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Study on optimization of stocking density of air breathing fish (Shing, *Heteropneustes fossilis* Bloch, 1794) in cemented dewatering canal at BAPARD campus, Gopalganj

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Abstract
The experiment was carried out to optimize the stocking density of air breathing fish *Heteropneustes fossilis* in a cemented dewatering canal with six segments in Bangabandhu Academy for Poverty Alleviation and Rural Development (BAPARD), Kotalipara campus under Gopalganj district, Bangladesh from 15 February to 15 July, 2018. Three stocking densities such as 20 (T_1), 25 (T_2) and 30 (T_3) per m^2 were tested with two replications each. Fish were fed with commercial pelleted feed containing 36% crude protein. After six months rearing, the mean harvesting weights of *Heteropneustes fossilis* were 59.70±0.51, 52.40±0.87 and 48.21±0.1.23 g in T_1, T_2 and T_3, respectively. The best survival was found in T_1 among the treatments. The FCR was 1.5±0.30, 1.75±0.35 and 1.85±0.14 in T_1, T_2 and T_3 respectively. SGR in T_1 (1.15) was significantly higher than T_2 (1.04) and T_3 (0.97). FCR was lower in T_1 (2.39) than in T_2 (3.11) and T_3 (3.45). The percentage of survival as recorded in the present study was 80, 68 and 60 for T_1, T_2 and T_3, respectively. The mean production of *H. fossilis* was 0.95, 0.89 and 0.87 kg per m^2 or 9386.00, 8793.20 and 8595.60 kg/ha in T_1, T_2 and T_3, respectively. In the present study, the total expenditure of production (BDT/ha) was lower in T_1 (25, 18, 115.60) than T_2 (31, 75, 440.80) and T_3 (31, 86, 102. 40). The net return gained from 180 days culture period was obtained as BDT 12,36,284.40, 6,54,747.60 and 2,52,137.60/ha for T_1, T_2 and T_3, respectively.

Keywords: growth, air breathing, stocking densities, cemented reservoir

Introduction

Stinging catfish *(Heteropneustes fossilis)*, commonly known as "Singhi" is plentifully available in open water system of floodplains, canals, beels, haors, baors and other swamps of Bangladesh. This species is highly regarded as an edible specie due to its high protein (22.8%), low fat (0.6%) and high iron content (226 mg/100g tissue) (Anon, 1982) [1]. It is considered to be highly nouri Shing, 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) [7]. Due to high nutritive values, this fish is recommended for the diet of sick and convalescent patients. Being a lean fish it is very suitable for people for whom animal fats are undesirable (Rahman *et al.*, 1982) [11]. This is an excellent fish for culture in derelict water bodies as it is able to live in poorly oxygenated water due to its capacity to exchange via accessory respiratory organ (Singh and Hughes, 1971) [14]. It can be cultured very densely, in extensive and semi-extensive conditions and on a large scale in industrialized sectors and the yield per hectare are several time higher in comparison to carp species (Dehadrai *et al.*, 1985) [4]. The fish adapts well to hypoxic water bodies and to high stocking densities (Dehadrai *et al.*, 1985) [4]. Culture of *H. fossilis* has not yet been well succeeded in dewatering canal of Bangladesh due to lack of appropriate culture technique. Considering its high market value and high consumer demand it is important to develop a proper culture technique in cemented dewatering canal in Bangladesh. The culture technique will helpful to enhance the production and at the same time this delicious tasty fish will be available for people.

Materials and Methods

Dewatering canal selection and preparation

The experiment was conducted for a period of six months from 15 February to 15 July 2018 in cemented dewatering canal with six segments of length 40±0.5 meter and width 1.5±0.25 meter each with a depth of 1.00 meter at BAPARD campus, Kotalipara, Gopalganj. Prior to stocking, cemented dewatering canals were cleaned with bleaching powder and quick lime.

Experimental design

Three different stocking densities of Shing (*H. fossilis*) were tested in the experiment. Stocking density was maintained as treatment and which replicated twice.

Source of fingerlings

The fingerlings of *H. fossilis* were used in this experiment were collected from a private hatchery of Jashore, Bangladesh.

Fish stocking

Fingerlings of *H. fossillis* were stocked in 15 February 2018 according to the experimental design. Fingerlings of Shing were stocked at the rate of 20, 25 and 30 per m^2 in T_1, T_2 and T_3, respectively.

Fish sampling

Random samples of ten fishes from each dewatering canal was sampled fortnightly by using a scoop net. The total weight was measured by using a portable electronic balance (Tanita, Japan).

Feeding

After stocking, in order to meet up the increasing dietary demand, commercial fish feed named Quality feed (Nursery-2 to Grower) containing average 36% crude protein were applied as supplementary feed at the rate of 3-10% of standing biomass of fish twice daily.

Water sampling and analysis

Water quality parameters such as air temperature, water temperature, pH, dissolved oxygen (DO), total alkalinity and transparency were determined at weekly interval. 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 by removing water from canal. The harvested fishes were counted and weight were recorded.

Data analysis

Data were analysed using the SPSS Version-20. ANOVA was performed on all the dependent variables to see whether the treatment had any significant effect or not.

Results

Water quality parameters

Mean values of physico-chemical parameters over the period of air breathing fish farming are presented in Table 1.

Table 1: Water quality parameters

Water Quality Parameters	Treatments		
	T_1	T_2	T_3
Water temperature (^{0}c)	29.00±0.50^a	28.90±0.51^a	28.84±0.47^a
pH	7.70±0.04^a	7.80±0.10^a	7.86±0.14^a
DO (mg/L)	5.00±0.50^a	4.40±0.49^b	4.43±0.46^b
Ammonia	0.25±0.00^a	0.35±0.12^b	00.50±0.20^c
Total alkalinity (mg/L)	120.30±0.41^a	120.60±0.44^a	121.00±0.30^a
Transparency (cm)	25.20±1.60^a	25.10±1.30^a	24.13±1.80^b

*Mean± SD (Standard deviation); Table in the same row having the same superscript are not significantly different (P > 0.05).

Growth and production

Table 2: 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 2.

Parameters	Treatments		
	T_1	T_2	T_3
Stocking densities (No./m^2)	20	25	30
Initial length (cm)	8.00^a	8.00^a	8.00^a
Initial weight (gm)	15.00^a	15.00^a	15.00^a
Culture duration (Days)	120	120	120
Final length (cm)	18.00^a	18.00^a	18.00^a
Final weight (gm)	59.70±0.51^a	52.40±0.87^b	48.21±0.1.23^c
FCR	2.39^a	3.11^b	3.45^c
SGR	1.15^a	1.04^b	0.97^c
Survival rate (%)	80.00^a	68.00^b	60.00^c
Production (kg/m^2)	0.95^a	0.89^b	0.87^c
Production (kg/dec)	38.00^a	35.63^b	34.80^c
Production (kg/ha)	9,386.00^a	8,801.10^b	8,595.00^c

*Mean± SD (Standard deviation); Table in the same row having the same superscript are not significantly different (P > 0.05).

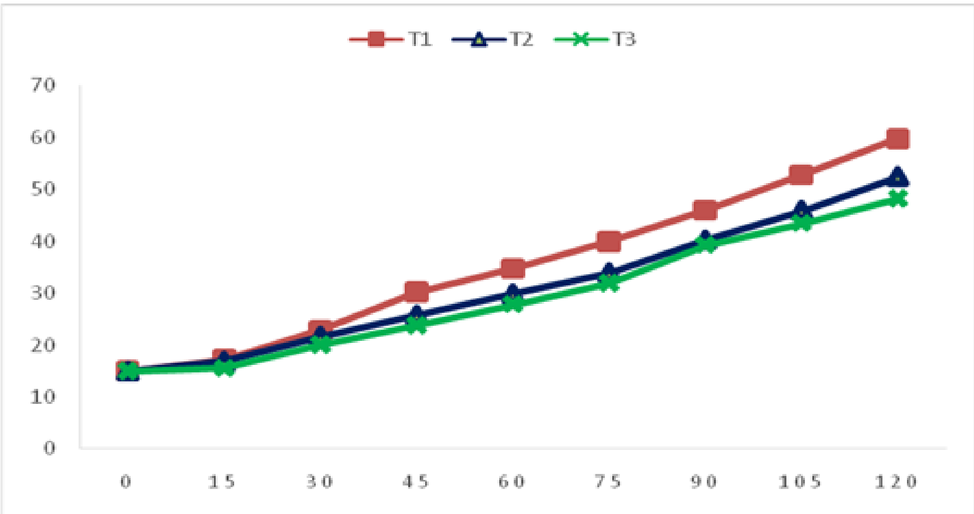

Fig 1: Growth performance of Shing (*H. fossilis*)

Table 3: Economic analysis for Shing (*H. fossilis*) production in ponds reared for 180 days

Components	Treatments		
	T_1	T_2	T_3
Expenditure (Tk/m^2.)			
Fingerlings cost	30	37.50	45.00
Feed cost	124.87	152.23	167.48
Lime cost (15 Tk/kg)	50.00	50.00	50.00
Medicine	-	-	10
Operational cost	50.00	50.00	50.00
Total expenditures (Tk/m^2)	254.87	289.73	322.48
Total expenditures (Tk/dec.)	10,194.80	11,589.20	12,899.20
Total expenditures (Tk/ha)	25,18,115.60	31,75,440.80	31,86,102.40
Income			
Gross return (Tk/m^2)	380.00	356	348.00
Net return (Tk/m^2.)	125.13	66.27	25.52
Net return (Tk/dec.)	5,005.20	2,650.80	1,020.80
Net return (Tk/ha)	12,36,284.40	6,54,747.60	2,52,137.60
BCR (Benefit Cost Ratio)	1.49	1.22	1.08

Discussion

In the study, water temperature (^{0}c) in T_1, T_2 and T_3 were 29.00±0.50, 28.90±0.51 and 28.48±0.47, respectively which is similar to (Haque *et al*., 1984; Kohinoor *et al*., 1998, 2007 and Monir *et al.*, 2014) [5, 6, 8, 12]. Boyd (1982) [3] reported that the range of water temperature from 26.06 to 31.97°C is suitable for fish culture. The water transparency (cm) were 25.20±1.60, 25.10±1.30 and 24.13±1.80 in T_1, T_2 and T_3, respectively. Monir *et al.*, (2014) [12] was reported that the transparency was varied from 28.78 to 31.93 cm among the treatments and mean values were 28.78 ± 3.70, 29.11 ±2.62 and 31.93 ±3.55 cm in T_1, T_2 and T_3, respectively. The level of pH in T_1, T_2 and T_3 were 7.70±0.04, 7.80±0.10 and 7.86±0.14, respectively. 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) [3]. Roy *et al.* (2002) [14] obtained a pH range 7.03 to 9.03 in fish ponds located in Trishal, Mymensingh. The dissolved oxygen (mg/L) content in T_1, T_2 and T_3 were 5.00±0.50, 4.40±0.49 and 4.43±0.46, respectively. Comparatively lower level of dissolved oxygen as observed in the T_3. Monir *et al.*, (2014) [12] was reported that the dissolved oxygen (DO) concentrations in T_1 (4.89±0.74 mg/l), T_2 (4.34±0.84 mg/l) and T_3 (4.36±0.67) respectively. Total alkalinity were 120.30±0.41, 120.60±0.44 and 121.00±0.30 mg/L in T_1, T_2 and T_3, respectively. These values did not show any significant difference (P<0.05) among the treatments. Total alkalinity was significantly (P<0.05) highest in T_1 (115.93 ±28.16) followed by T_2 (109.28 ±21.43) and lowest in T_3 (103.07 ±15.10 mg/l) reported by Monir *et al.*, (2014) [12]. Total alkalinity levels for natural waters may range from less than 5 mg L-1 to more than 500 mg/L (Boyd, 1982) [3]. Kohinoor *et al.* (1998) [6] and Roy *et al.* (2002) [13] found the average total alkalinity above 100 mg/L in their studies. The mean values of ammonia-nitrogen (unionized) was 0.25±0.00, 0.35±0.12 and 00.50±0.20 in T_1, T_2 and T_3, respectively. The suitable range of Ammonia (NH_3) below 0.1 mg/L (Boyd, 1982) [3].

The end of experiment, the mean harvesting weights of *Heteropneustes fossilis* were 59.70±0.51, 52.40±0.87 and 48.21±0.1.23 g in T_1, T_2 and T_3, respectively. The average final weight was found to be 40.47±0.38, 44.27±0.09 and 45.90±0.42g in T_1, T_2 and T_3 in seasonal ponds of Rajshahi, Bangladesh (Samad and Bhuiyan, 2017) [15]. The specific growth rate (% per day) of fish in different treatments varied among the treatments. Highest value was obtained in T_1 (1.15) and lowest in T_3 (0.97). SGR in T_1 was significantly higher than T_2 and T_3 similar to Monir *et al.*, (2014) [12]. FCR was significantly lower in T_1 (2.39) than in T_2 (3.11) and T_3 (3.45). The mean FCR value of T_1, T_2 and T_3 were obtained 2.51±0.04, 3.12±0.53 and 3.93±0.07, respectively Monir *et al.*, (2014) [12]. The percentage of survival as recorded in the present study was 80, 68 and 60 for T_1, T_2 and T_3, respectively. The highest survival rate was observed in T_1 and the lowest in T_3. Monir *et al.*, (2014) [12] reported that the survival rate of *H. fossilis* as recorded in the Northern Region of Bangladesh was 71.61±3.17, 62.47±2.02 and 53.62±3.91% for T_1, T_2 and T_3, respectively. Khan *et al.* (2003) [7] and Kohinoor *et al*., (2012) [12] recorded survival rates of *H. fossilis* 76.13 to 98.81 and 71 to 817, respectively. The mean production of *H. fossilis* was 0.95, 0.89 and 0.87 kg per m^2 or 9386.00, 8793.20 and 8595.60 kg/ha in T_1, T_2 and T_3, respectively. Khan *et al*. (2003) [7] evaluated that the production of *H. fossilis* in different stocking densities and got the gross production range 2080 to 3364 kg/ha. Lipton (1983) [10] observed that the Shing attained 30.35 g over 112 days with gross production 1242.35 g/m^2 in cage culture management.

In the present study, the total expenditure of production (BDT/ha) was lower in T_1 (25, 18, 115. 60) than T_2 (31,75,440.80) and T_3 (31,86,102.40) (Table 3). The net return gained from 120 days culture period was obtained as BDT 12,36,284.40, 6,54,747.60 and 2,52,137.60/ha for T_1, T_2 and T_3, respectively. The total cost of production (BDT/ha) was lower in T_1 (15, 32, 799) than those in T_2 (15, 28, 579) and T_3 (15, 23, 696) (Table 3). The net benefits generated from 210 days culture period was obtained as BDT 28,35,873, 18,89,616 and 10,68,659/ha for T_1, T_2 and T_3, respectively Monir *et al.*, (2014) [12].

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Conclusion

After end of the experiment, it can be decided that treatment T_1 (20 fingerlings/m^2 or1,97,600 fingerlings/ha) is suitable for *H. fossilis* due to higher total weight gain, better feed conversion ratios as well as higher net profit. Application of this findings for *H. fossilis* culture might be developed the aquaculture production especially in cemented dewatering canal.

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