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Effects of Cowdung and Poultry Manure on Growth Performance of Indian Major Carps (*Catla catla, Labeo rohita*) and Exotic Carp (*Cyprinus carpio*) in Thatta District (Sindh), Pakistan

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Abstract. In the manuring trials conducted in earthen ponds of 120 m^2 for one year, the juveniles of Indian major carps (*Catla catla* and *Labeo rohita*) and exotic carp (*Cyprinus carpio*) responded positively during warmer months i.e. March to August. The mean weight increase and mean specific growth rate (SGR) were better in the ponds fertilised with cowdung. Total growth rate per day calculated for *Catla catla* was 32.96 g, for *Labeo rohita* 95.02 g and for *Cyprinus carpio* 14.37 g under the influence of cowdung. Moreover individual growth rates/day were also high i.e. 2.06, 2.50 and 1.43 g, respectively. Percent contribution in fish production was 23.15%., 66.74% and 10.09%, respectively. Total growth rate of the three was significantly higher in cowdung (142.36 g) as compared to that in poultry manure i.e. 106.64 g. Both the fertilisers significantly differed in terms of monthly and treatment variations ($P<0.05$) except for treatment variation for *Cyprinus carpio*. Water temperature, light penetration, electrical conductivity, total dissolved solids, total suspended solids and nitrates were highly significant ($P<0.05$) both for treatment and monthly variation except pH and dissolved oxygen.

Keywords: poly-culture, carp farming, organic manure, *Catla catla*, *Labeo rohita*, *Cyprinus carpio*

Introduction

Use of animal wastes like poultry manure and cowdung has been practiced for long for generation of algal blooms which play a vital role in developing ecofriendly, economical and socially viable cultural system. According to Dhawan and Kaur (2002), cowdung and poultry manure proved to be the best organic fertilisers when used adequately.

Conversely, indiscriminate use of these fertilisers in fish ponds, instead of improving the primary productivity, may also lead to pollution. Therefore, developing standards for doses is necessary which would control the ecological parameters of pond water for favourable growth of fish like major and common carps (BARC, 1997). The cowdung and poultry manure, when recycled, produce soluble phosphorous, nitrogen and carbon for algal growth and natural food production (Knud-Hansen *et al*., 1991).

Work has been on record on the utilization of cowdung and poultry manure for growth of conventional Indian major carps. The present study was conducted to work out the effects of these manures on (i) growth performance, (ii) production of planktonic biomass and (iii) physicochemical parameters of fish pond of carps (Indian major and exotic carps) in poly-culture system.

Conventionally, three species of Indian major carps namely *Catla catla* (suface feeder), *Labeo rohita* (column feeder) and *Cirrhina mrigala* (bottom feeder) were stocked in a fish pond (Javed *et al.*, 1992). Presently instead of *C. mrigala*, *Cyprinus carpio* has been stocked as bottom feeder considering the findings of Milstein *et al*. (2002).

Materials and Methods

Experiments were conducted in three replications for both manuring trials in earthen ponds (size ~120 m^2, water depth 1.5 m) in Thatta district (Sindh), Pakistan. The experimental neonates of Indian major carp and exotic carp were obtained by means of induced breeding technique. The ponds were stocked with stocking density of 16:38:10 (*Catla catla: Labeo rohita: Cyprinus carpio*) according to Sheri *et al*. (1986).

Pond preparation. The existing fish ponds were emptied and sun dried. To avoid any infection, liming was done after fifteen days interval. The inlets and

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outlets of all ponds were sealed with fine mesh gauze for blocking the intrusion of any predator into the pond or the exit of experimental fish from the pond.

Manuring of fish ponds. Nitrogen content of the test manures was estimated by means of Kjeldahl method following the analytical procedure of AOAC (1990). The amount of manure used in the ponds was calculated on the basis of nitrogen availability. Poultry manure at the rate of 0.17 g N/100 g and cowdung at the rate of 0.2 g N/100 g of stocked fish were introduced daily.

Parameters studied. During the study, following parameters were recorded:

1. Monthly increase in weight = Final mean weight (g) - Initial mean weight (g)
2. Specific growth rate
$$(\%/\text{day}) = \frac{\text{Log Wt}_t\text{-Log Wt}_i}{\text{Time}} \times 100$$
3. Individual performance of experimental Indian major carps and common carp.
4. Physical parameters of pond water included temperature, light penetration, pH, electrical conductivity, total dissolved solids (TDS) and total suspended solids (TSS).
5. Chemical parameters included nitrate nitrogen, dissolved oxygen and total hardness of water. Prior to chemical analysis, water samples were collected and brought in the laboratory. For dissolved oxygen, water samples were fixed immediately after sampling as described by Welch (1952). Nitrate nitrogen and total hardness were determined by Merck chemical test kits for testing water and wastewaters.

Statistical analysis. The obtained data were subjected to statistical analysis using MINITAB Release 14. Mean values for various parameters and significance levels were determined using two way analysis of variance (ANOVA).

Results and Discussion

Growth of fish. When fertilised with poultry manure, *Catla catla* mean weight (g) was observed to lower considerably during the four months of November to February (16.44, 13.12, 12.64 and 14.78 g) because of lowering of water temperature (Table 1). It started to improve after winter; from March to August, mean weight increased upto 112.9 g. While in cowdung treated ponds the mean weight of *C. catla* started to increase right from the beginning (16.47 g in September) and continued upto 92.93 g in July but lowered slightly in the last month of experiment (August, 86.80 g) (Table 1). Better specific growth rate (SGR) was noted during the whole experimental periods.

Table 1. Growth performance of *Catla catla* under the influence of poultry manure and cowdung

Months	Poultry manure			Cowdung		
	Mean weight	Mean wt. increase	Mean SGR	Mean weight	Mean wt. increase	Mean SGR
September	78.15	58.92	0.813	68.53	16.47	0.306
October	137.32	59.0	0.323	85.00	22.57	0.336
November	172.27	16.44	0.126	107.57	30.97	0.360
December	188.7	13.12	0.093	138.5	48.0	0.416
January	201.83	12.64	0.083	186.5	68.1	0.400
February	214.47	14.78	0.093	247.6	67.43	0.343
March	229.3	39.63	0.226	315.0	82.33	0.340
April	269.2	49.68	0.240	397.3	84.93	0.276
May	318.8	55.5	0.223	482.3	87.83	0.240
June	374.3	67.5	0.223	570.1	88.90	0.210
July	441.9	84.7	0.236	659.0	92.93	0.186
August	526.5	112.9	0.336	751.9	86.80	0.153

Table 2 exhibits growth performance of *Labeo rohita* in ponds receiving poultry manure and cowdung. *L. rohita* responded similar to *C. catla* in poultry manured ponds i.e. the attainment of weight was observed during warmer months up to 130.79 g in August. In cowdung treated ponds, the weight gain increased in the beginning and continuously showed addition upto August (95.13 g). With respect to

Table 2. Growth performance of *Labeo rohita* under enrichment of the poultry manure and cowdung

Months	Poultry manure			Cowdung		
	Mean weight	Mean wt. increase	Mean SGR	Mean weight	Mean wt. increase	Mean SGR
September	58.77	47.49	0.847	88.27	19.66	0.283
October	106.25	41.07	0.463	107.93	32.06	0.373
November	147.3	39.47	0.333	140.00	42.03	0.376
December	186.8	14.24	0.100	181.97	70.90	0.470
January	201.0	10.36	0.066	252.87	90.10	0.436
February	211.4	23.31	0.150	342.97	93.96	0.346
March	234.7	39.29	0.220	437.00	93.06	0.276
April	274.0	58.14	0.283	530.07	94.33	0.233
May	332.1	76.3	0.296	624.40	95.93	0.203
June	408.5	114.4	0.343	720.33	97.00	0.176
July	522.9	130.4	0.313	817.33	95.40	0.153
August	653.2	130.7	0.253	912.73	95.13	0.136

growth per day it was noticed that SGR was healthy (0.305%/day) with poultry manure treatment as compared to 0.288%/day in the case of cowdung.

Approximately same size of juvenile *Cyprinus carpio* were stocked in poultry manure and cowdung treated ponds. The minimum weight increase was recorded during December to March (12.129 g in January), the winter months, while weight increased by 100.8 g (maximum) in July when ponds were enriched with poultry manure. *C. carpio* did not show good response earlier in cowdung enriched ponds as generally they prefer food items in bottom soil; the organic materials sometimes took about two months to settle in the bottom soil or pond embarkment. Later on, their weight increased gradually in the range of 33.70 g in January upto 57.10 g in August. SGR followed, the trend of *L. rohita*, being 0.243%/day with poultry manure treatment and 0.203%/day with cowdung treatment (Table 3).

Table 3. Growth performance of *Cyprinus carpio* under enrichment of the poultry manure and cowdung

Months	Poultry manure			Cowdung		
	Mean weight	Mean wt. increase	Mean SGR	Mean weight	Mean wt. increase	Mean SGR
September	84.25	35.05	0.496	88.20	23.00	0.326
October	119.3	41.08	0.433	111.20	25.93	0.296
November	161.53	35.52	0.296	137.20	39.07	0.290
December	198.80	22.6	0.076	168.00	34.87	0.290
January	209.75	12.12	0.076	206.20	33.70	0.216
February	221.84	13.54	0.086	239.90	44.20	0.236
March	236.8	22.13	0.166	284.1	42.77	0.196
April	267.5	37.67	0.213	326.9	45.40	0.180
May	311.9	58.19	0.283	372.3	47.50	0.170
June	381.0	77.80	0.306	419.8	50.57	0.156
July	472.4	100.8	0.246	470.3	54.53	0.153
August	567.9	62.3	0.243	524.8	57.10	0.146

Individual performance. In cowdung treated ponds, the growth rate per day of *C. catla* was 32.96 g, of *L. rohita*, 95.02 g and that of *C. carpio*, 14.37 g. Individual growth rate per day was 2.06, 2.50 and 1.43 g, respectively. Percent contribution of these experimental fishes was recorded as 23.15%, 66.74% and 10.09%. Total growth rate at the harvest of all the three species was 142.36 g per day (Table 4).

The growth rates per day of *C. catla* 23.07 g, *L. rohita* 68.00 g and *C. carpio* 15.55 g were recorded in poultry manure treated ponds. The individual growth rate per day of *C. catla* was 1.44 g, of *L. rohita* 1.78 g and that of *C. carpio* 1.55 g. Total growth rate at the time of harvest was recorded to be 106.64 g/day. Percent contribution of all fishes was recorded as 21.64%, 63.76% and 14.58% (Table 4). Statistically it was also noticed that *C. catla* mean weight significantly differed (P<0.05) both in case of the treatment and the monthly variations (Table 5).

Table 4. Individual performance and percent contribution of experimental fishes under enrichment of the poultry manure and cowdung

Fishes	Growth rate/day	Individual growth rate/day	Contribution (%)
Catla catla	23.07	1.44	21.64
Labeo rohita	68.00	1.78	63.76
Cyprinus carpio	15.55	1.55	14.58
Total growth rate of three species in poultry manure 106.64 g/day			
Catla catla	32.96	2.06	23.15
Labeo rohita	95.02	2.50	66.74
Cyprinus carpio	14.37	1.43	10.09
Total growth rate of three species in cowdung 142.36 g/day			

Table 5. Analysis of variance (GLM) of experimental fishes for monthly and treatment variations

Fishes	Months		Treatments	
	F-value	P-value	F-value	P-value
Catla catla	27.34	0.000*	12.82	0.000*
Labeo rohita	12.33	0.000*	16.09	0.002**
Cyprinus carpio	66.04	0.000*	0.90	0.362*

* = non-significant; ** = significant.

Physicochemical parameters of water. Poultry manure and cowdung were introduced to supply adequate levels of nutrients necessary for production of primary products and ultimately for the fish. During this process, the physicochemical parameters of water considerably fluctuated affecting the growth rate of experimental fish. Tables 6 and 7 show mean annual values along with their values for analysis of variance (F-values and P-values) for both the treatments and the monthly variations. Significant differences (P<0.05) were observed in light penetration, electrical conductivity, nitrates, total dissolved solids and total suspended solids of both the treatment and the monthly variations. However, non-significand difference was noticed only in temperature in case of treatment variation while the monthly variation remained significantly different.

Table 6. Physicochemical parameters of water enriched with poultry manure and cowdung

Variables	Poultry manure			Cowdung		
	Mean±SE	Min	Max	Mean±SE	Min	Max
Temperature (°C)	21.65 ± 2.16	11.98	31.15	22.18 ± 2.07	12.52	30.85
Light penetration (cm)	12.55 ± 1.34	7.93	23.59	18.492 ± 0.856	14.800	22.700
pH	8.017 ± 0.101	7.40	8.70	8.5325 ± 0.0580	8.250	8.950
Electrical conductivity (m.mhos.cm)	1.904 ±0.0423	1.700	2.09	1.780 ± 0.0193	1.660	1.870
Total dissolved solids (mg/L)	266.47 ± 6.59	222.33	308.66	244.8 ± 22.3	150.0	370.0
Total solids (mg/L)	1689 ± 102	1186	2238	1946 ± 130	450	1203
Dissolved oxygen (mg/L)	5.741 ± 0.584	2.90	9.93	13.225 ± 0.219	11.80	14.30
Nitrates (mg/L)	2.785 ± 0.379	0.220	5.220	5.252 ± 0.0665	4.880	5.650
Total hardness (mg/L)	266.47 ± 6.59	222.33	308.66	244.8 ± 22.3	150.0	370.0

pH, dissolved oxygen and total hardness also differed non-significantly only for monthly variation and was highly significant for poultry manure and cowdung (Table 7).

Indian major carps, including *Catla catla* (surface feeder) and *Labeo rohita* (column feeder) along with *Cyprinus carpio* (bottom feeder) were stocked to evaluate the response of pond enrichment. These fishes are excellent respondent to different pond niches. The present study revealed that these fishes fully utilized the available food, generated by pond enrichment. During the study, the stocking of *C.carpio* with *C. catla* and *L. rohita* produced positive environmental results because the *C.carpio* damaged the embarkment without creating any harmful effect on the rest of two fishes. Besides this, the nutrients released by the soil were evenly dispersed in the experimental ponds to promote the planktonic biomass. The present results regarding the stocking of major carps and common carp also conform to those of Wahab *et al*. (2002) who found that the feeding habit of common carp was certainly helpful for nutrient mixing from soil compared to conventional bottom feeder fish. There were no effects on the performance of *C. catla* and *L. rohita*. Considering present results of manuring trials, the best growth (142.36 g/day) was observed with the use of cowdung (Table 5) followed by the poultry manure (106.64 g/day) which concluded that cowdung has an edge over poultry manure (organic fertiliser). Rappaport and Sarig (1978) claimed that the cowdung feed for fish culture produced highly positive results as compared to that of the poultry droppings, which confirm present findings. Machaodo and Costagnolli (1979) also favoured the use of cowdung to rear carp fingerlings instead of inorganic fertilisers. However, Banergee *et al*. (1979) reported that poultry manure can maximize fish production as it can provide nitrogen adequately for development of phytoplankton and zooplankton which serve as food items for fish. Kang'ombe *et al*. (2006) suggested that chicken manure treatment produced large amount of chlorophyll along with large number of zooplanktons indicating high levels of primary producers than cattle and pig manure.

Table 7. Analysis of variance for various physicochemical parameters of water enriched with different fertilizers

Variables	Treatment		Months	
	F-values	P-values	F-values	P-values
Temperature (°C)	2.72	0.060	211.89	0.000**
Light penetration (cm)	36.46	0.000	4.36	0.000**
pH	10.97	0.000	1.33	0.254*
Electrical conductivity (m.mhos.cm)	70.11	0.000	18.14	0.000**
Total dissolved solids (mg/L)	38.82	0.000	2.41	0.025**
Total solids (mg/L)	31.43	0.000	2.95	0.008**
Dissolved oxygen (mg/L)	89.87	0.000	1.48	0.188*
Nitrates (mg/L)	49.26	0.000	2.34	0.029**
Total hardness (mg/L)	8.34	0.000	1.90	0.075*

** = significant; * = non significant.

As mentioned in Tables 1-3, growth rates of all the experimental fishes were slow due to low feeding rate up to the month of February. The available primary producers gradually flourished with the increase in the temperature and thus in the decomposition rate of poultry manure and cowdung.

Goolish and Adelman (1984) found that a unit change in temperature directly affects the growth of fish as the two are proportional to one another. Javed (1988) reported that the stocked fish (major carps) responded significantly when the temperature was between 30.00 to 33.73 °C. Conversely to this, during the present study, major carps showed the best growth within the temperature range of 22.89 °C to 31.15, 26.42 to 30.85 °C, 23.40 to 30.80 °C and 27.77 to 30.68 °C when the pond received poultry manure or the cowdung. The findings of Barthelmes and Bramick (2003) seemed to deviate. They reported silver carp grew better in the temperature range of 18.00 °C to 22.00 °C.

Individual performance of weight gain of *L. rohita* remained better with cowdung (250 g/day) followed by poultry manure (1.78 g/day). The maximum weight gained by *L. rohita* may be due to its efficiency in conversion of available food (phytoplankton) to flesh (Jhingran and Pullin, 1985). *C. catla* attained maximum weight gain (2.06 g/day) under the enrichment of cowdung followed by poultry manure (1.44 g/day). The *C. carpio*, as bottom feeder fish, gained 1.55 g/day of weight in pond receiving poultry manure while in cowdung treated pond, 1.43 g/day weight gain was observed (Table 5). The above-mentioned results are very much similar to the findings of some other workers including Javed and Sial (1991) who reported that Indian major carp yield of 3360.40 and 3215.60 kg/ha/year can be obtained through the use of broiler and layer droppings, respectively, when applied at the rate of 0.10 g N/100 g of body weight on daily basis. Natarjan and Varghese (1980) concluded that poultry manure was better fertilizer for maximizing the pond productivity (2728.0 kg/ha/year) than digested sewage sludge (2156.00 kg/ha/year) and cowdung (1811.00 kg/ha/year). Garg and Bhatnagar (1999) optimized the rate of cowdung for increasing the pond productivity and fish biomass; 4.45 kg fish biomass and 2.36% (SGR) weight per day were observed when the 15000 kg/ha/year cowdung was applied.

The present findings regarding the effect of temperature on fish yield are in line with the results of Beitinger and Fitzpatrick (1979) who suggested total optimum growth of fish may coincide with the temperature because the latter maximizes the metabolic efficiency of fishes. Jinghran (1982) stated that major carps thrived well in temperature range of 18.3-37.8 °C, while the grass carp, silver carp and common carp preferred temperatures below 30 °C. Annual variations in temperature have a great impact on primary productivity and also speed up the chemical change in water and soil. Singh (1964) reported that temperature and light penetration were the two important factors responsible for regulating the maximum and minimum production of phytoplankton. However, the report of Parveen (1986) contradicts the present findings as the correlation coefficient between the dry weight of planktonic biomass and physical factors like temperature, light penetration, electrical conductivity etc. was non-siginificant. Brezonic *et al.* (1984) suggested that high pH values prompted the growth of phytoplankton and resulted in blooms, while on the contrary, Nazneen (1980) argued that high values of pH during phytoplankton blooming period were the result of and not the cause of phytoplanktonic blooms. According to Hawkins and Griffith (1986), the pattern of light varies at different times of the year which exclusively depends on the stratification conditions and dominance of phytoplankton species.

Dissolved oxygen contents, when both the fertilizers were used, showed irregularity in variation related to temperature and abundance of phytoplanktons. The results of present experiments were similar to the ones reported by Chiba (1971). Sharma *et al.* (1979) reported that the concentration of dissolved oxygen depended on both the physical and the biological factors. Depletion of dissolved oxygen was due to respiration of bacteria and phytoplankton and it was compensated by zooplankton and algae during daytime through photosynthesis.

The availability of nitrogen in the form of nitrate was highly noticed during the present study. Nitrates in both the fertilisers significantly differed in months and treatments. It is an important factor in the planktonic biomass production and is accordingly related to the findings of Mahboob and Sheri (1993), who mentioned significant contribution of nitrates towards the growth of fish.

Total hardness was also highly significant during the whole experimental period but non-significant for both the types of applied fertilizers. These results are in line with the reports of Vasisht and Jindal (1980) that phytoplankton showed a direct relationship with the light penetration, pH, dissolved oxygen and hardness of water. Parveen (1986) reported that correlation coefficient for nitrates, total hardness and dry weight of planktonic biomass was non-significant.

The present study concluded that for ecological and economical sustainability, optimum dose of fertilisers for fish were evidently necessary for maximum net revenue.

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