J. Agrofor. Environ. 3 (1): 25-28, 2009 ISSN 1995-6983

Effect of fertilizer on the qualitative and quantitative abundance of benthic fauna in ponds

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Abstract: The present research was conducted to assess the effects of added fertilizers on the qualitative and quantitative abundance of benthic fauna in ponds for a period of six months from August, 2008 to January, 2009 in the Bangladesh Agricultural University, Mymensingh. All the experimental ponds were rectangular in shape, each with surface area of 44 m^2 and the average depth of water was 1m. Three treatments such as GM [Goat manure + Urea: 3000+50 kg/ha], SM (Sheep manure + Urea: 3000+50 kg/ha] and C (control) were run in duplicates. Fertilizers were used fortnightly and benthos samples were collected randomly from the ponds at monthly intervals. Seven groups of benthic fauna viz. Oligochaeta, Chironomidae, Ceratopogonidae, Mollusca, Ephemeroptera, Odonata and Hirudinea were recorded throughout the experimental period. The total average number in the abundance of benthic fauna was recorded as (2196.09 ± 216.35/m^2, 2108.49 ± 211.50/m^2 and 1397.36 ± 233.04/m^2) in the treatments GM, SM and C respectively. The abundance of Oligochaeta and Chironomidae were found dominant with the treatments GM and SM in all the months during the whole study period. The maximum numbers of benthic fauna (2743.90 ± 457.32/m^2, 2515.24 ± 228.66/m^2 and 1905.50 ± 228.66/m^2) were found with the treatments GM, SM, and C respectively in August, 2008 and minimum (1676.84 ± 304.88/m^2, 1600.62 ± 228.66/m^2 and 1219.52 ± 152.44/m^2) were found with the treatments GM, SM and C respectively in January, 2009. The mean values of temperature (^{0}C) [23.52 ± 1.78, 23.48 ± 1.82 and 23.70 ± 1.81], transparency (cm) [33.53 ± 0.90, 33.02 ± 0.89 and 33.08 ± 1.09], pH (8.03 ± 0.20, 8.18 ± 0.18 and 8.20 ± 0.19) and dissolved Oxygen (mg/l) [5.37 ± 0.35, 5.37 ± 0.37 and 5.67 ± 0.33] were found in the treatments GM, SM and C respectively. The fluctuations in abundance of benthic fauna were found to be more or less related with the pH, temperature, dissolved oxygen as well as transparency.

Key words*:* Benthic fauna, goat manure, sheep manure, urea.

Introduction

Aquaculture is very important to provide different types of nutrients essential for human body. But there are several constraints in Aquaculture. Feed constraints are most critical among all. Natural feeds play a vital role to increase fish production and minimize the traditional aquaculture based feed cost. One of the best option is to produce food organisms naturally that is benthos. Benthos is very important organisms of natural water bodies which are directly consumed by fish as food and energy source. Various physico-chemical properties of water and soil have combined effect on the growth of benthos. In scientific culture and management of fisheries resources, there is great need for understanding of benthic fauna as they play an important role in the aquatic environment. It is not only important food item of fishes but also an indicator of productivity of a water body (Dewan, 1973). The productivity of a water body largely depends upon the abundance of plankton and benthos. Benthic organisms are very important as food for fishes especially for bottom feeders. A major component of any aquatic ecosystem, the benthic fauna constitute an important food items for many fishes including carps and thus play an important role in aquatic food chains (Petr, 1968). They have fundamental importance to the economy of aquatic environment, as they take part in the nutrient release from the bottom sediments into the overlying water so enrich the productivity of water bodies. The potentiality of fish production of an aquatic environment is often evaluated from the volume of number of benthic fauna. So, the composition of abundance and distribution of benthic organisms in the natural water bodies throughout the year provide an index of an ecosystem.

Mollah and Haque (1978), Ali and Rashiduzzaman (1976) and Habib *et al*. (1984) initiated preliminary study on the benthic ecology but they are lacking in focusing any contribution of benthos to the diet of cultured fishes. Considering the above fact the present research was conducted to assess the effects of different fertilizers on the qualitative and quantitative abundance of benthic fauna in the context of physico-chemical parameter in ponds.

Materials and Methods

Study area: The present research was conducted to assess the effects of different fertilizers on the qualitative and quantitative abundance of benthic fauna in ponds for a period of six months from August, 2008 to January, 2009 in fertilized ponds which were situated at the south-west corner of the Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh. All the experimental ponds were rectangular in shape, each with surface area of 44 m^2 and the average depth of water was 1 meter. The water was supplied into the ponds from the deep tube-well. The ponds were without inlet and outlet.

Pond preparation: Aquatic vegetations were removed by manual methods after repairing the ponds dykes. Predatory and other unwanted species were removed by using cast and seine nets. The ponds were limed @ 250 kg/ha.

Experimental design and fertilization: The experiment was conducted in a completely randomized design to select the ponds without bias to any pond over the whole study area for getting better results, with three treatments namely, GM [Goat manure + Urea: 3000 + 50 kg/ha], SM [Sheep manure + Urea: 3000 + 50 kg/ha] and C (control) were run in duplicates. Goat manure and Sheep manure were applied into the ponds as slurry and urea was spread over the ponds. All the ponds were fertilized at every 15 days intervals

Sample collection and preservation: Benthic Samples were collected around 10 am from the ponds on each sampling day. The samples were collected from each pond randomly by using a plastic Ger which was of 0.0915 m in diameter (Area = 0.00656 m^2) and then it was be washed out by sieves and kept in 10% formalin containing vials. The preserved organisms were then washed clearly and identified into major taxonomic groups and kept in the vials containing 10% formalin separately.

Identification and Counting of benthic fauna: The benthic organisms were identified into major taxonomic

groups under a dissecting Microscope. A binocular microscope (NOVA 950 ES-NOVA MICRIOSCOPE INC. P.O. BOX-8020, 2295, YALE, San Av. U.S.A. with a magnification PL 4/0.1, 160/0.1) were used to identify the specimens. Then the benthic organisms were identified and counted according to different taxonomic groups. Identification was done following the keys of Needham and Needham (1966) and Brinkhurst (1971).

Calculation of benthic fauna: The plastic Ger used to collect benthos was of 9.15 cm (0.0915 m) in diameter. Therefore, its radius, r = 0.0915/2 = 0.0457 m

It's Area = πr^2 = 3.142 x $(0.0457)^2$ = 3.142 x 0.002088 = 0.00656 m^2

Here, Factor = 1 / 0.00656 = 152.44

Total number of benthos per m^2 = Factor x Number benthos in bottle

Physico-chemical parameters of water: The physicochemical parameters of water such as temperature, transparency, pH and Dissolved Oxygen (DO) were recorded monthly intervals by Centigrade Thermometer, Secchidisc, pH meter (Jenway model 3020) and DO meter (YSI Model 58, USA) respectively throughout the experimental period at 10 am. The depth of water was measured by a meter scale.

Statistical analysis: Finally, the collected data on the abundance of different groups of benthic organisms were statistically analyzed and then significant differences were tested by DMRT.

Results and Discussion

Physico-chemical parameters of water: Values of water quality parameters recorded from the experimental ponds are presented in Table 1. The average values of temperature (°C), (23.52±1.78, 23.48±1.82 and 23.70±1.81), dissolved oxygen (mg/l), (5.37±0.35, 5.37±0.37 and 5.67±0.33), pH (8.03±0.20, 8.18±0.18 and 8.20±0.19) and transparency (cm), (33.53±0.90, 33.02±0.89 and 33.08±1.09) in treatments GM, SM and C, respectively. The temperature observed in this study found suitable for productivity of benthic fauna. Hossain *et al.* (1997) and Wahab *et al.* (1995) also reported similar findings. DoF (1998) reported that the suitable range of dissolved oxygen in water body for fish culture would be 5-8 ppm. Banerjee (1967) and Bhuyan (1970) considered 5.0 to 7.0 mg/l of dissolved oxygen content of water is fair or good in respect of productivity and water having dissolved oxygen less than 5 mg/l to be unproductive. Wahab *et al.* (1995) recorded dissolved oxygen content ranging from 2.2 to 7.1 mg/l in ponds of BAU campus, Mymensingh; while Kohinoor (2000) measured that Dissolved Oxygen content range from 2.0 to 7.9 mg/l in the seasonal ponds of BAU campus, Mymensingh. From the above findings it can be concluded that the Dissolved Oxygen contents of the experimental ponds were within the good productive range. Swingle (1957) found a good relationship between pH of pond water and fish culture and obtained satisfactory results at pH 6.5 to 9.0. DoF (1998) reported that pH 5 to 8 is good for fish culture. Kohinoor (2000) recorded that pH ranges from 6.9 to 8.6 which matched with present findings. Kohinoor (2000) also recorded transparency values ranging from 15 to 58 cm. Rahman (1992) stated that the transparency of a productive water body should be 40 cm or less. Boyd (1982) suggested that transparency from 15 to 40 cm was good for fish culture. The values of water quality parameter as recorded from the experimental ponds were well within the acceptable range for aquaculture as opined by the above authors.

Table1. Monthly variation of water quality parameters in the pond during the study period

Parameters	Aug '08	Sep '08	Oct '08	Nov '08	Dec '08	Jan '09	Aug '08
Temperature (0C)	GM	27.9	28.0	26.2	21.3	19.2	18.5
	SM	28.1	28.0	26.2	21.0	19.4	18.2
	C	28.5	27.9	26.4	21.4	19.4	18.6
Transparency (cm)	GM	36.1	36.2	32.6	30.8	32.0	33.5
	SM	35.9	35.1	32.4	30.0	31.7	33.0
	C	36.1	34.7	34.2	28.8	31.1	33.6
pH	GM	7.2	7.8	8.1	8.6	8.4	8.1
	SM	7.5	7.9	8.2	8.7	8.6	8.2
	C	7.6	8.2	7.7	8.8	8.6	8.3
DO (mg/l)	GM	4.1	4.9	5.0	6.4	6.0	5.8
	SM	4.2	4.5	5.1	6.5	6.1	5.8
	C	4.6	5.2	5.2	6.8	6.2	6.0

Benthic fauna: Seven groups of benthic fauna viz. Oligochaeta, Chironomidae, Ceratopogonidae, Mollusca, Ephemeroptera, Odonata and Hirudinea were recorded during the experimental period (Table 2). Maximum abundance of all the different groups of benthic organisms except Ceratopogonidae were found in treatment GM followed by SM while Ceratopogonidae was found maximum in abundance with the treatment SM followed by GM. The abundance of Oligochaeta and Chironomidae were found dominant with the treatments GM and SM throughout the study period. Bais et al. (1992) found that Oligochaeta was the most dominant group of benthos in lake which is similar with the present findings. Chironomidae was the second dominant group of benthic fauna during the study period which supports the findings of Shariful et al. (2009) who recorded Chironomidae as the second dominant group in ponds. The total average number in the abundance of benthic fauna was recorded as (2196.09 ± 216.35/m2, 2108.49 ± 211.50/m2 and 1397.36 ± 233.04/m2) in the treatments GM, SM and C respectively (Figure 1). Shariful *et al.* (2009) found that the average number of benthic fauna was 69.15/m2 and this might be due to lack of using fertilizer in pond. Jones *et al.* (1974) stated that the average number of benthic

fauna was 3600/m2 in highly fertilized pond which did not agreed with the result of the present study due to low dose of fertilizer used in this study. The maximum numbers of benthic fauna (2743.90 ± 457.32/m2, 2515.24 ± 228.66/m2 and 1905.50 ± 228.66/m2) were found with the treatments GM, SM, and C respectively in August, 2008 and minimum (1676.84 ± 304.88/m2, 1600.62 ± 228.66/m2 and 1219.52±152.44/m2) were found with the treatments GM, SM and C respectively in January, 2009 (Table 3). Singh et al. (1994) stated that the highest collection benthic fauna was in the month of August and minimum in January which matched with the present findings.

Table 2. Monthly variations of benthic fauna (Nos. /m^2) in the pond during the study period

Treatments	Groups	Study period					
		Aug '08	Sep '08	Oct '08	Nov '08	Dec '08	Jan '09
GM	Chironomidae	838.42 ± 76.22b	609.76 ± 0	914.64 ± 0	762.20 ± 152.44	609.76 ± 0	685.98 ± 228.66
	Oligochaeta	762.20 ± 152.44	838.42 ± 76.22	762.20 ± 152.44	838.42 ± 76.22	762.20 ± 0b	762.20 ± 0
	Mollusca	381.10 ± 76.22	381.10 ± 76.22	152.44 ± 152.44	228.66 ± 76.22	152.44 ± 0	0 ± 0
	Ceratopogonidae	304.88 ± 0	304.88 ± 0	228.66 ± 76.22	152.44 ± 0	304.88 ± 0	152.44 ± 0
	Ephemeroptera	228.64 ± 76.22	228.66 ± 76.22a	152.44 ± 0	76.22 ± 76.22	76.22 ± 76.22	76.22 ± 76.22
	Odonata	152.44 ± 0	152.44 ± 0	76.22 ± 76.22	0 ± 0	76.22 ± 76.22	0 ± 0
	Hirudinea	76.22 ± 76.22	76.22 ± 76.22	0 ± 0	0 ± 0	0 ± 0	0 ± 0
SM	Chironomidae	990.86 ± 76.22a	685.98 ± 228.66	609.76 ± 0	685.98 ± 76.22	609.76 ± 0	762.20 ± 0
	Oligochaeta	762.20 ± 0	838.42 ± 76.22	838.42 ± 76.22	762.20 ± 152.44	838.42 ± 76.22a	609.76 ± 152.44
	Mollusca	304.88 ± 0	228.66 ± 76.22	228.66 ± 76.22	76.22 ± 76.22	76.22 ± 76.22	0 ± 0
	Ceratopogonidae	228.64 ± 76.22	152.44 ± 152.44	304.88 ± 0	228.66 ± 76.22	304.88 ± 0	152.44 ± 0
	Ephemeroptera	152.44 ± 0	152.44 ± 0b	152.44 ± 0	76.22 ± 76.22	228.66 ± 76.22	0 ± 0
	Odonata	76.22 ± 76.22	76.22 ± 76.22	0 ± 0	76.22 ± 76.22	76.22 ± 76.22	76.22 ± 76.22
	Hirudinea	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0
C	Chironomidae	609.76 ± 0c	457.32 ± 0	457.32 ± 0	685.98 ± 76.22	381.10 ± 76.22	457.32 ± 0
	Oligochaeta	457.32 ± 0	533.54 ± 76.22	304.88 ± 0	381.10 ± 76.22	609.76 ± 152.44c	533.54 ± 76.22
	Mollusca	304.88 ± 0	228.66 ± 76.22	152.44 ± 0	0 ± 0	0 ± 0	0 ± 0
	Ceratopogonidae	228.66 ± 76.22	152.44 ± 0	228.66 ± 76.22	152.44 ± 0	228.66 ± 76.22	76.22 ± 76.22
	Ephemeroptera	152.44 ± 0	76.22 ± 76.22c	76.22 ± 76.22	76.22 ± 76.22	0 ± 0	152.44 ± 0
	Odonata	76.22 ± 76.22	0 ± 0	76.22 ± 76.22	0 ± 0	0 ± 0	0 ± 0
	Hirudinea	76.22 ± 76.22	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0

Table 3. Monthly average variations of benthic fauna (Nos. /m^2) in the pond during the study period

Treatment	Study period						Average
	Aug '08	Sep '08	Oct '08	Nov '08	Dec '08	Jan '09	
GM	2743.9±457.32	2591.48±304.88	2286.6±457.32	2057.94±381.1	1981.72±152.44	1676.84±304.88	2196.09± 216.35
SM	2515.24±228.66	2134.16±152.44	2134.16±152.44	1905.5±304.54	2134.16±228.66	1600.62±304.54	2108.49± 211.50
C	1905.5±228.66	1448.18±228.66	1295.74±228.66	1295.74±304.84	1219.52±228.66	1219.52±228.52	1397.36± 233.04

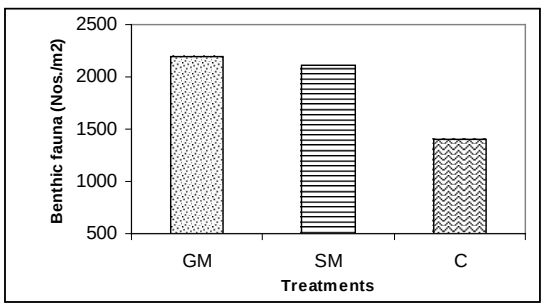

Fig.1. Treatment wise abundance of benthic fauna (Nos. / m^2) in ponds during study period

The benthic organisms showed maximum abundance in the treatment GM [Goat manure + Urea: 3000 + 50 kg/ha], SM [Sheep manure + Urea: 3000 + 50 kg/ha] during the whole study period. The fluctuations in abundance of benthic fauna were found to be more or less related with the pH, temperature, dissolved oxygen and transparency. The ponds fertilized with Goat manure plus urea was found as more suitable in response to higher abundance of different groups of benthic fauna. This might be due to the favorable condition of physicochemical parameters of water and positive effects of Goat manure.

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