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EFFECT OF BROILER DROPPINGS ON INDIAN MAJOR CARPS: GROWTH PERFORMANCE AND NITROGEN INCORPORATION.

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ABSTRACT

The effect of poultry droppings on growth of Indian major carps fingerlings was studied. Treatment group 1 (T_1) received 0.10% N while 2 (T_2) 0.16% N containing manure. The control group did not receive any external input during the whole experimental period. Each treatment group including control had two replicates. Sixty four individuals were stocked in each pond at stocking ratio of *Catla catla* 25%, *Labeo rohita* 60% and *Cirrhinus mrigala* 15% and stocking density was 60 g m^{-3}. A random sample of 7 fishes was weighed and measured for initial weight assessment. Studies were continued for 12 months. At the end of experiment all the fish were harvested, weighed and measured. Significant growth increments were observed in fish reared in manured ponds but negligible growth in control ponds. More nitrogen was incorporated in fish raised on 0.10% N (T_1) group than 0.16% N(T_2) group. Hence 93% of growth increment can be attributed to nitrates in former and 84% to phosphates in the later group. Performance of the control group remained very poor during the whole study period in both the parameters tested. Therefore, it can be suggested that broiler droppings are appropriate manures to a certain level beyond which it might deteriorate the water quality (pH, dissolved oxygen, total alkalinity and hardness) inflicting a negative impact on fish growth.

Key words: Broiler droppings; Nitrogen; phosphorus; Indian major carps.

INTRODUCTION

Biologically fertilization of the rearing pond means stimulation of primary productivity (zoo and phytoplanktons) through autotrophic and heterotrophic pathways which are a preferred food for bigger fish in general and smaller in specific (Goldman, 1960; Klimezyk, 1964; Javed *et al*., 1989 and Javed *et al*., 1990; Jana *et al*., 2001; Kadri and Emmanuel, 2003). Like land crops, the fertility of water determines the productivity of a pond. Pond fertilization can double or triple fish production. Excessive fertilization can create noxious algal blooms and deteriorates water quality which induces stress to fish, retards growth and causes variety of diseases (Jha *et al*. 2007). In addition, the decomposition of dead algae during summer months can cause low oxygen levels, which may cause fish kills during extended period of cloudy weather.

Naturally fertile ponds do not need fertilization. Though fertilization increases productivity but it takes time and costs money and demands proper time of application. In pond fish culture, poultry manure, seems to be the most efficient way of adding nitrogen and other essential nutrients and in this connection broiler excreta is more abundant, nutrient rich and cost effective. The present work was planned to investigate the effect of broiler droppings on pond productivity, water quality and growth of *Catla catla*, *Labeo rohita* and *Cirrhinus mrigala* when applied at different nitrogen concentrations.

MTERIALS AND METHODS

Experimental Design: Earthen ponds (15m x 8m x 2m) located at the University of Agriculture Faisalabad, were used for these trials. There were two treatment groups varying in nitrogen concentration with two replications in each. The control group had no external input

Experimental Protocol and Setup: The ponds were disinfected with calcium oxide (CaO) @ 9.60 kg/pond (200 kg/ha) (Hora and Pillay, 1962). Both ponds were then filled with water up to 1.5m level which was maintained throughout the experimental period. Sixty four fish (2.87 fish m^{-3} or 60 g m^{-3}) (Javed, 1988) comprising of *Catla catla* (25%), *Labeo rohita* (60%) and *Cirrhinus mrigala* (15%), were then stocked in each pond. Prior to stocking, individual fish was weighed and measured. A day after stocking of fish broiler manure was added to treatment T_1 and treatment T_2 @ 0.10 and 0.16g nitrogen per 100 g of wet fish daily (Table 1) and then reduced to half during the last four months of growing period to avoid fish mortality due to water quality deterioration. Supplementary feed was not given because it might confound the effect of fowl excreta. On the termination of experiment, a sample of seven fish was taken out from each pond (14 fish per treatment) for weight and total length measurements. Weight was also monitored monthly in relation to plankton biomass fluctuations. The sample size was determined by the following statistical formula:

$$n = \frac{t^2 s^2}{d^2}$$

t^2= The value from the normal probability table against $\alpha = 0.05$

s^2= The variance among units in the population from previous experiment

d^2= Desired margin of error in the estimate (5%).

LIMNOLOGICAL STUDIES

A. Water quality parameters: Water samples were collected fortnightly by "Kammerer" from the surface, column and bottom of each pond at five different locations marked as A, B, C, D and E, to minimize the possibility of chance error. Water samples were filtered and stored in 1L clean stoppered glass bottles and rushed to the laboratory for analysis. Dissolved gases, temperature and pH were determined on the site daily from the surface, column and bottom of the pond. The light penetration was determined by Secchi disc while pH and electrical conductivity were determined with a pH meter (HI-8520 HANNA) and conductivity meter (MC-1 Mark V) respectively. Dissolved oxygen, carbon dioxide, total alkalinity and total hardness were determined by methods described in A.P.H.A. (1971). Determination of these parameters was not fixed but were checked when water quality seemed deteriorating. Alkalinity and hardness, however, were checked on fortnightly basis because their values do not fluctuate and normally remain stable.

B. Nutrient level estimation: Sodium and potassium was determined using flame photometer (PEPI) (Richards, 1954) and Phosphates were determined following the method described by Boyd (1981) and nitrates by Sims and Jackson (1971) as modified by Kowalenko and Lowe (1973).

C). Dry weight estimation of planktonic biomass: Total solids and total dissolved solids were estimated by oven drying at 103 ^{0}C and then converted to planktonic biomass (Javed, 1988).

Statistical Analysis: The growth data were subjected to statistical analysis through two-way classification considering one parameter at a time and comparing among treatment groups (Steel *et al*., 1996). Differences in growth, length, plankton productivity and water quality parameters were considered significant at $p<0.05$.

RESULTS AND DISCUSSION

Limnology (Water quality parameters): Sheri *et al*. (1986) in his studies reported the best growth of major carps at water temperature range of 26.00 to 29.00 ^{0}C. Dissolved oxygen contents of water did not fall below 5.21 ppm (mg/L) (normal requirement is 5 ppm). Electrical conductivity, CO_2 and phosphates increased from control to T_2 while alkalinity and hardness declined from control to T_2. Remaining parameters remained unchanged. However, decline in dissolved oxygen can be expected during night due to eutrophication and consumption oxygen by phytoplankton in the absence of light if excessive doses of organic manure are used (Chandra *et al*., 2005). Comparatively higher concentrations of dissolved oxygen in T_2 ponds during daylight and variations in other parameters can be conveniently attributed to increased planktonic biomass stimulated by additional nutrient inputs. These nutrients stimulate phytoplankton productivity by motivating other elements present in water. This decrease in various elements and compounds induces reduction in alkalinity and hardness values.

Fertilizer levels in both T_1 and T_2 generated the planktonic biomass at the cost of total alkalinity, total hardness and nitrates in T_1 and potassium, electrical-conductivity, phosphates, total hardness and total alkalinity in T_2 (Table 2). The findings of present work are quite in line with those of Abbas (2001). Chandra *et al*. (2005) observed in their studies that variations in fish growth depended on electrical conductivity, pH, and total alkalinity and phosphorus contents of rearing water. Kang'ombe *et al*. (2006) further verified that poultry manure mainly donates nitrogen and phosphates to pond water which boosts pond productivity (natural food of fish) which in turn enhances the weight increment in fish. Lee (1970) and Garg and Bhatnagar (2000) reported in their investigative work that phosphorus is a key metabolic nutrient in fish ponds which promotes planktonic production. In our studies in both treated groups phosphates, potassium and total hardness were responsible for about 94.70 % of the variations in fish yield in T_2 while 93.1% in T_1(Table 5(i step 2)). Pond productivity followed the similar trend and there was statistically significant positive correlation ("r" = 0.816) (Table 6) between plankton productivity and fish yield in T_1 and (r = 0.933) in T_2 (Table 6). Similarly strong r^2 (Coefficient of determination) was observed between different parameters, fish yield and pond productivity (Table 5, i, ii, iii and Table 6). Accumulation of different parameters ameliorated response (Table 5i step 2) while single parameter significantly reduced r^2 value (Table 5 i step 1). Table 5 (ii and iii) followed the same trend. Linear correlation coefficient (r) also showed positive correlation means heavy dependency of fish yield on planktonic biomass.

Our studies favorably corroborate with the previous findings and further confirm that nitrogen and phosphates are the key contributors in fish production. Therefore, it can be deduced that that nitrates, phosphates and potassium stimulate planktonic biomass which in turn enhances fish yield (Table 4).

Table 1: N.P.K. contents of pond bottom and broiler droppings.

	Nutrient	Bottom soil	Poultry droppings
i	Nitrogen (%)	0.039 ± 0.02	4.60 ± 0.09
ii	Phosphorus (ppm)	2.460 ± 0.45	1.61 ± 0.12
iii	Potassium (ppm)	35.250 ± 6.33	1.32 ± 0.04
iv	pH	7.850 ± 0.09	3.90±0.08

Table 2: Physico-chemical characteristics of tube well water and treated ponds.

Variable	Control	T1 (0.10% N level)	T2 (0.16% N level)
Water temperature ^{0}C	25.52 ± 8.36^a	25.52 ± 8.36^a	25.85 ± 8.91^a
Light penetration (cm)	16.95 ± 4.021^b	14.95 ± 4.921^b	14.15 ± 5.839^b
pH	8.00 ± 0.269^b	8.29 ± 0.369^b	8.19 ± 0.335^b
Electrical conductivity (μ mhos cm^{-1})	1.58 ± 0.098^a	1.88 ± 0.098^b	2.09 ± 0.176^c
Dissolved oxygen (mg/1)	7.05 ± 1.300^b	8.50 ± 1.426^b	7.52 ± 1.352^b
Carbon dioxide (mg/1)	1.23± 0.517^b	0.23± 0.617	0.54± 0.836^c
Total hardness (mg/1)	195.16± 18.264^a	160.16± 21.264^b	144.55± 5.720
Total alkalinity (mg/1)	360±30.122^a	409±39.122^b	144.55± 5.720
Sodium (mg/1)	308.12±30.500^a	326.12±41.500^b	343.32±61.552^b
Potassium (mg/1)	6.061±1.055^a	14.01±1.295^b	15.63±3.266^b
Phosphates (mg/1)	0.001±0.012^a	0.01±0.012^b	0.02±0.020
Nitrates (mg/1)	1.09±1.067^a	5.07±4.058^b	6.10±6.155^b

Values in rows with different superscript letters are significantly different from each other ($p \leq 0.05$).

Table 3: Monthly planktonic biomass conversion ratios of ponds fertilized with broiler droppings at 0.10 and 0.16% level of N.

Month	Planktonic Biomass (g m^{-3})			Increase in fish Yield(g m^{-3})		
	Control	0.10% N level	0.16% N level	Control	0.10% N level	0.16% N level
February	0.5±0.2^a	1.64±0.5^b	1.57±0.6^c	0.0±0 ^{a}	10.15±1.3 ^{b}	10.68±2.3 ^{b}
March	1.2±0.6^a	3.13±1.5^b	6.13±2.1^c	0.0±0 ^{a}	35.19±45.4 ^{b}	33.69±3.5 ^{b}
April	2.2±1.2^a	7.23±3.1^b	23.11±5.2^c	15.2±3.2 ^{a}	106.37±10.2 ^{b}	96.5±8.3 ^{b}
May	3.3±1.3^a	32.65±5.9^b	88.30±12.9^c	20.5±4.3 ^{a}	170.86±11.3 ^{b}	156.36±10.3 ^{b}
June	4.5±2.1^a	79.79±13.7^b	17.64±4.6^c	35.2±503 ^{a}	232.47±30.2 ^{b}	198.1±25.1 ^{b}
July	4.6±1.3^a	171.43±22.8^b	224.32±30.5^c	145.5±15.3 ^{a}	409.23±400.5 ^{b}	394.8±35.2 ^{b}
August	4.8±2.1^a	210.06±22.9^b	249.97±25.0^c	62.45±10.5 ^{a}	376.74±45.2 ^{b}	476.5±45.1^c
September	3.9±1.2^a	221.62±23.0^b	242.21±22.9^b	40.2±5.2 ^{a}	306.15±37.2 ^{b}	329.08±35.2 ^{b}
October	3.5±1.4^a	121.40±17.1^b	184.27±20.9^c	35.5±7.3 ^{a}	147.8±20.5 ^{b}	206.9±15.2 ^{c}
November	2.1±1.0^a	109.59±10.6^b	84.63±10.9^b	40.5±6.0 ^{a}	75.90±8.2 ^{b}	105.26±07.2^c
December	1.2±0.8^a	53.85±9.1^b	64.04±9.9^b	35.3±5.2 ^{a}	44.68±5.3 ^{b}	61.5±7.5^c
January	1.09±0.6^a	76.36±8.5^b	80.97±9.1^b	10.4±3.5 ^{a}	40.32±6.3 ^{b}	38.15±5.3^b
Total	32.8±7.5^a	1098.75±121.9^b	1367.16±130.5^c	440	1955.14	2107.52
Average	2.7	91.56	113.93			

Values in rows with different superscript letters are significantly different from each other ($p \leq 0.05$).

Weight and length: Fish in both treated groups grew significantly ($p<0.05$) higher than control (Table 4). On the other hand both the treated groups (T_1 and T_2) grew equally (Table 4) except the months of August, October, November and December where growth in T_2 was significantly ($p<0.05$) higher than its counterpart (T_1). It makes sense because when each fish was weighed individually *Catla* growth was higher in T_2 during the aforementioned months. Control on the whole grew significantly ($p<0.05$) less than treated groups (Table 4 (i, ii)). When planktonic biomass was compared among all the treatments, it was significantly higher in T_2 and T_1 than control group (Table 3). When both treatments were compared between each other T_2 showed higher planktonic biomass than T_1 which indicates that pond with 0.16% nitrogen intake incorporated more nitrogen than T_1 and control and showed higher planktonic biomass(Table 3). Similarly T_1 (0.10%) incorporated more nitrogen in the form of planktonic biomass than control. It means that provision of more nitrogen provided ample opportunity to phytoplankton to absorb surplus nitrogen and multiply in proportion to

Table 4: Species wise weight and length increments of fish at the end of experimental duration (12 months).

i) Increase in weight (g)

Species	Treatment								
	Control			0.10 % level N			0.16 % level N		
	Initial wt. (g)	Final wt. (g)	Increase	Initial wt. (g)	Final wt. (g)	Increase	Initial wt. (g)	Final wt. (g)	Increase
Catla catla	23.00±4.0[a]	212.5±25.2	189.5 ±20.3[b]	23.61±4.1[a]	781.65±60.9	758.04±70.3[b]	20.18±4.1[a]	818.51±101.9	798.33±80.9[b]
Labeo rohita	20.12±3.7[a]	140.5±15.9	120.38±17.5[b]	19.84±3.8[a]	562.16±55.6	542.32±60.1[b]	20.71±4.3[a]	668.29 ±70.8	647.58±67.8[c]
Cirrhina mirgala	18.90±3.9[a]	164.1±16.5	145.19±20.9[b]	20.12±3.5[a]	676.51±71.3	656.39±65.7[b]	19.17±3.9[a]	679.21 ±75.6	660.04±65.7[c]
Total	62	517gm	455	63.57	2020.16	1956	60	2166	2105.58

Values in rows with same superscript letters are not significantly different from each other ($p \leq 0.05$)

ii) Increase in total length (mm)

Species	Treatment								
	Control			0.10 % level N			0.16 % level N		
	Initial length	Final length	Increase	Initial length	Final length	Increase	Initial length	Final length	Increase
Catla catla	123±18.9[a]	221±35.8	98±10.9[b]	122±15.6[a]	381±60.8	259±40.6[bc]	128.00±25.0[a]	388.89±65.8	260.89±45.1[bc]
Labeo rohita	121±20.7[a]	177±25.6	57±6.7[b]	122±16.7[a]	344±55.9	222±35.8[bc]	123.44±20.4[a]	376.25±70.6	252.81±15.1[bc]
Cirrhina mirgala	122±20.2[a]	188±30.3	66±8.7[b]	120±17.2[a]	374±60.6	254±42.3[bc]	122.20±23.0	376.70±75.3	254.50±13.4[bc]

Values in rows with same superscript letters are not significantly different from each other ($p \leq 0.05$).

Table 5: Step-wise regression of increase in fish yield (g m^{-3}) and dry weight of planktonic biomass (g m^{-3} on selected physico-chemical parameters of pond water fertilized with 0.10 and 0.16% levels of nitrogen.

i) 0.10% level of Nitrogen (T_1)

Step No.	Regression Equation		r^2
1	Increase in fish yield =-0.098 = 1.69 (N)		0.377
	S.E. 0.200		
2	Increase in fish yield =0.39.071 + 1.59 (N) + 4.77 (pH)		0.931
	S.E. 0.163 1.790		

N= Nitrogen , pH = Hydrogen ion concentration, r^2 = Coefficient of determination

ii) 0.16% level of Nitrogen(T_2)

Step No.	Regression Equation		r^2
1	Increase in fish yield =	2.494 + 395.03 (P)	0.845
	S.E.	53.533	
2	Increase in fish yield =	-8.968 + 305.44 (P) + 0.84 (K)	0.902
	S.E.	59.546 0.368	
3	Increase in fish yield =	-85.699 + 401.25 (P) + 0.97 (K) +0.51(T.Hard)	0.947
	S.E.	59.433 .292 0.193	

P = Phosphate, K = Potassium, T. Hard = Total hardness r^2 = Coefficient of determination

iii) Regression of dry weight of planktonic biomass on selected physico-chemical parameters.

Treatment	Regression Equation	r^2
T_1	Plankton biomass= 189.29 + 1.04(T.Alk)-1.14(T.Hard)+7.76(Nitrate)	0.956
	S.E. 0.197 0.276 1.894	
T_2	Planktonic biomass= -1553.36=13.73(K)= 168.77(E.C) + 390.451(P) +6.90 (T.Hard)	0.994
	S.E. 1.627 23.137 320.517 0.97	
	+0.72 (T.Alk.) -28.11pH 0.218 15.087	

Note : T.Alk. = Total Alkalinity, T.Hard = Total Hardness, E.C. Electrical Conductivity, K = Potassium, S.E. Standard error, P = Phosphate , r^2 = Coefficient of determination

Table 6: Regression of increase in fish yield on the dry weight of planktonic biomass under two treatments.

Treatment	Dry weight of planktonic biomass (gm^{-3})	Increase in fish yield($g\ m^{-3}$)	Regression Equation	r	r^2
	Means +SE	Means + SE			
T_1	91.56±22.23	16.85±4.14	Increase in fish yield =2.94 + 0.15 (Planktonic biomass) S.E. 0.034	0.816	0.666
T_2	113.93±26.07	20.05±5.00	Increase in fish yield = 0.35 + 0.179 (plankt. biomass) S.E. 0.022	0.933	0.870

r = Linear correlation coefficient, r^2 = Coefficient of determination

the nitrogen present in water. But fish growth on the other hand did not follow pond productivity pattern. It definitely increased yield better than control but the difference between the two treatments was not significant (Table 3 and 4(i, ii)). It means that pond productivity increases with increasing nitrogen but not the fish yield and phytoplankton level present in T_1 can suffice the requirements of fish for normal growth.

Studies of Bhakta *et al*, (2004) verifies our findings who observed growth increments up to 844 g $tank^{-1}$ $week^{-1}$ on combined manure applications, above this level, water deteriorated and growth declined even fish started to die. Jha *et al.* (2004) in his studies had similar observations. His findings showed growth increments up to 0.26 kg poultry manure m^{-3} and declined when supplementation rate was increased beyond this level. Results of Knud-Hansen *et al*.(2008) were, however, not encouraging, they found very minor contribution from poultry manure(10%) when combined with inorganmic fertilizers which may depend on the level of existing nutrients. Previously Javed (1988) though had similar observations but he got continuous growth increments with the manipulations of individual nutrient. There may be differences in level of existing nutrients and frequency of application.

Poultry manure has been considered as a complete fertilizer (Njoku and Ejiogu, 1999 ; Njoku, 2008) having characteristics of both organic and inorganic fertilizers and a yield up to 2717.22 kg of fish $acre^{-1}$ has been reported when applied in fish ponds. Much better production of 2166 and 2105.58 kg ha^{-1} has been realized during the present study in T_1 and T_2, respectively (Table 4 (i)) which further verifies the potential of this manure as fish growth enhancer.

The overall nitrogen incorporation efficiency (NIE) of fish under T_1 (91.56 g m^{-3}) differed significantly from that of T_2 (113.93 g m^{-3}) (Table 3). Increase in pond productivity proportionately induced increase in fish yield means NIE was higher in these months. It means that July to October are the best months for manure applications, pond productivity and fish yield. It can be further said and deduced that 0.10 percent level of nitrogen application is better for maximum nitrogen incorporation than 0.16%. Further increase in poultry manure will increase production cost, will pollute water and stress the fish inhibiting its growth.

The present study has, therefore, indicated that broiler droppings can serve as a source of food to stimulate planktonic productivity in fish ponds safely up to 0.10% level of nitrogen.

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