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Response of Different Levels of Nitrogen from Broiler Droppings Towards Planktonic Biota of Major Carps Rearing Ponds

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Abstract: Response of five levels of nitrogen, viz. 0.10, 0.13, 0.16, 0.19 and 0.22 g N/100 g fish daily, from broiler droppings towards planktonic productivity of major carps rearing ponds. Six genera of Chlorophyceae, viz. Chlamydomonas, Closterium, Microspora, ❑edogonium, Pandorina, Spirogyra; two genera of Chrysophyceae including *Botryococcus, Synura;* and three genera of Bacillariophyceae *(Cyclotella, Cymbella* and *Navicula)* were recorded during different months in six treatments. As regards Dinophyceae and Euglenophyceae, the genera observed were *Peridinium* and *Euglena* respectively. Myxophyceae included the genera *Anabaena, Microcystis* and *Oscillatoria.* Zooplankton represented by ciliates (Protozoans) and 10 other genera in all treatments except under 0.16 g level of nitrogen. However, the increase beyond 0.16 g nitrogen level showed gradual decrease in zooplankton productivity upto 0.22 g nitrogen level. The correlation coefficients between phytoplankton and zooplankton productivities, under all the treatments, were positive and significant.

Key words: Broiler droppings, correlation, major carps, phytoplankton, zooplankton

Introduction

The growth of phytoplankton and aquatic macrophytes is the most critical aspect of fish production in pond culture. The phytoplankton growth and its ecological factors in fish ponds have concerned fish farmers the world over. Many Chinese carp farmers judge the water quality of fish ponds by their colour and the degree of greenness reflects the abundance of phytoplankton (Lin, 1970). Plankton algae are food for fish as well as for zooplankton which, in turn, is food for major carps also (Hassan and Javed, 1999; Javed *et al*., 1996). Unfortunately such expertise seldom provides precise information on species combination and related water quality parameters influencing the fish growth under semi-intensive polyculture system in which excretory products are recycled.

The pathways of organic material entering the pond food web have been outlined by Tang (1970): (1) the material enters as a source of nutritive substance (e.g., carbon, phosphorus) for photosynthesis in chlorophyll-bearing plants, (2) serves *as* an organic substrate for microorganisms which, in turn, support the zooplankton population, or (3) it may be directly consumed by the fish, crustaceans, or insects. Zooplankton are also the rich source of proteins and fats (Siefken and Armitage, 1968). Tang (1970) fish polyculture experiments indicated. Only half of the total fish growth was attributed to the consumption of natural food organisms like plankton or insects while the other half came from the direct consumption of organic materials like night soil. The manures which have been analyzed for most of their efficiencies in producing useful foods for fish are liquid cow manure, poultry manure, mustard oil cake, liquid swine manure and human wastes (Moll, 1986). Various studies (Gosh, 1983; Behrends *et al*., 1980; Javed and Sheri, 1998) have reported successful results with different manures as nutrient additives in fish farming system. Many authors (Sharma and Olah, 1986; Tripathi and Mishra, 1986; Sharma, 1990; Javed *et al.,* 1990) have suggested that the concept of unitary culture of either fish, crop or animal husbandry has gradually been changed to the integrated culture system with the view of producing fish, meat, egg, milk, vegetables and other allied products within a farm itself on an economic scale. The basic necessity of such integration is not only to make the farm an independent unit but also to fulfil the demands as input to other structural units (Rath, 1989a, b; Sharma and Das, 1988).

Materials and Methods

Factorial experiment, with two replications for each of the treatments, was conducted under ambient condition using earthen ponds. After preliminary preparations (Javed, 1988), all the ponds were initially fertilized, separately, with 40 kg broiler droppings (3333.33 kg ha^{-1}) as a starter dose to stimulate primary productivity. Fingerling major carps, 6-7 months old (induced bred, procured from Fish Seeds Hatchery, Faisalabad), average weight 21.32 ± 1.99 g, were randomly stocked, from a selected population, in each of the ponds with stocking density of 25, 60 and 15% for *Catla catla, Labeo rohita* and *Cirrhina mrigala* respectively (64 fish in each of the ponds). Fertilization of ponds with broiler droppings (4.37 % nitrogen) was started on the basis of nitrogen contents. Five levels, viz. 0.10, 0.13, 0.16, 0.19 and 0.22 g nitrogen per 100 g of wet fish weight daily, were used as nitrogen treatments. However, sixth treatment served as control (without additives). For the quantitative and qualitative study of plankton, from each of the five sub-stations at each pond, two samples were collected both from the surface and from the bottom. The method of microscopic examination as described in APHA (1975) was employed following the sand filtration procedure for the enumeration of phytoplankton (Boyd, 1981). Zooplankton, insect larvae and other animals were studied by taking 10 liters of each pond water from surface, column and bottom at each sub-station. These were pooled and filtered through a plankton net fitted with a glass bottle of 400 ml capacity (mesh size 56 µ). The retenate containing different animals was preserved in

Longyi acid and stored in refrigerator. A 5 ml portion of the above sample was taken for the quantitative and qualitative study of zooplankton. The organisms were identified under the microscope upto generic level. The identification of fauna and flora was made by using the books (literature) of Ward and Whipple (1959), Desikachary (1959), Hegner and Engemann (1968) and Marshall and Williams (1972). Data were analyzed for ANOVA and DMR tests. Correlation and regression analyses were also performed to find out relationships/trends among various parameters under study.

Results

Table 1 shows the mean phytoplankton densities in ponds fertilized with broiler droppings at five nitrogen levels and

Table 1: Mean (±SD) phytoplankton productivities (Nos./5 ml of water/month) in fish ponds

Phytoplankton	0.10 g N level	0.13 g N level	0.16 g N level	0.19 g N level	0.22 g N level	Control (without additives)
a. Chlorophyceae						
Chiamydomonas	41.25±47.26a	24.17±29.16c	44.83±52.07 a	12.50±13.31d	31.92±33.46b	1.75±1.48e
Closterium	22.42 1 25.31d	54.75±60.82c	72.33±86.92b	90.17±98.60a	81.50±104.31ab	1.75±1.21e
Microspora	46.25±55.06a	-	20.42±25.34b	22.25±22.60b	9.17±11.08c	-
Oedogonium	-	-	-	-	24.17±39.00a	-
Pandorina	41.58±47.75b	67.50±74.50a	43.50±43.91b	-	55.08±62.45b	2.17±2.12c
Spirogyra	6.83±7.67a	-	11.08±13.03a	67.92±92.20a	-	-
b. Chryspohyceae						
Botryococcus	2.42±3.34c	11.67±14.99a	1.50±3.34c	7.42±12.80b	13.58±13.93a	2.08±1.78c
Synura	25.25±31.46d	35.50±33.77c	40.67±40.76b	49.33±51.19a	41.17±45.78b	1.17±0.83e
c. Bacillariophyceae						
Cyclotella	8.67±15.86c	12.25±15.37b	9.50±7.32c	17.50±15.49a	18.92±18.4a	1.58±1.38d
Cymbella	-	-	-	14.08±16.77a	-	-
Na vicula	31.25±33.96	38.08±39.57b	46.67±55.74a	44.25±41.77a	35.50±41.16b	4.00±3.13d
d. Dinophyceae *Peridinium*	2.75±4.24d	6.42±5.77b	9.67±8.63a	6.25±6.19b	4.75±4.94c	2.58±1.78d
e. Euglenophyceae *Euglena*	3.67±3.89b	3.08±2.35b	3.17±4.34b	5.33±5.38a	5.17±5.62a	1.75±0.62c
f. Myxophyceae						
Anabaena	10.58±10.61c	10.58±9.99c	12.92±13.08b	13.50±13.21a	11.42±12.63bc	1.92k±0.90d
Microcystis	0.67±0.65c	1.83±2.04b	1.08±0.97b	15.67±19.11a	-	1.83±0.72b
Nostoc	-	-	-	-	1.17±1.19a	-
Oscillatoria	0.75±0.87c	0.83±0.83c	0.67±0.78c	3.50±3.42a	2.50±2.75b	-
Un-identified	1.33±0.89	1.08±1.24	0.83±0.83	1.92±1.38	1.42±0.79	0.17±0.39

Means with similar letters in a single row are statistically similar at P<0.05.

Table 2: Mean (±SD) zooplankton productivities (Nos./5 ml of water/month) in fish ponds

Phytoplankton	0.10 g N level	0.13 g N level	0.16 g N level	0.19 g N level	0.22 g N level	Control (without additives)
a. Protozoans						
Ciliates	11.83±11.46c	19.00±17.10a	17.67±12.74b	18.50±18.92a	19.25±14.89a	2.08±1.00d
b. Rotifers						
Asplanchna	8.25±6.78b	5.58±6.02c	10.00±8.57a	11.75±19.60a	8.25±6.59b	1.33±0.78d
Branchionus	4.00±3.33c	6.58±6.85a	7.00±7.08a	5.33±4.58b	5.25±5.63b	1.00±0.95d
Keratella	2.88±1.58b	1.67±1.61c	8.67±7.34a	2.50±1.78b	3.92±4.12b	1.25±1.36c
Mytiline	1.00±1.21b	0.83±0.83b	1.17±1.75ab	2.00±1.76a	0.83±1.40b	1.08±0.90b
Polyarthra	-	-	3.92±4.52a	-	-	-
c. Crustaceans						
Bosmina	1.83±1.58ab	1.75±1.71ab	1.67±1.72b	1.83±1.95ab	2.33±1.23a	0.92±1.08c
Canthocampyus	1.58±1.68b	1.83±1.53b	4.25±4.59a	2.00±1.81b	1.75±1.54b	0.42±0.51c
Cyclops	1.83±1.70b	2.75±2.49a	2.42±2.15a	2.08±1.44ab	2.92±2.27a	1.00±0.95c
Cypretta	-	-	2.33±2.15a	-	-	-
Daphnia	1.00±1.04b	1.50±1.44ab	2.00±2.42a	1.50±1.98ab	1.17±1.27b	0.50±0.67c
Diaptommus	1.58±1.00a	1.08±1.50ab	0.75±1.05	0.92±0.99ab	1.50±1.17a	0.25±0.45c
Moina	1.08±0.79b	1.17±1.11ab	1.42±1.24a	1.33±1.43a	0.92±0.79bc	0.67±0.78c
Un-identified	0.50±0.52	1.00±0.74	0.52±0.67	0.42±0.51	0.25±0.45	0.08±0.29
d. Insects						
Chironomus larvae	1.17±0.94a	1.33±1.07a	1.50±1.38a	1.08±0.79ab	0.83±0.83b	0.42±0.51b
Culex larvae	1.00±1.04ab	1.08±0.90ab	0.75±0.75b	1.33±1.37a	1.08±0.99ab	0.58±0.79b
Dragon Fly nymphs	0.92±0.79a	0.83±0.58ab	1.17±1.03a	1.00±0.95a	0.83±0.58ab	0.67±0.49b
May Fly nymphs	0.92±0.67ab	1.17±0.94a	-	0.83±0.83ab	0.83±0 58ab	0.58±0.79b
e. Vertebrates						
Tadpole of ford	0.58±0.79a	0.50±0.80a	0.25±0.45b	0.58±0.79a	0.33±0.49bc	0.17±0.39c

Means with similar letters in a single row are statistically similar at P<0.05.

Table 3: Mean planktonic productivities of ponds under different levels of nitrogen

Treatments	Phytoplankton x (Nos.15 ml of water)	Zooplankton y (Nos.15 ml of water)	Regression Equation	Correlation Coefficient (r)	Standard Error (SE)	Probability
0.109 N level	245.67 b	37.25 b	Y = 19.31 +0.073(x)	0.811	0.017	P<0.01
0.13g N level	270.75 ab	44.58 b	Y =14.99+0.109(x)	0.809	0.025	P<0.01
0.16g N)eve	318.75 ab	63.83 a	Y=21.96+0.131(x)	0.852	0.025	P<0.01
0.199 N level	371.58 a	50.17 ab	Y=12.91 + 0.100(x)	0.849	0.020	P<0.01
0.22g N level	337.42 ab	48.25 b	Y= 14.90 + 0.099(x)	0.895	0.016	P<0.01
Control (without additives)	22.75 c	10.42 c	Y=-2.84+0.583(x)	0.715	0.180	P<0.01

Column means with similar letters are statistically similar at P<0.05: N = Nitrogen; x = Independent variability; Y = Dependent variable; Nos = Numbers.

Table 4: Regression of increase in fish yield on phytoplankton and zooplankton productivities

Treatments	Phytoplankton x (Nos.15 ml of water)	Increase in fish yield Y (g/m')	Regression Equation	Correlation Coefficient (r)	Standard Error (SE)	Probability
0.10g N level	245.67	16.86	Y = 3.97 + 0.052 lx)	0.912	0.007	P<0.01
0.13g N level	270.75	18.41	4.73 + 0.051 (x)	0.809	0.012	P<0.01
0.16g N leve	318.75	20.10	Y = 3.86 + 0.051 (x)	0.916	0.007	P<0.01
0.19g N level	371.58	19.98	Y - 7.11 + 0.035 (x)	0.694	0.011	P<0.01
0.22g N level	337.42	13.66	Y = 3.14 + 0.031 (x)	0.762	0.008	P<0.01
Control	22.75	2.86	Y =-0.11+ 0.130 (x)	0.608	0.054	P<0.05
Treatments	**ZOOLPLANKTON (Nos.15 ml of water)**	**Increase in fish yield Y (g/m')**	**Regression Equation**	**Correlation Coefficient (r)**	**Standard Error (SE)**	**Probability**
0.109 N level	37.25	16.86	Y -0.55 + 0.467 (x)	0.732	0.138	P<0.01
0.139 N level	44.58	18.41	Y = 4.31+ 0.316 (x)	0.685	0.106	P<0.01
0.16g N leve	63.83	20.10	Y = 0.69 + 0.304 (x)	0.842	0.062	P<0.01
0.19g N level	50.17	19.98	Y = 2.12 + 0.356 (x)	0.843	0.072	P< 0 .01
0.22g N level	48.25	13.66	Y - 2.58 + 0.230 (x)	0.619	0.092	P<0.05
Control	10.42	2.86	Y = 0.61+ 0.217 (x)	0.823	0.047	P<0.01

x = Independent variable; Y = Dependent variable; Nos = Numbers: N = Nitrogen

control (without additives). Six genera of Chlorophyceae, *viz. Chlamydomonas, Closterium, Microspora, Oedogonium, Pandorina, Spirogyra;* two genera of Chrysophyceae including *Botryococcus, Synura;* and three genera of Bacillariophyceae *(Cyclotella, Cymbella* and *Navicula)* were recorded during different months in six treatments. As regards Dinophyceae and Euglenophyceae, the genera observed were *Peridinium* and *Euglena* respectively. Myxophyceae included the genera *Anabaena, Microcystis* and *Oscillatoria.*

Among phytoplankton *Chlamydomonas, Microspora,* and *Spirogyra* showed significantly maximum mean densities under 0.10 g N level while under 0.13g N level *Pandorina* and *Botryococcus* showed significantly maximum mean densities than rest of the treatments. Four genera viz. *Chlamydomonas, Spirogyra, Navicula* and *Peridinium* showed significantly higher densities in pond water under 0.16 g N level. However, 0.19 g N level promoted significantly higher densities of genera *Pandorina, Synura, Cyclotella, Cymbella, Navicula, Euglena, Anabaena, Microcystis* and *Oscillatoria.* However the densities of *Pandorina* under 0.13 and 0.19 g N levels were statistically non-significant. Navicula densities under 0.16 and 0.19g N levels were statistically non-significant also. Under 0.22 g N level the densities of *Closterium, Oedogonium, Botryococcus, Cyclotella, Euglena* and *Nostoc* were statistically higher than rest of the treatments. However, *Closrerium, Cyclotella* and *Euglena* showed non-significant differences between 0.19 and 0.22 g N levels. The control treatment exhibited significantly lower densities of phytoplankton than all the five treatment levels (Table 1). Table 2 shows the mean of zooplankton densities in ponds. Zooplankton represented by ciliates (Protozoans) and 10 other genera in all treatments except under 0.16 g N level 112 genera). The genera belonged to Phyla, viz. Rotifera and Arthropoda (crustaceans), were the inhabitants of different treatments. Zooplankton viz. *Bosmina* and *Diaptomus* showed significantly higher densities under 0.10 g N level than rest of the treatments. Under 0.13 g N level Ciliates, *Branchionus, Bosmina, Cyclops, Daphnia, Diaptomus* and *Moine* showed significantly high distribution. 0.16 g N level promoted significantly high densities of *Asplanchna, Branchionus, Keratella, Mytilina, Polyarthra, Cantliocamptus, Cyclops, Cypretta, Daphnia and Moine.* Ciliates and genera *Asplanchna, Mytilina, Bosmina, Cyclops, Daphnia, Diaptomus* and *Moines* showed significant distribution under 0.19 g N level. However, 0.22 g N level provided suitable environment for the significantly high occurrence of Ciliates, *Bosmina, Cyclops* and *Diaptomus.* The response of control treatment towards Zooplankton productivity was significantly lower than the five treatments. Insect larvae, nymphs and tadpoles of frog showed significantly variable occurrence.. under different treatments also (Table 2).

Mean annual phytoplankton productivity under 0.19 g leve of nitrogen was the highest followed by the productivities under 0.22, 0.16 and 0.13 g levels of nitrogen with statistically non-significant differences. However, the same under control treatment was the lowest with the value of 22.75 individuals per 5 ml of water (Table 3). Zooplankton productivity was the best under 0.16 g level of nitrogen (63.83 individuals per 5 ml of water). However, the productivity under this level showed non-significant difference with 0.19 g level of nitrogen. Increasing the level of nitrogen showed significant increase in the zooplankton productivity upto 0.16 g level of nitrogen. However, the increase beyond 0.16 g nitrogen level showed gradual decrease in zooplankton productivity upto 0.22 g nitrogen level. The correlation coefficients between phytoplanktor and zooplankton productivities, under all the treatments were positive and significant (Table 3).

Table 4 shows the regression of increase in fish yield o the phytoplankton and zooplankton productivities of ponds under six treatments. Under all the treatments increase in fish yield had positive and highly significant regression on phytoplankton productivity except for control treatment ($p < 0.05$). Increase in fish yield also showed positive and highly significant regression on zooplankton productivities under all the treatments except for 0.22 g N level ($p < 0.05$).

Discussion

As regarded zooplankton productivity of ponds, both 0.16 and 0.19 g N levels responded equally well while the third best treatment for zooplankton productivity was 0.22 g N level (Table 3), however, control responded poorly for zooplankton growth. The correlation coefficients between phytoplankton and zooplankton densities were positive and significant for all the treatments (Table 3). Javed *et al.* (1995) reported direct correlation between phytoplankton and zooplankton productivities in major carps rearing ponds under broiler droppings, cow-dung and layer droppings fertilized ponds (added at the rate of 0.10g nitrogen/100 g of fish weight daily). Khan and Siddiqui (1976) reported direct correlation ($r = 0.98$) between chlorophyll-a content and phytoplankton. However, the correlation between zooplankton and phytoplankton was negatively significant. Several possible explanations may account for the prominent relationships between zooplankton and phytoplankton in a pond ecosystem because an actively grazing *Diaptomus* may reduce the standing crops of algae (Hazelwood and Parker, 1961), such an activity would produce a negative correlation between zooplankton and phytoplankton. This type of negative correlation could be observed as the grazing effect of zooplankton upon phytoplankton (Sladecek, 1958). But the positively significant correlation between phytoplankton and zooplankton, as observed during this investigation, was due to the responses of different treatments for successive production of phytoplankton which were significantly more than were used either by the fish or zooplankton. Thus, the specific phytoplankton and zooplankton productivity indices of fish ponds may depict the responses of different treatments towards fish yield increments in an integrated semi-intensive major carps polycultrure systems.

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