Production performance of stinging catfish (*Heteropneustes fossilis*, Bloch) in monoculture at two different locations

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Abstract. An on-farm mono culture experiment was conducted for a period of four months from May to September 2014 to compare the growth and production of stinging catfish, *Heteropneustes fossilis*, at two different environmental conditions. Two locations were one in Gazipur Sadar (AEZ 28) and the other in Narsingdi Sadar (AEZ 9). At each location, there were five ponds of almost similar size and water depth. The stocking density was 500 fry per decimal for each location. Pre-stocking and post-stocking management were similar in both locations. There were considerable variations in most of the water and soil qualities between two locations. After four months of rearing, significantly higher ($p < 0.05$) mean harvesting weight of *H. fossilis* (48.10 ± 7.12 g) was observed in Narsingdi, as compared to that of Gazipur (23.18 ± 6.24 g).

Keywords: *Heteropneustes fossilis*, Monoculture, Dissolve Oxygen

Introduction

Fish production through aquaculture is rapidly gaining importance due to increasing human population and diminishing natural fisheries resources in Bangladesh. But fish culture on a small scale basis has often been failed due to inadequate knowledge about fish culture technique and feeding regime of fish (Reza 2013). Among the catfishes, stinging catfish (*H. fossilis*) is very popular and a high valued fish in Bangladesh. 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 ($226 \text{ mg } 100\text{g}^{-1}$) 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 1999). It is a very hardy fish and can survive for quite a few hours outside the water due to presence of accessory respiratory organs. Fish perform all their bodily functions in water. Water quality in turn mainly depends on soil quality/types. Again, both water and soil quality depends on the location based on agro-climatic conditions.

With the above background and justification, the production trials of *H. fossilis* culture technology was carried out in two different locations under two different Agro-Ecological Zones (AEZ). There have been a large variations in different parameters within each zone such as, AEZ 28 (Gazipur Sadar) contain low pH, low amount of nitrogen, phosphorous, potassium, calcium but iron content was high compare with AEZ 9 (BARC 2012). The present study was carried out with an aim of ascertaining the feasibility of adoption of *H. fossilis* culture at two different locations with the following specific objectives: To compare the growth and production performance of *H. fossilis* under monoculture in Gazipur and Narsingdi locations.

Materials and Methods

The experiment was conducted at two different locations of Sadar upazila in Gazipur and Narsingdi district, which fall under the AEZ 28 and AEZ 9, respectively. There are large variations in different parameters within each zone.

Description of the ponds: The average area of experimental ponds was 12 decimal with an average water depth of 1.5 m. All ponds possessed almost similar size, shape and bottom type. The ponds were free from aquatic vegetation and well exposed to sunlight. The main sources of water in ponds were rainfall but had facilities to supply water from a big reservoir using water pump whenever needed.

Design of experiment: The experiment was designed to compare the aquaculture production potential of *H. fossilis* in two different AEZs (Agro-ecological Zone) of 28 (Gazipur) and 9 (Narsingdi). There were five ponds in each location. The stocking density of *H. fossilis* in each pond in each location was 500 fry per decimal. The duration of the experiment was four months from May to August 2014. Here the two experimental locations were considered as treatment and the numbers of ponds in each location were as replication.

Pond preparation and stocking: Ponds were prepared by removing weeds and unwanted fish species with repeated netting. Afterwards, the ponds were treated with lime at the rate of 1.0 kg decimal⁻¹. Thereafter, the ponds were left out for 7 days to allow the development of plankton community. The fish were stocked on 11 May, 2014 with fry of stinging catfish (*H. fossilis*) collected from fish hatchery, located in Mymensingh. Before stocking all fishes were kept in a hapa for conditioning, and length and weight of fry were recorded. The stocking rate of *H. fossilis* fry was 500/decimal respectively. The average weight and length was about 0.22 g and 3.06 cm, respectively during stocking.

Feeding: Commercial fish feed was used for feeding the fish daily. Feeds were applied twice a day, half in the morning and the rest in the afternoon. Feeds were supplied at the rate of 20% for the first month, 15% for the second month, 10% for the third month and 5% for the fourth month. Feeding rates were adjusted according to increase of fish body weight observed after fortnightly sampling.

Analysis of water quality parameters: Various water quality parameters were recorded and estimated fortnightly. Water temperature were recorded by a portable digital Celsius thermometer. Transparency of water of the experimental ponds were measured by a Secchi-disc (30 cm in diameter) tied to a rope along with measuring tape. First the Secchi-disk was immersed into the water then the visible and invisible lengths under the water to the naked eye were measured in cm. Dissolved oxygen (mg/l) of water was measured by a portable digital dissolved oxygen (DO) meter (Lutron, PDO-519) on the spot. pH of water samples was measured by a direct reading using digital pH meter (HANNA, HI 8428) on the spot. Total alkalinity of the water samples was determined by titrimetric method using methyl orange indicator. It was calculated by the following formula:

Total alkalinity (mg l^{-1}) as $\text{CaCO}_3 = A \times 20$ (when amount of sample is 50 ml), A = Total ml of titrant used.

Ammonia-nitrogen was also determined by the HACH device (FF2, CAT. NO. 9262600) with Rochelle salt and Nessler reagent.

Plankton analysis: For qualitative and quantitative study of phytoplankton and zooplankton, ten liters of water sample were randomly collected from five different locations of each of the ponds and passed through a plankton net (mesh size 55 μm) and finally concentrated to 100 ml. Then concentrated samples were preserved in small plastic bottles in 5% buffered formalin for further study. Counting of plankton was done with the help of Sedgwick-Rafter Counting Cell (S-R cell) following Rahman (1992). Identification of plankton (phytoplankton and zooplankton) up to generic level was made according to Belcher and Swale (1978).

Soil analysis: Soil samples were collected monthly from the surface soil of the pond bottom with the help of an Ekman Dredge which was designed to trap normally a column of soil of 3-4 cm deep from the soil-water interface. Soil colour of both wet and dry soil samples were determined by eye estimation. Total nitrogen was determined by micro Kjeldahl Method (Bremner and Mulvancy 1982). Phosphorus was determined by Bray and Kurtz' method (Olsen and Sommers 1982). Potassium was determined by Ammonium acetate extraction method (Barker and Surh, 1982). This was determined by Ammonium acetate extraction method (Barker and Surh 1982). Iron was determined by using the Atomic Absorption Spectrophotometer (AAS) according to their respective wave length (Ullah *et al.* 1993).

Estimation of growth and yield of fish: Fishes were sampled fortnightly by using seine net. Weight and length of about 25 fishes were measured to assess the health condition and growth of fishes. Weight was taken by using a portable balance and length by using a centimeter scale. The gross and net yield of fish for each treatments were determined by multiplying the average gain in weight of fish both in gross and net by the total number of fish survived in each treatments at the end of the experiments. The growth performance of fish in different treatments was measured by using the following formula (Brown 1957):

$$\begin{aligned} \text{Survival Rate} &= \frac{\text{Total number of harvest}}{\text{Total number of stock}} \times 100 \\ \text{Weight gain (g)} &= \text{Final body weight (g)} - \text{Initial body weight (g)} \\ \% \text{ weight gain} &= \frac{\text{Final body weight (g)} - \text{Initial body weight (g)}}{\text{Initial body weight (g)}} \times 100 \\ \text{Specific growth rate (\% per day)} &= \frac{\ln \text{ final body weight (g)} - \ln \text{ initial body weight (g)}}{\text{Culture period (days)}} \times 100 \\ \text{Gross Production (Kg/decimal/120days)} &= \text{Gross weight (Kg) of fish} \end{aligned}$$

Statistical analysis: The obtained data were analyzed statistically to observe the water quality parameters, plankton abundance and production performance of fishes in different treatments. t-tests were followed to analyze the mean values of water quality parameters, plankton abundance and growth, survival and yield data, using SPSS (Statistical Packages for Social Science) and MSTAT-C software.

Result and Discussion

Various water quality parameters were recorded and estimated fortnightly in this experiment. Mean $\pm$ SD values of different water quality parameters in experimental ponds of two locations have been presented in Table I.

Table I. Mean $\pm$ SD values of water quality parameters recorded from two different locations

Water quality parameters	Locations (Treatment)	
	Gazipur (T ₁)	Narsingdi (T ₂)
Water Temperature (°C)	30.74 $\pm$ 1.19 ^a	30.72 $\pm$ 0.94 ^a
Transparency (cm)	27.49 $\pm$ 0.30 ^b	29.89 $\pm$ 0.21 ^a
DO (mg l ⁻¹)	5.12 $\pm$ 0.14 ^b	7.77 $\pm$ 0.15 ^a
pH	7.71 $\pm$ 0.09 ^b	8.18 $\pm$ 0.19 ^a
Total alkalinity (mg l ⁻¹)	31.09 $\pm$ 0.25 ^b	54.10 $\pm$ 0.34 ^a
Ammonia-nitrogen (mg l ⁻¹)	0.40 $\pm$ 0.20 ^a	0.25 $\pm$ 0.13 ^b
Phytoplankton (cells l ⁻¹)	1758 $\pm$ 45 ^b	3908 $\pm$ 186 ^a
Zooplankton (cells l ⁻¹)	1210 $\pm$ 49.93 ^b	1506 $\pm$ 23.01 ^a

*Means values with different superscript letters in the same row indicate significant difference at 5% significance level.

The mean $\pm$ SD values of water temperature were 30.74 $\pm$ 1.19 and 30.72 $\pm$ 0.94°C in the Gazipur (T₁) and Narsingdi (T₂) region respectively. There was no significant difference ($p>0.05$) between temperature values recorded in different locations (Table I). Water transparency is a gross measure of pond productivity. In the present experiment, the transparency of pond water was found to vary from 26.2 to 28.1 cm and 29 to 30.5 cm in Gazipur (T₁) and Narsingdi (T₂) region, respectively, which indicate that the ponds in both sites were productive. The DO concentration in pond of Narsingdi location, were within the more suitable range compared to that in ponds of Gazipur location. The mean values of pH were 7.71 $\pm$ 0.09 and 8.18 $\pm$ 0 in Gazipur (T₁) and Narsingdi (T₂) region respectively. There was significant ($p<0.05$) difference in pH variations between two different locations. The mean $\pm$ SD values of total alkalinity were 31.09 $\pm$ 0.25 and 54.10 $\pm$ 0.34 mg l⁻¹ in Gazipur (T₁) and Narsingdi (T₂) region respectively. There was significant ($p<0.05$) difference in alkalinity values between two different locations. The plankton production higher in Gazipur than Narsingdi. According to the values of alkalinity in the present experiment and those have been reported by others researchers, ponds in Narsingdi region were more productive than Gazipur region.

Throughout the present study period, the soil colour of treatment 1 (ponds of Gazipur Sadar) was reddish brown and the soil of treatment 2 (ponds of Narsingdi Sadar) remained dark gray before drying, and gray after drying. The general gray colour might be due to the presence of organic matter while the brownish red tinge provided an indication of deposition of ferric oxide. As per textural classification the bottom soil of ponds of Treatment 2 (Narsingdi Sadar) was found to be silt loam and that of Ponds of Treatment 1 (Gazipur Sadar) in general clay loam throughout the present investigation. The mean $\pm$ SD values of soils total nitrogen were 0.0884 $\pm$ 0.0052% and 0.1604 $\pm$ 0.0065% in the Gazipur (T₁) and Narsingdi (T₂) region respectively. There was significant difference ($p<0.05$) among nitrogen values recorded in two

different locations (Table II). The highest value of total nitrogen in Narsingdi region was observed (0.1604%) and the lowest value was recorded in Gazipur region (0.0884%) as has been shown in Table II.

Total phosphorus of soil was found to vary from 2.80 and 3.6 mg/100g to 6.6 and 7.9 mg/100g in the Gazipur (T₁) and Narsingdi (T₂) region respectively. The mean $\pm$ SD values of soils total phosphorus were 3.0692 ± 0.24 mg/100g and 7.2880 ± 0.37 mg/100g in the Gazipur (T₁) and Narsingdi (T₂) region respectively. There was significant difference ($P < 0.05$) among phosphorus values recorded in two different regions (Table II). Therefore, considering the P content, pond soil in Narsingdi was more suitable for maintaining high productivity.

Table II. Mean $\pm$ SD values of different soil parameters recorded from two different locations

Soils parameters	Treatments	
	Gazipur (T ₁)	Narsingdi (T ₂)
Total N(%)	0.0884 ± 0.0052^a	0.1604 ± 0.0065^b
Total P(mg/100g)	3.0692 ± 0.24^a	7.2880 ± 0.37^b
Total K(mg/100g)	0.2424 ± 0.024^a	0.4304 ± 0.034^b
Ca(mg/100g)	11.156 ± 0.36^a	16.640 ± 0.25^b
Fe (μ g/g)	80.652 ± 0.38^a	14.660 ± 0.30^b
pH	5.5 ± 0.41^b	6.4 ± 0.05^a

*Means values with different superscript letters in the same row indicate significant difference at 5% significance level.

Total potassium of soil was found to vary from 0.20 and 0.28 mg/100g to 0.37 and 0.47 mg/100g in the Gazipur (T₁) and Narsingdi (T₂) region respectively. The mean $\pm$ SD values of soils total potassium were 0.2424 ± 0.024 mg/100g and 0.4304 ± 0.034 mg/100g in the Gazipur (T₁) and Narsingdi (T₂) region respectively. There was significant difference ($p < 0.05$) among potassium values recorded in two different region (Table II). Fish can absorb calcium either from the water or from food. The mean $\pm$ SD values of soils total calcium were 11.156 ± 0.36 mg/100g and 16.640 ± 0.25 mg/100g in the Gazipur (T₁) and Narsingdi (T₂) region respectively. There was significant difference ($p < 0.05$) among calcium values recorded in two different locations (Table II). Iron is an important soil quality variable in aquaculture. It is a dissolved nutrient required in small quantities by both aquatic plants and animals. But chemical reactions of iron in sediment and water can have negative impacts on aquatic life. The data for iron have been presented in Table II. Soil iron was found to vary from 80.00 and 81.30 μ g/g to 14 and 15.3 μ g/g in the Gazipur (T₁) and Narsingdi (T₂) region respectively. The mean $\pm$ SD values of soils total iron were 80.652 ± 0.38 μ g/g and 14.660 ± 0.30 μ g/g in the Gazipur (T₁) and Narsingdi (T₂) region respectively. But in ponds with acidic sediment, iron deposits on fish can damage gills and cause unsightly blotches on scale. Liming can reduce high iron concentrations in sediment (Boyd 1992).

Growth and production of fish: For the evaluation of proper growth performance of (*H. fossilis*) in two different locations during experimental period, initial length and weight of fry, final length and weight of fish, % weight gain, SGR (% per day), survival (%) and total fish production (kg dec⁻¹120 days⁻¹) were calculated and are shown in Table III. There was significant variation ($p < 0.05$) of length increment of *H. fossilis* between two locations. Average length (cm) increment of catfish higher in Narsingdi region compare to Gazipur region. The

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reasons might be due to variation in water quality parameters between Gazipur and Narsingdi region. The percent weight gain of *H. fossilis* was 10437 ± 611.13 and 21764 ± 615.11 for the Gazipur (T₁) and Narsingdi (T₂) region respectively (Table III).

Table III. Stocking and harvesting size, survival, SGR and gross production of *H. fossilis* in two different locations during the 120 days culture period

Growth and production parameters	Locations	
	Gazipur (T ₁)	Narsingdi (T ₂)
Initial mean weight (g)	0.22 ± 0.08	0.22 ± 0.07
Initial mean length(cm)	3.06 ± 0.81	3.06 ± 0.91
Final mean weight (g)	23.18 ± 6.24^b	48.10 ± 7.12^a
Final mean length(cm)	15.57 ± 4.31^b	20.70 ± 5.23^a
Mean weight gain (g)	22.96 ± 6.51^b	47.88 ± 7.13^a
Mean length gain(cm)	12.51 ± 4.31^b	17.64 ± 5.23^a
% Weight gain	10437 ± 611.13^b	21764 ± 615.11^a
Survival (%)	65.8 ± 4.21^b	68 ± 5.32^a
SGR (% wt. gain day ⁻¹)	2.95 ± 0.03^b	3.69 ± 0.05^a
Gross Production (Kgdec ⁻¹ 4 month ⁻¹)	7.55 ± 5.61^b	16.31 ± 6.13^a
FCR	2.96	2.63

*Means values with different superscript letters in the same row indicate significant difference at 5% significance level.

The average values of specific growth rate of *H. fossilis* were 2.95 ± 0.03 and 3.69 ± 0.05 in the Gazipur (T₁) and Narsingdi (T₂) region respectively. There were significant ($p < 0.01$) differences in SGR value in the different locations (Table III). The highly significant specific growth rate 3.69 was observed in Narsingdi region. In contrast, the lowest specific growth rate 2.95 was observed in Gazipur region. Mean food conversion ratio (FCR) in two locations ranged from 2.96 and 2.63 (Table III). The highest FCR was obtained in Gazipur region and lowest FCR was obtained in Narsingdi region. The survival rate of *H. fossilis* was $65.8 \pm 4.21\%$ and $68 \pm 5.32\%$ in the Gazipur (T₁) and Narsingdi (T₂) region respectively. The survival rate was higher in Narsingdi region whereas the survivability rate was low in Gazipur region (Table III).

The final weight of fish was 23.18 ± 6.24 g in Gazipur region and 48.10 ± 7.12 g in Narsingdi region. There was significant ($p < 0.01$) difference in final weight of *H. fossilis* in different locations (Table III). The maximum final weight was observed in Narsingdi region. The minimum final weight was observed in Gazipur region. 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*. Ali *et al.*, (2013) observed that the highest total production of *H. fossilis* 6.47 kg/ decimal/110 days was recorded in T1. In T2 and T3 the production was 5.94 kg/ decimal/110 days and 5.47 kg/ decimal/110 days, respectively. Khan *et al.* (2003) evaluated that the production of *H. fossilis* in different stocking densities and got the gross production range 8.42 and 13.62 Kgdec⁻¹. The pond productivity was significantly higher in Narsingdi region (T₂) than the Gazipur region (T₁) and subsequently the growth of fishes was better in Narsingdi region (T₂) than Gazipur region (T₁).

Conclusion: All parameters of water and soil remained within more productive range for *H. fossilis* culture in Narsingdi region but less productive range for *H. fossilis* culture in Gazipur region. The reasons might be due to variation in water and soil quality parameters between Gazipur and Narsingdi region.

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