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EFFECTS OF DIFFERENT KINDS OF FERTILIZERS ON PRODUCTION OF FISHES IN POLYCULTURE SYSTEM

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Abstract

A study was conducted to assess the effects of different kinds of inorganic fertilizers on the production of fishes in six ponds during October to December 2011. There were three treatments with two replications under each treatment and each of the ponds was stocked with 80 fish fry. In treatments I, II and III, ponds were fertilized fortnightly @ urea 100 g decimal^{-1}, T.S.P. 100 g decimal^{-1} and urea 50 g decimal^{-1} + T.S.P. 50 g decimal^{-1}, respectively. Selected water-quality parameters of ponds under study were more or less similar and within the productive range. Mean phytoplankton and zooplankton densities under treatments I, II and III were 57.08 ± 1.35, 8.80 ± 0.09 and 77.29 ± 3.72, 12.88 ± 0.74 and 98.93 ± 1.61, 16.16 ± 1.75 (x10^3) cells L^{-1}, respectively. The net and gross fish productions of the ponds under treatments I, II and III were 0.85 and 3.11 t ha^{-1} yr^{-1} and 1.32 and 3.58 t ha^{-1} yr^{-1} and 1.85 and 4.11 t ha^{-1} yr^{-1}, respectively. Fish production under treatment III was better than those under treatments I and II because plankton population densities under treatment III was the highest. Therefore, the mixed fertilization is suitable for production of plankton that enhance growth and production of fishes.

Keywords: Fish Culture, Pond, Limnological Factors, Fertilizer, Fish Production

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Introduction

Optimizing production in pond fish culture by the use of fertilizers is an important task. Fertilizer is helpful for the increase of natural food of fish i.e. plankton, benthos and periphyton. Plankton is the basic food of all the organisms living in the water. Fishes and other aquatic organisms depend on this basic food directly and indirectly. Extensive work on water quality and pond fertilization has been conducted elsewhere (Boyd, 1982) but very few of them have relevance to the Asian carp culture. Both over and under fertilization may cause adverse effects on fish production, water quality and economic returns. It is therefore necessary to evaluate fertilization regimes and recommend appropriate fertilization strategies to farmers in order to maximize fish production, maintain good water quality, reduce environmental bad impact and maximize economic returns.

Successful fisheries management and scientific fish culture depends on the various limnological factors of the water bodies. According to Hickling (1968) fish farming is a practical application of limnology and fresh-water biology, According to Reid (1971) the chemical analysis for dissolved gases and solids are highly important for the study of natural waters. He also reported that fish culture can be enhanced by the improvement of substratum by the use of fertilizers along with other pond management measures. The physico-chemical characteristics of pond water are of great importance and essential in case of fish culture and fisheries management. The physico-chemical properties play the most important role in governing the production of phytoplankton i.e. primary production in fishponds (Banerjee, 1967).

For successful aquaculture, knowledge on several factors is very important among which fertilization is one of them. The necessities and principles of fertilization of ponds for the increase of production are similar to those of crop production. The amount and proportions of various fertilizers needed vary from country to country and even from area to area within a country. The use of fertilizers in proper doses is also very important to reduce the unit cost of production. As for example, Hepher *et al.* (1971) found in Israel that if there applied no fertilizers in fishpond, the cost of production per ton was 935 dollars and after applying fertilizers, the cost of production of fish per ton was 691 dollars. Therefore, the present study was conducted to know the effects of different kinds of fertilizers on production of fishes in polyculture system along with some limnological parameters.

Materials and Methods

The experiment was conducted for a period of three months from October to December 2011 in six experimental ponds at Bangladesh Agricultural University, Mymensingh, Bangladesh. The ponds were rectangular in size and similar in area (about 40 m^2). They were numbered arbitrarily as P_1, P_2, P_3, P_4, P_5 and P_6 for the convenience of experimental work and data analysis. The ponds were treated by lime before two weeks of starting the experiment.

Table 1. Experimental layout

Treatments	Replication	Fish species & ratio	Fertilization
I	2 (P1 & P2)	Silver carp : tilapia : mrigal (2 : 2 : 1)	Urea 100 g decimal^{-1}
II	2 (P3 & P4)	Do	TSP 100 g decimal^{-1}
III	2 (P5 & P6)	Do	Urea 50 g+TSP 50 g decimal^{-1}

Stocking the pond

The ponds were stocked with fingerlings of silver carp, tilapia and mrigal with the stocking density of 80 (32+32+16) fingerlings per decimal. The average lengths of fingerlings of silver carp, tilapia and mrigal were 12.14 cm, 10.15 cm and 8.12 cm, respectively.

Fertilization

Inorganic fertilizers such as only urea, only TSP and urea and TSP mixed were used for the experiment. Fertilizers were applied at fifteen days interval. In the ponds of treatment 1 (T_1) only urea was applied at the rate of 100 g decimal^{-1}. In the ponds of treatment 2 (T_2) only TSP was applied at the rate of 100 g decimal^{-1}. In the ponds of treatment III, urea and T.S.P. were applied at the rate of 50 g urea and 50 g TSP decimal^{-1}.

Study of physico-chemical factors

The water samples were collected twice a month in the morning at about 10 a.m. The water samples were collected by dipping the bottle just below the surface water. All the bottles containing water samples were carried to the Laboratory of Limnology for analysis. The Physico-chemical factors which were studied are water temperature (°C), water depth (m), transparency (cm), dissolved oxygen (mg L^{-1}), Free CO_2 (mg L^{-1}), P^H and total alkalinity (mg L^{-1}). Water temperature was recorded with a Celsius thermometer and transparency was measured with a Secchi disc of 30 cm diameter. Dissolved oxygen was measured directly with a DO meter (Lutron, DO-5509) and a portable digital pH meter was used to measure pH. Free CO_2 and total alkalinity were determined by titrimetric method (APHA, 1992).

Study of plankton

For the quantitative and qualitative study of phytoplankton and zooplankton of water, samples were collected from the different spots of water of the ponds with the help of bottle. Fifteen to thirty liters of water was passed through the plankton net (mesh size 55 μ) for each sample and the volume of sample collected was 30 ml. The concentrated samples were poured into vials and preserved by 5% formalin. Plankton samples were collected fortnightly. The study of plankton was done by a haemocytometer under a compound microscope and calculating by using following formula (Rahman, 1992):

$$N = \frac{A \times 1000 \times C}{V \times F \times L}$$

Where,

N= No. of plankton cells per L,
A= Total no. of plankton counted,
C= Volume of final concentrate of samples in ml,
V= Volume of a field in cubic mm,
F= Number of the fields counted,
L= Volume of original water in liter,

Study of growth of fishes

Before releasing the fingerlings in the ponds average initial length (cm) and average weight (g) were recorded with the help of a meter scale and a balance. At the end of the experiment all the fishes were caught by a cast net and then by using rotenone in the ponds. Fish mortality, gross and net productions have been calculated using the following formulas:

(i) The survival rate was estimated by the following formula

$$\text{Survival rate (\%)} = \frac{\text{No. of harvested fishes}}{\text{Initial no. of fish}} \times 100$$

(ii) Calculation of gross fish production (t ha^{-1} yr^{-1})

$$= \frac{\text{Gross weight (kg) of fish per decimal per month} \times 250 \times 12}{1000}$$

(iii) Calculation of net fish production (t ha^{-1} yr^{-1})

$$= \frac{\text{Net weight (kg) of fish per decimal per month} \times 250 \times 12}{1000}$$

Statistical analysis

T-test of net fish production of the ponds under three treatments was done by a computer using SPSS package programme.

Results

Physico-chemical parameters

The results of physico-chemical parameters are shown in Table 2. All physical and chemical parameters of the ponds were found to be within the acceptable ranges for fish culture in all treatments.

Table 2. Physico-chemical parameters (Means ± SD; n = 3) of the ponds during the experimental period

Parameters	Treatment II	Treatment II	Treatment III
Average water depth (m)	0.89±0.01	0.85±0.04	0.91±0.02
Water temperature (^{0}C)	20.53±4.34	20.53±4.34	20.53±4.34
Transparency (cm)	35.41±2.89	31.91±0.75	31.35±1.71
pH	7.38±0.20	7.33±0.10	7.48±0.37
Dissolved oxygen (mg L^{-1})	9.50±0.58	9.79±0.52	10.12±0.36
Free CO_2 (mg L^{-1})	1.21±0.16	1.18±0.11	1.22±0.12
Total alkalinity (mg L^{-1})	106.08±5.02	104.67±3.11	112.17±5.56

Plankton

Mean phytoplankton and zooplankton densities under treatments I, II and III were 57.08 ± 1.35, 8.80 ± 0.09 and 77.29 ± 3.72, 12.88 ± 0.74 and 98.93 ± 1.61, 16.16 ± 1.75 (x10^3) cells L^{-1}, respectively (Fig. 1 and 2). It was observed that both the phytoplankton and zooplankton densities were significantly higher in Treatment III. The generic status of phytoplankton and zooplankton found during the tenure of experiment are shown in Table 3. During the study period, 45 genera of phytoplankton belonging to five groups and 10 genera of zooplankton belonging to three groups were found in all the experimental ponds.

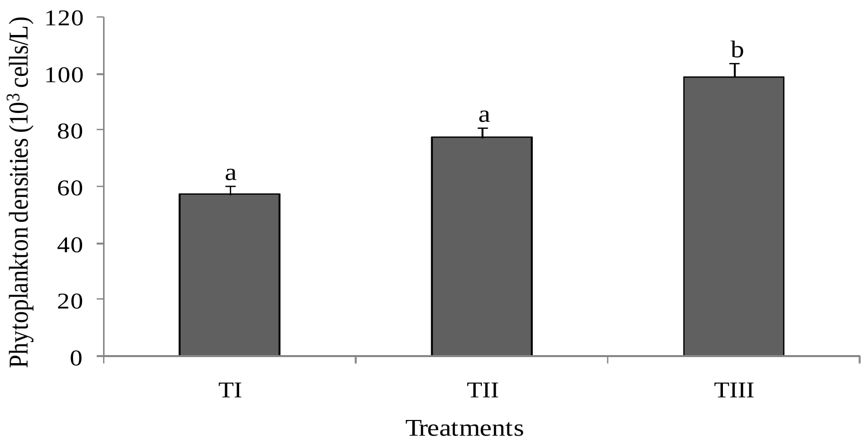

Fig. 1. Mean phytoplankton densities. Values accompanied by different letters are statistically significantly different ($p < 0.05$).

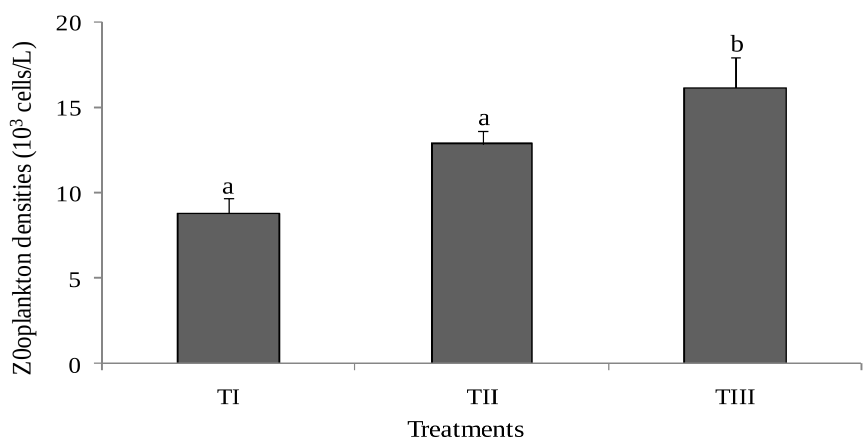

Fig. 2. Mean zooplankton densities. Values accompanied by different letters are statistically significantly different ($p < 0.05$).

Table 3. Generic status of phytoplankton and zooplankton found in the experimental ponds

Phytoplankton	Zooplankton
Bacillariophyceae: *Navicula , Diatoma,,Cyclotella, Melosira, Frustulia, Asterionella, Stauronesis, Fragilaria, Synedra, Frustulia, Surirella* **Chlorophyceae:** *Ulothrix, Ganatozygon, Gloeocystis, Spirogyra, Euastrum,Chroococcus, Ophiocytium, Protococcus, Volvox,Coelastrum, Cladophora, Tetraedron,Histococcus, Actinastrum,Closterium,Melosira, Scenedesmus, Pediastru, Pediastrum, Ankistrodesmus, Selenastrum, Actinastrum, Stistococcus* **Cyanophyceae:** *Anabaena, Oscillatoria, Microcystis, Nostoc, Spirulina, Aphanocapsa* **Euglenophyceae:** *Euglena, Phacus, Trachelomonas* **Dinophyceae:** *Ceratium, Peridinium*	**Rotifera:** *Brachionus, Keratella, Filinia, Polyarthra* **Cladocera:** *Daphnia, Diaphanosoma, Moina* **Copepoda:** Nauplius, *Cyclops, Diaptomus*

Growth and production of fish

The net productions (t ha^{-1} yr^{-1}) of silver carp, tilapia and mrigal under three treatments have been presented in Fig. 3. The net productions of fishes are shown in Figure 4. Significantly highest net productions of fishes were obtained in Treatment III.

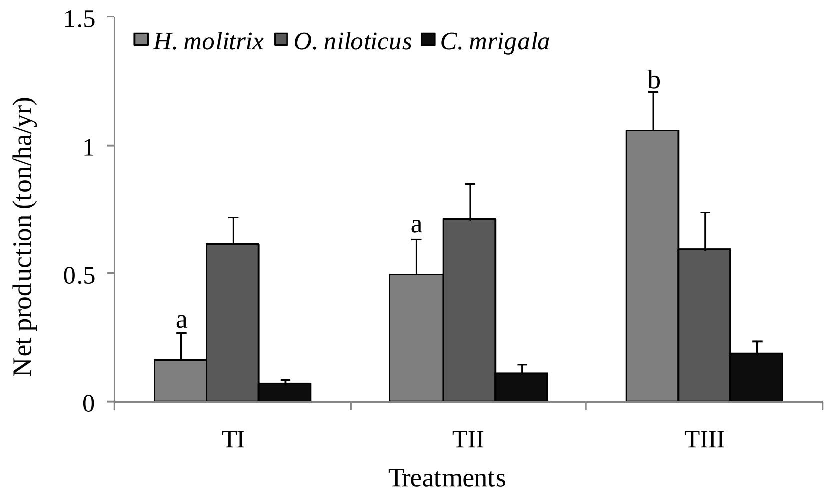

Fig. 3. Species wise net production of fish. Values accompanied by different letters are statistically significantly different ($p < 0.05$).

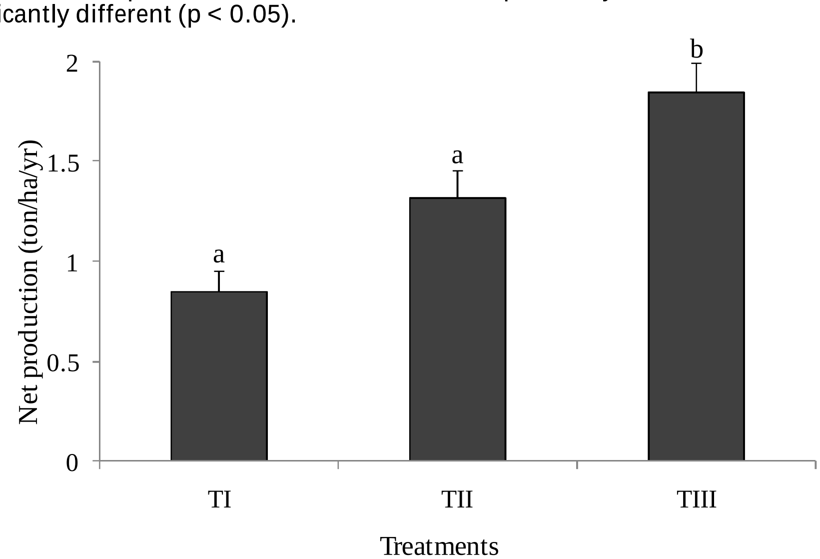

Fig. 4. Net production of fish. Values accompanied by different letters are statistically significantly different ($p < 0.05$).

Discussion

The present study was conducted to evaluate the effects of fertilization on growth and production of fishes in polyculture of tilapia, silver carp and mrigal. The fishes showed better growth and production performance in supply of mixed fertilizer as both phytoplankton and zooplankton production were highest in this condition.

The physico-chemical parameters of the experimental ponds were within the productive ranges for the growth of plankton and benthos during the tenure of experiment (Table 2). Within limit productive ranges of such water quality parameters have also been observed by a number of authors (Uddin *et al.,* 2007; Chowdhury *et al*., 2008; Uddin *et al.,* 2012; Rahman *et al*., 2012; Talukdar *et al*., 2012; Siddika *et al*., 2012; Nupur *et al.,* 2013) in the aquaculture ponds of BAU area which are in conformity with those of the present study.

In the present study, phytoplankton and zooplankton population densities were significantly higher in Treatment III (Figures 1 & 2) indicating that both urea and TSP fertilizer needed for their production. More or less similar results also observed by Amin *et al.* (2005), Ferdousi *et al.* (2005), Uddin *et al*. (2007), Chowdhury *et al.* (2008) and Talukdar *et al*. (2012).

The net production of fishes of the ponds under treatment III was higher than those of treatments I and II. Higher net fish production of treatment III indicates the positive and better effects of mixed fertilization of urea and TSP on primary productivity as well as fish growth. All the species of fishes showed the highest rate of growth in all respects in treatment III, which is probably due to high production of both phytoplankton and zooplankton. More or less similar results recorded by Rabanal (1967). Saha *et al.* (1974) recorded that fertilizers enhanced growth of phytoplankton and zooplankton, which in turn induced better growth of fish. The yields of fish were higher in fertilized ponds compare to unfertilized ponds (Shahjahan *et al*., 2003). Donbrovskij *et al.* (1975) reported that introduction of mineral nitrogenous and phosphoric fertilizers increased the productivity of ponds by 1.4 times at the same stocking rate in fertilized ponds and by 2.3 times at higher stocking rates in fertilized ponds. Therefore, it can be concluded that the higher fish productions of treatment III was due to application of mixed fertilization of urea and TSP in the experimental ponds.

In conclusion, effects of fertilizer on the growth and production of fishes along with some limnological conditions were conducted in polyculture system under three treatments. In treatments I, II and III, ponds were fertilized fortnightly at the rates of urea 100 g decimal^{-1}, T.S.P. 100 g decimal^{-1} and urea 50 g decimal^{-1} + T.S.P. 50 g decimal^{-1}, respectively. Physico-chemical parameters were more or less similar in the ponds under three treatments and were within suitable ranges. The net fish production of fish was significantly higher in Treatment III compared to Treatments I and II indicated that mixed fertilization might play a vital role in pond fish culture to increase production of fishes in polyculture system.

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