (*L. rohita*) and Rahman and Rahman (2003) for calbashu (*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 tanks. Roy *et al.* (2002) obtained a pH range 7.03 - 9.03 in fish ponds located in Trishal, Mymensingh. The observed pH values of water ranging from 6.8 - 7.8 indicated that the experimental tanks were suitable for fish culture.

The suitable range of ammonia (NH_3) below 0.1 mg/l (Boyd 1982). Growths of fish 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 T1 where the stocking density was low compared to the treatments of T2. Hence, the observed poor growth at higher stocking densities could be due to space limiting effect, stressful situation caused by supplementary feed, some variations in environmental parameters and less availability of natural food. The results in the present experiment are very similar to the study of Ameen *et al.* (1984); Vijayakumar *et al.* (1998); Usmani *et al*. (2003) and Chakraborty *et al.* (2005).

The stinging catfish is a high valued species and has potential for tank culture system, however further studies are needed to improve the system. Tank culture systems might open a new horizon for further research. Trial should be conducted in constructed tanks with participating of the farmers' household. However, availability and quality of catfish seed is a constraint for such system.

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