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EFFECTS OF FEEDING AND FERTILIZATION ON THE GROWTH AND PRODUCTION OF *PUNTIUS SOPHORE* IN SEASONAL PONDS IN NATORE, BANGLADESH

B M Mostafa Kamal[1], Md Istiaque Hossain[2*], Md Mosaddequr Rahman[2], Md Abdul Mannan [3], Md Al-Amin Sarker [2]

[1]Natore fish farm, Natore, Bangladesh
[2] Department of Fisheries, Faculty of Agriculture, University of Rajshahi, Rajshahi, Bangladesh,
[3] Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh

Abstract

Context: Local farmers believe that the seasonal ponds and ditches which can retain water for 4 to 6 months in a year cannot be utilized for fish production but in fact such waters hold tremendous potential for culture of small indigenous fish species.

Objectives: To evaluate the effects of fertilization and feeding in the growth and production of *Puntius sophore* culture in seasonal ponds.

Materials and Methods: Six ponds were used during this study under two treatments. Two treatments such as T_1 (only fertilizer) and T_2 (fertilization and supplementary feeding) were run in triplicate. *P. sophore* was stocked in the two treatments at the rate of 15500 ha^{-1} after necessary pond preparation and fertilization.

Results: Important physico-chemical factors viz., temperature, transparency, pH dissolved oxygen and total hardness of two treatments were found within the productive ranges. Four groups of phytoplankton were found in the ponds namely Bacillariophyceae, Chlorophyceae, Cyanophyceae and Euglenophyceae and two groups of zooplankton viz. Crustacea and Rotifera. *P. sophore* successfully breed in both treatments. However, the number of fish harvested was 122135 ha^{-1} in T_1 and 113335 ha^{-1} in T_2. Yet the total production was higher in T_2 (1091.40 kg ha^{-1}) than in T_1 (842.72 kg ha^{-1}) as the individuals found in T_2 gained more weight than those in T_1 reflecting the effects of regular feeding.

Conclusion: The study indicated that both fertilizer and feed based treatment was to improve more production than only fertilizer based treatment under seasonal pond conditions.

Key words: Growth and production, *Puntius sophore*, feeding and fertilization

Introduction

Rural people of many South Asian countries including Bangladesh, consume 56-73 species of SIS (Minkin 1993), among which Mola (*Amblypharyngodon mola*, Hamilton), Chela (*Chela cachius*, Hamilton) and Punti (*Puntius sophore*, Hamilton) are most commonly preferred (Ahmad *et al.* 2010). The pool barb *Puntius sophore* (Hamilton 1822) (Cyprinidae) is an indigenous small fish of Bangladesh distributed extensively throughout the Indian sub-continent including Bangladesh, Bhutan, India, Nepal, and Pakistan (Rahman 1989, Talwar & Jhingran 1991, Menon 1999, Petr 1999) and is also reported from Afghanistan (Petr 1999), China (Talwar & Jhingran 1991) and Myanmar (Oo 2002). As *P. sophore* inhabits rivers, streams, ponds, beels, floodplains, baors, haors in plains and sub-montane regions predominantly (Menon 1999, Craig *et al.* 2004), it is an important target species for small-scale fishers (Shafi & Quddus 1982, Rahman 2005), who

* Corresponding author *Email:* bitanrubd@yahoo.com, bitan@ru.ac.bd

use a variety of traditional fishing gear (Kibria & Ahmed 2005). However, *P. sophore* is declining rapidly due to heavy fishing pressure, and in recent studies from the Indian waters is categorized as lower risk to near threatened in the Western Ghat (Balasundaram *et al.* 2000) and in Harike wetland, a Ramsar site (Dua & Parkash 2009). This fish is a major source of animal protein and micronutrients in the diet of rural small-scale farmers (Roos *et al.* 2007). In addition, it is an important indigenous small fish species of Bangladesh and much famed food fish item (Rahman 2005) that can also be used as an aquarium fish (Froese & Pauly 2011).

Considering the growing trend of aquaculture and importance of *P. sophore* in the diet and nutrition of rural people in Bangladesh, it is high time to consider *P. sophore* as an important aquaculture species. This species be cultured in seasonal water bodies and ditches where water stay for about 4 to 6 months (e.g. small seasonal ponds, ditches etc.).

Several studies on the *P. sophore* populations include the growth in the Jamuna River, Bangladesh (De Graff 2003), length–weight and length–length relationships in the Mathabhanga River, northwestern Bangladesh (Hossain *et al.* 2006) and population structure, LWR and LLR in the chalan *beel* (Rahman *et al.* 2012). However, to the best of the authors' knowledge there is no study in the literature describing the culture techniques of *P. sophore* in ponds. Subsequently, the objectives of this study aimed to describe the effects of feeding and fertilization in the growth and production of *P. sophore* in seasonal ponds.

Materials and Methods

The study was conducted for a period of 6 months from June 2011 to November 2011 in six fish ponds located at Fish Seed Multiplication Farm, Natore, Rajshahi. Experimental ponds were rectangular in shape with an area of 75 m^2 each and average depth of 1.5 meters. Two treatments of each T_1 and T_2 were consisted with 3 replications. In T_1, only fertilization was done weekly and no supplementary feed was provided and T_2, both fertilization and supplementary feeding were provided. However, fish were stocked at the same rate in both treatments.

Pond preparation:

Before stocking, ponds were initially dried, and treated with lime at a rate of 200 kg ha^{-1}. Cow dung, Urea and Triple Super Phosphate (TSP) were used at a rate of 1235 kg ha^{-1}, 50 kg ha^{-1} and 15 kg ha^{-1}, respectively. The ponds were then filled up with water from deep pump. The ponds were then left for approximately two weeks in order to allow the development of healthy pond community.

Analysis water quality parameters:

Water quality parameters including water temperature, transparency, dissolved oxygen, pH, and total hardness were analyzed fortnightly. Water temperature and dissolved oxygen of water were determined by a portable DO meter (YSI model 58), pH of water was determined with a pH meter (Jenway Model 3020). Total hardness was measured titrimetically following Stirling (1985). Transparency of water was determined with a secchi disc and a measuring scale.

Plankton collection and enumeration:

Water samples were taken from different areas and depths from each pond fortnightly. The concentrated planktonic samples were preserved in 5% of formalin and stored in a small, sealed plastic bottle until examined. By using a Sedgwick- Rafter Cell, a 1 ml sub sample of each sample was examined under a microscope (SWIFT, M4000-D). The plankton contents of water were calculated in percentage for each pond. Both qualitative and quantitative studies of plankton were performed in this study.

Fish stocking:

Fish seeds of *P. sophore* were collected from the nearest Satni *beel* and carried to the experimental ponds using plastic bucket and canvas tank. Good condition fish seeds were used for this experiment. Fish seeds were acclimatized before stocking in the ponds. Each pond was stocked with *P. sophore* at the rate of 15500/ha.

Fertilization and supplementary feeding:

T_1 was fertilized weekly with cow-dung, Urea and TSP at a rate of 300 kg/ha, 7.5 kg/ha, 3 kg/ha, respectively. On the other hand, T_2 was fertilized fortnightly with cow-dung, Urea and TSP at the rates of 600 kg/ha, 15 kgha^{-1}and 6 kgha^{-1}and rice bran was supplied as supplementary feed only in the treatment 02 at a rate of 150kg/ha/week.

Fish sampling:

To study the growth, 20 fishes from each of the ponds were caught fortnightly by a cast net. Total length and weight of fishes were measured carefully and overall body condition was inspected visually.

Stomach contents analysis:

The abdomen of the sampled fish was cut open and the gut contents were taken out carefully and then put into a clean petridish. Only the anterior portion of the digestive tract between the esophagus and the small intestine was used for the stomach content analysis as the food items in this portion of the digestive tract are least digested and mostly identifiable. Sampling method was designed following McCombish (1967), Mckechnie & Fenner (1971) and Dewan *et. Al.* (l99l). The gut contents were then diluted with distilled water to 5 ml. 1 ml sub-sample from each sample was transferred by a pipette to a Sedgwich-Rafter Cell (SR-Cell). Using a binocular microscope (SWIFT M4000-D) and phase contrast facilities, all organisms found in 10 of the thousand cells chosen randomly were identified and counted carefully.

Statistical analysis:

Statistical analyses were performed using Microsoft® Excel-add-in-DDXL and SPSS software (Version-11.5). All statistical analyses were considered significant at 5% ($p<0.05$).

Results

Water quality parameters:

Water quality parameters with their minimum and maximum values, mean and standard error are given in Table 1. Water temperatures of both treatments were recorded during each sampling date. The water temperature ranged from 25.5°C to 32.6°C (mean±SE = 29.9±0.79) in T_1 and 26°C to 31.7°C (mean±SE = 29.83±0.64) T_2. On the other hand, the transparency fluctuated between 19 cm and 49 cm (mean±SE = 28.83±3.27) in case of T_1 and 19 cm and 40 cm (mean±SE = 28.83±2.77) in case of T_2. In addition, pH values ranged from 6.88 to 9.22 (mean±SE = 7.72±0.25) in T_1 and 6.79 to 8.22 (mean±SE = 7.65±0.18) in T_2. Furthermore, dissolved oxygen levels of two treatments were found to be varied between 4.25 mg/1 and 9.8 mg/1 (mean±SE = 7.26±1.04) for T_1 and 1.80 mg/1 and 9.2 mg/1 (mean±SE = 5.57±0.99) for T_2. Moreover, total hardness varied from 35 mg/l to 58 mg/l (mean±SE = 45.41±3.84) in T_1 and 30.03 mg/l to 103.30 mg/l (mean±SE = 62.44±8.88) in T_2. No significant differences were found in water temperatures, transparency and pH values between two treatments. However, significant differences were found in dissolved oxygen and total hardness levels between 2 treatments.

Table 1. Water quality parameters of fish ponds under two treatments during study period.

Water quality parameters	T_1			T_2		
	Min	Max	Mean±SD	Min	Max	Mean±SD
Temperature (°C)	25.5	32.6	29.96±0.73	26	31.7	29.83±0.64
Transparency (cm)	19	49	28.83±3.27	19	40	28.83±2.77
pH	6.88	9.22	7.72+0.25	6.79	8.44	7.65±0.18
Dissolved oxygen (mg/1)	4.25	9.8	6.15±0.68	1.80	9.2	5.57±0.99
Total hardness (mg/1)	35	58	45.41±3.84	30.03	103.30	62.44±18.88

Min, Minimum; Max, Maximum; SD, Standard deviation

Plankton population:

The results of the qualitative and quantitative studies of plankton population of two treatments during the period of study are shown in Table 2.

Table 2. Generic status of plankton identified during study period.

Phytoplankton	Zooplankton
Bacillariophyceae	Crustacean
Navicola, *Diatima, Cyelotella*	Nauplius, Diaphanosoma, *Cyclops*, Daphnia
Euglenophyceae	Rotifera
Phacus	*Keratella*
Chlorophyceae	
Gonatozygon, *Pediastrum*, *Chlorococcus*, *Tetraedron*, *Ankistrodeonnis*, *Scenedesmus*, *Botryococcus*, *Trachelomonas*, *Characium*, *Chlorella*, *Clisterium*, *Surirella*, *Volvox*	
Cyanophyceae	
Anabaena, *Aphanocapsa*, *Gloeotrichia*, *Microcystis*, *Oscillatoria*	

28 genera under 6 plankton groups were identified during the study. 23 genera of Phytoplankton under 5 groups namely Bacillariophyceae (2), Chlorophyceae (15), Cyanophyceae (5) and Euglenophyceae (1) and five genera of Zooplankton under two groups viz. Crustacea (4), Rotifera (1) were found (Table 2). Total phytoplankton ranged from 0.02×10^4 (Euglenophyceae) to 1.62×10^4/l (Chlorophyceae) in T_1 and 0.04×10^4/l (Euglenophyceae) to 3.68×10^4/l (Cyanophyceae) in T_2 (Table 3). Zooplankton population fluctuated from 0.02×10^4/l (Rotifera) to 0.04×10^4/l (Crustacea) in T_1 and 0.24×10^4/l (Rotifera) to 0.44×10^4/l (Crustacea) in T_2 (Table 3).

Table 3. Abundance of plankton (x 10^4/l) in pond water under two treatments

Plankton groups	Treatment-1	Treatment-2
Phytoplankton		
Bacillariophyceae	0.24 (±0.06)	0.06 (±0.04)
Chlorophyceae	1.62 (±0.19)	1.14 (±0.31)
Cyanophyceae	1.12 (±0.26)	3.68 (±1.84)
Euglenophyceae	0.02 (±0.02)	0.04 (±0.03)
Zooplankton		
Crustacea	0.04 (±0.03)	0.44 (±0.12)
Rotifera	0.02 (±0.02)	0.24 (±0.10)

Electivity indices:

The electivity indices were determined according to Ivlev (1961). Electivity indices indicate that, *P. sophore* preferred to ingest maximum genera of phytoplankton than zooplankton. The phytoplankton group Cyanophyceae was consumed in higher quantity in both T_1 (7.37%) and T_2 (9.80%) followed by Chlorophyceae (Table 4). However, in case of Zooplankton, Crustaceans were dominant than Rotifera and *P. sophore* was found to prefer Crustaceans than the Rotifera in both treatments.

Table 4. Electivity indices in T_1 and T_2 during study

Phytoplankton	Treatment – 1			Treatment - 2		
	Pw%	Fg%	E	Pw%	Fg%	E
Bacillariophyceae	13.79	3.28	-0.62	10.79	2.78	-0.59
Chlorophyceae	31.3	7.21	-0.62	28.28	5.33	-0.68
Cyanophyceae	51.72	7.37	-0.75	81.48	9.8	-0.79
Euglenophyceae	03.45	0.49	-0.75	04.25	0.65	-0.73
Crustacea	06.89	0.98	-0.75	03.95	0.80	-0.66
Rotifera	04.17	0.54	-0.77	02.85	0.32	-0.80

Growth and production of fish:

Production of *P. sophore* was found higher in T_2 than in T_1. Maximum total length and body weight were found as 8.9 cm and 9.8 g in T_1 and 11.5 cm and 24.7 g in T_2. *P. sophore* was found to breed in both treatments. Final number of fish in T_1 was 122135ha^{-1}and in T_2 it was 113335 ha^{-1}. Total production was higher in T_2 (1091.40 kg ha^{-1}) than in T_1 (842.72 kg ha^{-1}) (Table 5).

Table 5. Details of number and weight of fish at stocking and harvesting and net production in two treatments

Parameters	T_1	T_2
Number of fish stocked	116	116
Initial average weight of stocked fish (g)	2.94	3.01
Average weight (g) at harvest	6.90	9.63
Number of fish harvested	916	850
Total production (kg ha^{-1})	842.72	1091.40

Discussion

Indigenous small fish species are of great demand in the rural areas as well as in the urban markets. Indigenous small fish including the *P. sophore* contains high protein, macro and micro-nutrients sometimes even higher than Indian major carps (Roos *et al.* 2007). Small fish species play an important role in eliminating the protein deficiency of rural poor people of Bangladesh and it may also help to improve their socio-economic condition through proper and scientific culture of these small indigenous fish species. As a consequence, it is very important to develop the culture techniques for these species.

Aquaculture depends almost completely on water quality and suitable of aquatic environment, In turn, the quality of aquatic environment depends on physical, chemical, biological and meteorological factors. Water quality parameters like temperature, transparency, pH, dissolved oxygen, total hardness and plankton population were measured during present study. Water temperature was found to be suitable for fish culture throughout the study period in both treatments. Significant differences were found in dissolved oxygen concentration and total hardness between the treatments. Dissolved oxygen level fluctuated more in T_2 than that in T_1. This could be attributed to the decomposition of supplementary food and fertilizer in the ponds of T_2. Nonetheless, except for one month (November) in T_2, dissolved oxygen levels were within the suitable range (Boyd 1998). pH levels in both treatments varied from 6.79 to 9.22 which were within the suitable limits for fish culture (Swingle 1967). No significant differences were found in transparency between treatments and were within the suitable range for fish culture.

Present study revealed that *P. sophore* ingested various types of phytoplankton and zooplankton but preferred to consume phytoplankton more than zooplankton. Among phytoplankton *P. sophore* ingested Cyanophyceae in greater number followed by Chlorophyceae in both treatments. A small number of Crustacean and Rotifera were also consumed by the fish in both treatments. No previous information found on the food and feeding habit of *P. sophore* restraining the comparison with previous studies. Shafi and Quddus (1974) described the main food of *Puntius stigma* as cyclops, daphnia, crustacean larvae and plant debris. Moreover, Phaorm (1980) found that *Puntius gonionotus* feeds mainly on aquatic plants, grasses and algae.

The initial number of fish stocked was 15500 ha^{-1} in both treatments and the number of fish harvested was 122135 ha^{-1} in T_1 and 113335 ha^{-1} in T_2. *P. sophore* successfully bred in both treatments. The number of fish found in T_1 was higher than that of T_2. This could be due to the divergence in sex ratios between the fish stocked in both treatments. However, the average final weight of fish was higher in T_2 than that in T_1 which is a clear indication of the effects of regular feeding that was provided only in the T_2. Subsequently the total production of fish was found to be higher in T_2 than in T_1. However, there is no study found on the culture of

P. sophore in the literature inhibiting the comparison. Thus this study will provide important baseline for further such studies. Nonetheless, Ameen *et al.* (1984) found the production of monoculture of *Amblypharyngodon mola* in miniponds as 1.75 tons ha^{-1} which is much higher than that found in this study. These differences could be attributed to the differences in growth rate among species and the level of management. Nevertheless, fish seeds of *P. sophore* are available and low cost. In addition, following extensive aquaculture good production is possible in the seasonal ponds which could be sufficient not only for family consumption but also could be a source of extra income.

Conclusion

In spite of having high nutritional and market value and culture potential especially in the seasonal ponds, indigenous small species are often ignored for aquaculture in Bangladesh. This study showed that the culture of *P. sophore* in seasonal ponds is possible using either fertilizer or in combination of fertilization and feeding with moderate productivity.

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