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Planktonic Biomass Conversion Efficiency of Major Carps Integrated Farming Systems

Muhammad Hassan and Muhammad Javed*
Department of Zoology, Government College, Faisalabad
*Fisheries Research Farms, Department of Zoology and Fisheries,
University of Agriculture, Faisalabad-38040, Pakistan

bstract

he response of different levels of nitrogen from broiler droppings towards planktonic productivity and fish yield increments as been studied. There existed significant differences among six treatments, i.e. 0.10, 0.13, 0.16, 0.19, 0.22 g N/100 fish levels and control (without additive) for both increase in fish yield and planktonic productivity of ponds. However, e treatment responses towards planktonic biomass conversion efficiency of ponds were statistically non-significant. lanktonic productivity of ponds under all the five fertilization regimes had positively significant regression on fish yield crements. Nitrogen conversion ratio in ponds had positively significant correlation with planktonic biomass conversion fficiency. Increase in fish yield, planktonic productivity and nitrogen conversion ratio showed positively significant gression on water temperature.

ntroduction

sh farming has, without doubt, a promising future in akistan as water, land, animal wastes and by-products of griculture are available for utilization in commercial fish roduction. By monitoring various conditions of fish rming, under polyculture system, it may become possible expand the yield many folds with a consequent increase the availability of good quality and low cost proteins.

ond fertilization is one of the key factors in increasing the aximum carrying capacity of fish ponds (Javed, 1988). armers adopted the method of pond manuring to rear fish, ges ago. In nursery and fish rearing ponds, fertilization is imed at development of natural food and saving artificial eeds. Javed (1988) has described a positive relation in utrient dynamics and fertilizer application in pond quaculture management. In Pakistan, increasing attention as been paid towards recycling of various agricultural and nimal wastes through aquaculture production process for nhancing fish yield (Javed *et al.*, 1990; Javed and Sial, 991 and Javed *et al.*, 1992). The major objective of tilizing wastes in fish farming system is to recycle different utrient elements present in such wastes. Proper pond anagement ensuring continued maintenance and building p fertility of an ecosystem is indispensable for greater fish roductivity. This necessitates the importance of recycling rganic wastes like poultry and livestock manures for nhancing the productivity of fish pond ecosystem. herefore, integrated fish farming can be called model of ecycling wastes, comprehensive utilization of various farm roducts, saving energy, fully exploitation of the natural esources and finally maintaining the ecological balance.

laterials and Methods

actorial experiment, with two replications for each of the reatments, was conducted under ambient condition using earthen ponds. All the ponds used in this experiment were approximately two meters deep and were supplied with unchlorinated tube-well water. Water levels in the ponds were maintained at 1.50 m by periodic additions to replace losses due to evaporation. After preliminary preparations (Javed, 1988), all the ponds were initially fertilized, separately, with 40 Kg broiler droppings (3333.33 kg/ha) as started dose to stimulate primary productivity. Fingerling major carps, 6-7 months old, (induced bred, procured from Fish Seed Hatchery, Faisalabad) of following weights, fork and total lengths (± S.D.) were randomly stocked, from a selected population, in each of the ponds with stocking density of 25, 60 and 15 percent for *Catla catla, Labeo rohita* and *Cirrhina mrigala* respectively (64 fish in each of the ponds).

Broiler droppings (pure pellets) were procured from the sheds of cage-broiler birds, Department of Poultry, University of Agriculture, Faisalabad (Pakistan). Fertilizations of ponds were done by using dusting method (Javed, and Sial, 1991) between 08 and 10 hours daily, for one year. Amounts of broiler droppings, to be added in ponds, were determined on the basis of wet fish weights obtained for each treatmental fish at the start and every 30-day interval as mentioned above. However, the fertilization rates were reduced to half during the last 4 months (i.e. from October to January; Javed, 1988).

The dry weights of the planktonic biomass were measured indirectly from the values of total solids and total dissolved solids on fortnightly basis determined through evaporation method by the formula:

Dry weight of planktonic biomass = Total solids - Total dissolved solids

Total solids were estimated by the evaporation method. The pond water sample of 1000 ml was taken in a pre-weighed beaker and evaporated in an oven at 103°C. After evaporation the beaker was weighed again and the total

Fish species	TREATMENT 0.10 g N lever	0.13 g N level	0.16 g N lever (± S.D)	0.19 g N lever	0.22 g N lever	Control (Without additives)
Wet weights (g)						
Catla catla	23.61 ± 1.04	24.42 ± 1.33	23.18 ± 1.40	23.06 ± 1.66	24.20 ± 1.70	23.05 ± 1.32
Labeo rohita	21.84 ± 1.25	21.14 ± 1.05	20.71 ± 1.25	22.02 ± 1.03	20.74 ± 0.95	21.79 ± 0.87
Cirrhina mrigala	22.12 ± 0.84	22.95 ± 0.53	21.17 ± 0.77	22.29 ± 0.85	22.62 ± 0.71	22.34 ± 0.95
Wet Fork Length (mm)						
Catla catla	96.12 ± 2.75	98.33 ± 2.98	94.34 ± 2.05	95.12 ± 2.01	96.80 ± 1.95	94.17 ± 2.13
Labeo rohita	104.00 ± 1.85	108.54 ± 1.90	103.65 ± 1.55	105.55 ± 1.82	103.98 ± 1.94	103.42 ± 1.88
Cirrhina mrigala	105.28 ± 1.44	108.62 ± 1.53	105.75 ± 1.62	107.50 ± 1.80	104.22 ± 1.35	101.05 ± 1.22
Wet Total Length (mm)						
Catla catla	122.43 ± 1.55	129.20 ± 1.72	128.00 ± 1.47	121.58 ± 1.35	127.98 ± 1.83	125.66 ± 1.72
Labeo rohita	121.53 ± 1.38	120.95 ± 1.53	120.44 ± 1.66	120.18 ± 1.90	120.00 ± 1.37	120.21 ± 1.45
Cirrhina mrigala	124.00 ± 1.65	124.73 ± 1.94	123.20 ± 1.52	124.33 ± 1.50	124.57 ± 1.87	124.99 ± 2.01

Table 1: Nitrogen, phosphorus and potassium contents of bottom soil at the start of experiment.

Available nitrogen	%	0.039 ± 0.02
Available phosphorus	(ppm)	2.460 ± 0.45
Available potassium	(ppm)	35.250 ± 6.33
pH		7.850 ± 0.09

Fertilizations of ponds with broiler droppings (Table 1) were started on the basis of nitrogen contents of broiler droppings to each of the ponds, separately, as follows:

TREATMENT	NITROGEN LEVEL (FROM BROILER DROPPINGS)
T1	0.10 g nitrogen per 100 g of wet fish weight daily
T2	0.13 g nitrogen per 100 g of wet fish weight daily
T3	0.16 g nitrogen per 100 g of wet fish weight daily
T4	0.19 g nitrogen per 100 g of wet fish weight daily
T5	0.22 g nitrogen per 100 g of wet fish weight daily
T6	Control (without additives)

solids were calculated. Total dissolved solids were estimated by evaporation method. The pond water sample of 1000 ml was first filtered and then taken in a pre-weighed beaker and evaporated in an oven at 103°C. After evaporation, the beaker was weighed again for the determination of T.D.S. in a sample.

Data were analyzed for analysis of variance and Duncan's Multiple Range tests. Correlation and regression analyses were performed to find-out relationships/trends among various parameters under study.

Results

The author has made a hypothetical planktonic biomass conversion efficiency of ponds based on the fish weight gains upto the point when the standing biomass was determined. Since the standing planktonic biomass indicates the amount of planktonic life that existed at the end of a certain period after fish grazing. Thus, this standing planktonic biomass may become a point to indicate the growth achieved / to be achieved by the fish. So, it was suggested that the status of standing planktonic biomass in the ponds, treated with various nitrogen levels, from broiler droppings, may be taken as a bench mark which could be related to the weight gains of fish, despite the fact that amount of planktonic biomass consumed by the fish for growth at that particular point remained undetermined. Thus, the standing planktonic biomass serves as an index of biomass consumption by the fish as reported by Javed (1988). If standing biomass is less than the previous recording, the fish has consumed the biomass in the previous interval more rapidly than it was produced in the ponds. If continued, this would cause either greater reduction in planktonic biomass or reduced growth of the fish.

A level of nitrogen, i.e. 0.16 g nitrogen level (T3), gave significantly higher average fish yield increment of 20.10 g/m^3 followed by the increments of 19.98, 18.41 and 16.86 g/m^3 under 0.19, 0.13 and 0.10 g nitrogen levels respectively, with statistically non-significant differences (Table 2). The performances of T1, T2 and T5, towards increase in fish yield, were statistically at par. Control treatment (T6) gave significantly lower fish yield increment than rest of the treatments.

The performances of all the treatments towards the planktonic productivity values followed almost the same trend of increase and decrease with respect to increments in fish yields. T3 gave the best overall plankton productivity of 115.70 g/m^3 and this treatment differ non-significantly when compared with T2 and T4. T performed significantly poor than rest of the treatments. However, there were non-significant differences among the treatments for their response towards plankton biomass conversion efficiency. The trends in fish yie increments corresponded with the planktonic productiv indices under all the treatments. The planktonic biom conversion efficiency of 22.85 per cent was nonble 2 : Responses of treatments towards increase in fish yield, planktonic productivity and planktonic biomass conversion efficiency of ponds.

eatments	Inc. In fish yield (g/m^3)	Planktonic Biomass (g/m^3)	PBCE (%)
10 g nitrogen per 100 g of wet fish weight daily	16.86 ab	87.85 b	22.85a
13 g nitrogen per 100 g of wet fish weight daily	18.41 ab	108.50 ab	20.47 a
16 g nitrogen per 100 g of wet fish weight daily	20.10 a	115.70 a	19.51 a
19 g nitrogen per 100 g of wet fish weight daily	19.98 a	96.90 ab	21.85 a
22 g nitrogen per 100 g of wet fish weight daily	13.66 b	87.41 b	17.91 a
ontrol (without additives)	2.86 c	16.21 c	21.35 a
E	1.9619	9.5378	1.9493

eans with similar letters in a single column are statistically non-significant at $P < 0.01$.

gnificantly higher under T1 than rest of the treatments able 2)

crease in Fish Yield v/s Planktonic Biomass: Increase in h yield showed highly significant and positive regression the planktonic productivity of ponds in all the eatments. The positively significant regression coefficients r these equations show direct dependence of fish yield crements on the planktonic productivity of the ponds able 3).

trogen Conversion Ratio of Ponds v/s Planktonic Biomass onversion Efficiency: The regression models were mputed to find-out relationships between nitrogen nversion ratio and planktonic biomass conversion ficiency of ponds under six treatments. Positively gnificant regression of nitrogen conversion ratios on the anktonic biomass conversion efficiency in all the eatments were observed. The regression model computed nder T1 explains 68.06 per cent variations in nitrogen nversion ratio of fish due to planktonic biomass nversion efficiency while in T5 planktonic biomass nversion efficiency contributed 79.91 per cent towards trogen conversion ratio in fish (Table 3).

crease in Fish Yield v/s Water Temperature: Under all the x treatments, increase in fish yield was positively rrelated ($P < 0.01$) with water temperature. The high lues of r under all the treatments showed almost linear end between increase in fish yield and water temperature able 3).

anktonic Biomass v/s Water Temperature: The standing anktonic biomass (dry weight) in all the treatments was sitively and significantly ($P < 0.01$) correlated with the ater temperature. The coefficient of determination (R^2) lues computed for each of the regression models, under x treatments, explain the percentage variations in anktonic biomass due to water temperature.

itrogen Conversion Ratio v/s Water Temperature: The gression coefficients computed between nitrogen onversion ratio and water temperature under all the treatments were positively significant. The positive regression of nitrogen conversion ratio on water temperature showed the conversion of nitrogen from broiler droppings into fish yield was directly dependent on water temperature (Table 3).

Discussion

Increase in fish yield, under all the five fertilization treatments showed almost linear trend with concomitant increase in water temperature as the correlation coefficient between increase in fish yield and water temperature was positive and highly significant (Table 3). So, better response of treatments towards planktonic productivity of ponds enhanced the growth rate of major carps significantly (Javed *et al.*, 1995). Javed and Sial (1991) reported significantly better growth rates of major carps which correlated positively with the existing planktonic productivity in layer manure fertilized ponds. During this research endeavour the increase in fish yield under all the six treatments correlated positively (at $P < 0.01$) with water temperature and R^2 values for all the regression equations, computed for these relationships, ranged between 0.6972 (in T5) and 0.8649 (under T1). These high values of R^2 for the regression equations revealing more than 69.72 per cent variations in fish yield, under all the treatments, due to water temperature (Table 3). Soderberg (1990) reported highly significant and positive correlation ($r = 0.99$) between water temperature and growth rate of fish reared under intensive aquaculture. Javed and Sial (1991) observed highly significant correlation between water temperature and growth rates of *Catla catla, Labeo rohita* and *Cirrhina mrigala* in layer manure fertilized ponds. However, increase in fish yield was the maximum at water temperature range of 30.5 - 33.0 °C. Positively significant correlation between water temperature and fish yield was due to increased fish anabolic rate with the increase in water temperature (Delong *et al.*, 1958; Javed, *et al.*, 1993). Significantly positive correlation coefficients among increase in fish yield, planktonic biomass and water temperature (Table 3) indicated that within each treatment planktonic biomass increased the growth rate of fish significantly with the concomitant increase in water

Table 3: Regression models computed for various parameters under study.

Treatments (Nitrogen Levels)	Plank. Biomass (g/m^3) X	Inc. In fish yield (g/m^3) Y	Regression Equation	r	R^2	SE
0.10 g nitrogen per 100 g of wet fish weight daily	87.52	16.86	y = 0.70 + 0.84**x	0.8930	0.7974	0.029
0.13 g nitrogen per 100 g of wet fish weight daily	108.49	18.41	y = -0.53 + 0.175**x	0.9090	0.8263	0.025
0.16 g nitrogen per 100 g of wet fish weight daily	115.72	20.10	y = -1.19 + 0.184**x	0.9480	0.8987	0.019
0.19 g nitrogen per 100 g of wet fish weight daily	96.90	19.28	y = 0.37 + 0.202**x	0.9270	0.8593	0.028
0.22 g nitrogen per 100 g of wet fish weight daily	87.41	13.66	y = -0.80 + 0.165**x	0.8940	0.7992	0.028
Control (without additives)	16.21	2.86	y = 1.35 + 0.093*x	0.5980	0.3576	0.040

Treatment	PBCE (%)	NCR (1:I.F.Y)	Regression Equation ($\log^{-10}$ transformed data)	r	R^2	SE
0.10 g nitrogen per 100 g of wet fish weight daily	22.85	11.82	log y = -0.83 + 1.352**(log x)	0.8250	0.6806	0.29
0.13 g nitrogen per 100 g of wet fish weight daily	20.47	9.21	log y = -0.87 + 1.321**(logx)	0.7470	0.5580	0.37
0.16 g nitrogen per 100 g of wet fish weight daily	19.51	7.88	log y = 0.74 + 1.172*(logx)	0.5870	0.3446	0.51
0.19 g nitrogen per 100 g of wet fish weight daily	21.85	6.50	log y = -1.68 + 1.745*(logx)	0.5200	0.2704	0.90
0.22 g nitrogen per 100 g of wet fish weight daily	17.91	5.01	log y = -1.56 + 1.686**(logx)	0.8480	0.7191	0.33
Control (without additives)	21.35	2.86	Not applicable			

Treatment	Temp (°C)	I.F.Y (g/m^3)	Regression equation	r	R^2	SE
0.10 g nitrogen per 100 g of wet fish weight daily	20.39	16.86	y = -17.02 + 1.662(x)	0.9300	0.8649	0.20
0.13 g nitrogen per 100 g of wet fish weight daily	20.46	18.41	y = -16.03 + 1.683(x)	0.9200	0.8464	0.22
0.16 g nitrogen per 100 g of wet fish weight daily	20.84	20.10	y = -15.87 + 1.726(x)	0.8830	0.7797	0.29
0.19 g nitrogen per 100 g of wet fish weight daily	21.09	19.98	y = -15.40 + 1.678(x)	0.9060	0.8208	0.24
0.22 g nitrogen per 100 g of wet fish weight daily	21.49	13.66	y = -11.94 + 1.191(x)	0.8350	0.6972	0.24
Control (without additives)	20.34	2.86	y = -0.53 + 0.167(x)	0.9040	0.8172	0.02

Treatment	Temp (°C)	Plank. Biomass (g/m^3)	Regression equation	r	R^2	SE
0.10 g nitrogen per 100 g of wet fish weight daily	20.39	87.85	y = -44.69 + 6.501**(x)	0.7500	0.5625	1.81
0.13 g nitrogen per 100 g of wet fish weight daily	20.46	108.49	y = -48.08 + 7.651**(x)	0.8030	0.6448	1.79
0.16 g nitrogen per 100 g of wet fish weight daily	20.84	115.72	y = -66.48 + 8.741**(x)	0.8670	0.7517	1.58
0.19 g nitrogen per 100 g of wet fish weight daily	21.09	96.90	y = -59.42 + 7.412**(x)	0.8730	0.7621	1.30
0.22 g nitrogen per 100 g of wet fish weight daily	21.49	87.41	y = -63.62 + 7.028**(x)	0.9110	0.8299	1.00
Control (without additives)	20.34	16.21	y = -1.46 + 0.869**(x)	0.7370	0.5432	0.25

Treatment	Temp (°C)	NCR (1:I.F.Y)	Regression equation ($\log^{-10}$ transformed data)	r	R^2	SR
0.10 g nitrogen per 100 g of wet fish weight daily	20.39	11.82	log y = -1.16 + 1.626**(logx)	0.6640	0.4409	0.5
0.13 g nitrogen per 100 g of wet fish weight daily	20.46	9.21	log y = -1.58 + 1.830**(logx)	0.7000	0.4900	0.5
0.16 g nitrogen per 100 g of wet fish weight daily	20.84	7.88	log y = -1.65 + 1.831**(logx)	0.7340	0.5387	0.5
0.19 g nitrogen per 100 g of wet fish weight daily	21.09	6.50	log y = -1.50 + 1.654**(logx)	0.6920	0.4789	0.5
0.22 g nitrogen per 100 g of wet fish weight daily	21.49	5.01	log y = -1.37 + 1.393*(logx)	0.5860	0.3434	0.7
Control (without additives)	20.34		Not applicable			

x = Independent variable; y = Dependent variable; N = Nitrogen; Plank. = Planktonic; Inc. = Increase; SE = Stand error; * = Significant at $P < 0.05$ ** = Significant at $P < 0.01$; r = Correlation coefficient ; R^2 = Coefficient determination; PBCE = Planktonic biomass conversion efficiency; NCR = Nitrogen conversion ratio ; I.F.Y. = Increas fish yield; Temp. = Temperature.

temperature (Javed and Sial, 1991). Significantly low net fish yield increment (decreased planktonic biomass conversion efficiency and nitrogen conversion ratio of pond) under T5 (0.19 g N level), even under significantly higher mean water temperature than the other treatments could be attributed to water quality variables.

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