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NITROGEN INPUT II: PERFORMANCE EVALUATION OF BUFFALO MANURE ON THE PRODUCTION OF NATURAL FISH FOOD AND GROWTH PERFORMANCE OF MAJOR CARPS

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ABSTRACT

Fish growth and yield depend on the organic and inorganic fertilizer and supplementary feed in freshwater fish culture practices. In ponds, the required nutrients for the proper growth of fish are limited because of the nutrient loss in pond sediments. This loss of nutrients in pond ecosystem can be reduced through the addition of fertilizer. Thus the aim of this study was to assess the influence of buffalo manure on the primary productivity, and the net fish yield of major carps for one year in four earthen fish ponds. *Catla catla, Labeo rohlita* and *Cirrhinus mrigala* were stocked with a ratio of 40:30:30 to test the input of buffalo manure and compared with control pond (no buffalo manure). Based on its nitrogen contents (1.02 percent) buffalo manure was applied at a rate of 0.15 g nitrogen / 100 g of fish weight daily. The input of this nitrogen source significantly increased fish weight, fork length and total length. The final an average weight of *Catla catla*, *Labeo rohita* and *Cirrhinus mrigala* in the treated and control pond were recorded as 590.24 ± 1.94, 511.34 ± 2.62 and 391.94 ± 2.12 and 162.19 ± 1.72, 160.08 ± 2.01 and 156.84 g's ± 1.66, respectively. The plankton productivity; phytoplankton and zooplankton abundance and phytoplankton / zooplankton ratios were significantly different in treated and control ponds. Increase in fish yield and nitrogen incorporation efficiency of fish was found to be correlated with water temperature and plankton productivity in treated and control ponds. The net fish yield of 421.35 and 135.75 kg/pond/year of major carps were secured from buffalo manure treated and control ponds respectively.

Key words: Warm water fishes; pond fertility; buffalo manure; productivity; fish growth; carp production.

INTRODUCTION

Fish is very important dietary animal protein source in human nutrition. The production of aquatic species through freshwater fisheries and aquaculture for protein supply is being encouraged in developed or developing countries, but in under- developed countries, it is declining. The total production of an aquatic system can be enhanced by the effective utilization of various ecological resources within the pond environment. Organic fertilizers are applied mainly to stimulate the heterotrophic food chain of aquaculture ponds. Although virtually all biological materials can be considered as potential organic fertilizers, the commonest fertilizer used in aquaculture is animal or farmyard manure (ie. farm animal faeces, with or without urine and bedding material). Apart from being a readily available and inexpensive commodity, animal excreta represents a nutrient packed resource containing 72–79% of the nitrogen and 61–87% of the phosphorus originally fed to the animal (Knud-Hansena *et al*., 1991). The average nutrient composition of animal manures and other commonly used organic fertilizers has been presented previously (Hassan and Javed, 1999; Mahboob and Al-Ghanim, 2014). In contrast to chemical fertilizers which act directly on the autotrophic food chain, organic fertilizers act mainly through the hetero-trophic food chain by supplying organic matter and detritus to the pond ecosystem; the manure serving principally as a substrate for the growth of bacteria and protozoa, which in turn serve as a protein rich food for other pond animals, including the cultured fish. The beneficial effects of organic fertilization on natural pond productivity are well illustrated by the studies of Schroeder (1980) and Rappaport, Sarig and Bejerano (Lutz, 2003).

Organic manure is less expensive than chemical fertilizers. Animal manure has a long history of use as a source of soluble phosphorus, nitrogen and carbon for algal growth. It is often used in earthen ponds to improve primary production and fish growth (Kang'ombe *et al*., 2006; Terziyski *et al*., 2007). An increase in nutrient content provides favorable conditions for phytoplankton production. Phytoplankton as well as microorganisms responsible for mineralization of organic matter, serves as a food source for zooplankton. Moreover, it increases biomass of zooplankton and benthic organisms which are important as natural fish food. In organically manured ponds, the organic matter is degraded by aerobic bacteria into carbon dioxide and ammonia. Algae will utilize the carbon dioxide. During photosynthesis, the algae will produce oxygen which will sustain fish, zooplankton and phytoplankton. Algae represent a major food source for fish in ponds.

Frequent application of organic and inorganic fertilizers, provision of supplementary feed and fish species ratios make the maintenance of production population of natural food organism, and maximal utilization of primary productivity of the pond ecosystem. Carp culture system is efficient in utilyzing animal wastes such as cow, poultry, pig, duck, goat, and sheep excreta, biogas slurry and effluents from different kinds of food industries to enhance the production of natural food for carps and other cultured fish species in ponds. Besides, many organic wastes and by products such as agricultural by products, industrial by-products and wastes from animal husbandry have been utilized in the feed formulation of carp as an ingredient to minimize the cost of feed formulation (Seghal and Seghal, 2002). Biologically fertilization of fish rearing pond means stimulation of primary productivity (planktons) through autotrophic and heterotrophic pathways which are preferred food for smaller fish in general and bigger in specific (Enamul *et al*., 1999). The availability of appropriate food, i.e. planktons and suitable ecological parameters for particular fish in pond, are the basic requirements for obtaining a high fish yield (Mahboob and Sheri, 1997; Jha *et al*., 2004; Jasmine *et al*., 2011). The annual variations in water physical and chemical parameters effect on the distribution and density of plankton life in pond (Mahboob, 2010; Enamul *et al*., 1999; Ahmad *et al*., 2011). In Pakistan, still limited research work is conducted on pond fertilization with organic and inorganic fertilizers (Sheri *et al*.,1986; Ahmad *et al*., 2013; Jasmine *et al*., 2011; Mahboob, 1992; Hassan and Javed, 1999; Abbas *et al*., 2008; Mahboob, 2014).

When animal manures are applied in ponds,to boost fish production by increasing plankton growth through releasing nitrogen and phosphorus in water, or by providing an organic carbon through heterotrophic cycle. The fish may feed directly on the planktonic algae, detrital / fungal flies, zooplankton and snails which feed on algae and detritus (Colman and Edwards, 1987). This necessitates the recycling of organic manures to enhance production of fish because cattle dung and poultry droppings are available in the country almost without any cost . Therefore, integrated fish farming can be termed as a model for recycling of animal wastes, maximum utilization of various farm products, saving energy and maintaining ecological balance. The present study was conducted to asses the effects of buffalo manure application on pond's primary productivity, fish growth and annual yield of some warm water carps (*Catla catla, Labeo rohita* and *Cirrhinus mrigal*) in polyculture practices.

MATERIALS AND METHODS

Four newly dug earthen fish ponds of dimensions 15m X 8m X 2.5m (length X width X depth) were used for this investigation. All the ponds were sun-dried and liming was done with CaO at the rate of 2.40 kg/pond with the dusting method (Mahboob, 1992). All the ponds were filled with a un-chlorinated tube well water up to the level of 2.0 m and this level was maintained. A total of 82 four months old fingerlings of, *Catla, catla* (weight 2.87±0.08 g; fork length 53.23±0.05mm), *Labeo rohita* (weight 1.91±0.05 g; fork length 50.84±0.08 mm) and *Cirrhinus mrigala* (weight 1.68±0.02 g; fork length 51.68±0.06 mm*)* were stocked / pond with a stocking density of 2.87 m^3/fish (Javed, 1988). The interspecies ratios for *Catla catla, Labeo rohita* and *Cirrhinus mrigala* were, 40:30:30, respectively. The percentage of N, P and K contents of buffalo manure were determined by following the methods described in AOAC (1984). Fertilization was done with sun-dried buffalo manure (with 1.02 ±0.05 % nitrogen; 0.96 ± 0.02 % phosphorus; 0.92± 0.04 % potassium) added based on their nitrogen contents at the rate of 0.15 g nitrogen / 100 g of fish weight / day for one year. However, the control pond remained without any manure (Table 2).

Growth Studies: The experimental fish was randomly sampled, with three repeats on every 16th day (designated as fortnight) with the help of a nylon drag net from each of the ponds during the trial period. The fish body weight, fork length and total length were measured and recorded to monitor growth and released back into their respective ponds. The sample size for each fish species was 9 to check an increment in body weight and body length (Mahboob, 1992).

Statistical analysis: The data was statistically analyzed by using Minitab software. The differences among treatments were worked out using two way ANOVA. The differences were tested by the DMR test.

Table 1. Initial morphometric Characteristics of *Catla catla, Labeo rohita* and *Cirrhinus mrigala* in control and treated pond.

Fish Species	Average weight (g) ± S.E	Average fork length (mm) ± S.E	Average total length (mm) ± S.E
Catla catla	2.97±0.10	53.23±0.05	59.31±0.09
Labeo rohita	1.94±0.07	50.84±0.08	57.62±0.07
Cirrhinus mrigala	1.72±0.04	51.68±0.06	61.22±0.06

Table 2. N: P: K Contents of the Experimental Ponds

pH	7.95 ± 0.05
Available potassium (ppm)	41.07 ± 7.99
Available nitrogen (%)	0.015 ± 0.04
Available phosphorus (ppm)	2.10 ± 0.49

RESULTS

The initial average body weights of *Catla catla*, *Labeo rohita* and *Cirrhinus mrigala* were 2.97 ± 0.10, 1.94 ± 0.07 and 1.72 ± 0.04, respectively (Table 1). The final an average weight of *Catla catla*, *Labeo rohita* and *Cirrhinus mrigala* in the treated and control pond were recorded as 590.24 ± 1.94, 511.34 ± 2.62 and 391.94 ± 2.12 and 162.19 ± 1.72, 160.08 ± 2.01 and 156.84 g's ± 1.66, respectively (Table 3). A steady increase in weight was observed from the beginning of the experiment till the end of the study. Data on fork lengths and total lengths and net fish yields, from treated and control ponds, are presented in Table 3. The input of buffalo manure tremendously increased the growth of all the three fish species. The interactions (treatment X species) for morphometric characteristics were also highly significant. The buffalo manure used in the present experiment had an average nitrogen content of 1.02 percent. The higher growth of three fish species in a treated pond was probably the result of higher primary productivity (86.14 g/m^3) compared to controls (Table 4). The maximum nitrogen incorporation efficiency of fish with this treatment was recorded during the 5th fortnight as 0.0688 when the total fish weight of 3376.88 g was gained by using 112.5 g nitrogen in the form of buffalo manure fertilizer, while the minimum NIE ratio (1.73) was recorded during the 24th fortnight. A quantity of 1160.89 kg sun-dried cow-dung was added (which contained 1718 g nitrogen) to get 140.13 kg of fish with an overall NIE of 12.26%. An increase in fish yield, plankton biomass, phytoplankton and zooplankton densities were significantly better in the treated pond compared to control the pond (Table 4). In treated and control ponds the increase in fish production was positive and significantly correlated with water temperature and existing dry weight of plankton biomass. The planktonic biomass were also found positively correlated with water temperature (Table 5).

Table 3. Final average weights (g), fork lengths (mm) and total lengths (mm) of *Catla catla, Labeo rohita* and *Cirrhinus mrigala* in control and treated ponds.

Fish Species	Weight (g)		Fork length (mm)		Total length (mm)	
	Treated	Control	Treated	Control	Treated	Control
Catla catla	590.24±1.94	162.19±1.92	296.17±1.04	200.27±1.13	356.14±1.02	241.82±0.74
Labeo rohita	511.34±2.62	160.08±2.01	285.51±1.13	199.50±1.26	335.60±1.32	235.27±1.59
Cirrhinus mrigala	391.94±2.12	156.84±1.66	308.16±2.34	208.32±1.08	342.60±2.34	238.09±2.18

Values are the means. ± S.E of three replicates; Treatment means with the same letter in a single column are statistically similar at the 5 % level of significance.

Table 4. Treatment values for increase in fish yield, planktonic biomass conversion efficiency, plankton productivity and net fish yield.

	Increase in fish yield (g/m^3)	Planktonic biomass (g/m^3)	Biomass conversion efficiency (%)	Phytoplanktonic Ind./5ml water	Zooplankton Ind./5ml Water	Phytoplankton / Zooplankton ratio	Net yields kg ha^{-1}
Treated	841a	86.41a	15.25b	69.21a	46.61a	1.90b	2488.51a
Control	3.07b	14.64b	224.40a	18.90b	11.02b	2.20a	790.65b

Treatment means with the same letters in a single column are statistically similar at the 5 %

Table 5. Correlation coefficients among different parameters under study

Variable	Treated Pond		Control Pond	
	Water temperature	Planktonic biomass	Water temperature	Planktonic biomass
Increase in fish yield	0.860	0.790	0.690	0.610
Dry weight of Planktonic biomass	0.7.52		0.387	
Nitrogen incorporation Efficiency (NIE)	0.877	0.480	0.455	0.589
Critical value (J-tail, 0.05) = + or -0.334				

DISCUSSION

The increasing demand for required protein production can be satisfied through increasing fish culture by utilizing a large network of natural and man made reservoirs like ponds, tanks and cages etc. as well as by increasing production per unit area. The extensive fish cultures is dependent upon the natural or inherit pond productivity, while the semi-intensive fish culture system makes more optimum use of various inputs such as manures, fertilizers and supplementary feed. In freshwater fish ponds, total primary fish production, mainly depend upon the availability of nutrients, nutrient recycling and primary nutrients in the form of organic and inorganic fertilization (Mahboob, 1992). The increase in the growth of the fish in the application of manure has been reported by Hassan and Javed (1999) and Mahboob (1992). Jha *et al*. (2004) reported cow-dung efficiently enhanced the production of plankton. In this investigation the maximum weight was gained by *Catla catla* compared to *Labeo rohita* and *Cirrhinus mrigala* in control and treated pond (Table 3). The fork and total length increase in *Catla catla* was also significantly better than other two fish species, thereby indicating that this species of fish responded better to buffalo manure than the other two species. Javed *et al*. (1989) reported better growth performance after an application of cow-dung which is contradictory to the present results. This could be due to the difference in the nitrogen content of the two organic manures.

The higher growth of fish may be due to better utilization of phytoplankton and zooplankton life which were with the mean annual densities of 69.21 and 46.61 individuals per 5 ml of water, respectively, in the buffalo manure treated pond, and conversion efficiency associated with the existing planktonic biota as exhibited in Table 5. These findings suggest that organic manure promoted the synthesis of phytoplankton biota in particular, which stimulated the growth increment of these fish species in optimum water temperature (24.85 to 31.16 °C). These findings support earlier investigations (Green *et al*. 1989; Knud-Hansena *et al*. 1991; Shailender *et al*., 2013) which concluded that organic manures can increase fish production by providing inorganic phosphorus, nitrogen and carbon (through respiration) for phytoplankton growth, and organic carbon in detritus production and heterotrophic utilization (Ahmad *et al*., 2013).

The overall NIE, with the influence of buffalo manure was worked out as 0.2849. The results of this study substantiate the earlier reports for nitrogen level of significance incorporation efficiency of fish (NIE), being the variable, determined the growth rate of fish at an annual average water temperature of 21.94 ^{0}C as reported by Nayak and MandaI (1990). Our results were in line with the findings of Shailender *et al*. (2013). They reported the overall maximum value of nitrogen incorporation efficiency (NIE) in organic manure treated pond as 1: 5. Javed *et al*. (1990) reported 12.20% incorporation of nitrogen from the cow-dung into fish.

The increase in phytoplankton leads to high primary productivity which leads to increased zooplankton abundance (Knud-hansen *et al*., 1991). It revealed the dependence of fish yield on plankton productivity, and both planktonic productivity and fish yield, in turn, were dependent on water temperature (Mahboob, 1992). Incorporation of nitrogen from buffalo manure into the fish was found correlated with water temperature and plankton biomass in both the ponds. The present results confirm that this organic manure may serve as a direct source of food for the fish food organisms, or they may get decomposed for the release of inorganic nutrients (Boyd, 1981) that stimulated planktonic growth as evident from the relative abundance of zooplankton (46.61 g/m^3 of water) with a pond treated with buffalo manure (Table 3). At the end of 12 months trial period, the ponds were harvested for a final net fish yield. Net fish yields of all the three fish species, together from treated and control ponds were 421.35 and 135.75 kg/ pond, respectively. These results could be compared with the findings of Shailender *et al*. (2013; Mahboob and Al-Ghanim, 2014).

Conclusion: It has been concluded that buffalo manure can be used as a source to enhance planktonic productivity in fish ponds safely. In the absence of any harmful effects of ammonia on survival of the fish the fish yields can be quite easily enhanced by application of the buffalo manure at low or no cost. It has been concluded the application of buffalo manure can enhance a fish production upto minimum three folds compared to the control ponds.

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